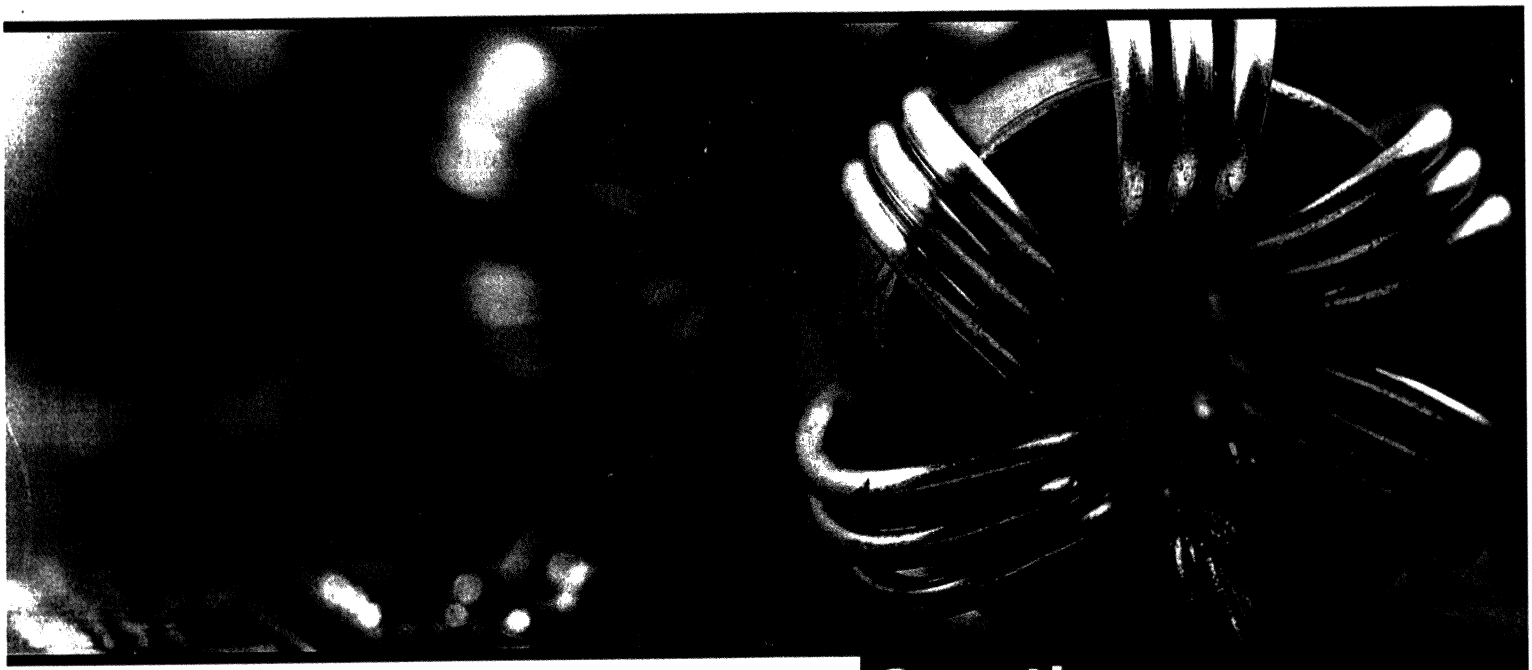
EL-MOASSER

PHYSICS

By A Group Of Supervisors



Questions

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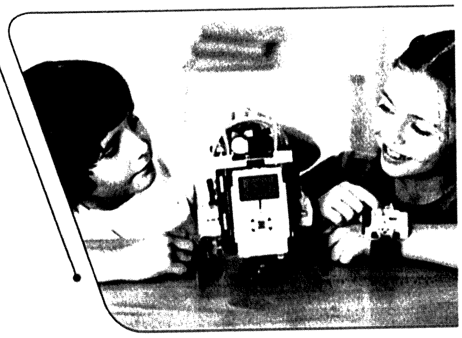
Contents

UNIT 1 Dynamic Electricity and Electromagnetism

UNIT 2

Introduction to Modern Physics



Chapter Five : Wave Particle Duality.

Lesson 1 : • The Blackbody Radiation.
• Thermal Emission and the Photoelectric Effect.

Lesson 2 : • Compton Effect.
• Wave Particle Duality.
• Electron Microscope.

Chapter Six : Atomic Spectra.

Chapter Seven : Laser.

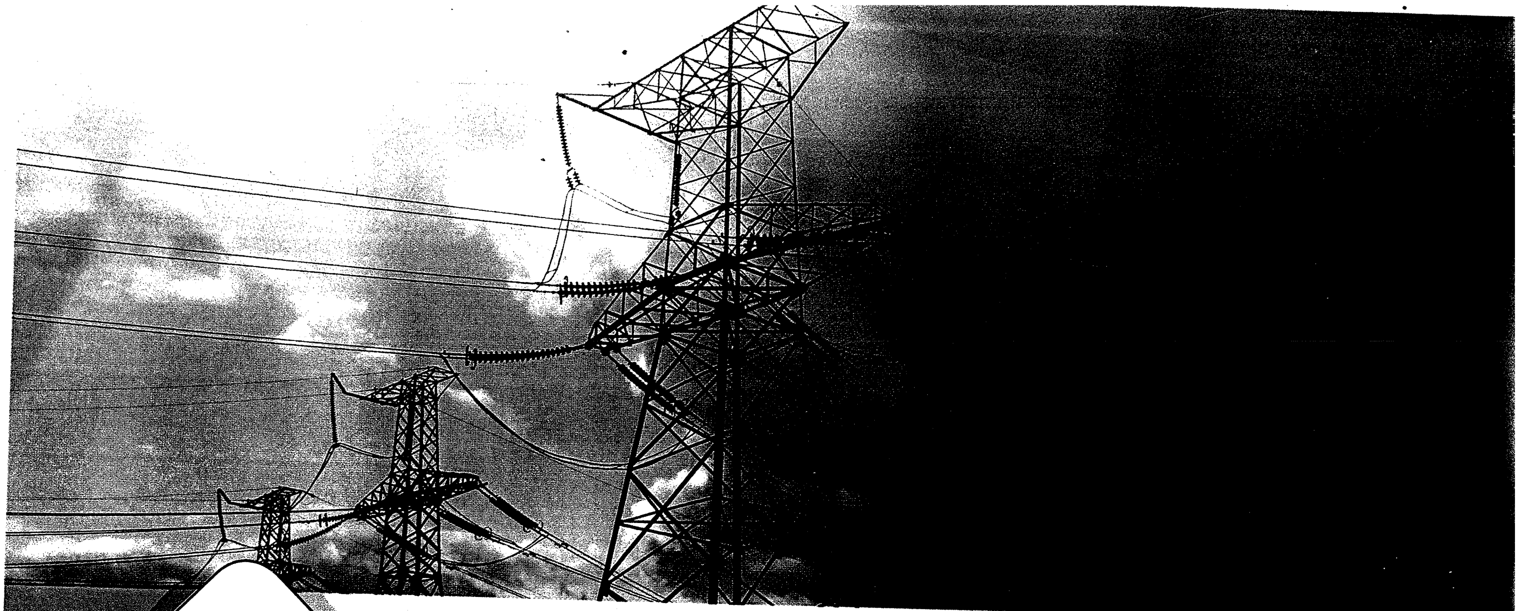
Chapter Eight : Modern Electronics.

Lesson 1 : • The Semiconductor Crystal.
• pn Junction.

Lesson 2 : • The Transistor.
• The Digital and Analog Electronics.

Important

- **Questions and problems of the school book are signed with .**
- **Questions and problems of the student evaluation guide are signed with .**
- **Questions and problems signed with measure the high levels of thinking (for excellent student).**



UNIT 1

Dynamic Electricity and Electromagnetism

Chapter 1 Electrical Current and Ohm's Law.

Lesson 1 : Electrical Current and Ohm's Law.
Lesson 2 : Resistors Connection.
Lesson 3 : Ohm's Law for the Closed Circuit.
Lesson 4 : Kirchhoff's Laws.

Chapter 2 Magnetic Effects of Electric Current and Measuring Instruments.

Lesson 1 : Magnetic Effect of the Electric Current.
Lesson 2 : Following of the Magnetic Effect of the Electric Current.
Lesson 3 : The Magnetic Force and the Torque.
Lesson 4 : The Measuring Instruments.

Chapter 3 Electromagnetic Induction.

Lesson 1 :
- Faraday's Law.
- The Induced Electromagnetic Force Produced in a Straight Wire.

Lesson 2 :
- Mutual Induction between Two Coils.
- Self Induction of the Coil.

Lesson 3 : Electric Generator (Dynamo).

Lesson 4 :
- The Electric Transformer.
- The Electric Motor.

Chapter 4 Alternating Current Circuits.

Lesson 1 : Alternating Current Circuits.
Lesson 2 : Following AC Circuits.
Lesson 3 :
- The Oscillating Circuit.
- The Resonant Circuit.

Chapter 1

Electrical Current and Ohm's Law

⊙ **Questions on :**

Lesson 1 Electrical Current and Ohm's Law.

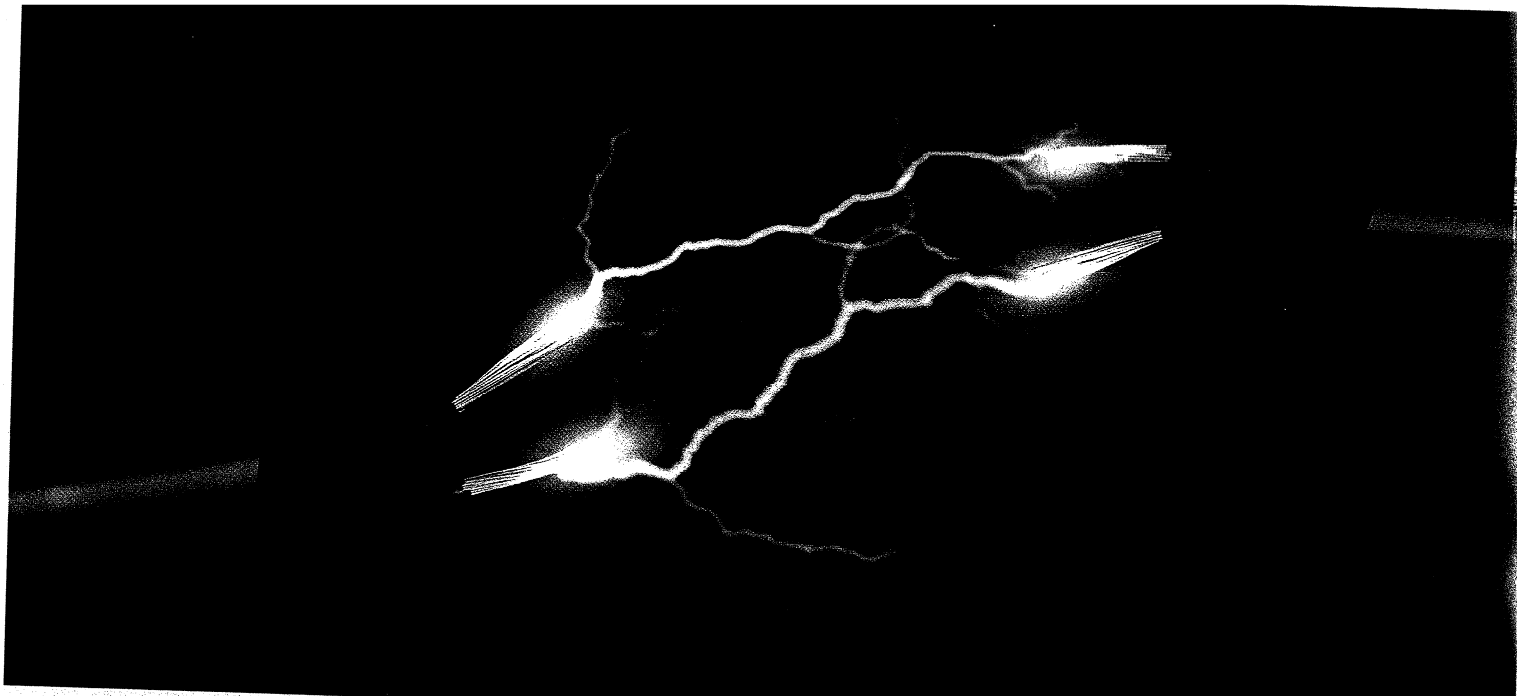
Lesson 2 Resistors Connection.

Lesson 3 Ohm's Law for the Closed Circuit.

Lesson 4 Kirchhoff's Laws.

⊙ **Selected Questions on Chapter 1 from :**

- Student Evaluation Guide (2017).
- Booklet Models of the Ministry of Education.



QUESTIONS ON **Chapter 1** LESSON 1

Electrical Current and Ohm's Law

1 Write down the scientific term for each statement of the following :

1. A flow of electric charges through conducting material. *(1st session 14)*
2. The quantity of electricity passing through cross-section of a conductor in one second. *(Exp. 14)*
3. The electric current intensity due to the flow of a quantity of electricity of 1 Coulomb through the cross-section of a conductor in one second. *(2nd session 17)*
4. The quantity of electric charge that when passes through a cross-section of a conductor in one second it produces electric current of 1 Ampere.
5. The work done to transfer a quantity of charge of 1 Coulomb from point to another.
6. The potential difference between two ends of a conductor when a work of 1 Joule is done to transfer unit charge between them.
7. • The opposition to the flow of the electric current when it passes in a conductor.
   • It is the ratio between the potential difference between the two ends of the conductor and the electric current intensity passing through it. *(Azhar 01)*
8. The electric current intensity passing in a conductor at a certain temperature is directly proportional to the potential difference between its terminals.
9. The resistance of a conductor that permits the flow of a current intensity of 1 A when the potential difference between its ends is 1 V.
10. • The resistance of a conductor of length 1 m and its cross-section area 1 m^2. *(2nd session 11 , 17)*
    • The reciprocal of the electric conductivity of the conductor material.
    • The resistance between opposite faces of a unit cube of the material.
11. • The reciprocal of the resistivity of the conductor material.
    • The reciprocal of the resistance of a conductor of length 1 m and cross-section area 1 m^2 at a specific temprature. *(Sudan 17)*

2 Choose the correct answer of the given answers :

1. The equivalent unit to Coulomb/s is .... *(2nd session 02)*

   a. Volt. b. Ampere. c. Ohm. d. Farad.

2. If the length of a copper wire is doubled and its cross-section area is decreased to its half, then its resistance .... *(2nd session 12)*

   a. doubles. b. decreases to its half.
   c. increases four times. d. decreases to its quarter.

3. A conductor of regular cross-section, its length 20 m and its resistance 108 Ω and another conductor of the same material its length 5 m and its cross-section area is three times that of the first conductor, then the resistance of the second conductor equals .... *(1st session 10)*

   a. 84 Ω. b. 27 Ω. c. 9 Ω. d. 18 Ω.

4. If a wire is stretched till its length is increased by 50% from its original length, its resistance will increase by ....

   a. $\frac{3}{2}$ b. $\frac{2}{3}$ c. $\frac{5}{4}$ d. $\frac{4}{9}$

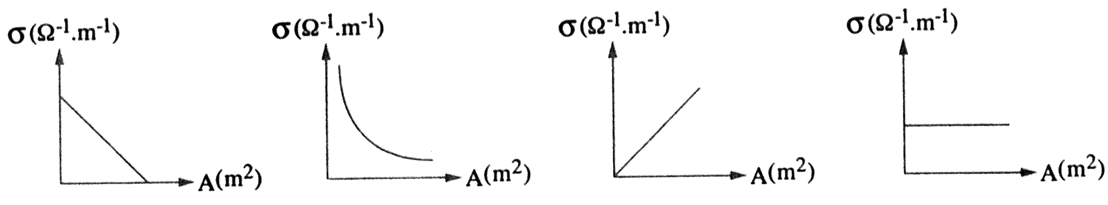
5. The product of the resistivity and conductivity for the same material .... one.

   a. is greater than b. is less than c. equals d. remains constant

6. When the length of a wire decreases to half and its radius increases to double, the conductivity of its material .... *(2nd session 15)*

   a. increases to double. b. decreases to half.
   c. remains unchanged. d. becomes the same as the resistivity.

7. Which of the following figures represent the relation between the conductivity of the material of a conductor and its cross-section area ? ....



(a) (b) (c) (d)

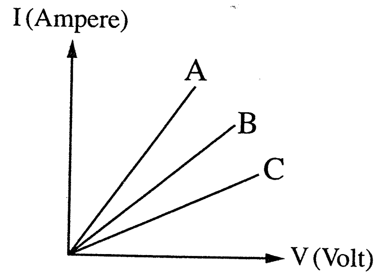
8. A conductor of radius (r), length (ℓ) and resistivity (ρ) has resistance (R). If it is stretched till its radius is decreased to its half original value. What is the new resistance ? ....

   a. 2 R. b. 4 R. c. 8 R. d. 16 R.

9. Two conductors made of the same material are connected across the same potential difference. Conductor A has twice the diameter and twice the length of conductor B. What is the ratio of the power delivered to A to the power delivered to B ? ....

   a. 0.5 b. 2 c. 4 d. 8

10. A , B and C are three copper wires have the same length but different in diameters (D_A , D_B and D_C respectively) at certain temperature with resistances R_A , R_B and R_C respectively. The opposite graph shows the relation between the current passing through each wire and the potential difference across its terminals. Which of the following is true ? ....



a. $D_A < D_B < D_C$ b. $D_A > D_B > D_C$ c. $R_B > R_A > R_C$ d. $R_C > R_A > R_B$

11. If a wire is stretched so that its length increased to the double of its original length, then its resistance increases to .... of its original value. *(Azhar 05)*
a. double b. half c. 4 times d. remains constant

12. Two wires are of the same length and resistance but one of them is copper and the other is iron, so the ratio $r_I : r_c$ equals ....
a. $(\rho_e)_I : (\rho_e)_c$ b. $(\rho_e)_I : \sqrt{(\rho_e)_c}$ c. $\sqrt{(\rho_e)_I} : (\rho_e)_c$ d. $\sqrt{(\rho_e)_I} : \sqrt{(\rho_e)_c}$

3 What is meant by ...?

1. The electric current passing in a conductor = 0.3 A
2. The potential difference between the terminals of a conductor = 5 V
3. The electric resistance of a conductor = 200 Ω
4. The consumed work to transfer amount of charge of 8 C between two points in an electric circuit = 64 J *(1st session 02 - 2nd session 07 - Azhar 11)*
5. The current intensity passing in a conductor of resistance 3 Ω equals 4 A.
6. The resistivity of copper = 1.8×10^{-8} Ω.m *(1st session 07 - Sudan 15)*
7. The electric conductivity of a conductor material = 1.5×10^{8} $\Omega^{-1}.m^{-1}$ *(Aug. 97- 2nd session 11)*
8. Reciprocal of the resistivity of a conductor material = 3×10^{7} $\Omega^{-1}.m^{-1}$

4 Give reasons for :

1. Work must be done to transfer the electric charges from point to another.
2. Some materials conduct the electric current while others are electrically insulators.
3. Doubling the radius of a copper wire decreases its resistance to the quarter.
4. The resistance of a conductor increases as its temperature increases.
5. • The resistivity differs from material to another.
   • The resistivity of a conductor material is a physical characteristic of this material.
6. The conductivity of a conductor material is a physical characteristic of this material. *(2nd session 03)*
7. The electrical conductivity coefficient of copper is high. *(1st session 06)*
8. It's preferable to use copper wires in the electric connections.

5 Define the following :

1. Electric current.
2. The conventional direction of electric current.
3. The actual direction of electric current.
4. The electric current intensity.
5. The Ampere. *(Azhar 98)*
6. The Coulomb.
7. Potential difference between two points. *(2nd session 10)*
8. The Volt.
9. Resistance of a conductor.
10. The Ohm. *(2nd session 02)*
11. Electric resistivity of the material of a conductor. *(Sudan , Exp. 14)*
12. Electric conductivity of the material of a conductor. *(2nd session 12 - 1st session 14)*
13. Ohm's law.

6 What are the factors affecting each of the following :

1. Resistivity of a conductor. *(2nd session 14)*
2. Conductivity of the material of a conductor. *(Sudan 14)*

7 What are the results for each of the following, then explain your answer :

1. Increasing the quantity of electricity passing through the cross-section of a conductor in one second concerning the current intensity passing through it.
2. Increasing the current intensity passing in a conductor concerning the potential difference between its terminals.
3. Doubling the current intensity passing in a conductor concerning the value of its resistance. *(Sudan 15)*
4. Doubling the conductor length with decreasing its diameter to its half concerning the value of its resistance. *(2nd session 14)*
5. The rise in temperature of a conductor concerning its resistance.

8 Compare between each of the following :

1. Ammeter and voltmeter (in terms of : its use – connection method in the electric circuit).
2. Resistance and resistivity (in terms of : measuring units). *(1st session - Sudan 12)*
3. Resistivity and conductivity (in terms of : definition – the used law – measuring unit). *(Exp. 14)*

9 Miscellaneous questions :

1. **Mention one factor that can increase :**
   (a) The resistance of a copper wire at a specific temperature.
   (b) The potential difference between the terminals of a battery in a closed circuit. *(1st session 17)*
2. **Mention the mathematical relations used to determine each of the following, writing the used measuring unit :**
   (a) Electric resistivity of the material.
   (b) Electric conductivity of the material. *(2nd session 06)*
   (c) Electric resistance.

3. **Mention the physical quantities measured using the following units and deduce the equivalent units :**

(a) Coulomb

(b) Coulomb/second *(2nd session 03- Sudan 11)*

(c) Ampere.second *(Exp. 15)*

(d) Joule.Coulomb^{-1} *(Azhar 05)*

(e) Volt. Ampere^{-1}

(f) Ohm.meter

(g) Ohm^{-1}.meter^{-1}

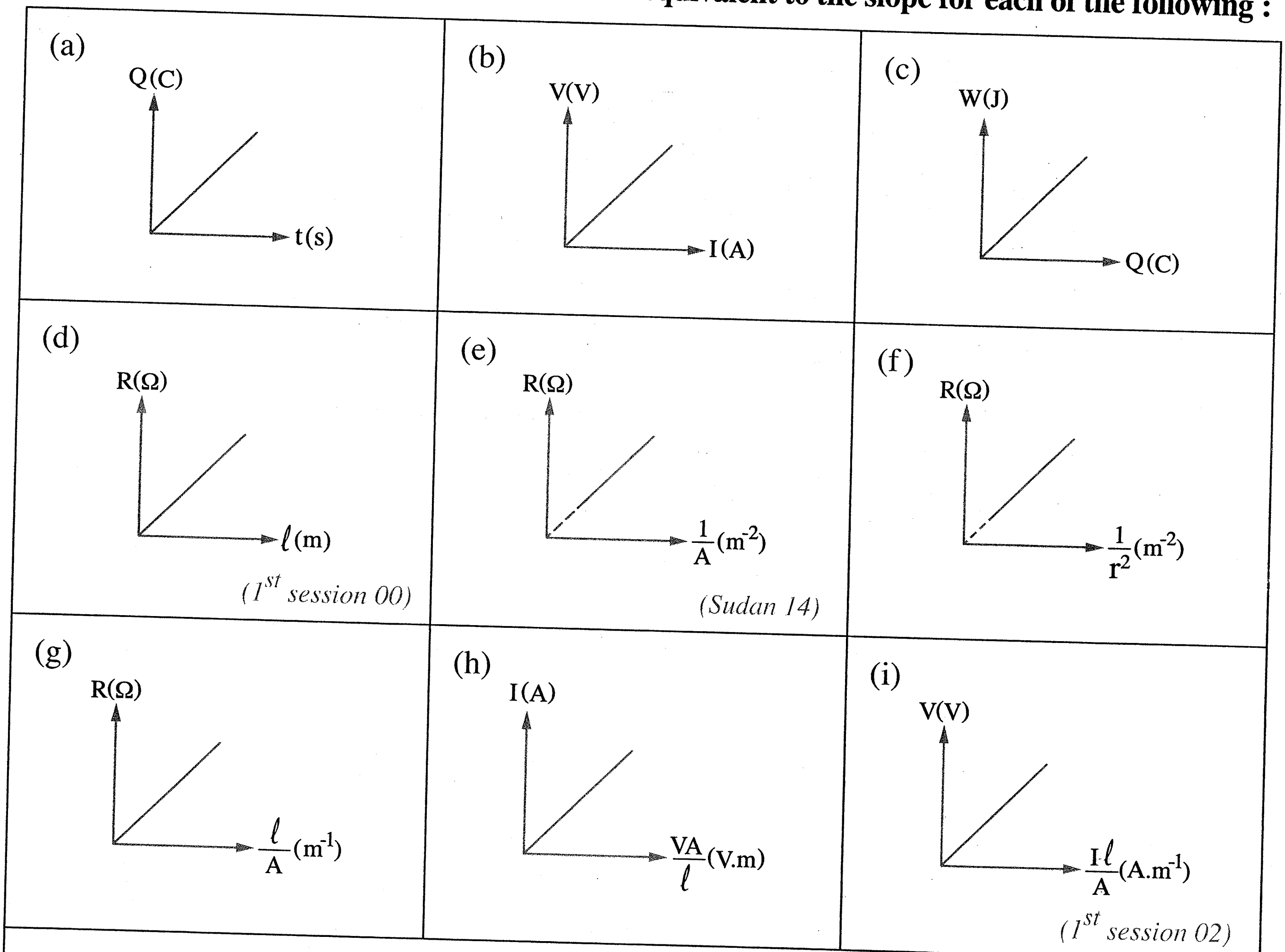
(h) Volt.Coulomb

(i) Volt.second.Ohm^{-1}

(j) Joule/Ohm.Coulomb *(2nd session 14)*

(k) Volt. *(Exp. 14)*

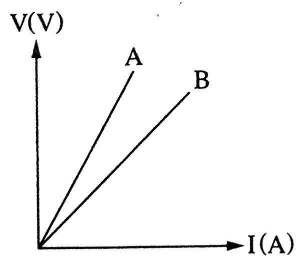
4. **Write the mathematical relation and the equivalent to the slope for each of the following :**



Where : (Q) quantity of electricity, (t) time, (V) potential difference, (I) current intensity, (R) resistance, (ℓ) conductor length, (A) conductor cross-section area, (r) conductor radius, (W) work.

5. 📖 What are the factors affecting the resistance of a conductor ? Deduce mathematically the relation between these factors. *(Azhar 92, 95, 01, 08 - Exp. 14)*

6. The opposite graph represents the relation between the potential difference and the electric current intensity for two conductors A, B of the same material and having the same length at constant temperature :



(a) Which of them has the higher resistance ? And why ?

(b) Which of them has the higher cross-section area ? And why ?

(Sudan 08)

7. Using the relation : $I = \frac{V}{R}$

Explain two different methods to increase the electric current intensity passing in the electric circuit.

8. The opposite table shows the description of three metallic conductors made of different materials (x , y , z) and having the same cross-section area , deduce the ratio between σ_x , σ_y , σ_z where σ is the electric conductivity, then deduce which of these materials has the highest conductivity.

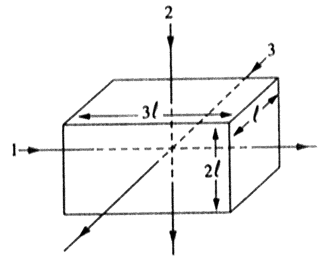
Conductor	Conductor length	Conductor resistance
x	2 m	1 Ω
y	3 m	4 Ω
z	3 m	6 Ω

(1^{st} session 15)

9. **In the opposite figure :**

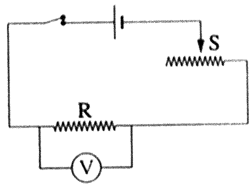
A solid cuboid made of a conducting material, when electric current passes in the path (1), its resistance becomes R, calculate its resistance when the same electric current passes through path :

(a) 2 (b) 3



10. **In the opposite figure :**

What will happen to the reading of voltmeter when increasing the variable resistance (S) ?



11. A potential difference V is applied across a conductor of length ℓ and diameter D. How are the electric resistance and the electric current intensity passing through the conductor affected when (without changing the potential difference) :

(a) ℓ is halved. (b) D is doubled.

12. The following table gives the current I (in Amperes) through two devices for several values of potential difference V (in Volts). From these data, determine which device does not obey Ohm's law. And why ?

Device 1

V	I
2	1.5
3	2.2
4	2.8

Device 2

V	I
2	4.5
3	6.75
4	9

13. A potential difference V is connected across a device with resistance R, causing current I through the device. Rank the following variations according to the change in the rate at which electrical energy is converted to thermal energy due to the resistance, greatest change first :

(a) V is doubled with R unchanged.
(b) I is doubled with R unchanged.
(c) R is doubled with V unchanged.
(d) R is doubled with I unchanged.

10 Problems :

Guiding notes for solving problems 1

- To determine the electric current intensity passing in a conductor (I) : $I = \frac{Q}{t}$ (A)
- To determine the number of electrons passing through a cross-section area of a conductor (N) : $N = \frac{Q}{e}$ (electron)
- To determine the potential difference between the terminals of a conductor (V) :

$$V = \frac{W}{Q} \text{ (V)}$$

- Ohm's law : $V = IR$
- To determine the resistance of a conductor (R) : $R = \rho_e \frac{\ell}{A} = \frac{\rho_e \ell}{\pi r^2}$ (Ω)
- To determine the resistivity (ρ_e) and the conductivity (σ) :

$$\rho_e = \frac{RA}{\ell} \text{ (}\Omega\text{.m)}$$

$$\therefore \sigma = \frac{1}{\rho_e} = \frac{\ell}{RA} \text{ (}\Omega^{-1}\text{.m}^{-1}\text{)}$$

1. Calculate the quantity of electricity passing through a certain cross-section area of a wire carrying electric current of intensity 5 mA for 10 s and if this current is due to the flow of electrons calculate the number of electrons passing through this cross-section during this period. (Knowing that : Charge of electron = 1.6×10^{-19} C)

(0.05 C, 3.125×10^{17} electrons)

2. If the work done to transfer a quantity of electricity of 5 C within 1 s between two points in a conductor is 100 J, **calculate :**
(a) Potential difference between the two points.
(b) The flowing electric current.
(c) Number of electrons passing within 2 s.
(Knowing that : Charge of electron = 1.6×10^{-19} C) *(20 V, 5 A, 6.25×10^{19} electrons)*

3. A copper wire of length 30 m and cross-section area 0.33×10^{-6} m^2 and its resistivity 1.79×10^{-8} Ω.m, calculate its resistance. *(1.63 Ω)*

4. A copper wire 30 m long and cross-section area 2×10^{-6} m^2 when an electric current passes through it, the voltage difference between its ends becomes 3 V. Calculate the electric current intensity knowing that the copper resistivity is 1.79×10^{-8} Ω.m. *(11.17 A)*

5. A wire of length 200 m and of resistivity 3.14×10^{-7} Ω.m, if the wire allows the flow of 2×10^{19} electrons per second when it is connected to a source 64 V, calculate the radius of the wire. (Knowing that : $\pi = 3.14$, $e = 1.6 \times 10^{-19}$ C) *(10^{-3} m)*

6. A power station is connected to a factory 2.5 km away by two wires. The potential difference between the terminals of the wires at the station 240 V and that for the other terminals at the factory is 220 V, if the factory is using a current of 80 A, **calculate :**
   (a) The resistance of each meter of the wire.
   (b) The radius of the wire if the resistivity of its material 1.57×10^{-8} Ω.m. ($\pi = 3.14$)
   (5×10^{-5} Ω , 0.01 m)

7. A wire of length 30 m and cross-section area 0.3 cm^2 connected to a DC source and ammeter of negligible resistance in the closed circuit, if the electric current passing through the wire is 2 A and the potential difference at its ends 0.8 V. Calculate the conductivity of the wire. *(25×10^5 $\Omega^{-1}.m^{-1}$) (May 94)*

8. A metal insulated wire of diameter 0.1 mm made of an alloy, the resistivity of its material 5×10^{-7} Ω.m, calculate the electric conductivity for the material of that wire and what length of that wire is required to obtain a resistance of 200 Ω ? (Where : $\pi = 3.14$)
   (2×10^6 $\Omega^{-1}.m^{-1}$, 3.14 m) (Azhar 91)

Guiding notes for solving problems 2

- To determine the value of resistance (R) :

$$R = \frac{\rho_e \ell}{A} = \frac{\rho_e \ell^2}{V_{ol}} = \frac{\rho_e \ell^2 \rho}{m}$$

$$R = \rho_e \frac{\ell}{A} = \frac{\rho_e V_{ol}}{A^2} = \frac{\rho_e m}{\rho A^2}$$

- For comparison between the resistances of two conductors we use the relation :

$$\frac{R_1}{R_2} = \frac{(\rho_e)_1 \ell_1 A_2}{(\rho_e)_2 \ell_2 A_1} = \frac{(\rho_e)_1 \ell_1 r_2^2}{(\rho_e)_2 \ell_2 r_1^2} = \frac{(\rho_e)_1 \rho_1 \ell_1^2 m_2}{(\rho_e)_2 \rho_2 \ell_2^2 m_1}$$

9. A cube made of a conducting material of side length 10 cm is reshaped to be a wire of electric resistance 20 Ω, if the resistivity of the material of the cube is 1×10^{-7} Ω.m. Calculate the length of the wire and its radius. ($\pi = 3.14$) *(447.21 m, 8.44×10^{-4} m)*

10. A wire of length 2 m and density 7000 kg/m^3 if its resistance 2 Ω and its resistivity 10^{-6} Ω.m , calculate its mass. *(0.014 kg)*

11. A metal wire its volume 2×10^{-4} m^3 and cross-section area 4×10^{-5} m^2 and resistance 1.25 Ω, calculate its conductivity. *(10^5 $\Omega^{-1}.m^{-1}$)*

12. A wire of resistance 200 Ω calculate the resistance of a wire of the same material of double the length and double the cross-section area of the first wire. *(200 Ω)*

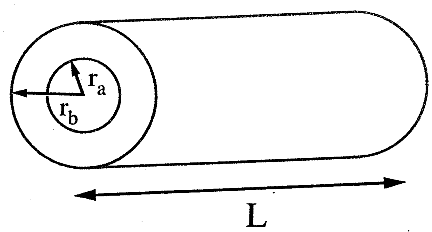
13. Two wires (a), (b) of the same material, length of the first wire (a) is double that of (b), if the ratio between the resistance of wire (a) to that of (b) equals 8 and radius of wire (a) 4 mm. Calculate the cross-section area of wire (b). ($\pi = 3.14$) *(2.01×10^{-4} m^2)*

14. Two wires of the same material, length of the second wire is double the length of the first wire and its diameter is half that of the first wire, calculate the ratio between the resistance of the second wire to that of the first wire. *($\frac{8}{1}$)*

15. Two wires of different materials length of the first is double that of the second and its radius is double that of the second wire but resistance of the first equals that of the second, calculate the ratio between their resistivity. *($\frac{2}{1}$) (Egy. 92)*

16. Two wires are made of copper, the length and mass of the first are 10 m and 0.1 kg, respectively and those of the other are 40 m and 0.2 kg, respectively. Compare their resistances. *($\frac{1}{8}$)*

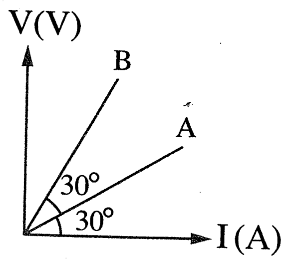
17. A resistor of material of resistivity 3.5×10^5 Ω.m reshaped into the shape of a hollow cylinder of length 4 cm and inner and outer radii 0.5 cm and 1.2 cm respectively as shown in the figure, a potential difference is applied between the ends of the cylinder, producing a current parallel to the axis. Calculate the electrical resistance (R).



(3.74×10^7 Ω)

18. Two conductors of the same material and length have different resistances. Conductor A is a solid 1 mm diameter wire. Conductor B is a tube of inner diameter 1 mm and outer diameter 2 mm. Find the ratio of the resistances of conductor A to conductor B. *(3 : 1)*

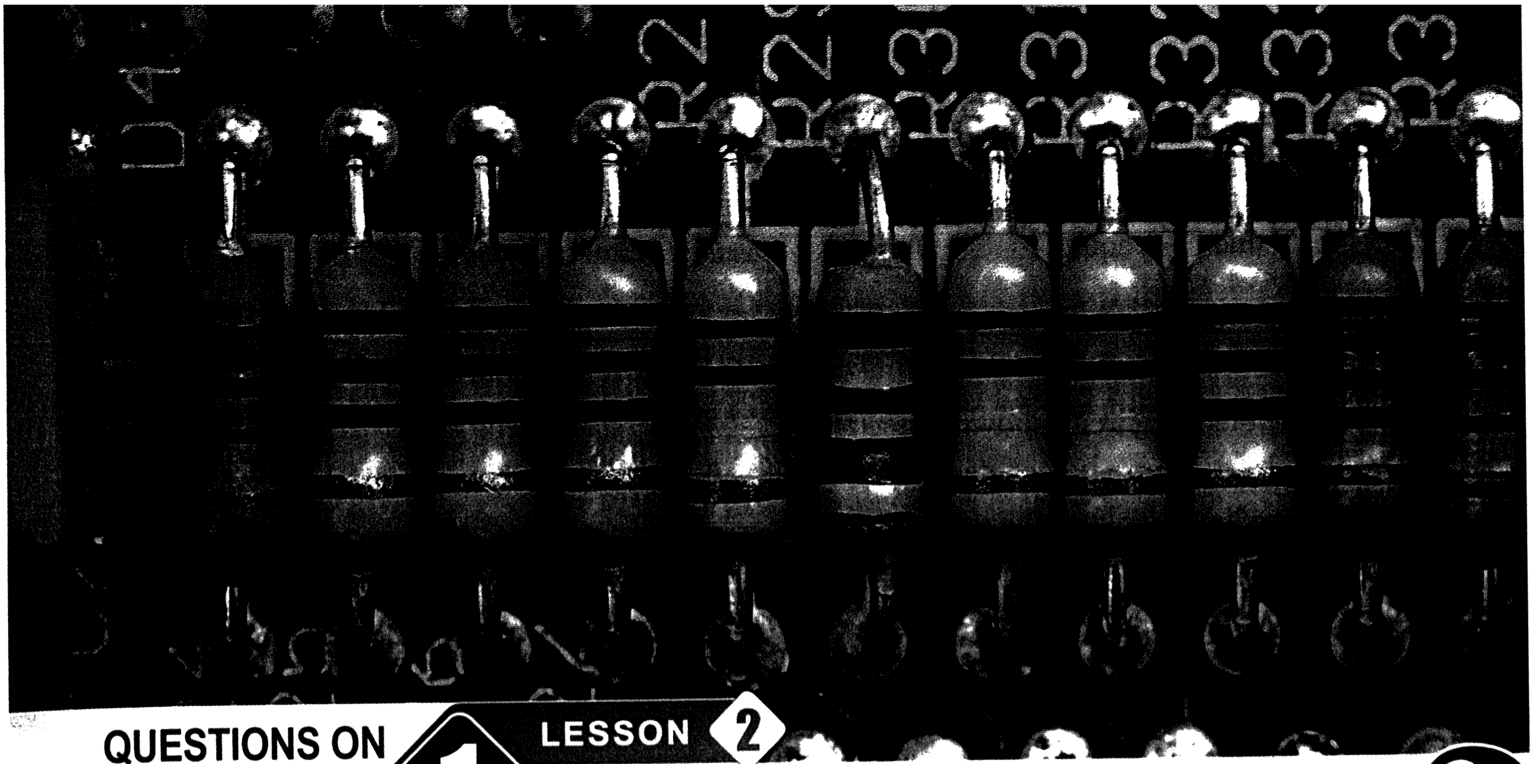
19. The opposite graph shows the relation between the electric potential difference and the electric current intensity in two wires of the same material, calculate :



(a) The cross-section of wire A, if both wires have the same length and the cross-section of wire B is 3×10^{-6} m^2.

(b) The length of wire A , if both have the same cross-section and the length of wire B is 3 m.

(9×10^{-6} m^2, 1 m)



QUESTIONS ON **Chapter 1** LESSON 2

Resistors Connection

1 Choose the correct answer of the given answers :

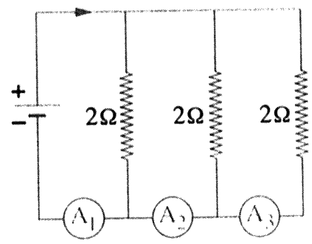
1. Two resistors one of them is 1 Ω are connected in series, then their equivalent resistance ·········· one Ohm.

   a. is greater than b. equals c. is less than d. remains constant

2. Three resistors are connected in parallel, if one of them is one Ohm then their equivalent resistance is ·········· one Ohm. *(1st session 05)*

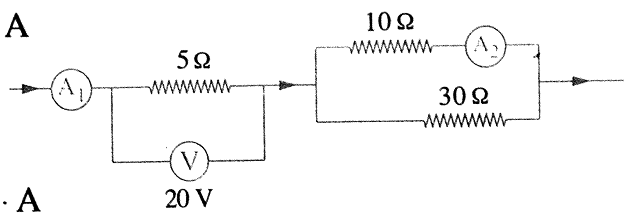
   a. greater than b. equal c. less than d. remains constant

3. In the electric circuit shown in the figure :
   If the reading of the ammeter (A_1) equals 1.2 A, then the reading of the ammeter (A_2) equals ·········· A. *(1st session 03)*



   a. 0.2 b. 0.4
   c. 0.6 d. 0.8

4. In the electric circuit shown in the figure :



   i. The reading of the ammeter (A_1) = ·········· A

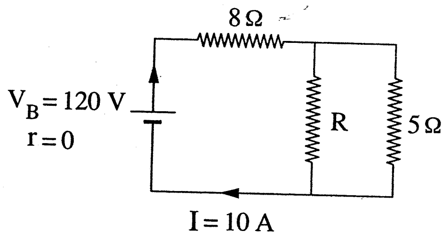
   a. 2 b. 4
   c. 6 d. 8

   ii. The reading of the ammeter (A_2) = ·········· A

   a. 1 b. 2
   c. 3 d. 4

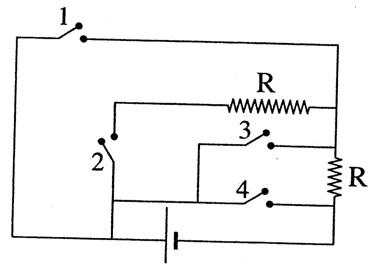
5. In the electric circuit shown in the figure the value of R equals .... Ohms. *(1st session 14)*

a. 20
b. 40
c. 60
d. 80



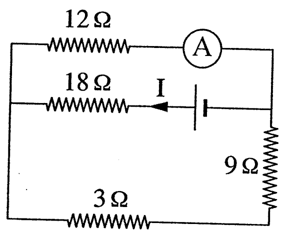
6. In the electric circuit shown in the figure, the electric current becomes minimum value when closing switch ....

a. 1
b. 2
c. 3
d. 4



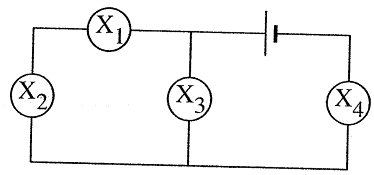
7. In the electric circuit shown in the figure, the ammeter reading equals .... *(1st session 13)*

a. I
b. $\frac{I}{2}$
c. $\frac{I}{3}$
d. $\frac{I}{4}$



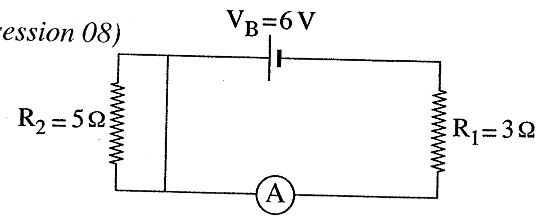
8. In the electric circuit shown in the figure, four lamps are lighted, if lamp X_1 is blown up the lamps that will be kept lighted are .... *(Azhar 11- 1st session 17)*

a. X_2 , X_3.
b. X_2 , X_4.
c. X_3 , X_4.
d. X_2 , X_3 , X_4.



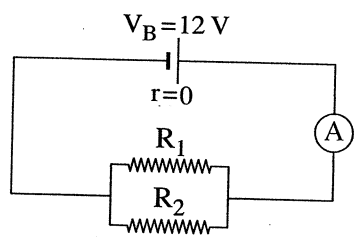
9. In the electric circuit shown in the figure , the ammeter reading equals .... Amperes. *(2nd session 08)*

a. $\frac{1}{2}$
b. $\frac{3}{4}$
c. 2
d. $\frac{1}{4}$



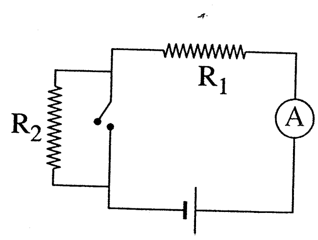
10. In the electric circuit shown in the figure, if the reading of the ammeter (A) is 5 A and the current intensity passing in the resistance (R_1) equals 2 A, then the value of the resistance (R_2) is .... Ohm. *(2nd session 03)*

a. $\frac{1}{4}$
b. 2
c. 4
d. 6

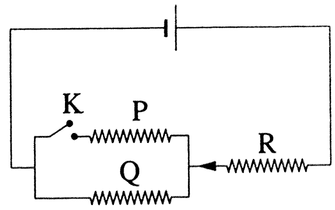


11. In the electric circuit shown in the figure, when closing the switch the ammeter reading .... *(1st session 12)*

a. increases.
b. decreases.
c. remains unchanged.

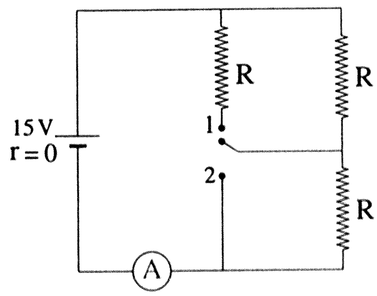


12. In the electric circuit shown in the figure three similar connected resistors, when switch K is closed ....



a. the current in R decreases while in Q increases.
b. the current in R decreases while in Q decreases.
c. the current in R increases while in Q decreases.
d. the current in R increases while in Q increases.

13. In the electric circuit shown in the figure :



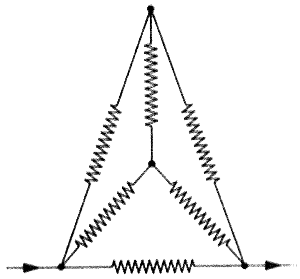
i. When putting the switch in position (1) , a current of 2 A passes in the ammeter , thus the value of the resistance R is .... Ω.

a. 30　　b. 5
c. 7.5　　d. 2.5

ii. When putting the switch in position (2) , a current of .... A passes in the ammeter.

a. 1　　b. 2　　c. 3　　d. 4

14. In the electric circuit shown in the figure, if the resistance of each resistor = R, then the equivalent resistance of the network = ...



a. 6 R　　b. 3 R
c. $\frac{R}{2}$　　d. $\frac{R}{6}$

15. 📖 Four lamps 6 Ω each, are connected in parallel. Then the combination is connected to a 12 V battery with a negligible internal resistance :

i. The current in the battery equals ....

a. 8 A.　　b. 6 A.　　c. 4 A.　　d. 2 A.

ii. The total charge leaving the battery in 10 s is ....

a. 80 C.　　b. 60 C.　　c. 40 C.　　d. 20 C.

iii. The electric current intensity passing in each lamp = ...

a. 8 A　　b. 2 A　　c. $\frac{3}{2}$ A　　d. $\frac{2}{3}$ A

iv. The potential difference at the terminals of each lamp equals ....

a. 12 V.　　b. 6 V.　　c. 3 V.　　d. 2 V.

v. The total resistance of the four lamps = ...

a. 24 Ω　　b. 6 Ω　　c. $\frac{3}{2}$ Ω　　d. $\frac{2}{3}$ Ω

vi. The total resistance of the four lamps when connected in series = ...

a. 24 Ω　　b. 6 Ω　　c. $\frac{3}{2}$ Ω　　d. $\frac{2}{3}$ Ω

16. A group of equal resistors connected in series, so their equivalent resistance was 100 Ω and when they connected in parallel their equivalent resistance become 4 Ω , then the value of one of them is .... Ω. *(1st session 15)*

a. 20 b. 25 c. 100 d. 125

17. Two electric bulbs of resistances R_1, R_2 respectively are connected in series to an electric source, if $R_1 < R_2$, then ....

a. the glow of bulb R_1 is greater.
b. the glow of bulb R_2 is greater.
c. the two bulbs the same glow.
d. no correct answer.

18. Two electric bulbs of resistances R_1, R_2 respectively are connected in parallel to an electric source, if $R_1 > R_2$, then .... *(Olym. 08)*

a. the glow of bulb R_1 is greater.
b. the glow of bulb R_2 is greater.
c. the two bulbs the same glow.
d. no correct answer.

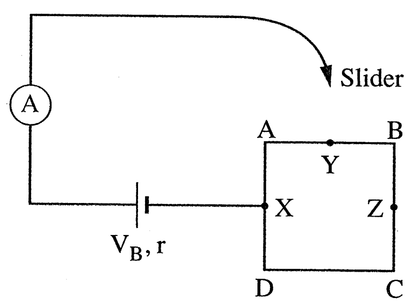
19. The length of three conducting wires are in the ratio 1 : 2 : 3, all the wires are of the same material and their radii are also equal. If we join them in parallel across a battery, what will be the ratio of currents in them ? ....

a. 1 : 2 : 3 b. 3 : 2 : 1 c. 2 : 3 : 6 d. 6 : 3 : 2

20. Two identical resistors are connected in series to a battery of emf V and zero internal resistance. The current drawn from the battery is 1 A. When the two resistors are connected in parallel to the same battery the current drawn will be ....

a. $\frac{1}{2}$ A. b. 1 A. c. 2 A. d. 4 A.

21. A thin uniform wire of resistance 24 Ω is bent to form a square ABCD and then connected to a battery as shown in the opposite figure. Points X, Y and Z represent the midpoints of determined sides. To get the higher reading of ammeter, the slider must be placed at point ....



a. A b. B c. Y d. Z

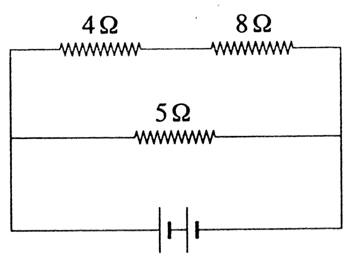
22. Two electric bulbs marked 25 W - 220 V and 100 W - 220 V are connected in series to a 440 V supply which of the bulbs will fuse ? ....

a. 100 W. b. 25 W. c. None of this. d. Both.

23. Three identical resistors connected in series with a battery, together dissipate 10 W of power. What will be the power dissipated, if the same resistors are connected in parallel across the same battery ? ....

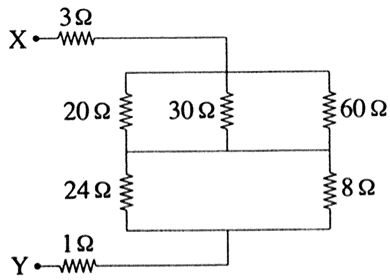
a. 60 W. b. 30 W. c. 90 W. d. 120 W.

24. If the power dissipated in 5 Ω resistor is 20 W, then the power dissipated across 4 Ω resistor will be ....



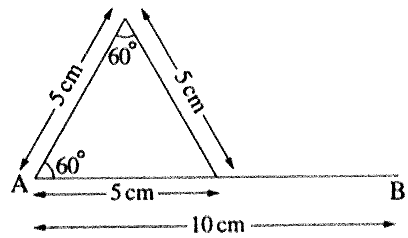
a. 1 W. b. 2 W.
c. 3 W. d. 2.78 W.

25. The potential difference across 8 Ω resistance is 48 V as shown in the figure. The value of potential differences across X and Y will be ....



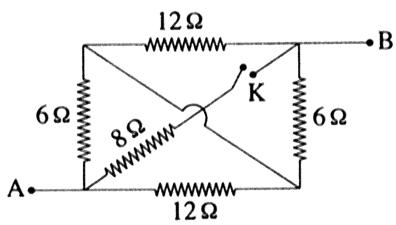
a. 180 V. b. 160 V.
c. 140 V. d. 120 V.

26. A wire has resistance of 24 Ω is bent in the following shape. The effective resistance between A and B is ....



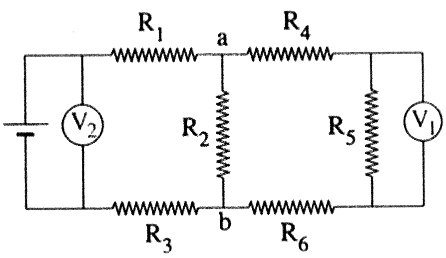
a. 24 Ω. b. 10 Ω.
c. $\frac{16}{3}$ Ω.

27. The equivalent resistance between the points A and B when the switch K is opened and when it is closed respectively are ....



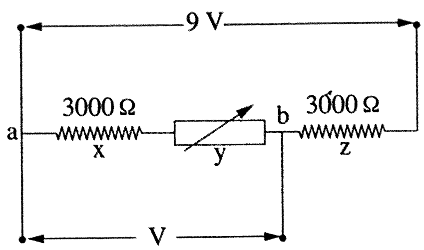
a. 8 Ω , 2 Ω. b. 9 Ω , 4 Ω.
c. 8 Ω , 4 Ω. d. 36 Ω , 6 Ω.

28. In the opposite figure :
If each resistor has a resistance R and V_2 reading was 33 V, so the reading of V_1 is ....



a. 9 V. b. 11 V.
c. 3 V. d. non of them.

29. In the opposite figure :
Resistors x , z have fixed values and y can be changed from zero to 3000 Ω , so the range of potential differences between a and b is ....



a. 0 V to 6 V. b. 3 V to 6 V.
c. 4.5 V to 6 V. d. 4.5 V to 9 V.

2 What is meant by ...?

The equivalent total resistance of many resistors connected together = 10 Ω

3 Give reasons for :

1. • To obtain a small resistance from a group of big resistors the group is connected in parallel. *(Azhar 01)*
   • The equivalent resistance for a group of resistors decreases when connected in parallel. *(1st session 13)*
2. The resistance of a conductor increases as its length increases.
3. The resistance of a conductor decreases as its cross-section area increases.
4. Home appliances are connected in parallel.
5. Home appliances are not connected in series.
6. In the electric circuits connected in parallel, thick wires are used at the battery terminals while thinner wires are used at the terminals of each resistor.
7. The consumed power from an electric source, increases when a resistor is connected in parallel to another resistor in the electric circuit of that source.

4 What are the results for each of the following :

1. Connecting a group of resistors in series concerning the total value of resistance, the current intensity passing in each of them and the potential difference at the ends of each of them.
2. Connecting a group of resistors in parallel concerning the total value of resistance, the current intensity passing in each of them and the potential difference at the ends of each of them.

5 Compare between series and parallel connection of resistors (in terms of : method – purpose – the law used to determine the total resistance – the current intensity passing through the resistors – the potential difference across resistors). *(Sudan 14 - Exp. 15)*

6 Miscellaneous questions :

1. Mention the scientific idea on which the home appliances are connected. *(Exp. 10)*
2. **Explain how to prove that :**
   (a) The equivalent resistance for three resistors connected in series is determined from the relation : $R' = R_1 + R_2 + R_3$
   (b) The reciprocal of the equivalent resistance for three resistors connected in parallel equals sum of the reciprocal of the three resistors : $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ *(Sudan 15, 17)*

3. If you have three different resistors show by drawing and mathematical proof the method that makes the equivalent resistance for these resistors :

(a) Maximum value. (b) Minimum value.

Showing the effect of that on the electric current passing in the circuit in the two cases. *(Sudan 87)*

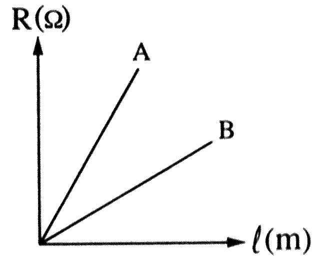
4. Three lamps having the same electric resistance show by drawing how they can be connected in an electric circuit with an electric cell such that :

(a) The intensity of the three lamps is maximum.

(b) The intensity of the three lamps is minimum. *(2^{nd} session 15)*

5. Seven equal resistors, show by drawing how to connect them together to obtain equivalent resistance equals the value of one of them. *(Olym. 08)*

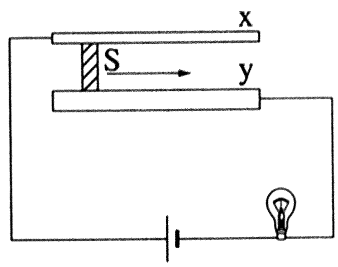
6. The opposite graph represents the relation between the electric resistance (R) and length (ℓ) for a group of wires of two different materials A, B having the same cross-section area :



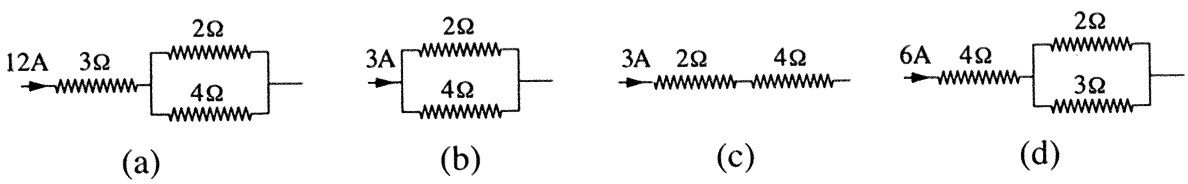
(a) Which of the two materials has higher resistivity ? And why ?

(b) If two wires one of material A and the other of material B having the same length are connected in parallel in an electric circuit, which of them passes higher current ? And why ? *(1^{st} session 14)*

7. **In the opposite figure :** Two rods x, y of the same metal having the same length but the cross-section of y is double that of x, they are connected via a copper slider S in an electric circuit as in figure , if the slider is moved to east explain what happens to the glowing of the lamp.



8. **The following figures show a number of resistors connected together in different ways :**



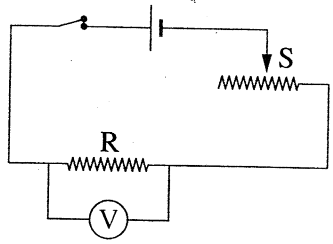
i. In figure .... the current intensity passing in the resistance 2 Ω equals 3 A.

ii. In figure .... the current intensity passing in the resistance 2 Ω equals 8 A.

iii. In figure .... the potential difference between the terminals of resistance 4 Ω equals 4 V.

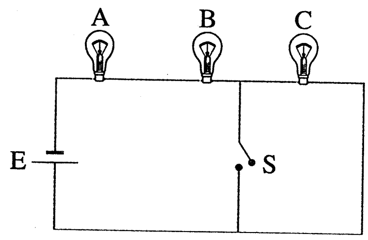
iv. In figure .... the potential difference between the terminals of resistance 4 Ω equals 24 V.

9. In the circuit shown in the opposite figure, what happens to the reading of the voltmeter as the variable resistor (S) increases ?



10. Two wires A and B are connected in parallel together then the combination is connected to a battery of emf. Both wires are made of the same material and are of the same length, but the radius of wire A is half the radius of wire B.
   (a) Which wire has greater resistivity ? Why ?
   (b) Which wire has greater resistance ? Why ?
   (c) Which wire has greater potential difference across its ends ? Why ?
   (d) Which wire has greater electric current flowing through it ? Why ?
   (e) What is the ratio between the power dissipated in wire A to that in wire B ?
   (f) Calculate the ratio between the total current and the current passing through wire A.

11. A series circuit consists of three identical lamps connected to a battery as in figure. When the switch S is closed, what happens to :
   (a) The brightness of lamps A, B and C.
   (b) The current in the circuit.
   (c) The voltage drop across each one of the three lamps.
   (d) The power dissipated in the circuit.



12. A single resistor R_1 is connected to a battery. Then resistor R_2 is added in parallel to R_1 (where $R_1 > R_2$).
   (a) Is the potential difference across R_1 after adding R_2 more than, less than, or the same as before adding R_2 ? Why ?
   (b) Is the current I_1 through R_1 after adding R_2 more than, less than, or the same as before adding R_2 ? Why ?
   (c) Is the equivalent resistance R_{eq} of R_1 and R_2 more than, less than, or equal to R_1 ? Why ?
   (d) Is the total current through R_1 and R_2 together more than, less than, or equal to the current through R_1 previously ? Why ?

7 Problems :

Guiding notes for solving problems 1

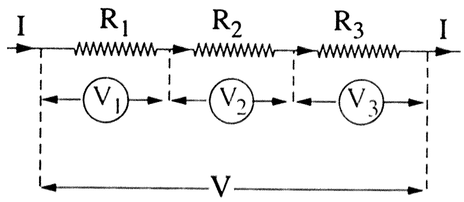
⇒ **The series connection of resistors :**

- To determine the equivalent resistance ($\grave{R}$) :

  $\grave{R} = R_1 + R_2 + R_3$

  In case of N equal resistors each of resistance R

  then : $\grave{R} = NR$



- To determine the total voltage (V) : $V = V_1 + V_2 + V_3$

  (Where the voltage is different for each resistor)

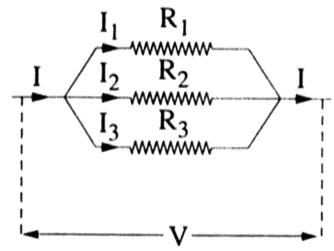
- To determine the current intensity (I) : $I = \frac{V}{\grave{R}} = \frac{V_1}{R_1} = \frac{V_2}{R_2} = \frac{V_3}{R_3}$

  (Where the current intensity passing through all the resistors is the same)

⇒ **The parallel connection of resistors :**

- To determine the equivalent resistance ($\grave{R}$) :

  $\frac{1}{\grave{R}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$



- In case of N equal resistors each of resistance R then : $\grave{R} = \frac{R}{N}$

- In case of two different resistors R_1 and R_2 : $\grave{R} = \frac{R_1 R_2}{R_1 + R_2}$

- To determine the potential difference (V) : $V = I\grave{R} = I_1R_1 = I_2R_2 = I_3R_3$

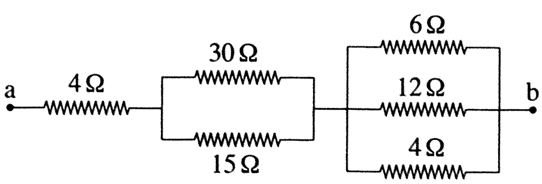
  (Where the voltage is the same for each resistor)

- To determine the total current (I) : $I = I_1 + I_2 + I_3$

  (Where the current is distributed on the resistors)

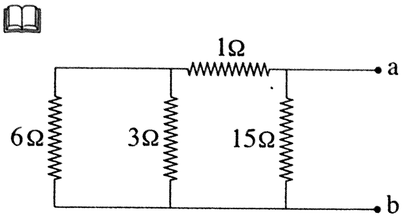
1. **Find the equivalent resistance between points a, b in all of the following electric circuits :**

(a)



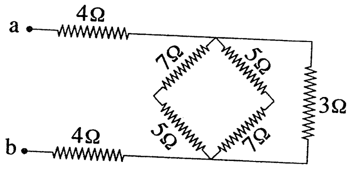
(16 Ω)

(b) 📖



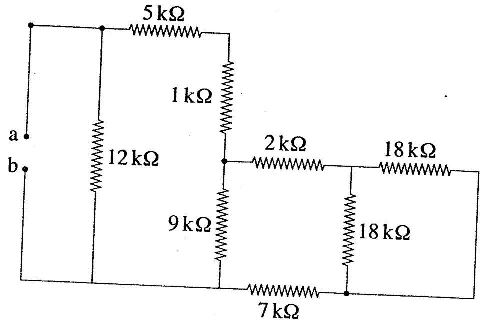
(2.5 Ω)

(c)



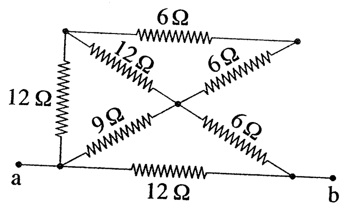
(10 Ω)

(d)



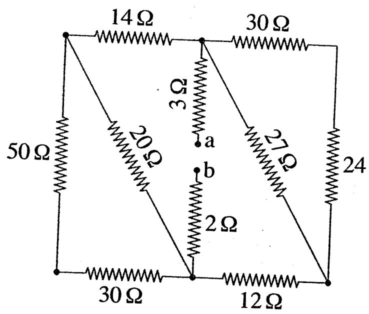
(6 kΩ)

(e)



(6 Ω)

(f)



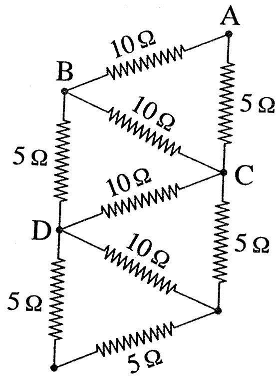
(20 Ω)

2. Calculate the equivalent resistance for the opposite electric circuits in case of connecting the points :

(a) B – A

(b) B – C

(c) C – D



(5 Ω , 3.75 Ω , 3.44 Ω)

3. Three resistors 80 Ω , 150 Ω , 100 Ω find the total equivalent resistance when connecting them in :

(a) Series.

(b) Parallel.

(330 Ω , 34.29 Ω)

4. Two resistors of 18 Ω , 12 Ω connected in parallel , **calculate :**

(a) Their equivalent resistance.

(b) The potential difference at their ends that makes the total electric current intensity in the circuit 1.5 A.

(7.2 Ω , 10.8 V)

5. Number of resistors each of resistance 40 Ω , calculate how many resistors of them are required to carry a current of 15 A on a line the potential difference between its ends 120 V.

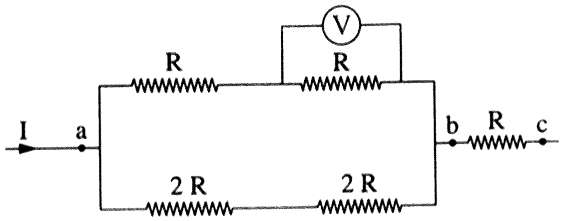
(5 resistors) (Azhar 08)

6. If the fuse in one of the houses can withstand a maximum current of 5 A at potential difference of 110 V, what is the maximum number of lamps that can be lighted at the same time without blow up of the fuse ? Knowing that the resistance of each lamp is 620 Ω and the resistance of the other parts of the circuit is 2 Ω. *(31 lamps)*

7. Two resistors 300 Ω , 400 Ω are connected in series to 130 V power supply. Calculate the readings of a voltmeter of resistance 200 Ω when connected across :
(a) The two terminals of the first resistance.
(b) The two terminals of the second resistance. *(30 V , 40 V)*

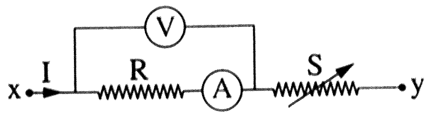
8. Two resistors R_1, R_2 when connected in parallel it is found that their equivalent resistance equals 6 Ω and when connected in series their equivalent resistance equals 27 Ω , find the value of each of R_1, R_2 *(18 Ω , 9 Ω)*

9. **In the opposite figure :**
If the reading of the voltmeter is 4 V, calculate its reading when it is connected between points :



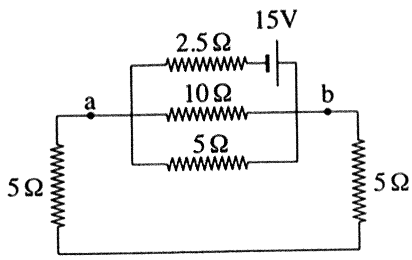
(a) b , c (b) c , a *(6 V , 14 V) (Azhar 14)*

10. **In the opposite figure :** If the potential difference between the two points x, y equals 20 V, reading of the ammeter 1 A and that of the voltmeter 5 V, **find :**



(a) Value of the two resistors S, R.
(b) Reading of the ammeter and the voltmeter when connecting resistance 20 Ω in series with S with constant potential difference between points x, y. *(5 Ω , 15 Ω , 0.5 A , 2.5 V)*

11. **In the electric circuit shown in the figure, calculate :**



(a) The total resistance value in the circuit.
(b) The total electric current intensity passing in the circuit.
(c) The potential difference between points a, b.
(5 Ω , 3 A , 7.5 V) (1st session 12)

12. A wire of a uniform cross-section carries a current of 0.1 A, when the potential difference between its terminals is 1.2 V. If a square abcd is made of this wire, calculate the equivalent resistance for the wire when :
(a) The power source is connected to points a, c.
(b) The power source is connected to points a, d. *(3 Ω , 2.25 Ω)*

13. Three resistors, the value of each is 3 Ω , explain by drawing how they can be connected to obtain equivalent resistance, its value is :
(a) 4.5 Ω. (b) 2 Ω. (c) 1 Ω.

14. Six similar electric bulbs connected in parallel to electric source of emf 100 V. It's required to operate them on another source of emf 200 V without being burnt. Explain by drawing only the method of connecting them to acheive this purpose, then calculate the current intensity passing in each bulb where the resistance of each bulb is 240 Ω. *(0.42 A) (Azhar 90)*

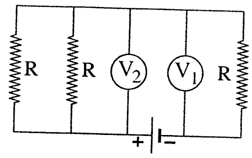
15. Three resistors 1 Ω, 3 Ω, 6 Ω are connected together to electric source where the electric current intensity passing in each resistor were 0.3 A, 0.2 A, 0.1 A respectively. Show by drawing how are they connected. Then calculate the total resistance of the circuit.

(3 Ω) (2nd session 06)

16. Three resistors 60 Ω, 40 Ω, 20 Ω are connected together to electric source where the potential difference between the ends of each resistor were 30 V, 20 V, 50 V respectively. Show by drawing how are they connected. Then calculate the total resistance of the circuit.

(16.67 Ω) (1st session 09)

17. From the opposite figure, find : The ratio between V_1, V_2.



($\frac{2}{1}$) (2nd session 17)

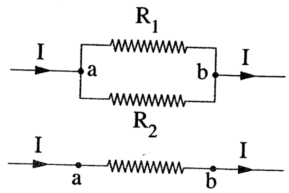
Guiding notes for solving problems 2

- Current intensity of the branch :

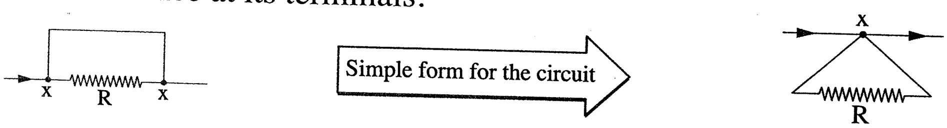
$$\grave{R} = \frac{R_1 R_2}{R_1 + R_2}$$

$$V_1 = V_2 = V_{ab}$$

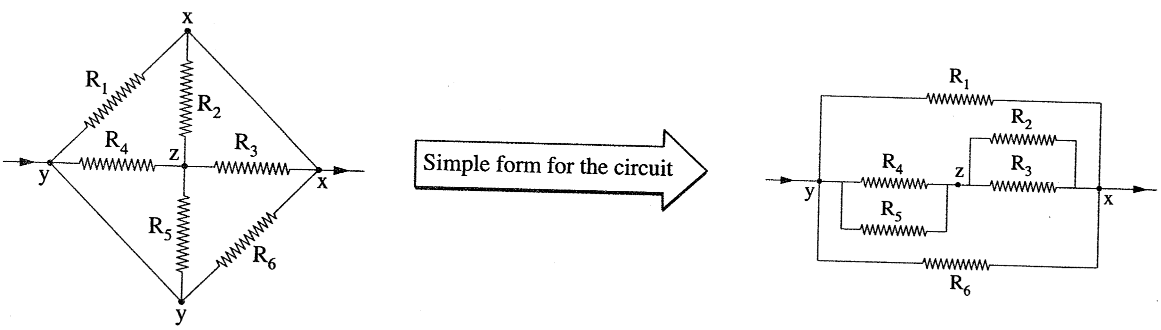
$$I_1 R_1 = I_2 R_2 = I\grave{R}$$



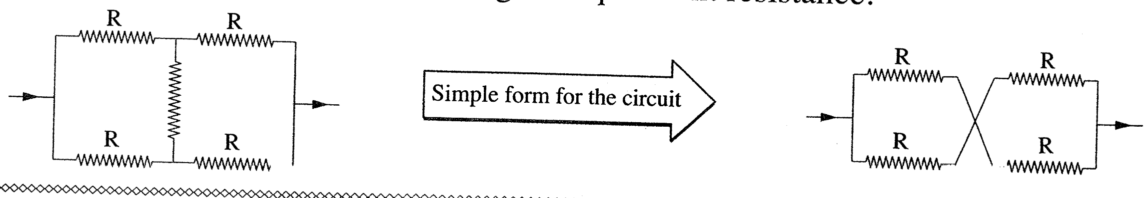
- In case that terminals of a resistor are connected together with a conducting wire, its value is ignored when calculating the equivalent resistance because there is no potential difference at its terminals.



- In case of presence of a connecting wire of no resistance , its ends can be considered one point.

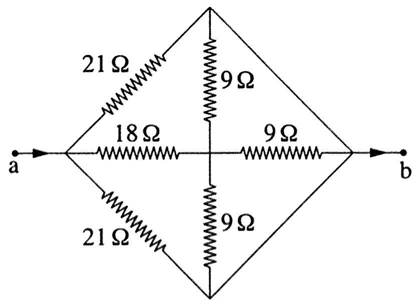


- In case that the potential at the terminals of a resistor is equal, the value of this resistor is ignored when calculating the equivalent resistance.



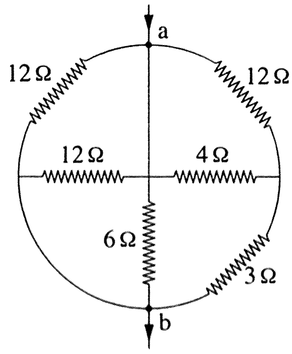
18. **Find the equivalent resistance between points a, b in all of the following electric circuits :**

(a)



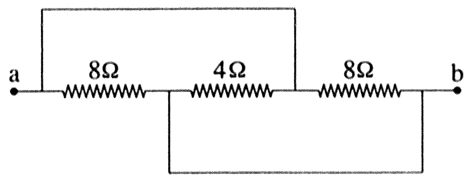
(7 Ω)

(b)



(2 Ω)

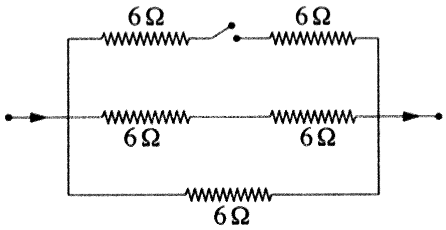
(c)



(2 Ω) (Olym. 08)

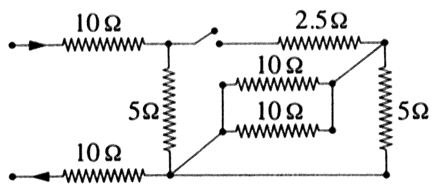
19. **Calculate the equivalent resistance for each electric circuits in case of opening and closing the switch :**

(a)



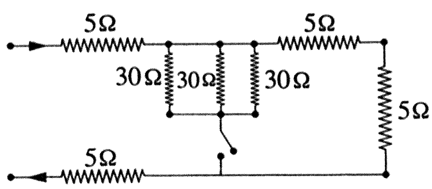
(4 Ω , 3 Ω)

(b)



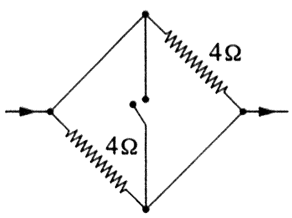
(25 Ω , 22.5 Ω)

(c)



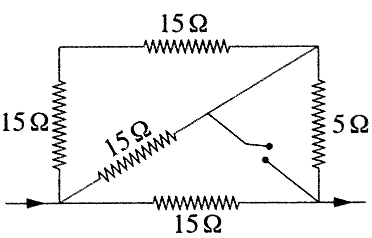
(20 Ω , 15 Ω)

(d)



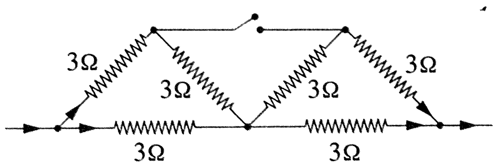
(2 Ω , 0)

(e)



(7.5 Ω , 6 Ω)

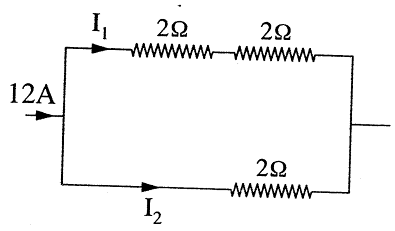
(f)



(4 Ω , 3 Ω)

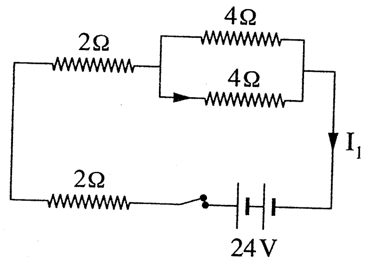
20. **Find the unknown values of the electric current intensities in all of the following electric circuits :**

(a)



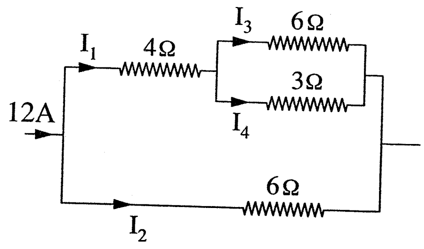
(4 A , 8 A)

(b)



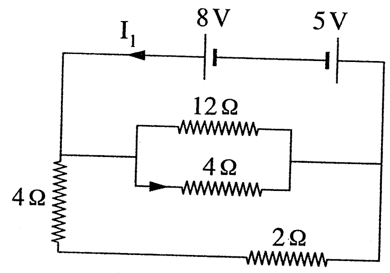
(4 A)

(c)



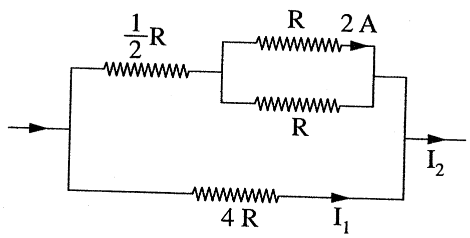
(6 A , 6 A , 2 A , 4 A)

(d)



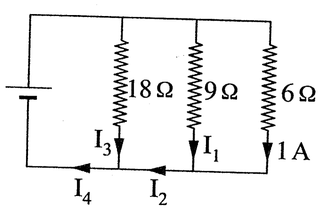
(1.5 A)

(e)



(1 A , 5 A)

(f)



($\frac{2}{3}$ A , $\frac{5}{3}$ A , $\frac{1}{3}$ A , 2 A)

21. Electric circuit is formed of three resistors 60 Ω , 30 Ω , 20 Ω connected together in parallel with a battery gives potential difference of 12 V. **Find :**
   (a) The total equivalent resistance.
   (b) The total current intensity.
   (c) The potential difference at the ends of each resistor.
   (d) The electric current intensity passing in each resistor.

(10 Ω , 1.2 A , 12 V , 0.6 A , 0.4 A , 0.2 A)

22. Two wires of the same length and material, cross-section of the first is double that of the second, connected together in parallel in an electric circuit and when the circuit is closed the electric current intensity passing in the circuit was 3 A, calculate the electric current intensity passing in each of them.

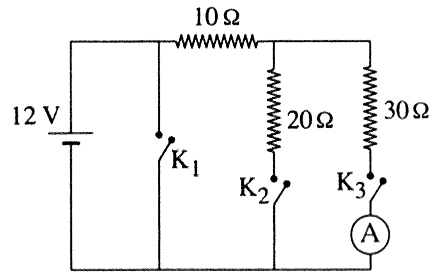
(2 A , 1 A) (Azhar 11)

23. Electric current of intensity 8 mA passes in a thin wire and when another wire of the same material and length is connected with it in parallel, the electric current increased to 10 mA at the same potential difference, calculate the ratio between the diameters of the two wires.

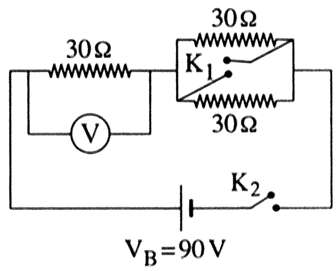
($\frac{2}{1}$) (Azhar 93)

24. A wire ab carrying electric current of intensity 3 mA connected in parallel to another wire of the same material and length but its diameter is 3 times that of the first, calculate the electric current intensity required to keep the potential difference at the ends of ab constant. *(0.03 A) (Azhar 15)*

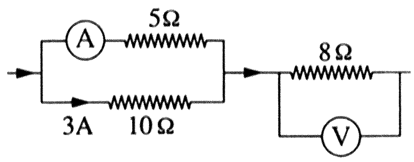
25. From the opposite figure, find the reading of the ammeter in the following cases :
(a) Opening K_1, K_2 and closing K_3
(b) Opening K_1 and closing K_2, K_3
(c) Closing K_1, K_2, K_3 *(0.3 A , 0.22 A , 0)*



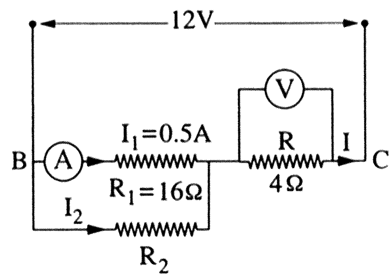
26. In the opposite figure, find the voltmeter reading in the following cases :
(a) K_2 closed, K_1 opened.
(b) K_2 closed, K_1 closed.
(c) K_2 opened, K_1 closed. *(60 V , 90 V , 0) (1st session 08)*



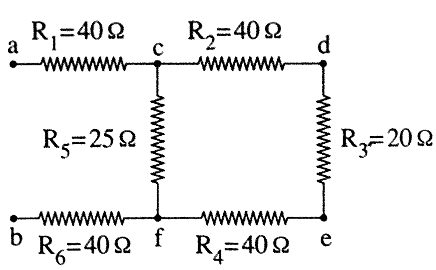
27. **In the opposite figure, find :**
(a) Reading of the ammeter.
(b) Reading of the voltmeter. *(6 A , 72 V)*



28. The opposite figure represents a part of electric circuit, **calculate :**
(a) Reading of the voltmeter (V).
(b) Value of the resistor (R_2). *(4 V , 16 Ω) (2nd session 10)*



29. In the electric circuit, shown in the opposite figure, if the potential difference V_{ab} equals 200 V, **calculate :**
(a) The equivalent resistance of the circuit.
(b) The electric current intensity passing through resistance (R_1).
(c) The electric current intensity passing through resistance (R_5). *(100 Ω , 2 A , 1.6 A) (1st session 15)*



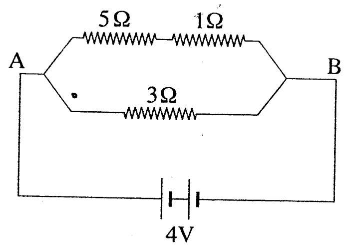
30. **In the opposite figure calculate :**

(a) The total resistance between points A, B.

(b) Electric current intensity passing in the battery circuit.

(c) Electric current intensity passing in the resistor 5 Ω.

(d) Electric current intensity passing in the resistor 1 Ω.



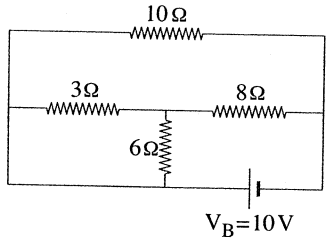
(2 Ω , 2 A , $\frac{2}{3}$ A , $\frac{2}{3}$ A)

31. **In the electric circuit shown in the figure, calculate :**

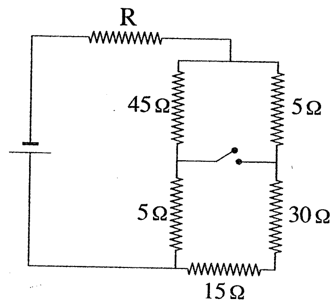
(a) The equivalent resistance of the circuit.

(b) The total electric current intensity passing in the circuit.

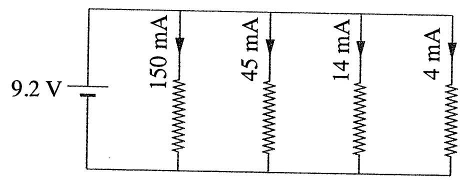
(c) The total electric current intensity passing through a resistance 6 Ω. *(5 Ω , 2 A , 0.33 A) (1st session 11)*



32. In the opposite circuit, when the switch is closed the total equivalent resistance decreases to its half value, calculate the value of the resistor R. *(7 Ω)*



33. Four resistors are connected in parallel to a battery 9.2 V, where values of the electric current intensity passing in each of them are 150 mA, 45 mA, 14 mA, 4 mA, as shown in the figure. Calculate the value of the total resistance of the circuit, then calculate the value of the total electric current passing in the battery in both of the following cases :



(a) If the resistor with the highest value is replaced with another of double its value.

(b) If the resistor with the lowest value is replaced with another of double its value.

(43.19 Ω , 211 mA , 138 mA)

34. Show by drawing how the three resistors 3 , 6 , 9 can be connected together to obtain an equivalent resistance 11 Ω and if the total current intensity 10 A, **calculate :**

(a) The electric current intensity passing in every resistor.

(b) The potential difference at the ends of each resistor.

(10 A , 3.33 A , 6.67 A , 90 V, 20 V, 20 V)

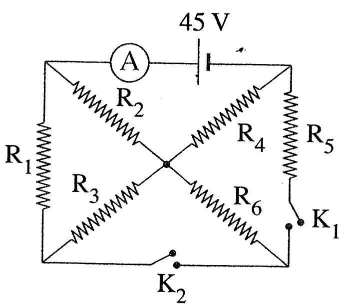
35. In the shown circuit if the value of each resistor is 9 Ω, calculate the reading of the ammeter in case of :

(a) Opening K_1 and closing K_2

(b) Opening K_2 and closing K_1

(c) Opening both K_1 and K_2

(d) Closing both K_1 and K_2 *(3.125 A , 3.75 A , 3 A , 5 A)*



Guiding notes for solving problems 3

- To determine the electric power (P_W) : $P_W = \frac{W}{t} = VI = I^2R = \frac{V^2}{R}$ (Watt)

In case of comparing the consumed power in two resistors if they are :

- carrying the same current : $\frac{(P_W)_1}{(P_W)_2} = \frac{R_1}{R_2}$
- having the same potential difference : $\frac{(P_W)_1}{(P_W)_2} = \frac{R_2}{R_1}$

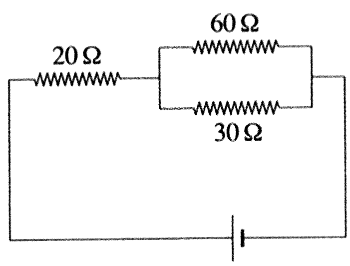
- To determine the consumed electric energy : $W = VQ = VIt = I^2Rt = \frac{V^2t}{R}$ (Joule).

36. A wire of a conducting material its resistivity 1.7×10^{-8} Ω.m and its length 2 m consumes power of 1 W when electric current of 10 A passes through it, **calculate :**
(a) Its cross-section area.
(b) The consumed electric energy within 1 minute if a voltage of 5 V is applied between its terminals. *(3.4×10^{-6} m^2 , 1.5×10^5 J)*

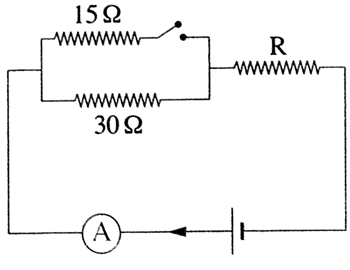
37. Two wires, the resistance of the first is R and passing through it 10^{20} electrons per second while the resistance of the second is 2 R and passing through it 2×10^{20} electrons per second, find the ratio between the consumed power in the first wire to that consumed in the second wire. *($\frac{1}{8}$)*

38. A wire of length 2 m and cross-section area 4×10^{-6} m^2. It consumes electric power of 10 W when the potential difference between its ends is 20 V. **Calculate :**
(a) Its resistivity.
(b) Number of electrons passing through its cross-section in one minute.
(Where : $e = 1.6 \times 10^{-19}$ C) *(8×10^{-5} Ω.m , 1.875×10^{20} electron)*

39. In the opposite circuit, calculate the consumed power in every resistor. *(180 W , 60 W , 120 W)*

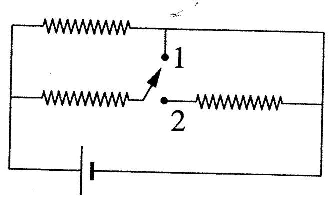


40. Three identical bulbs are connected in series then in parallel with the same source, compare between the consumed power of the bulbs in the two cases. *($\frac{1}{9}$)*

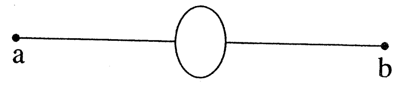


41. In the opposite circuit if the consumed power increases to the double when the switch is closed.
Calculate the value of R. *(10 Ω)*

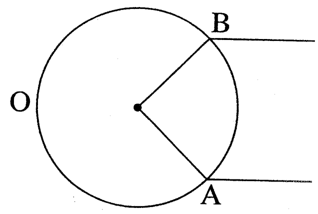
42. In the opposite circuit find the ratio between the consumed power when the switch is in position (1) and when it is in position (2) knowing that all resistors are of the same value. $(\frac{4}{3})$



43. A uniform wire of resistance R is cut into three equal lengths. One of these is formed into a circle and connected between the other two as shown in the opposite figure. Calculate the resistance between the opposite ends a and b in terms of R. $(\frac{3}{4} R)$



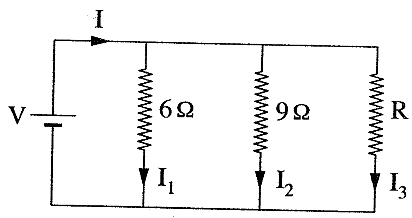
44. A wire in a circular shape has 10 Ω resistance. The resistance per one meter is 1 Ω. The resultant between A and B is equal to 2.4 Ω, calculate the length of the arc AB. *(4 m)*

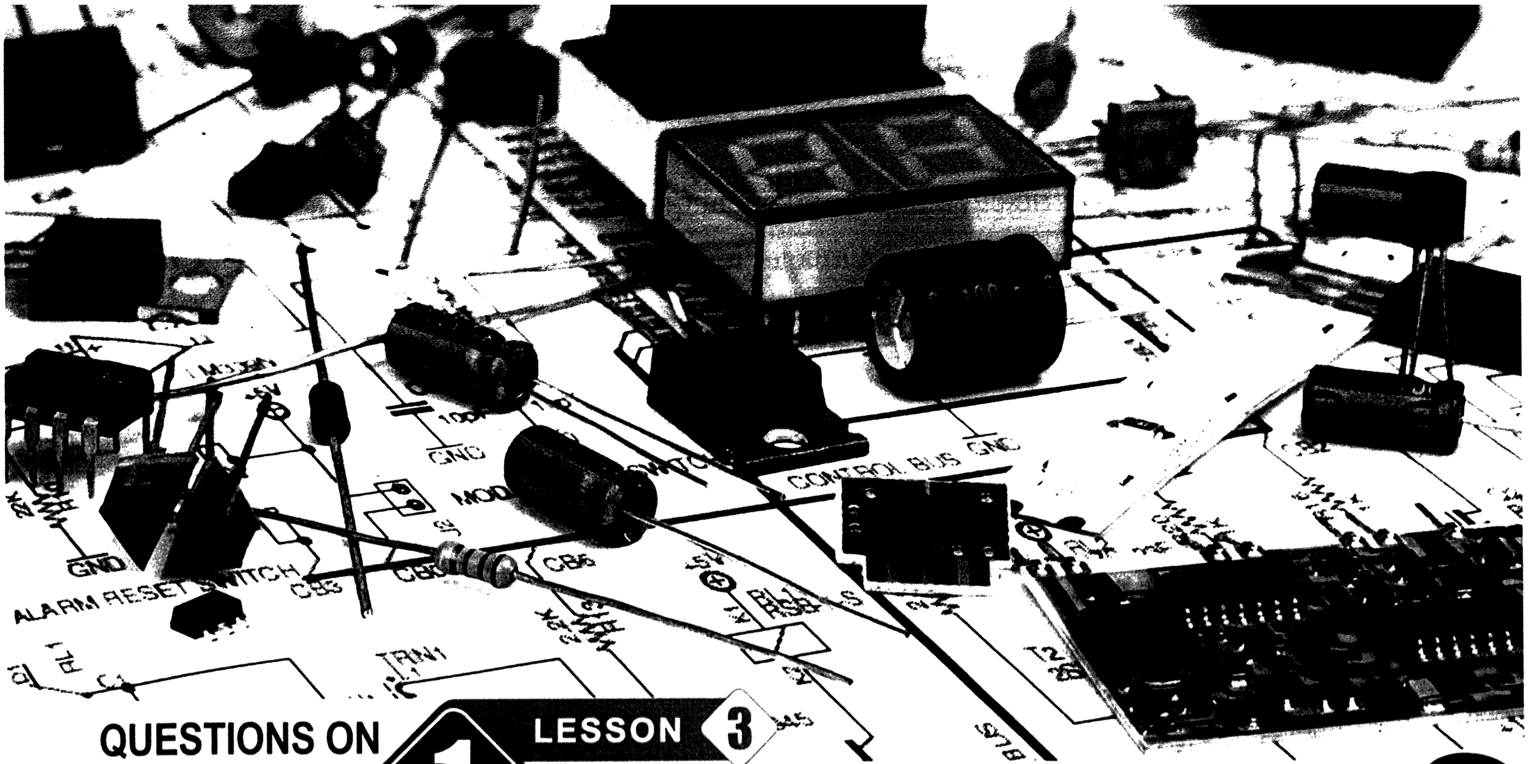


45. Two resistors 15 Ω and x Ω are connected in parallel. This combination is connected in series to a 5 Ω resistor and a battery of emf 5 Volts. If the current through x Ohm resistor is $\frac{1}{3}$ A, find the value of x. *(7.5 Ω)*

46. In the opposite circuit the consumed power in resistor R is 12 W and $I_1 = 2$ A, calculate each of : V , I_2 , I_3 , I , R.

$(12\ V , \frac{4}{3}\ A , 1\ A , \frac{13}{3}\ A , 12\ \Omega)$





QUESTIONS ON **Chapter 1** LESSON 3

Ohm's Law for the Closed Circuit

1 Write down the scientific term for the following :

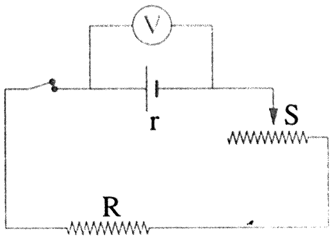
- The total work done inside and outside the electric cell to transfer a quantity of electricity of one Coulomb through the electric circuit.
- Potential difference between the poles of an electric cell at the absence of the electric current in the circuit.

2 Choose the correct answer of the given answers :

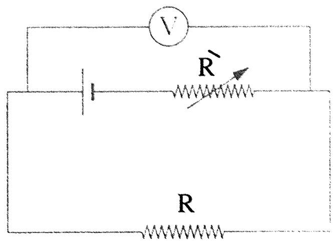
1. The emf is measured in ....
   a. Ampere. b. Volt. c. Ohm. d. Coulomb.

2. If the emf of a power source equals 8 V then the potential difference between its terminals during the flow of electric current in its circuit .... 8 V.
   a. equals b. less than c. more than *(Aug. 97 - 2nd session 13)*

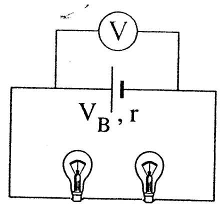
3. In the opposite electric circuit, when the variable resistor (S) increases, then the reading of the voltmeter ....
   a. increases. b. decreases.
   c. remains unchanged. d. reaches zero.



4. In the opposite electric circuit, when R̀ increases then the voltmeter reading (V) ....
   a. decreases. b. increases.
   c. remains unchanged. d. reaches zero.
   (2nd session 09 - Sudan 10)



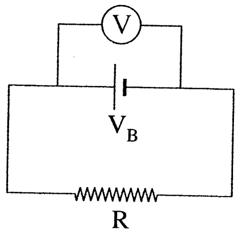
5. In the opposite electric circuit, if the filament of one of the lamps is blown up, then the voltmeter reading ....



a. increases.
b. decreases.
c. remains unchanged.
d. zero.

(Exp. 15)

6. In the opposite circuit, if the internal resistance of the battery is $\frac{1}{4}$ R, then the voltmeter reading ....

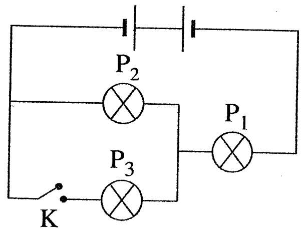


a. $\frac{2}{3}$ V_B
b. $\frac{5}{4}$ V_B
c. $\frac{1}{5}$ V_B
d. $\frac{4}{5}$ V_B

7. A cell of emf V Volt and internal resistance r Ohm is connected across an external resistance 5 r. The terminal voltage (terminal potential difference) of the cell is ....

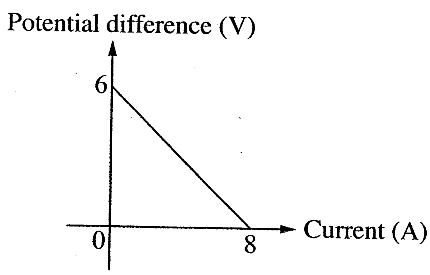
a. $\frac{V}{6}$
b. $\frac{5\,V}{6}$
c. $\frac{6\,V}{5}$
d. $\frac{V}{5}$

8. Three identical electric bulbs are connected within a circuit as shown in the opposite figure. What happens to the glowing of the bulbs P_1 and P_2 when the switch K is turned on ?



	The glowing of P_1	The glowing of P_2
a.	Gets dimmer	Gets dimmer
b.	Glows brighter	Gets dimmer
c.	Unchanged	Gets dimmer
d.	Glows brighter	Unchanged

9. From the opposite diagram :



i. The internal resistance of the cell is ....

a. 1.33 Ω.
b. 0.75 Ω.
c. 1 Ω.
d. 8 Ω.

ii. The emf of the cell is ....

a. 5 V.
b. 6 V.
c. 7 V.
d. 8 V.

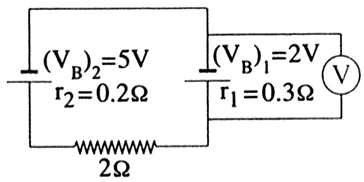
10. When a resistor of 2 Ω is connected across the terminals of the cell the current is 0.5 A and when the resistance is increased to 5 Ohm the current is 0.25 A. The emf of the cell is ....

a. 1 V.
b. 2 V.
c. 1.5 V.
d. 2.5 V.

11. Three equal resistors of 3 Ω each, are connected in series to a cell of internal resistance 1 Ω. If these resistances are connected in parallel and connected to same cell, then the ratio of respective currents through the electric circuits in the two cases is ....

a. 1 : 8 b. 1 : 7 c. 1 : 5 d. 1 : 3

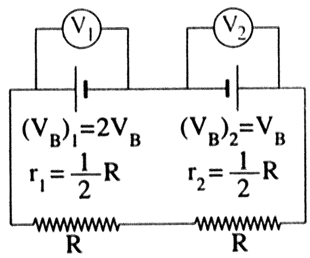
12. In the opposite electric circuit the voltmeter reading is ....



a. 7.64 V. b. 2.36 V.

c. 2 V. d. 1.64 V.

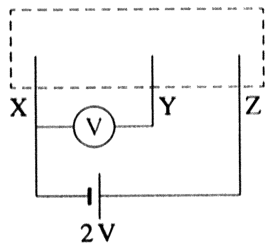
13. In the opposite circuit the ratio $\frac{V_2}{V_1}$ = ...

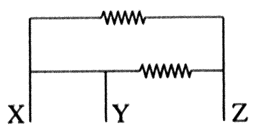


a. $\frac{5}{11}$ b. $\frac{2}{3}$

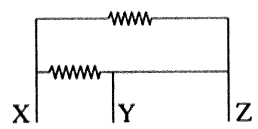
c. $\frac{7}{11}$ d. $\frac{1}{1}$

14. In the opposite figure a battery with electromotive force 2 V and negligible internal resistance, which of the following figures represent the correct combination of different resistors that can be connected to the previous circuit to get a reading of 1.5 V in the voltmeter ....

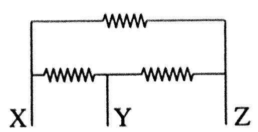




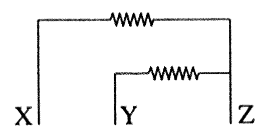
(a)



(b)



(c)



(d)

3 What is meant by ...?

The electromotive force (emf) for an electric cell = 1.5 V *(2nd session 02 - Sudan 15, 17)*

4 Give reasons for :

1. • The potential difference between the terminals of an electric source is equal to its emf when its circuit is opened.

- The potential difference between the terminals of an electric source equals its emf at the absence of the electric current in its circuit. *(1st session 14)*

2. The potential difference between the terminals of a battery increases when the resistance of its circuit increases. *(Exp. 10 - Azhar 11)*
3. The emf of an electric cell is greater than the potential difference between terminals of its external circuit when it is closed.

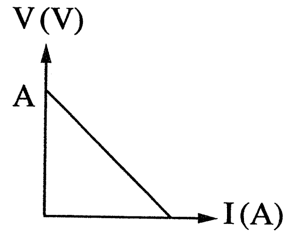
5 **Define** the emf of an electric source. *(Azhar 92 - 1st session 15 - 2nd session 14)*

6 **What are the results of each of the following :**

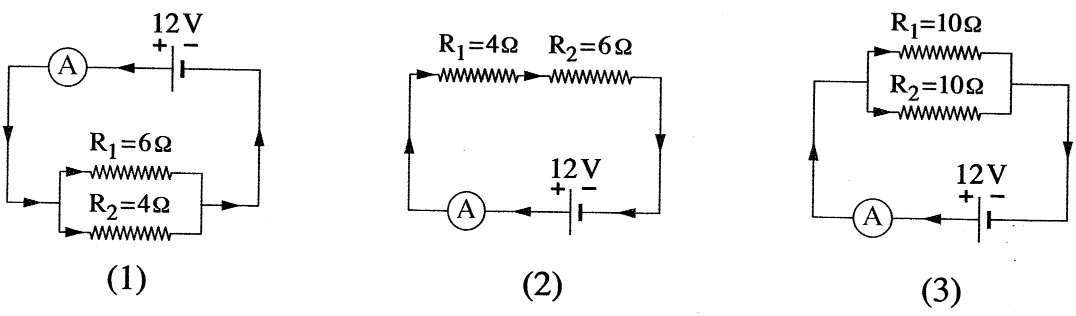
There is no electric current is withdrawn from an electric source concerning the potential difference between its ends.

7 **Miscellaneous questions :**

1. When the potential difference between the terminals of a battery in the electric circuit becomes maximum ? *(Azhar 08)*
2. Mention with drawing, Ohm's law for the closed circuit showing the relation between the emf for a battery and the potential difference between its terminals. *(Exp. 14)*
3. Write the mathematical relation and the equivalent for the slope in the opposite drawing. Then mention what is point (A). *(Sudan 15)*



4. **The following figures show three electric circuits (1), (2), (3) :**



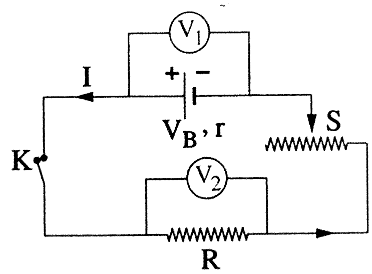
(a) Write the number of the circuit in which :

i. The electric current intensity passing in one of the two resistors differs from the other.

ii. The ammeter reading is maximum.

(b) What happens to the ammeter reading if the internal resistance of the battery is one Ohm ? *(1st session 06)*

5. **In the electric circuit shown in the figure :**



(a) Write the relation between the electric current intensity I passing in the circuit and the reading of each of (V_1, V_2).

(b) Deduce what happens to the reading of each of V_1, V_2 when the value of the rheostat resistance S increases.

(c) What is the reading of each of V_1, V_2 when the switch K is opened ?

(1st session 05 - Sudan 17)

6. Rank the following circuits in order from highest to lowest current.

(a) A 1.4 Ω resistor connected to a battery of 1.5 V that has an internal resistance of 0.1 Ω.

(b) A 1.8 Ω resistor connected to a battery of 4 V that has a terminal voltage of 3.6 V but an unknown internal resistance.

(c) An unknown resistor connected to a battery of 12 V has an internal resistance of 0.2 Ω has a terminal voltage of 11 V.

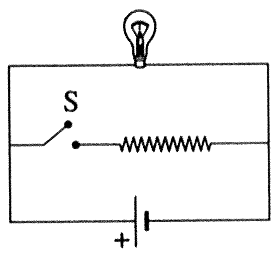
7. A battery has an emf of 12 V and an internal resistance of 2 Ω. Is the terminal to terminal potential difference greater than, less than, or equal to 12 V if the current in the battery is :

(a) from the negative to the positive terminal.

(b) from the positive to the negative terminal.

(c) zero.

8. A battery is connected across a light bulb as shown in the opposite figure, when the switch S is closed, what happens to the brightness of the bulb in the following cases ? Why ?



(a) If the battery has an internal resistance.

(b) If the battery has a negligible internal resistance.

8 Problems :

Guiding notes for solving problems 1

⇒ **Ohm's law for the closed circuit :**

$$V_B = V + Ir = IR + Ir = I(R + r)$$

To determine the electric current intensity (I) in a closed electric circuit :

$$I = \frac{V_B}{R + r} = \frac{V_B - V}{r}$$

- In case of absence of electric current (I = 0) then : $V_B = V$

1. A resistor of 4.7 Ω connected between the terminals of a battery its emf is 12 V and its internal resistance 0.3 Ω. **Calculate :**

(a) The electric current intensity passing in the circuit.

(b) The potential difference between the terminals of the resistor. *(2.4 A , 11.28 V)*

2. A battery its emf is 6 V, if connected to a resistor 10 Ω, a current of 0.5 A passes through it. Calculate the internal resistance of the battery. *(2 Ω)*

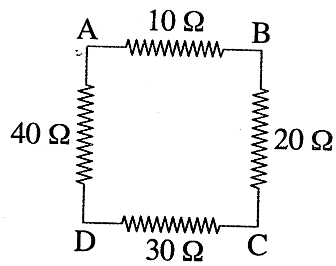
3. A metal wire its length is 30 m , cross-section 0.3 cm^2 and the resistivity of its material 5×10^{-7} Ω.m, connected in series to a resistor of 8.5 Ω and a battery its emf 18 V and its internal resistance 1 Ω. Calculate the electric current intensity passing in the circuit. *(1.8 A) (Aug. 98 - 2nd session 04)*

4. A 6 V battery, its internal resistance 1 Ω is connected to an ammeter of negligible resistance, a constant resistance (R) and a rheostat together in series. When the slider of the rheostat is adjusted at the beginning of the rheostat, electric current of 0.6 A passes in the circuit and when the slider is adjusted at the end of the rheostat electric current of 0.1 A passes in the circuit. **Calculate :**

(a) The resistance (R).

(b) The resistance of the rheostat. *(9 Ω , 50 Ω) (Egy. 92)*

5. The opposite drawing shows four resistors connected in the form of a square ABCD.



(a) What are the two points which when connecting them to a battery the same current passes in all resistors ?

(b) Calculate the emf of the battery. (Knowing that the current intensity passes in each resistance is 0.25 A and the internal resistance of the battery 1 Ω) *(D , B points , 13 V) (Sudan 15)*

6. Three resistors 4 Ω , 6 Ω , 3 Ω are connected together in series to a battery its emf is 30 V and its internal resistance 2 Ω, **calculate :**

(a) The total equivalent resistance.

(b) The electric current intensity passing in the circuit.

(c) The potential difference at the terminals of each resistor. *(15 Ω , 2 A , 6 V , 12 V , 8 V)*

7. Two resistors $R_1 = 6$ Ω , $R_2 = 4$ Ω connected together in parallel between the terminals of electric source its emf is 6 V and its internal resistance 0.1 Ω. **Calculate :**

(a) The electric current intensity passing in the circuit.

(b) The electric power provided by the electric source.

(c) The rate of the consumed electric energy in each of R_1 and R_2

(2.4 A , 14.4 W , 5.53 W , 8.29 W) (Sudan 90)

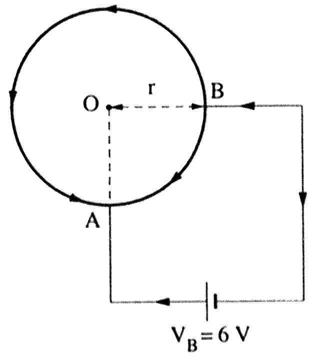
8. A metallic wire of length 30 m and cross-sectional area 0.3 cm^2 is connected in series with a resistance 8.5 Ω which the potential difference across it is 15.3 V; this combination is connected to a battery of emf 18 Volts and of internal resistance 1 Ω.

Calculate :

(a) The intensity of the electric current passing through such a circuit.

(b) The electric conductivity of the wire. *(1.8 A, 2000000 $\Omega^{-1}.m^{-1}$)*

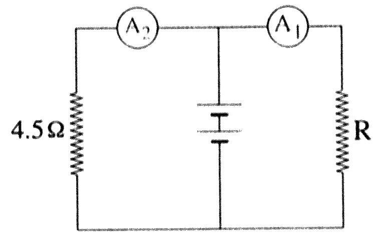
9. A straight wire of resistance 16 Ω is bent to form a closed circular loop of radius (r), then a battery of 6 V and internal resistance 1 Ω is connected between two points A and B on the circumference of the circle dividing it into a quadrant as shown in the figure. Calculate the currents in the two parts of the circle (AB and AOB). *(1.125 A, 0.375 A)*



10. **In the opposite circuit :** If the reading of the ammeter (A_1) = 1 A while reading of the ammeter (A_2) = 2 A and the internal resistance of the battery (r) = 1 Ω, **calculate :**

(a) The resistance R.

(b) The emf of the battery. *(9 Ω, 12 V) (1st session 10)*



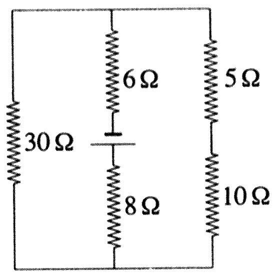
11. From the electric circuit shown in the figure, **calculate :**

(a) The equivalent resistance of the external circuit.

(b) The emf of the source.

(Where the current intensity passing in the resistance 30 Ω equals 1 A and the internal resistance of the source r = 2 Ω)

(24 Ω, 78 V) (2nd session 14)



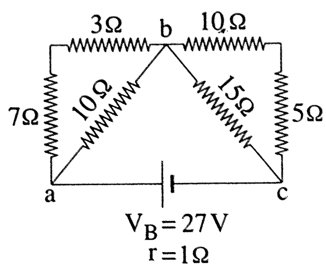
12. **In the circuit shown in the figure, calculate :**

(a) The total external resistance of the circuit.

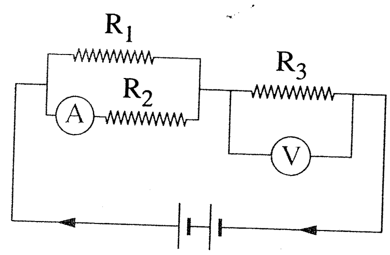
(b) The total current intensity.

(c) Potential difference between b, c.

(12.5 Ω, 2 A, 15 V) (Sudan 08)



13. **In the opposite figure :** Electric circuit consists of $R_1 = 6\ \Omega$, $R_2 = 3\ \Omega$, $R_3 = 2\ \Omega$ and a battery of internal resistance 1 Ω , if the current passing in R_1 equals 1 A, **calculate :**



(a) The reading of the ammeter (A).

(b) The reading of the voltmeter (V).

(c) The emf of the battery. *(2 A , 6 V , 15 V) (2nd session 09)*

14. Resistors 10 Ω , 20 Ω , 40 Ω are connected together with electric source its internal resistance 2 Ω , show by drawing how can we connect these resistors to pass an electric current of intensities 0.4 A , 0.5 A , 0.1 A through them respectively, calculate the emf of the source. *(15 V) (Azhar 05)*

15. Resistors 16 Ω , 6 Ω , 8 Ω are connected together with an electric source its internal resistance 1.2 Ω and when the circuit is closed the potential differences across these resistors were 4 V, 6 V, 2 V respectively, show by drawing how these resistors are connected, then calculate the emf of the source. *(7.5 V) (Azhar 11)*

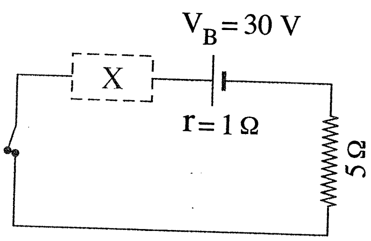
16. Electric circuit contains 4 resistors (R_1, R_2, R_3, R_4) Ohm where the electric currents passing through them are (0.3 A, 0.3 A, 0.4 A, 0.2 A) respectively and the value of $R_1 = 6\ \Omega$, $R_3 = 15\ \Omega$ and the internal resistance of the battery 1 Ω :

(a) Show by drawing how these resistors are connected together.

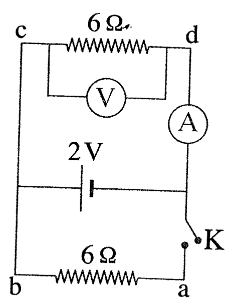
(b) Calculate the total resistance for the circuit.

(c) Calculate the emf of the battery. *(14 Ω , 7.667 Ω , 8.4 V , 6.9 V) (1st session 14)*

17. If you have three resistors $R_1 = 3\ \Omega$, $R_2 = 6\ \Omega$, $R_3 = 2\ \Omega$ explain how to connect them to have an equivalent resistance = 4 Ω, then insert the suggested shape in position (X) in the opposite figure and in your answer sheet draw the complete circuit, then calculate the current intensity passing in the resistance 6 Ω. *(1 A) (2nd session 13)*



18. **In the opposite circuit :** If the internal resistance of the battery 2 Ω, find the reading of both of the ammeter and voltmeter in case of :



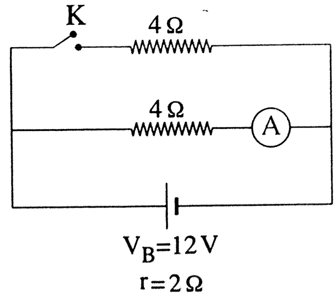
(a) The switch (K) is opened.

(b) The switch (K) is closed. *(0.25 A , 1.5 V , 0.2 A , 1.2 V)*

19. In the circuit shown in the figure, find the reading of the ammeter (A) when :

(a) The switch (K) is opened.

(b) The switch (K) is closed. *(2 A , 1.5 A) (2nd session 05)*

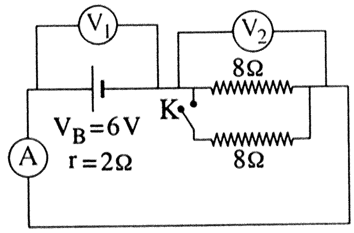


20. In the circuit shown in the figure, find the reading of each of A, V_1 and V_2 in both cases when :

(a) The switch (K) is opened.

(b) The switch (K) is closed.

(0.6 A , 4.8 V , 4.8 V , 1 A , 4 V , 4 V) (1st session 07 - 2nd session 11)



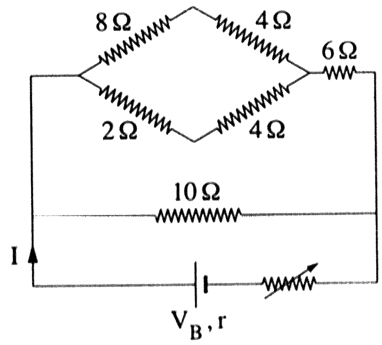
21. **In the electric circuit shown in the figure ;**
Calculate each of :

(a) The value of the used part of the rheostat.

(b) The current intensity passing in the resistor 2 Ω.

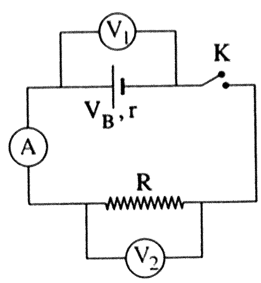
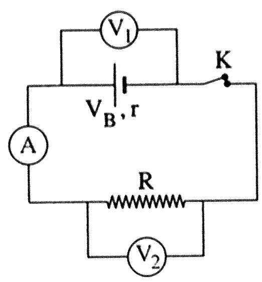
(Where : I = 1 A , r = 1 Ω , V_B = 12 V).

(6 Ω , $\frac{1}{3}$ A) (Azhar 09)



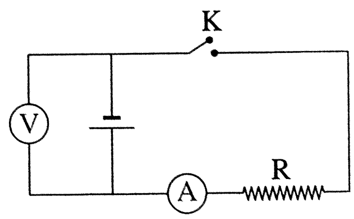
Guiding notes for solving problems 2

⇒ **In the electric circuit shown in the figure if switch K is :**

Opened	**Closed**
	
$I = 0$	$I = \frac{V_B}{R + r} = \frac{V_B - V_1}{r} = \frac{V_2}{R}$
$V_2 = 0$	$V_2 = IR$
$V_1 = V_B$	$V_1 = V_B - Ir$

22. In the opposite circuit, when the switch (K) is open the reading of the voltmeter is 12 V and when it is closed its reading is 9 V and that of the ammeter is 1.5 A, **find :**

(a) emf of the battery.



(b) The internal resistance of the battery.

(c) The resistance R.

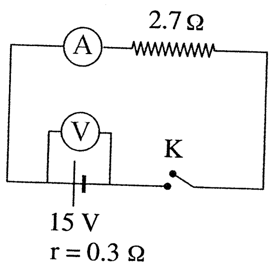
(d) The conductivity of the wire material of the resistor R if it is a wire of length 6 m and cross-section 0.1 cm^2.

(2^{nd} session 00)

(e) Reading of the voltmeter if resistor R is replaced by another of 8 Ω.

(12 V , 2 Ω , 6 Ω , 10^5 $\Omega^{-1}.m^{-1}$, 9.6 V)

23. **In the opposite figure :** Electric circuit is formed of a battery 15 V its internal resistance 0.3 Ω, connected to an external resistance 2.7 Ω, calculate the reading of the voltmeter in the following cases :

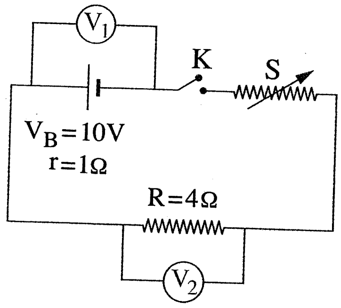


(a) The switch (K) is opened, considering the resistance of the voltmeter is infinity.

(b) The switch (K) is closed.

(15 V , 13.5 V)

24. In the circuit shown in the figure, if the switch K is closed and resistance S is adjusted at 5 Ω :



(a) Find the reading of V_1 , V_2

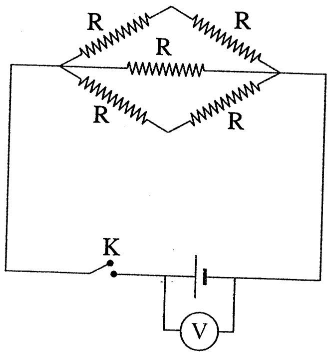
(b) What happens to the readings of V_1, V_2 at the increase of S ?

(c) Find the reading of V_1, V_2 when the switch K is opened.

(9 V , 4 V , 10 V , 0)

25. In the electric circuit shown in the figure, if the internal resistance of the battery is 2 Ω and the reading of the voltmeter is 12 V when the switch K is opened and 10 V when the switch K is closed, calculate the electric current intensity passing in the circuit and the value of the resistor R.

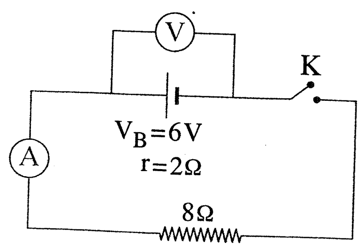
(1 A , 20 Ω) (Azhar 14)



26. Observe the electric circuit shown in the figure and record the readings of both the ammeter and voltmeter according to the following table :

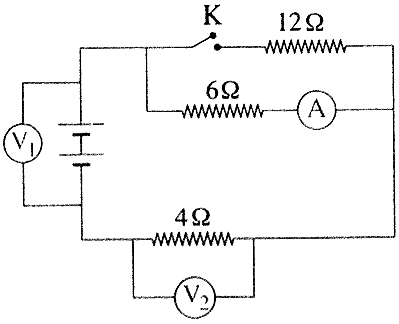
(1^{st} session 04)

Switch (K)	Voltmeter reading in (V)	Ammeter reading in (A)
Opened :	....	....
Closed :	....	....



27. In the electric circuit shown in figure, if the emf of the battery 12 V and its internal resistance 2 Ω , record the readings of the devices in the following table :

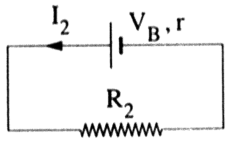
Device	Opened (K)	Closed (K)
Ammeter (A) :	....	....
Voltmeter (V_1) :	....	....
Voltmeter (V_2) :	....	....



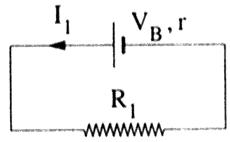
(Exp. 10 - Sudan 12 , 16)

Guiding notes for solving problems 3

⇒ When the external resistor R_1, which carries electric current of intensity I_1 is replaced by another R_2 , the electric current intensity passing in the circuit changes to I_2 at the same battery :



$V_B = I_2 (R_2 + r)$



$V_B = I_1 (R_1 + r)$

Thus the two equations are solved algebraically to find the unknown values.

28. When a resistor of 1.9 Ω is connected to an electric cell, the electric current intensity passing through it was 0.5 A and when it is replaced by another of 10.6 Ω the value of the electric current dropped to 0.125 A , calculate the emf of the cell. *(1.45 V)*

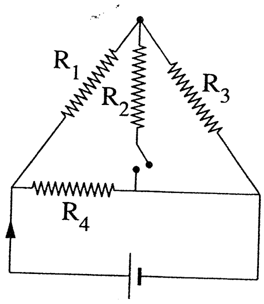
29. When a resistor (R) is connected to an electric cell, electric current intensity (I) passes through it and when another resistor of value $\frac{R}{2}$ is connected with the first in parallel , the electric current intensity increased to the double. Calculate the internal resistance of the electric cell in terms of R. $(\frac{R}{3})$

30. Two similar wires made of the same material, the length of each is 50 cm and its cross-section area 2 mm^2. When they are connected together in series in an electric circuit with a cell its internal resistance 0.5 Ω, the electric current intensity passing in the circuit was 2 A and when the same wires are connected in parallel to the same cell the total electric current intensity became 6 A. **Calculate :**

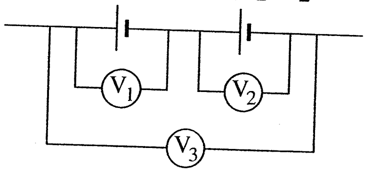
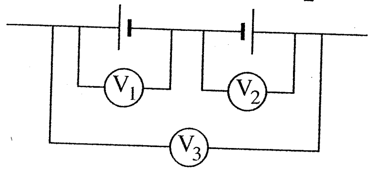
(a) The emf of the used electric cell.

(b) The conductivity of the material of the wire. *(9 V , $125 \times 10^3\ \Omega^{-1}.m^{-1}$) (Egy. 95 - Sudan 08)*

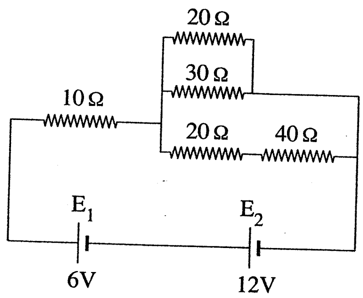
31. Four resistors $R_1 = 6\ \Omega$, $R_2 = 3\ \Omega$, $R_3 = 6\ \Omega$, $R_4 = 24\ \Omega$ are connected as in the opposite figure. When the switch is opened a current of 1 A passes in the battery and when the switch is closed that current becomes 1.25 A , calculate the internal resistance of the electric source and its emf. *(2 Ω , 10 V)*



Guiding notes for solving problems 4

- In case of 2 electric cells connected in series.	- In case of 2 electric cells connected opposite to each other.
	
$I = \frac{(V_B)_1 + (V_B)_2}{R + r_1 + r_2}$	$(V_B)_1 > (V_B)_2$ $I = \frac{(V_B)_1 - (V_B)_2}{R + r_1 + r_2}$
$V_1 = (V_B)_1 - Ir_1$ $V_2 = (V_B)_2 - Ir_2$ $V_3 = V_1 + V_2$	$V_1 = (V_B)_1 - Ir_1$ (discharging case) $V_2 = (V_B)_2 + Ir_2$ (charging case) $V_3 = V_1 - V_2$

32. 📖 Calculate the total external resistance for the circuit shown in figure and also the total current intensity passing through it if the internal resistance for each cell is 2 Ω. *(20 Ω , 0.75 A)*



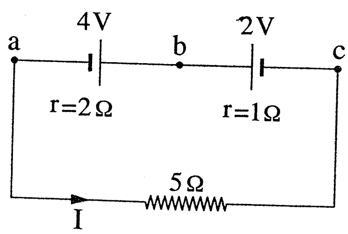
33. **From the opposite figure find :**

(a) The current intensity passing in the circuit.

(b) The potential difference between the points a, b.

(c) The potential difference between the points b, c.

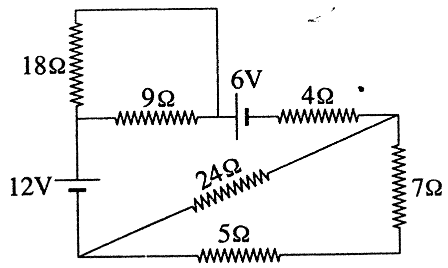
(0.25 A , 3.5 V , 2.25 V)



34. From the opposite circuit find :

(a) The current intensity passing through the battery 12 V.

(b) The consumed power in the resistor 9 Ω.



($\frac{1}{3}$ A , $\frac{4}{9}$ Watt)

35. **Figure (1) which is shown below represents a graph for the change of electric potential through the circuit which is shown in figure (2) :**

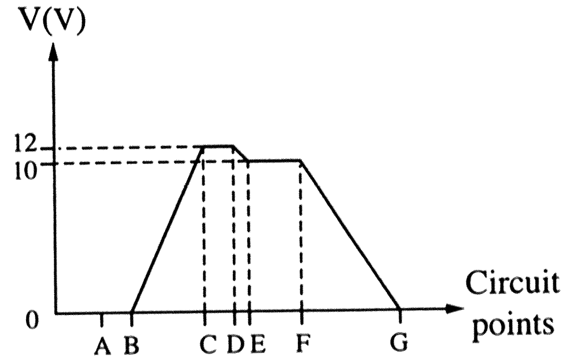


Figure (1)

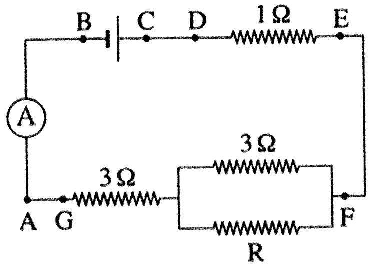


Figure (2)

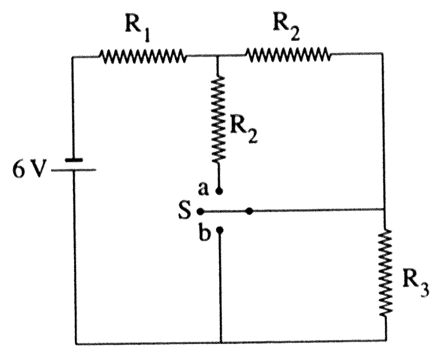
From studying these two figures (1) & (2) find :

(a) The ammeter reading.

(b) The resistance R.

(2 A , 6 Ω)

36. In the opposite figure the e.m.f of the battery is 6 V and the electric current intensity that passes through the battery in case of opening the switch S in both directions is 1 A, in case of closing switch S in the direction of (a) the electric current intensity will be 1.2 A and if it is closed in the direction of (b) the current will be 2 A , calculate each of R_1 , R_2 , R_3



(1 Ω , 2 Ω , 3 Ω)

QUESTIONS ON **Chapter 1** LESSON 4

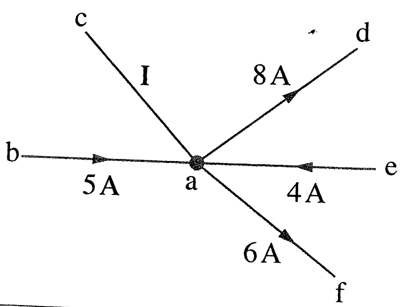
Kirchhoff's Laws

1 Write down the scientific term for each statement of the following :

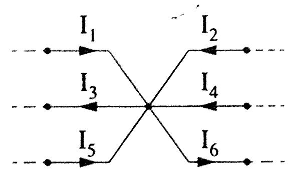
1. • Sum of currents flowing into a node is equal to the sum of currents flowing out of that node.
   • The algebraic sum of the electric currents at a junction in a closed circuit equals zero.
2. • The algebraic sum of the electromotive forces in any closed loop is equal to the algebraic sum of the potential differences within that loop.
   • The algebraic sum of the potential differences in any closed loop in the electric circuit equals zero.

2 Choose the correct answer of the given answers :

1. Kirchhoff's first law expresses the law of ....
   a. conservation of energy.
   b. conservation of mass.
   c. conservation of charge.
   d. conservation momentum.
2. The mathematical formula for Kirchhoff's first law ....
   a. $\Sigma I = 0$
   b. $\Sigma V = \Sigma IR$
   c. $\Sigma I = \Sigma VR$
   d. $\Sigma V = 0$
3. In the network shown in the figure, the value of the current (I) ....
   a. 3 A from a to c.
   b. 3 A from c to a.
   c. 5 A from a to c.
   d. 5 A from c to a.

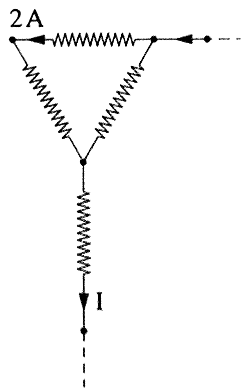


4. In the opposite figure, if $I_1 = I_2 = I_3 = I_4 = I_5$
, then ....



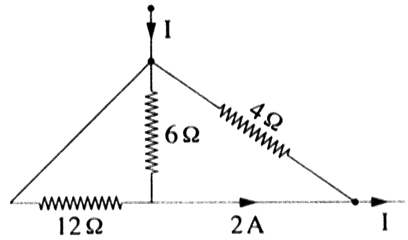
a. $I_6 = I_1$ b. $I_6 = 2I_1$
c. $I_6 = 3I_1$ d. $I_6 = 4I_1$

5. In the opposite figure if all the resistors are the same
, then the value of I is ....



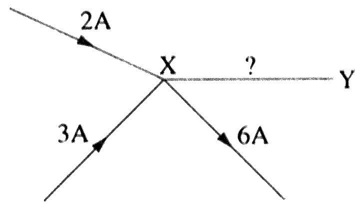
a. 2 A.
b. 4 A.
c. 6 A.
d. no correct answer.

6. In the opposite figure the value of I is ....



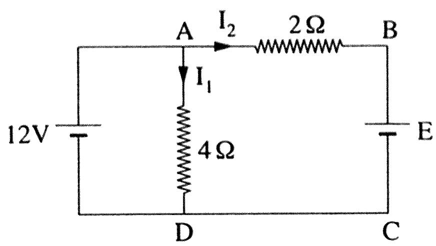
a. 2 A. b. 6 A.
c. 12 A. d. 4 A.

7. The diagram shows the magnitude and directions of the electric currents entering and leaving junction X. What will be the magnitude and direction of the current in the wire XY ? ....



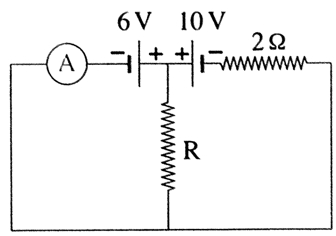
a.	1 A	from X to Y
b.	1 A	from Y to X
c.	5 A	from X to Y
d.	5 A	from Y to X

8. In the circuit shown in figure, current $I_2 = 0$
The value of E is ....



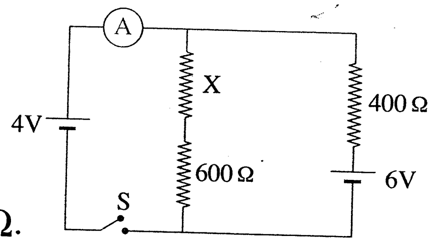
a. 3 V. b. 6 V.
c. 9 V. d. 12 V.

9. In the circuit shown, the ammeter shows zero current. If the two cells 6 V and 10 V have negligible internal resistance, what is the value of the resistor R ? ....



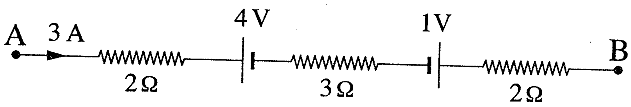
a. 2 Ω. b. 3 Ω.
c. 6 Ω. d. 10 Ω.

10. In the circuit shown in the adjoining figure, the ammeter reading is zero when the switch S is closed. If the batteries are of zero internal resistance, the value of resistance X is ....



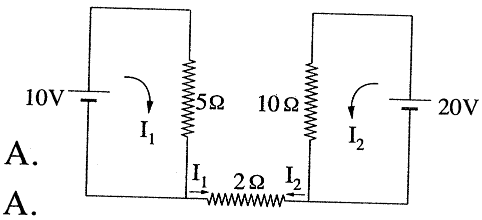
a. 100 Ω.
b. 200 Ω.
c. 300 Ω.
d. 400 Ω.

11. What is the potential difference between the terminals A and B ? ....



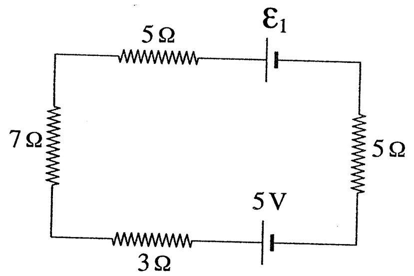
a. 12 V.
b. 24 V.
c. 36 V.
d. 48 V.

12. In the given circuit, the value of current through 2 Ω resistor is ....



a. 2 A.
b. 4 A.
c. zero.
d. 5 A.

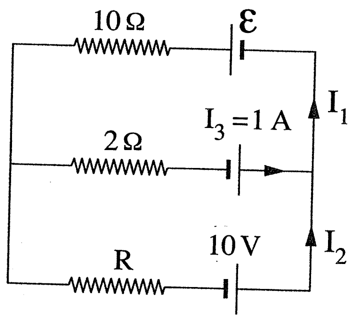
13. In the circuit shown $\varepsilon_1 = 30$ V. The power dissipated in the 7 Ω resistor is .... Watt.



a. 15.75
b. 10.94
c. 3.94
d. 1.75

14. In the circuit shown $I_1 = 2$ A and $I_3 = 1$ A. The value of ε is ....

a. 15 V.
b. 18 V.
c. 20 V.
d. 22 V.



15. In the previous question, the resistance of the unknown resistor R is ....

a. 12
b. 15
c. 20
d. 30

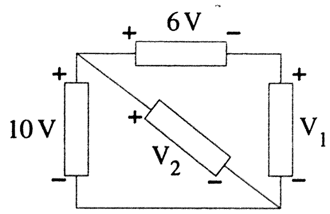
16. Kirchhoff's second law expresses the law of ....

a. conservation of charge.
b. conservation of mass.
c. conservation of energy.
d. conservation of momentum.

17. The mathematical formula for Kirchhoff's second law ....

a. $\Sigma I = 0$
b. $\Sigma V = \Sigma IR$
c. $\Sigma V = \Sigma IR^2$
d. $\Sigma V = \Sigma I^2R$

18. In the electric circuit shown in the figure :



i. Value of V_1 = ...

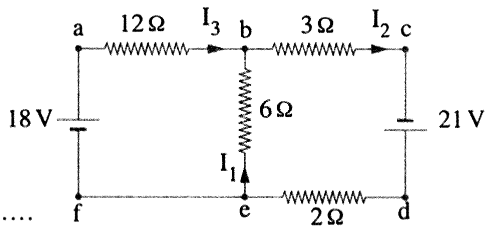
a. 4 V　　b. 6 V

c. 10 V　　d. 60 V

ii. Value of V_2 = ...

a. 5 V　　b. 7 V　　c. 10 V　　d. 20 V

19. In the circuit shown :



i. The value of I_1 = ...

a. 0.5 A　　b. 1 A

c. 2 A　　d. 3 A

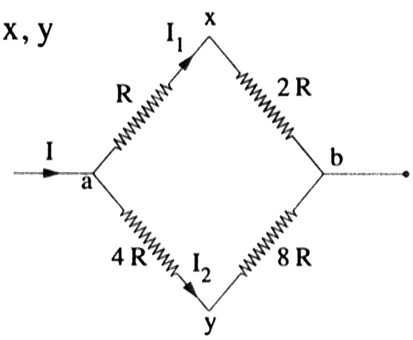
ii. Potential difference across the resistor 12 Ω is ....

a. 2 V.　　b. 12 V.　　c. 24 V.　　d. 36 V.

iii. The consumed power in the resistor 3 Ω is ....

a. 3 W.　　b. 9 W.　　c. 18 W.　　d. 27 W.

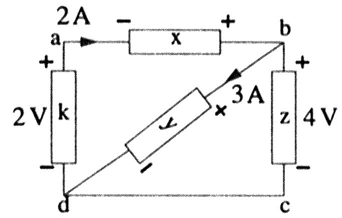
20. In the opposite figure the potential difference between x, y equals .... V.



a. 0　　b. 3 IR

c. 6 IR　　d. IR

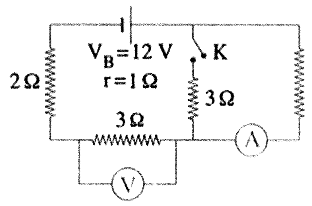
21. In the shown circuit, the powers $(P_w)_x$, $(P_w)_y$ respectively will be ....



a. 4 W, 12 W.　　b. 12 W, 4 W.

c. 16 W, 12 W.　　d. 4 W, 14 W.

22. In the opposite circuit, when closing switch K ....



(2[nd] session 17)

	Reading of (A)	Reading of (V)
a.	Increases	Decreases
b.	Decreases	Increases
c.	Increases	Increases
d.	Decreases	Decreases

3 What is meant by ...?

1. Kirchhoff's first law.　　2. Kirchhoff's second law.

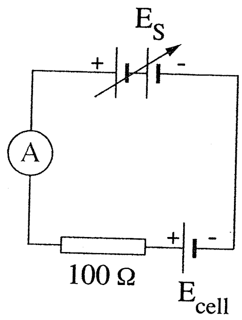
4 Mention one use for Kirchhoff's laws.

5 Miscellaneous questions :

1. Kirchhoff's first law expresses the conservation of an important physical quantity; name the physical quantity that is conserved ?

2. Kirchhoff's second law expresses the conservation of an important physical quantity; name the physical quantity that is conserved ?

3. The electric circuit shown in the opposite figure used to determine the value of emf of a cell (E_{cell}) by using Kirchhoff's second law, by changing the value of emf of the supply (E_s), the reading of ammeter (I) will change. By studying the relation between the value of emf of the supply (E_s) and the reading of ammeter (I), the opposite graph is obtained.



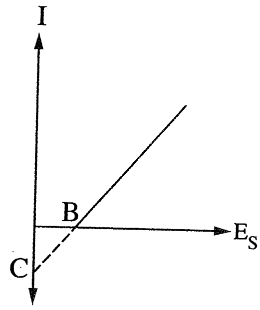
Answer the following questions :

(a) Write Kirchhoff's second law that expresses the electric circuit shown in the figure.

(b) What is the slope of the graph ?

(c) What does point B represent ?

(d) What does point C represent ?



6 Problems :

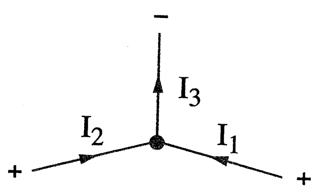
Guiding notes for solving problems

⇒ **Kirchhoff's laws :**

- Kirchhoff's first law :

$\Sigma I = 0$ $\qquad I_1 + I_2 - I_3 = 0$

$I_3 = I_1 + I_2$ $\quad$ or $\quad \Sigma I_{(in)} = \Sigma I_{(out)}$

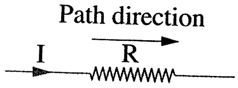
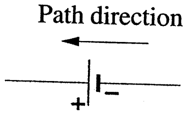
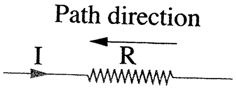
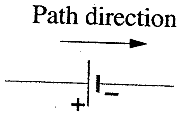


- Kirchhoff's second law :

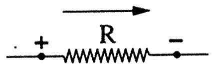
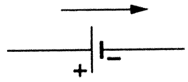
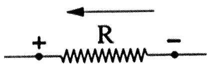
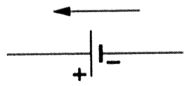
$\Sigma V_B = \Sigma IR$

$V_1 + V_2 = I_1R_1 + I_2R_2$

- The sign rule : (1) $\Sigma V_B = \Sigma IR$

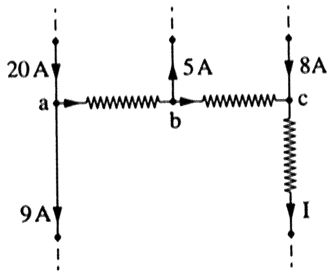
In the resistor	In the battery
Path direction  $V = + IR$	Path direction  $V = + V_B$
Path direction  $V = - IR$	Path direction  $V = - V_B$

(2) $\Sigma V = 0$

In the resistor	In the battery
Path direction  $V = -IR$	Path direction  $V = -V_B$
Path direction  $V = IR$	Path direction  $V = +V_B$

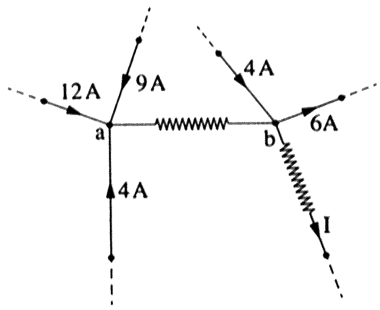
1. **The following figures are parts of electric circuits. Find the value of unknown (I) in each of them :**

(a)



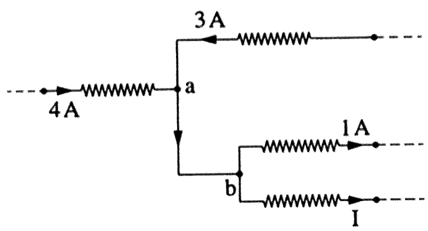
(14 A)

(b)



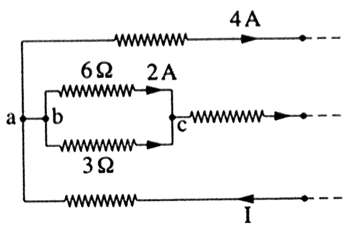
(23 A)

(c)



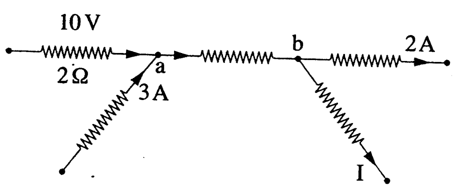
(6 A)

(d)



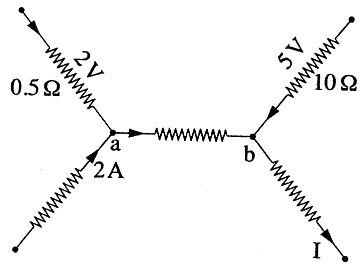
(10 A)

(e)



(6 A)

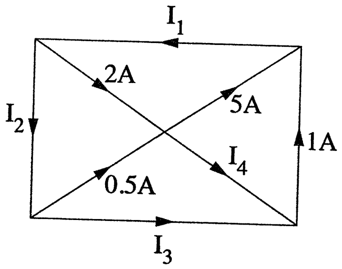
(f)



(6.5 A)

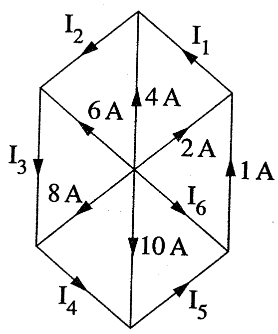
2. **In the shown networks, calculate the value of the unknown currents :**

(a)



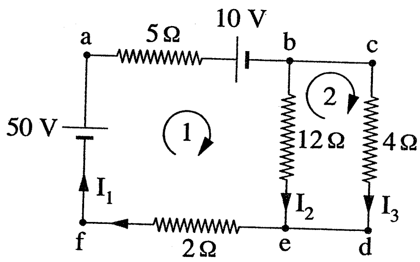
(6 A , 4 A , 3.5 A , – 2.5 A)

(b)



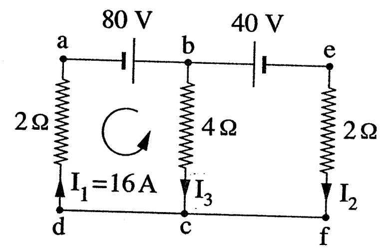
(3 A , 7 A , 13 A , 21 A , 31 A , – 30 A)

3. Using Kirchhoff's laws, how can you find I_1, I_2, I_3 in the opposite circuit. *(4 A , 1 A , 3 A)*



4. From the opposite circuit calculate I_2, I_3

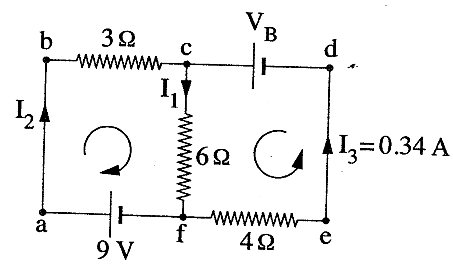
(4 A , 12 A)



5. **From the opposite circuit find :**

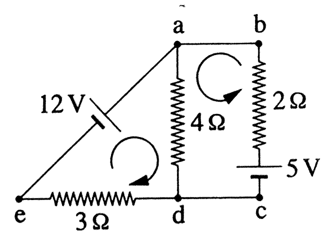
(a) I_1, I_2

(b) Potential difference V_B



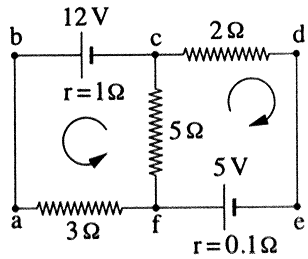
(1.11 A , 0.77 A , 8.02 V)

6. From the opposite circuit calculate, the current intensity in each branch. *(2 A , 1.5 A , 0.5 A)*

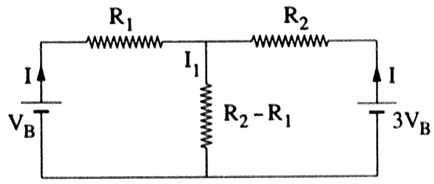


7. From the opposite circuit calculate, the current intensity in each branch in the circuit shown in the figure.

(1.546 A , 1.16 A , – 0.386 A)



8. In the circuit shown in the figure, find the ratio $\frac{R_1}{R_2}$ $(\frac{3}{1})$

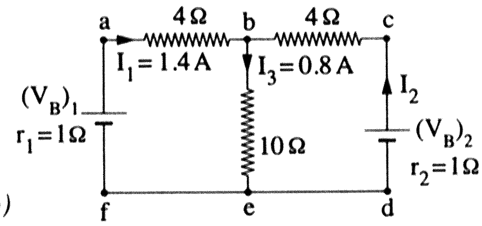


9. From the opposite circuit calculate :

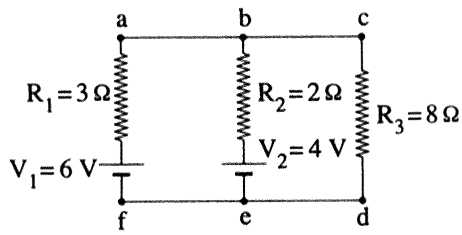
(a) $(V_B)_1$, $(V_B)_2$

(b) Potential difference between points e, b.

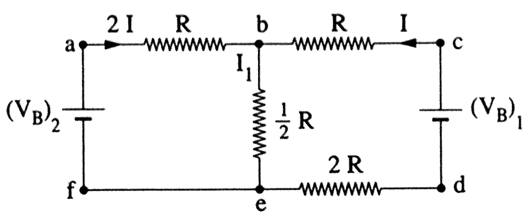
(15 V , 5 V , 8 V) (Exp. 16)



10. Calculate the current intensities passing through the resistances R_1, R_2, R_3 in the electric circuit shown in the figure ignoring the internal resistance of each source. *(0.609 A , 0.087 A , 0.52 A)*

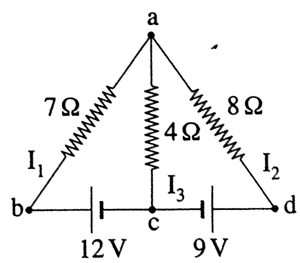


11. In the shown circuit find the ratio $\frac{(V_B)_1}{(V_B)_2}$. $(\frac{9}{7})$

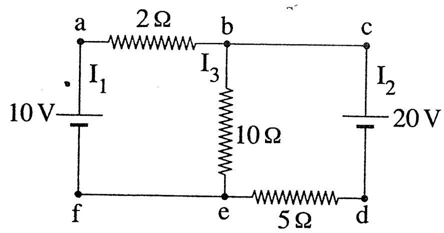


12. From the opposite circuit calculate I_1, I_2, I_3

(0.93 A , 0.44 A , 1.37 A)

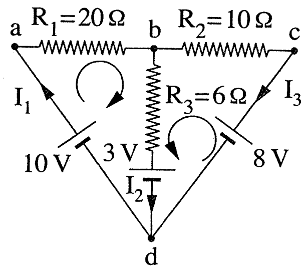


13. From the opposite circuit calculate the electric current intensity I_1, I_2, I_3 *(0.625 A , 1.75 A , 1.125 A)*



14. From the opposite circuit calculate the current intensities passing in resistors R_1, R_2, R_3

(0.215 A , 0.447 A , – 0.232 A)

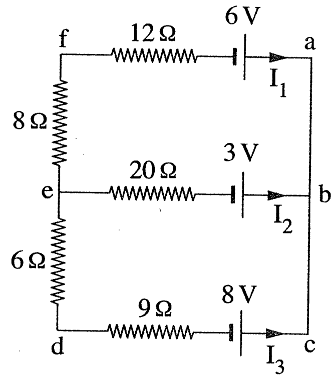


15. **From the opposite circuit calculate :**

(a) The current passing in resistor 12 Ω.

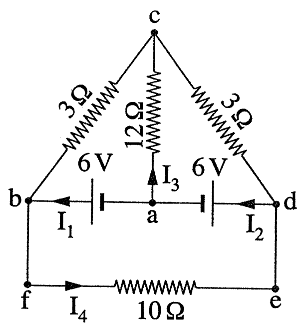
(b) The consumed power in resistor 20 Ω.

(c) The potential difference between the ends of resistor 9 Ω. *(0.005 A , 0.42 W , 1.26 V)*



16. From the opposite circuit calculate I_1, I_2, I_3, I_4

(0.22 A , – 0.22 A , – 0.44 A , 0)

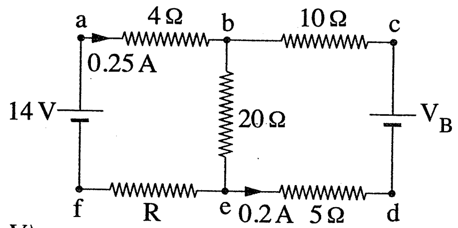


17. **From the opposite circuit find :**

(a) Electric current in resistor 20 Ω.

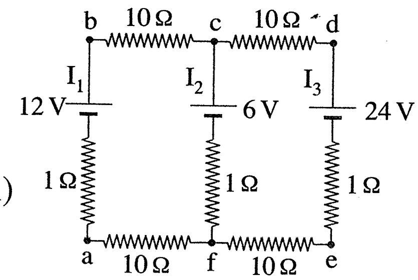
(b) Value of resistor R.

(c) The emf V_B *(0.45 A , 16 Ω , 12 V)*



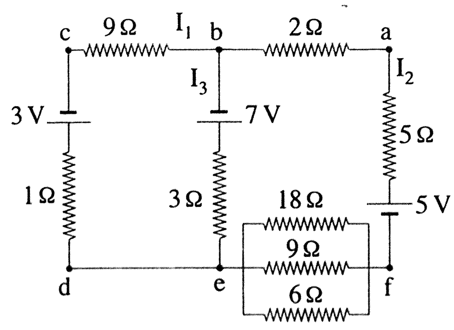
18. Calculate the current intensity passing in the opposite circuit.

(0.23 A , 1.04 A , 0.81 A)



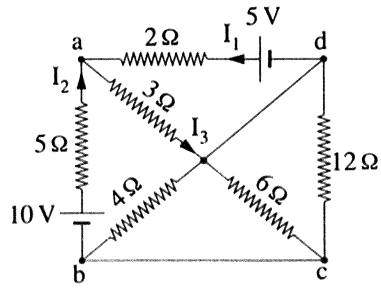
19. From the opposite circuit calculate I_1, I_2, I_3

(+ 0.1 A , 0.9 A , 1 A)

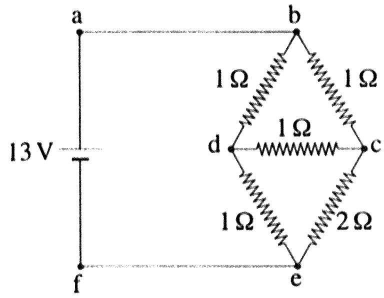


20. From the opposite circuit calculate I_1, I_2, I_3

(0.49 A , 0.85 A , 1.34 A)



21. Calculate the total resistance of the electric circuit shown in figure. *(1.18 Ω)*



22. The following equations express an electric circuit :

$I_1 + I_2 = I_3$ ... (1)

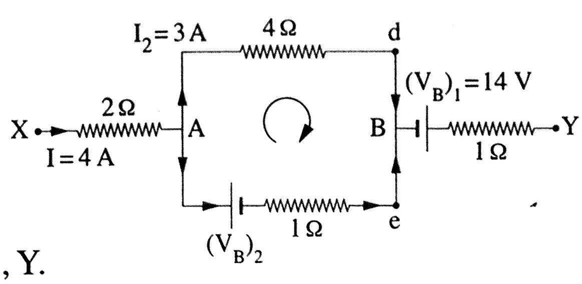
$5 \text{ (Volt)} = 5\, I_1 + 2.5\, I_3$ ... (2)

$25 \text{ (Volt)} = 7.5\, I_2 + 2.5\, I_3$ ... (3)

(a) Draw the electric circuit.

(b) Calculate each unknown value in the previous equations. *($-\frac{2}{11}$ A , $\frac{28}{11}$ A , $\frac{26}{11}$ A)*

23. The opposite figure represents part of an electric circuit. Using Kirchhoff's laws and the shown current pathes and the data on the figure, **calculate :**



(a) The potential difference between points X , Y.

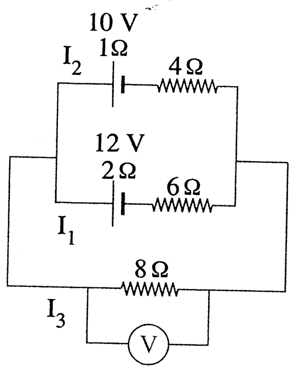
(b) e.m.f of the battery $(V_B)_2$

(Where the internal resistance for the two sources are ignored). *(10 V , 11 V) (1^{st} session 16)*

24. In the electric circuit shown in the figure, **calculate :**

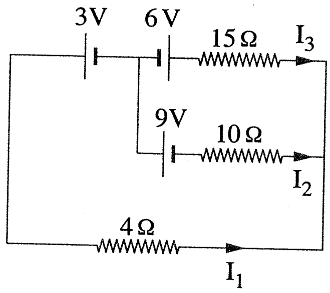
(a) The electric current intensity passing in the two resistors 6 Ω , 4 Ω.

(b) The voltmeter reading.



$(\frac{19}{36}\ A\ ,\ \frac{4}{9}\ A\ ,\ \frac{70}{9}\ V)$

25. Using Kirchhoff's laws calculate the currents intensities shown in the figure I_1 , I_2 , I_3
Are the proposed currents correct or not ?

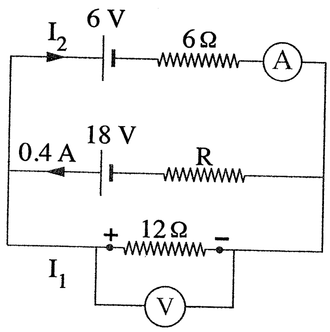


(0.6 A , – 0.96 A , 0.36 A) (Egy. 90)

26. Using the electric circuit shown in the figure , **calculate :**

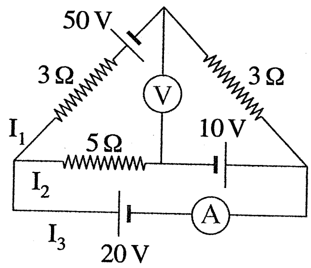
(a) The reading of both of the ammeter and voltmeter.

(b) Value of resistor (R).



(– 0.067 A , 5.6 V , 31 Ω)

27. In the electric circuit shown in the figure, calculate the reading of each of the ammeter and voltmeter.

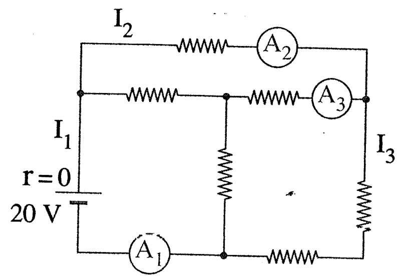


(– 1 A , 5 V)

28. In the electric circuit shown in the figure, if the value of each resistor is 2 Ω , **calculate :**

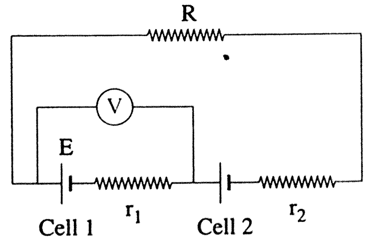
(a) Reading of A_1 , A_2 , A_3

(b) The total resistance of the circuit.

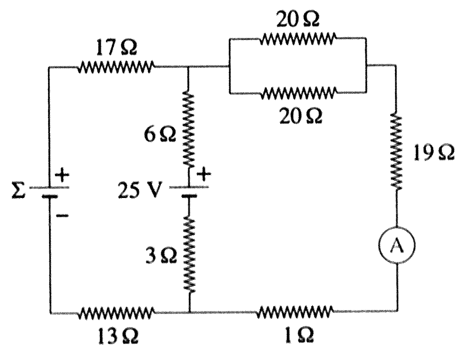


$(\frac{110}{13}\ A\ ,\ \frac{50}{13}\ A\ ,\ \frac{10}{13}\ A\ ,\ \frac{26}{11}\ \Omega)$

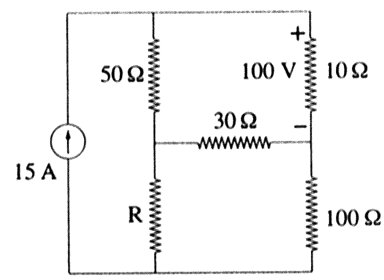
29. In the circuit shown, cells are of equal emf E but of different internal resistances $r_1 = 6\ \Omega$ and $r_2 = 4\ \Omega$. Reading of the ideal voltmeter connected across cell 1 is zero. Calculate the value of the external resistance R. (2 Ω)



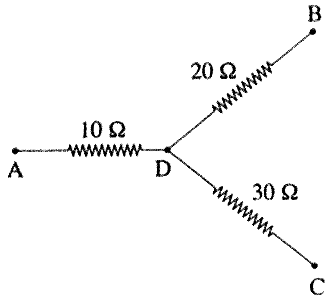
30. In the circuit shown in the figure : The 6 Ω resistor is consuming energy at a rate of 24 J/s when the current through it flows as shown.
(a) Find the current through the ammeter A.
(b) What are the polarity and emf Σ of the battery ? (Assuming it has negligible internal resistance) *(0.233 A , – 46 V)*



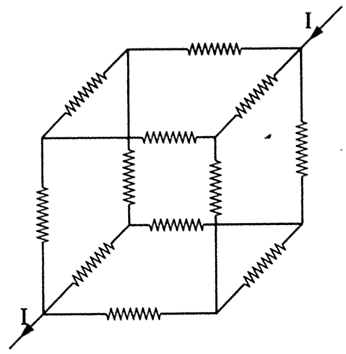
31. Using Kirchhoff laws for the circuit as shown (using the given current directions and symbols). Calculate the value of R. *(35 Ω)*



32. In the circuit shown in the opposite figure, the potential of points A, B and C are 70 V, 0 V, 10 V respectively. **Calculate :**
(a) The current passing through each resistor.
(b) The potential of point D. (3 A , 2 A , 1 A , *40 V)*

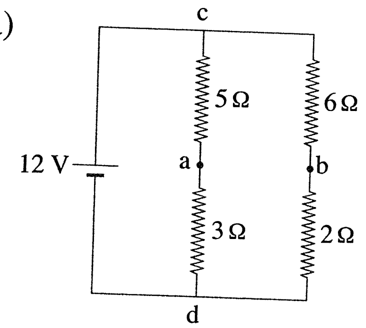


33. In the shown figure, 12 resistors each of resistance R, connected together in a form of a cube, calculate the equivalent resistance of the shape in terms of R. $(\frac{5}{6}R)$

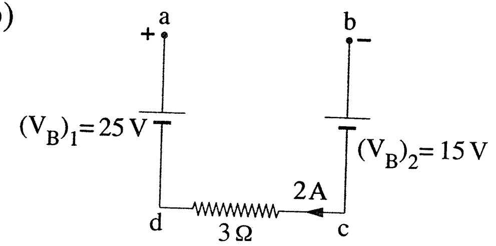


34. **Calculate the potential difference between a and b in the following circuits :**

(a)



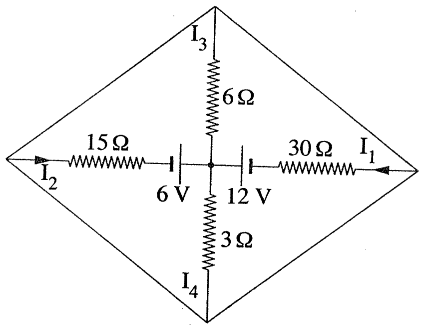
(b)



(1.5 V , 4 V)

35. In the shown circuit calculate :
I_1 , I_2 , I_3 , I_4

(0.36 A , 0.31 A , 0.22 A , 0.45 A)

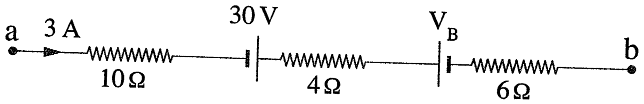


36. The following figure is showing a part of a circuit, if the dissipated power between point (a) and point (b) equals 210 W , calculate :

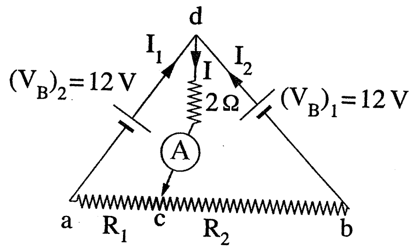
(a) The unknown electromotive force (V_B).

(b) The potential difference between points a , b.
(note that the internal resistance is negligible for all cells)

(10 V , 40 V)



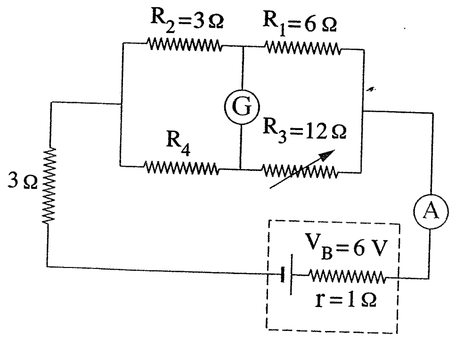
37. In the shown circuit if the wire ab has homogeneous resistance of 10 Ω and C is the point that contact the slider with the wire which divides the wire into two parts each of resistance R_1 , R_2 where $R_2 = 1.5\ R_1$, calculate the electric current intensity in each branch of the circuit. *(1.64 A , 1.09 A , 2.73 A)*

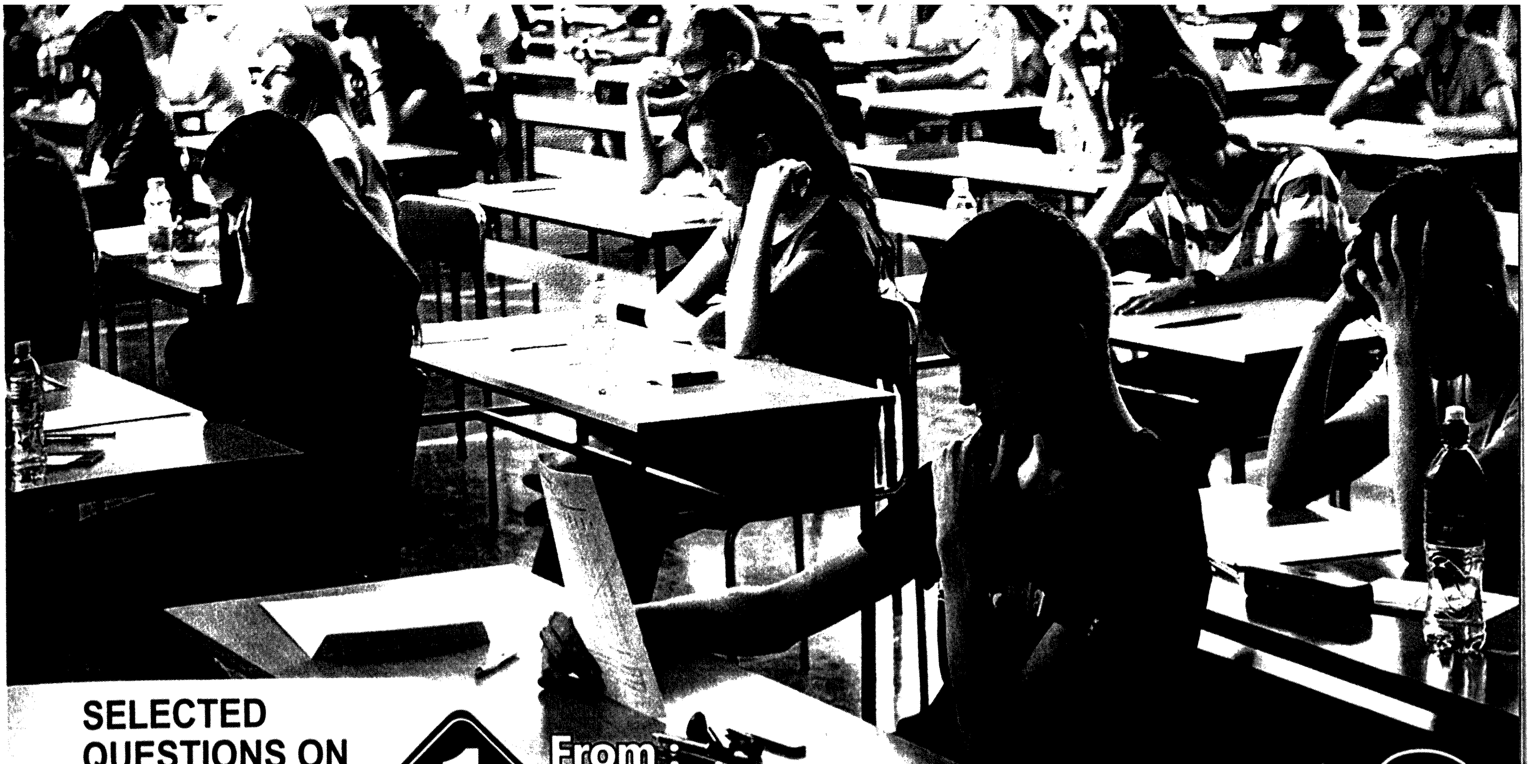


38. In the opposite circuit if the reading of the galvanometer vanished when the value of the rheostat R_3 became 12 Ω , **calculate :**

(a) The resistance of the unknown resistor R.

(b) The reading of the ammeter. *(6 Ω , 0.6 A)*





SELECTED QUESTIONS ON

Chapter 1

From :

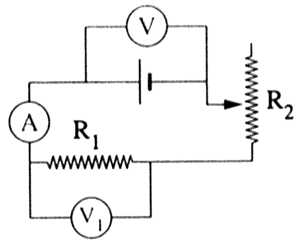
- **Student Evaluation Guide (2017).**
- **Booklet Models of the Ministry of Education.**

1 Choose the correct answer of the given answers :

1. To move 6.25×10^{18} electron between the terminals of a resistor in two seconds , the potential difference should be 12 V, so the value of resistance is ....

   a. 24 Ω. b. 12 Ω. c. 6 Ω. d. 3.84 Ω.

2. What will happen to the reading of the devices shown in the figure when the value of rheostat (R_2) increases ? ....



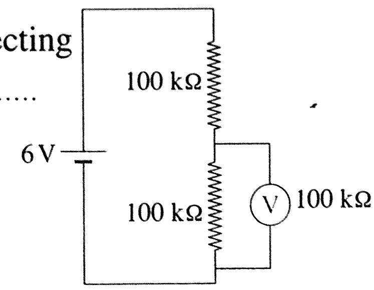
	Ammeter's reading (A)	Voltmeter's reading (V)	Voltmeter's reading (V_1)
a.	decreases	decreases	increases
b.	doesn't change	decreases	doesn't change
c.	decreases	decreases	decreases
d.	decreases	increases	increases

(Booklet 4)

3. The resistance of the voltmeter in the figure is 100 k Ω (neglecting the internal resistance of the battery) what is its reading ? ....

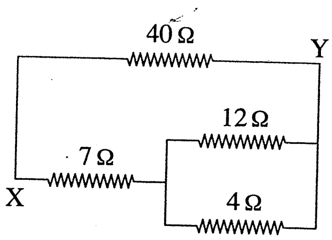
   a. 0 b. 2 V.

   c. 3 V. d. 4 V.



4. In the opposite figure :

When connecting a battery to points X, Y, the equivalent resistance between X, Y equals ....



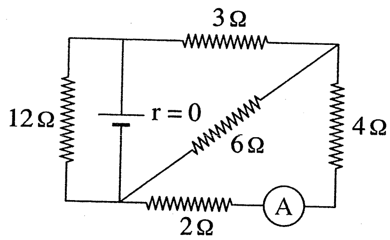
a. 2 Ω. b. 4 Ω.
c. 6 Ω. d. 8 Ω.

5. In the previous figure, if the resistor 7 Ω is replaced by a battery, the equivalent resistance of the circuit becomes .... *(Booklet 3)*

a. 40 Ω. b. 41 Ω. c. 42 Ω. d. 43 Ω.

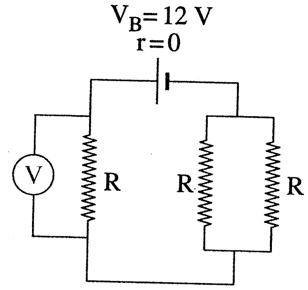
6. In the opposite figure :

If the electric current passing through a resistor 2 Ω is 1 A, so the current intensity passing through the resistor 12 Ω equals ....



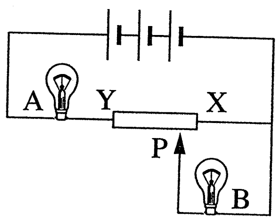
a. 0.5 A. b. 1 A.
c. 1.5 A. d. 2 A.

7. The reading of voltmeter in the opposite circuit ....



a. 4 V. b. 6 V.
c. 8 V. d. 12 V.

8. In the shown circuit : What will happen to illumination of the two bulbs A, B during sliding (P) from point X to point Y ? .... (neglecting the internal resistance of the battery).



	Bulb (A)	Bulb (B)
a.	doesn't change	increases
b.	increases	increases
c.	decreases	doesn't change
d.	increases	decreases

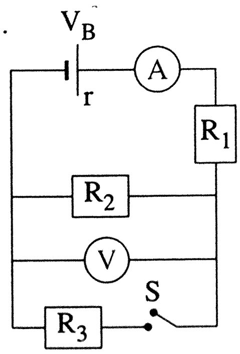
(Booklet 3)

9. If three identical lamps are connected in series to a battery, its internal resistance is negligible, then it is connected again in parallel to the same source, so the ratio between the consumed power in each of the two circuits respectively ....

a. $\frac{1}{2}$ b. $\frac{1}{3}$ c. $\frac{1}{6}$ d. $\frac{1}{9}$

10. When two resistors R, 4 R are connected in parallel to a battery, so the consumed power through the resistance R is .... the consumed power through resistance 4 R. *(Booklet 4)*

a. four times b. double c. equal d. quarter



11. In the circuit shown in front of you, when switch (S) is closed, so ....
   a. The reading of the voltmeter decreases and the reading of the ammeter decreases.
   b. The reading of the voltmeter decreases and the reading of the ammeter increases.
   c. The reading of the voltmeter increases and the reading of the ammeter decreases.
   d. The reading of the voltmeter increases and the reading of the ammeter increases.

2 Give reason for :

1. Potential difference between the terminals of the conductor must be existed to transfer electric charges through it.
2. The electric current intensity passing through an electric circuit can be controlled by using rheostat.
3. The resistivity of a conductor material doesn't change by changing its cross-sectional area.
4. The conductivity of a conductor material doesn't change by changing its dimensions.
5. If three identical lamps are connected in series to a battery, so the illumination of each one differ from the other unless it is connected in parallel with the same source.
6. The potential difference between the terminals of the electric source changes by changing the total resistance of its circuit.

3 When do the following quantities equal each other :

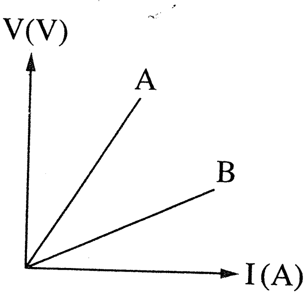
1. The electric resistance of the wire and the resistivity of a conductor material.
2. The current intensity passing through a conductor and the potential difference between its ends. *(Booklet 2)*
3. The electric current passing through two different resistances which are connected together in a closed electric circuit.

4 Miscellaneous questions :

1. **Compare between :** The potential difference between the terminals of two identical wires in length and cross-section area, one of them is made of copper and the other is made of platinum and they are connected in series with neglecting the change in temperature (Knowing that the resistivity of copper is less than that of platinum).

2. If you have a bully coiled with copper wire in form of a circular loop and its ends appears from the wire, explain the procedure to determine the resistivity of the wire by knowing that the radius of the wire is (r) and number of turns (N) by using ammeter, voltmeter, connecting wires, battery and ruler.

3. The graphical relation represents the relation between the potential difference across each of the two wires A, B and the current intensity passing through each of them if the two wires have the same length and cross-sectional area.



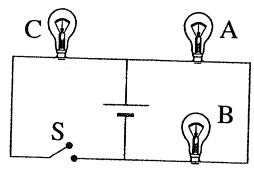
(a) Which of the two wires have large resistance ? And why ?

(b) If the two wires are connected together in parallel with the same source ? Which one consumes large power ? And why ?

(Booklet 1)

4. **In the opposite figure :**

Three identical lamps are connected to a battery of negligible resistance :



(a) What will happen to the illumination of lamp (B) at closing switch (S) with explanation ?

(b) If the internal resistance of the battery isn't neglected, what will happen to the illumination of lamp (B) at closing switch (S) ? With explanation.

5. Write two factors affecting the current intensity passing through the battery at closing its circuit.

(Booklet 1)

5 Problems :

1. A column of mercury in a tube of length 106.3 cm, cross-section area 1 mm^2 and resistance 1 Ω, **calculate :**

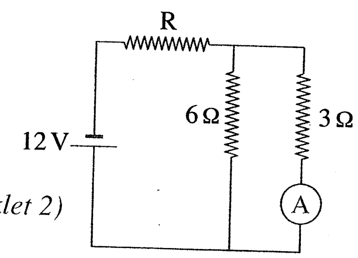
(a) The resistivity of mercury.

(b) The electric conductivity of mercury. *(9.41×10^{-7} Ω.m, 1.06×10^{6} $\Omega^{-1}.m^{-1}$)*

2. A voltmeter of resistance 500 Ω is connected in parallel to an unknown resistance then an ammeter is connected in series to them, when the terminals of the group are connected to an electric cell, so the reading of ammeter is 0.01 A and the voltmeter is 3 V, find the value of the unknown resistance.

(750 Ω)

3. If the reading of ammeter in the opposite circuit was 2 A. **calculate :**



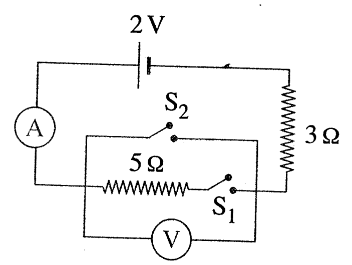
(a) The current intensity passes through the circuit.

(b) The value of resistance (R). *(3 A, 2 Ω) (Booklet 2)*

4. **In the opposite figure :**

What are the readings of ammeter and voltmeter in the following cases ?

(Knowing that the internal resistance of the battery is negligible).



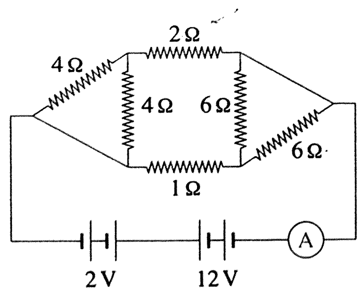
(a) at opening two switches S_1 , S_2 together.

(b) at closing two switches S_1 , S_2 together.

(c) at closing switch S_1 and opening switch S_2.

(0 , 2 V , $\frac{2}{3}$ A , 0 , 0.25 A , 1.25 V)

5. In the circuit shown in the figure, calculate the equivalent resistance and also the reading of ammeter. *(2 Ω , 5 A)*

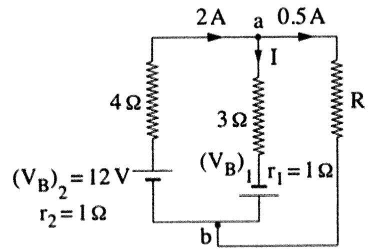


6. **In the opposite electric circuit, calculate :**

(a) The potential difference between two points a, b (V_{ba}).

(b) The electromotive force $(V_B)_1$

(c) The value of resistance (R). *(2 V , 4 V , 4 Ω)*

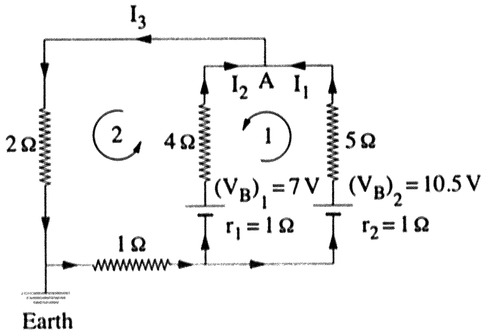


7. In the electric circuit shown in the figure and by using the two Kirchhoff's laws, find each of :

(a) The electric current passing through each branch.

(b) The electric voltage at point (A).

(1 A , 0.5 A , 1.5 A , 3 V)



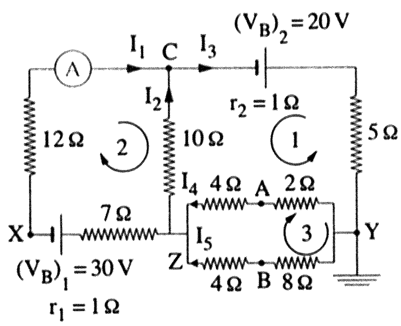
8. In the circuit shown in the figure and by using Kirchhoff's laws, find each of :

(a) The reading of the ammeter.

(b) The potential difference between points A, B.

(c) The electric voltage at point X.

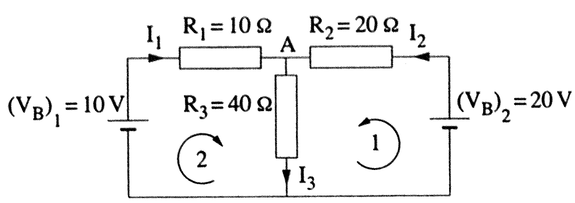
(0.8 A , 0.8 V , 26 V)



9. **In the opposite circuit, calculate :**

(a) The electric current intensity passes through the resistor R_3.

(b) The consumed power in the electric circuit.



($\frac{2}{7}$ A , 8.57 W) (Booklet 1)

Chapter 2

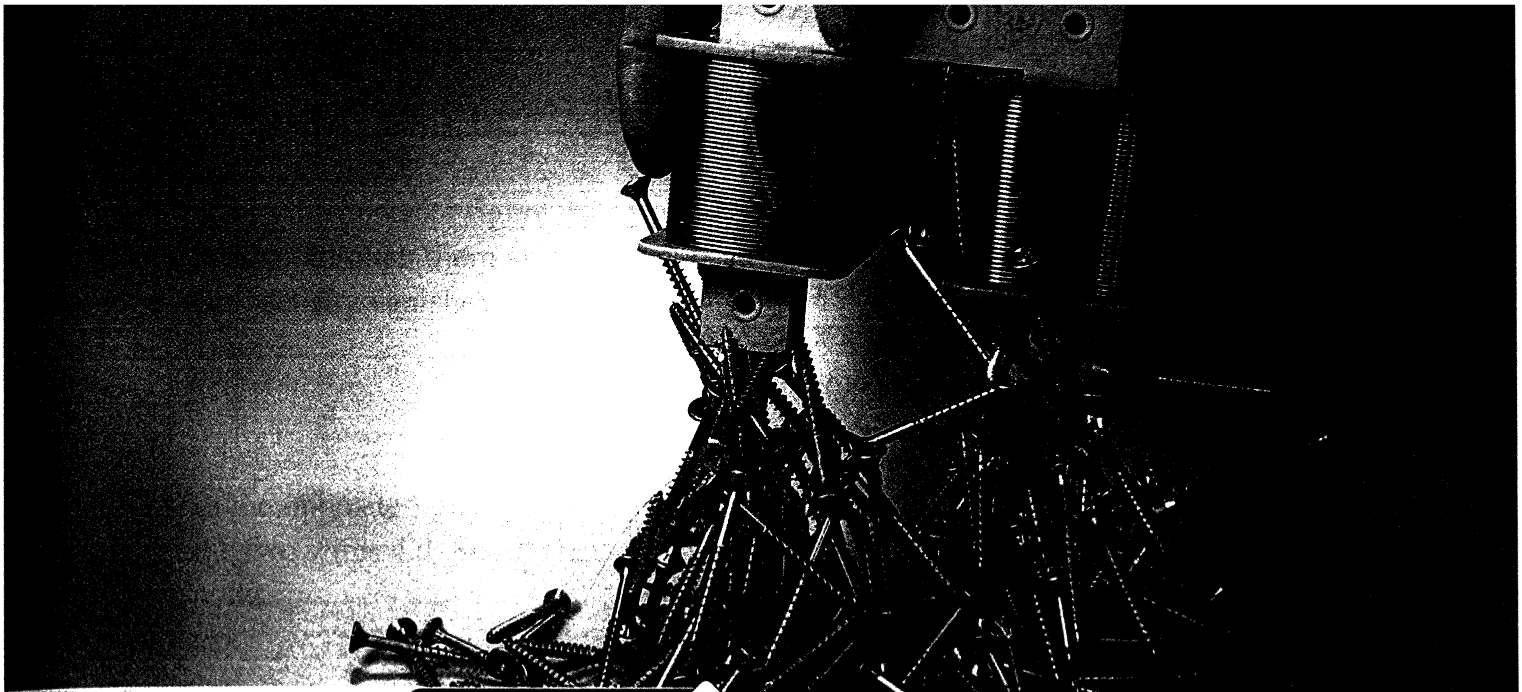
Magnetic Effects of Electric Current and Measuring Instruments

⊙ **Questions on :**

- **Lesson 1** Magnetic Effect of the Electric Current.
- **Lesson 2** Following of the Magnetic Effect of the Electric Current.
- **Lesson 3** The Magnetic Force and the Torque.
- **Lesson 4** The Measuring Instruments.

⊙ **Selected Questions on Chapter 2 from :**

- Student Evaluation Guide (2017).
- Booklet Models of the Ministry of Education.



QUESTIONS ON **Chapter 2** LESSON 1

Magnetic Effect of the Electric Current

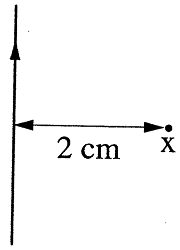
1 Write down the scientific term for each statement of the following :

1. The magnetic flux per unit area. *(Azhar 08)*
2. The ability of the medium to pass the magnetic flux through it.

2 Choose the correct answer of the given answers :

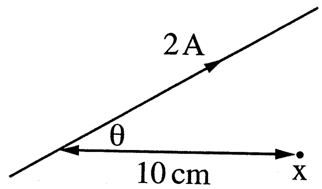
1. The measuring unit of the magnetic flux is ....
   a. T   b. T.m   c. $T.m^2$ d. $T.m^3$
2. If a coil of area 0.02 m^2 is placed perpendicular on a magnetic field of flux density 0.1 T, then :
   i. The magnetic flux cutting the coil in that position is ....
   a. 2 Wb   b. 0.1 Wb   c. 2×10^{-3} Wb   d. 0.12 Wb
   ii. The value of the magnetic flux when the coil rotates 60° is ....
   a. 0.2 Wb   b. 0.5 Wb   c. 0.001 Wb   d. $\sqrt{3} \times 10^{-3}$ Wb
3. The magnetic flux density due to current in a straight wire increases by .... *(Azhar 01)*
   a. increasing the resistance of wire.
   b. increasing the electric current intensity.
   c. decreasing the electric current intensity.
   d. all the previous.
4. The direction of the magnetic flux due to current in a straight wire is determined by using the .... rule.
   a. Fleming's right hand   b. Ampere's right hand
   c. Ampere's left hand   d. no correct answer

5. In the opposite figure :
A long straight wire of resistance 0.2 Ω and the potential difference at its ends is 1 V, then the magnetic flux density at point x is ....



a. 5×10^{-5} T and its direction is to the inside of the page.
b. 5×10^{-5} T and its direction is to the outside of the page.
c. 2×10^{-5} T and its direction is to the inside of the page.
d. 2×10^{-5} T and its direction is to the outside of the page.

6. In the opposite figure :
The magnetic flux density due to the flow of the electric current in the wire at point x is .... 4×10^{-6} T.



a. equal to
b. greater than
c. smaller than
d. no correct answer

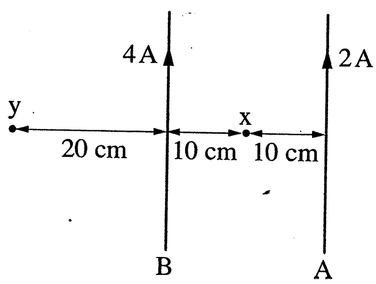
7. The total magnetic flux density at a point outside two wires passing through them electric currents in the same direction equals ....
a. $B_1 - B_2$ b. $B_1 + B_2$ c. $2B_1 + B_2$ d. $B_2 - B_1$

8. Two long parallel wires A, B carry equal currents in the same direction, if the magnetic flux density resulting from an electric current in wire A at midpoint between the two wires is B, so the total magnetic flux density at midpoint is ....
a. 4 B b. 2 B c. B d. zero.

9. Two long parallel wires A, B carry equal currents in the opposite direction, if the magnetic flux density resulting from an electric current in wire A at midpoint between the two wires is B, so the total magnetic flux density at midpoint is ....
a. 4 B b. 2 B c. B d. zero.

10. If the magnitude of the magnetic field at distance d from a very long, straight, current carrying wire is B, at what distance from the wire will the field have magnitude 3 B ? ....
a. 6 d b. 3 d c. $\frac{d}{3}$ d. $\frac{d}{6}$

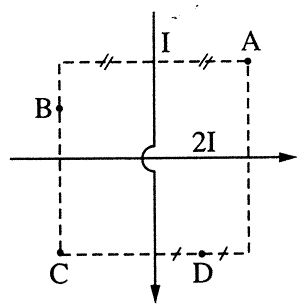
11. In the opposite figure, two parallel wires A, B are carrying DC electric current 2 A, 4 A respectively. So,



i. the value of the magnetic flux density at point (x) = ...
a. 2×10^{-6} T
b. 4×10^{-6} T
c. 8×10^{-6} T
d. 16×10^{-6} T

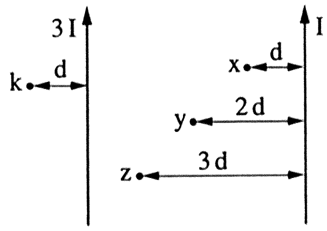
ii. the value of the magnetic flux density at point (y) = ...
a. 4×10^{-6} T b. 5×10^{-6} T c. 8×10^{-6} T d. 20×10^{-6} T

12. In the opposite figure, two perpendicular isolated wires passing through them an electric current I , 2I , the magnetic flux density vanishes at the point ·········· *(Olym. 08)*



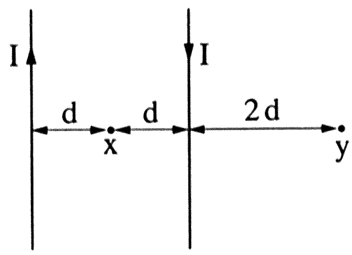
a. A b. B
c. C d. D

13. In the opposite figure, if the distance between the two wires 4 d. So, the neutral point is the ·········· point.



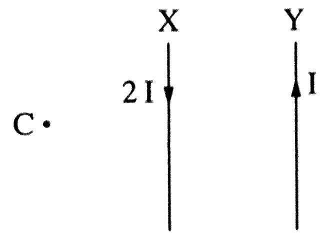
a. x b. y
c. z d. k

14. If the value of the magnetic flux density at point x is B, then the value of the magnetic flux density at point y is ··········



a. $\frac{B}{12}$ b. 12 B
c. $\frac{B}{2}$ d. $\frac{B}{8}$

15. Two currents I, 2 I pass in two parallel wires as in the figure, when moving wire Y away from wire X the magnetic flux density at point C ·········· *(Exp. 17)*



a. decreases. b. doesn't change.
c. increases.

16. If the ratio between the magnetic flux densities at the points (X, Y) near a straight wire carrying an electric current is $\frac{B_X}{B_Y} = \frac{2}{3}$, so the ratio between the perpendicular distances of these two points from the wire is ·········· *(2nd session 17)*

a. $\frac{2}{3}$ b. $\frac{1}{3}$ c. $\frac{1}{6}$ d. $\frac{3}{2}$

3 Give reasons for :

1. High voltage towers should be placed away from buildings. *(2nd session 06)*
2. The neutral point of two parallel wires carrying electric currents in the same direction lies between the two wires.
3. The neutral point of two parallel wires carrying electric current in opposite direction lies outside the wires.

4 What is meant by...?

1. Magnetic flux. 2. Ampere's right hand rule.

5 Mention the conditions of each of the following :

1. Vanishing of the magnetic flux density at a point between two parallel wires carrying an electric current.
2. There is no neutral point for two straight parallel wires carrying an electric current.

6 What will happen in the following and explain :

Increasing the electric current passing through a straight wire with respect to the magnetic flux density at a point at a certain distance from the wire.

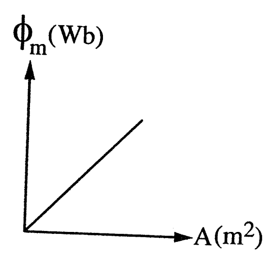
7 When does each of the following values equal zero ?

1. The magnetic flux density at a point between two parallel wires carrying electric current. *(1st session 12)*
2. The magnetic flux density at a point at the mid-distance between two parallel wires carrying the same value of electric current. *(Azhar 95)*
3. The total magnetic flux at a point outside two parallel wires carrying electric current. *(1st session 14)*

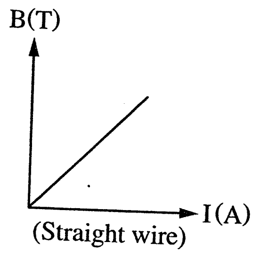
8 Miscellaneous questions :

1. What are the factors affecting the magnetic flux density due to passing an electric current through a straight wire ? And write the mathematical relation. *(Sudan 10 - Exp. 14)*
2. Mention one use for Ampere's right hand rule.
3. **Mention the physical quantities that are measured by the following units and mention the equivalent units :**
   (a) Wb/m^2 *(2nd session 03 - Sudan , 2nd session 11)*
   (b) $Wb.A^{-1}.m^{-1}$ *(Azhar 95 - Sudan 15)*
   (c) Tesla.m/A *(1st session 14)*
4. **Mention the unit of measurement of each of the following and its equivalent :**
   (a) The magnetic flux. (b) The magnetic flux density.
   (c) The magnetic permeability of air. *(Exp. 14)*
5. **Write the mathematical relation and the slope for each of the following graphs :**

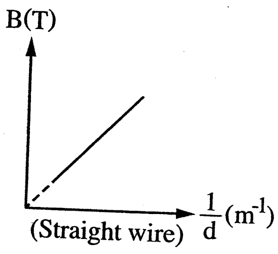
(a)



(b)

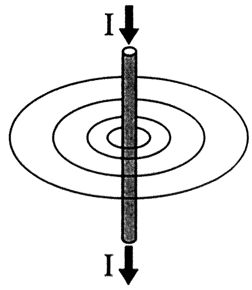


(c)

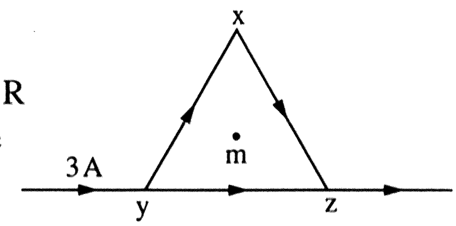


Where : (ϕ_m) the magnetic flux, (B) is the magnetic flux density, (A) is the area, (I) is the electric current intensity and (d) is the distance between the point and wire.

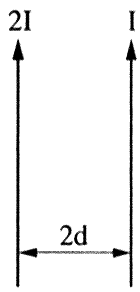
6. Mention the used rule to determine the direction of magnetic flux due to current in a straight wire.
7. Explain by drawing the magnetic field due to electric current in a straight wire and mention the characteristics of the field.
8. **In the opposite figure :**
A copper wire carrying electric current in the direction as shown :
Draw the arrows which indicate the direction of the magnetic field.
(Using the rules of field direction).



9. **In the opposite figure :**
If the resistance of each side of the triangular's sides is R
Prove that the magnetic flux density at the center of the triangle (m) = zero



10. Mention the mathematical relation which expresses Ampere's circuital law.
11. Two long parallel wires 2d apart carry currents of 2I and I in the same direction as shown in the figure.
Answer the following questions :
(a) Is there a neutral point between the two wires ? Why ?
(b) Determine the direction and magnitude of total magnetic field at the midpoint.

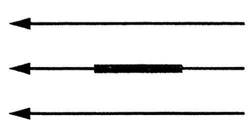


(c) In the previous question, the total magnetic field at the midpoint is B. If the current 2I is switched off (there is no current passing through this wire). Does it change the total magnetic flux density at the midpoint or not ? And why ?
(d) If a magnetic needle was placed at a distance 2d from the outside wire that carries current of I and the direction of current is reversed in this wire. What happens to the deflection of magnetic needle ?

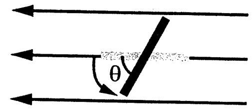
9 Problems :

Guiding notes for solving problems 1

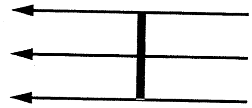
- To determine the magnetic flux (ϕ_m) passing through cross-sectional area (A) of a coil :
(Where θ is the angle between the magnetic field lines and the coil's plane)
(a) If the magnetic field lines are parallel to the coil's plane. So,
$\phi_m = BA \sin 0 = 0$
(The magnetic flux vanishes)



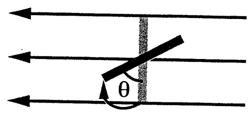
(b) If the coil rotates with angle θ from the parallel position. So,
$\phi_m = BA \sin \theta$



(c) If the magnetic field lines are perpendicular to the coil's plane. So,
$\phi_m = BA \sin 90 = BA$
(magnetic flux is maximum)



(d) If the coil rotates with angle θ from the perpendicular position. So,
$\phi_m = BA \sin (90 - \theta)$



Use the following constants if needed : ($\mu_{air} = 4 \pi \times 10^{-7}$ Wb/A.m , e $= 1.6 \times 10^{-19}$C)

1. 📖 A coil of cross-sectional area 0.2 m^2 is placed normal to a uniform magnetic flux of density 0.04 Weber/m^2. Calculate the magnetic flux which passes through this coil.

(0.008 Wb)

2. A coil of cross-sectional area 2 m^2 is placed in a magnetic field of density 0.05 Wb/m^2 where the magnetic flux passing through it is maximum. Calculate the magnetic flux when it rotates :

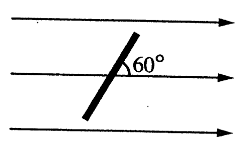
(a) 30° (b) 45° (c) 60° (d) 135° (e) 180°

(0.087 Wb, 0.07 Wb , 0.05 Wb , 0.07 Wb , 0.1 Wb)

3. A square coil of length 20 cm is placed in a magnetic field of density 3×10^{-2} Tesla, if the resulted flux 6×10^{-4} Weber, find the angle between the flux and the magnetic lines.

(30°)

4. A rectangular coil of area A , placed in a magnetic field its intensity B such that the plane of the coil makes an angle 60° with the field, so the value of the flux passing through it is 2×10^{-6} T.m^2. Calculate the value of the flux passing through it when the coil rotates :



(a) **clockwise :** 1. 30° 2. quarter cycle.

(b) **counter clockwise :** 1. 30° 2. quarter cycle.

(1.155×10^{-6} Wb , 1.155×10^{-6} Wb , 2.31×10^{-6} Wb , 1.155×10^{-6} Wb)

Guiding notes for solving problems 2

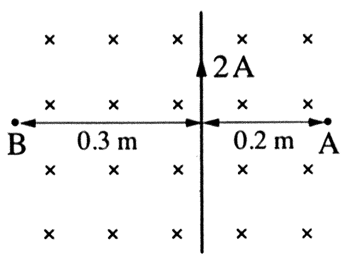
- To determine the magnetic flux density (B) at a point at a distance (d) from a straight wire carrying electric current (I) : $B = \mu \frac{I}{2 \pi d}$ (Tesla)
  Where (μ is the permeability of the medium)

5. A straight wire carrying a current of intensity 4 A, if the magnetic flux density at a point at a certain distance from its axis is 2×10^{-5} T. Find the distance of the point from the axis of the wire. *(0.04 m)*
6. A straight wire of diameter 2 mm carrying electric current 5 A. Calculate the magnetic flux density at a distance 0.2 m from its axis. *(5×10^{-6} T)*
7. A battery of e.m.f 8 Volts and internal resistance 2 Ω is connected to a straight wire of length 20 cm , cross-sectional area 3×10^{-8} m^2 and its resistivity 4.5×10^{-6} Ω.m Calculate the magnetic flux density at a point lies at normal distance of 10 cm away from the center of the wire. ($\mu = 4 \pi \times 10^{-7}$ Wb/Ampere.m)
   (5×10^{-7} T) (2^{nd} session 99, 07)

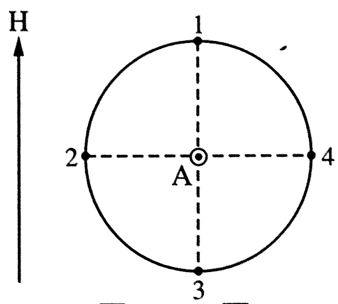
Guiding notes for solving problems 3

- The magnetic flux density (B) is a vector quantity, so if the magnetic flux density due to a wire is (B_1) and the wire is placed in an external magnetic field of flux density (B_2) then when :
  - The two fields have the same direction : $B_t = B_1 + B_2$
  - The two fields have opposite directions : $B_t = B_1 - B_2$ ($B_1 > B_2$)
  - The two fields are perpendicular to each other : $B_t = \sqrt{B_1^2 + B_2^2}$

8. **In the opposite figure :**
   A long straight wire carries an electric current 2 A and placed perpendicular on a uniform magnetic field of flux density 4×10^{-6} T. Calculate the resultant magnetic flux density at points A, B. *(6×10^{-6} T , 2.67×10^{-6} T)*



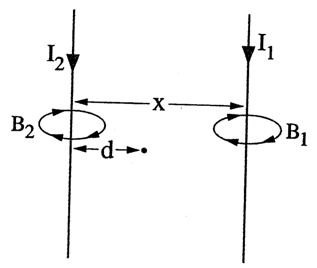
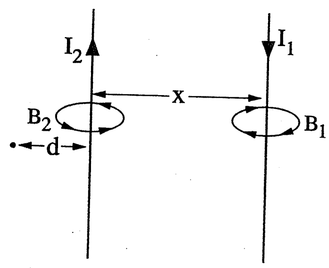
9. A straight wire (A) is placed perpendicular to the plane of the page carrying electric current, its direction is outside the page so, the density of the produced magnetic flux is H Tesla, if the density of the magnetic flux for horizontal component of the Earth is H Tesla. Calculate the resultant magnetic flux density at points 1, 2 , 3 and 4



($H\sqrt{2}$, 0 , $H\sqrt{2}$, 2 H)

Guiding notes for solving problems 4

If we have two parallel wires carrying two electric currents I_1 , I_2 :

	If the two currents are in the same direction	**If the two currents are in opposite direction**
The resultant of the magnetic flux density at a point between two wires	$B_t = B_1 - B_2$ $(B_1 > B_2)$	$B_t = B_1 + B_2$
The resultant of the magnetic flux density at a point outside the two wires	$B_t = B_1 + B_2$	$B_t = B_1 - B_2$ $(B_1 > B_2)$
The neutral point **$(B_1 = B_2)$** **lies always near to the wire carrying the less current**	 Between the two wires and is determined from the relation : $\frac{I_2}{d} = \frac{I_1}{(x - d)}$	 Outside the two wires and is determined from the relation : $\frac{I_2}{d} = \frac{I_1}{(x + d)}$
	Where : d is the distance between the neutral point and the wire which carries the less current (I_2) and x is the distance between the two wires.	

10. A straight wire which has 7.5×10^{20} electrons passing through it in 3 sec is placed parallel to another straight wire at a distance 5 cm which carries electric current of intensity 40 A. Find the value and the direction of the magnetic flux at a point in the middle of the distance between them :

(a) If the two currents are in the same direction.

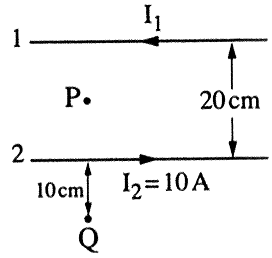
(b) If the two currents are in opposite directions. *$(0 , 6.4 \times 10^{-4}$ T) (Egy. 87)*

11. Two parallel wires are placed in air, the distance between them is 30 cm, the first wire carries a current of intensity 40 A, the second wire carries a current of intensity 20 A. Calculate the magnetic flux density generated at a point lies at a distance 20 cm from the first wire when the electric current in the two wires :

(a) In one direction. (b) In opposite directions. *(0 , 8 × 10^{-5} T) (Azhar 08)*

12. **In the opposite figure :**

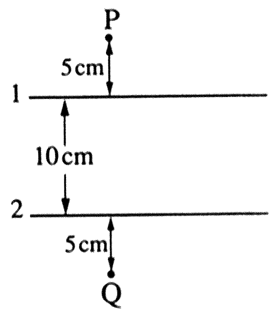
Two parallel straight wires 1, 2 if the total magnetic flux density B_t at a point P (In the middle distance between them) equals 6×10^{-5} Tesla. Calculate the total magnetic flux density at a point Q.



(6.7 × 10^{-6} T) (1^{st} session 02)

13. **In the opposite figure :**

Two parallel wires, the first wire carries a current of 2 A and the second wire carries a current 4 A. Calculate the total magnetic flux density at each of P , Q :



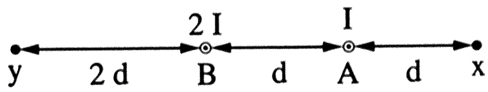
(a) If the two currents are in the same direction.

(b) If the two currents are in opposite directions.

(1.33 × 10^{-5} T, 1.87 × 10^{-5} T , 2.67 × 10^{-6} T, 1.33 × 10^{-5} T)

14. **In the opposite figure :**

Two parallel wires A , B carrying two electric currents I , 2 I respectively if the magnetic flux density at point x is 10^{-6} T. Calculate the magnetic flux density at point y.



(6.67 × 10^{-7} T)

15. A small compass is placed at a point between two straight parallel wires, if the first wire carries a current of 2 A from the South to the North direction and lies at a distance 20 cm from the compass while the second wire lies at a distance 40 cm. Find the intensity and the direction of the current in the second wire if it doesn't deflect the pointer of the compass. *(4 A)*

16. Two parallel straight wires, the distance between them in air is 0.3 m. The first wire carries a current of intensity 2 A and the second wire carries a current of intensity 3 A. Calculate the position of the neutral point in the following two cases :

(a) If the two currents in the two wires are in the same direction.

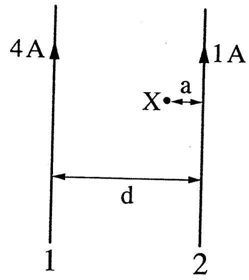
(b) If the two currents in the two wires are in opposite directions.

(0.12 m , 0.18 m , 0.6 m , 0.9 m) (Sudan 15)

17. Two parallel wires A , B , wire A carries a current 5 A and wire B carries 8 A if a magnetic needle is placed between the two wires at a distance 10 cm from wire A and didn't deflect. Are the two currents in one direction or in opposite directions ? Why ? Then calculate the distance between the two wires. *(26 cm)*

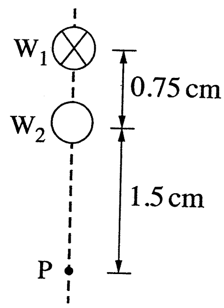
18. **In the opposite figure :**

Two parallel straight wires 1, 2 where point (X) lies at the neutral point if the electric current increases from 2 A to 4 A and the neutral point moved a distance 10 cm. Calculate the distance (d) between the axis of the two wires. *(33.33 cm)*

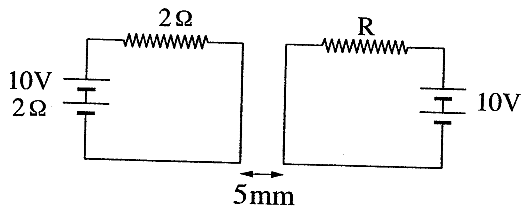


19. Two long straight parallel wires separated by 0.75 cm, are perpendicular to the plane of the page as shown in figure. Wire W_1 carries a current of 6.6 A into the page. What must be the current (magnitude and direction) in wire W_2 for the resultant magnetic field at point P to be zero ?

(4.4 A, out of the page)

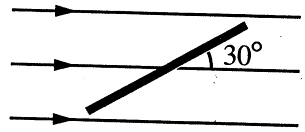


20. The two long parallel wires in the shown figure are separated by 5 mm, calculate the value of the resistor R if the total magnetic flux density at midpoint between the two wires is 4×10^{-4} T ($B_2 > B_1$). *(1.333 Ω)*



21. In the opposite figure a coil of cross-section area A, placed in a magnetic field of density B such that it makes an angle 30° with the field, so the total flux passing through the coil was ϕ_m

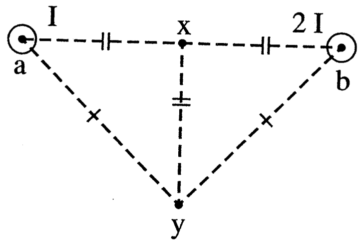
What is the minimum angle by which the coil should rotate such that the flux through it becomes :

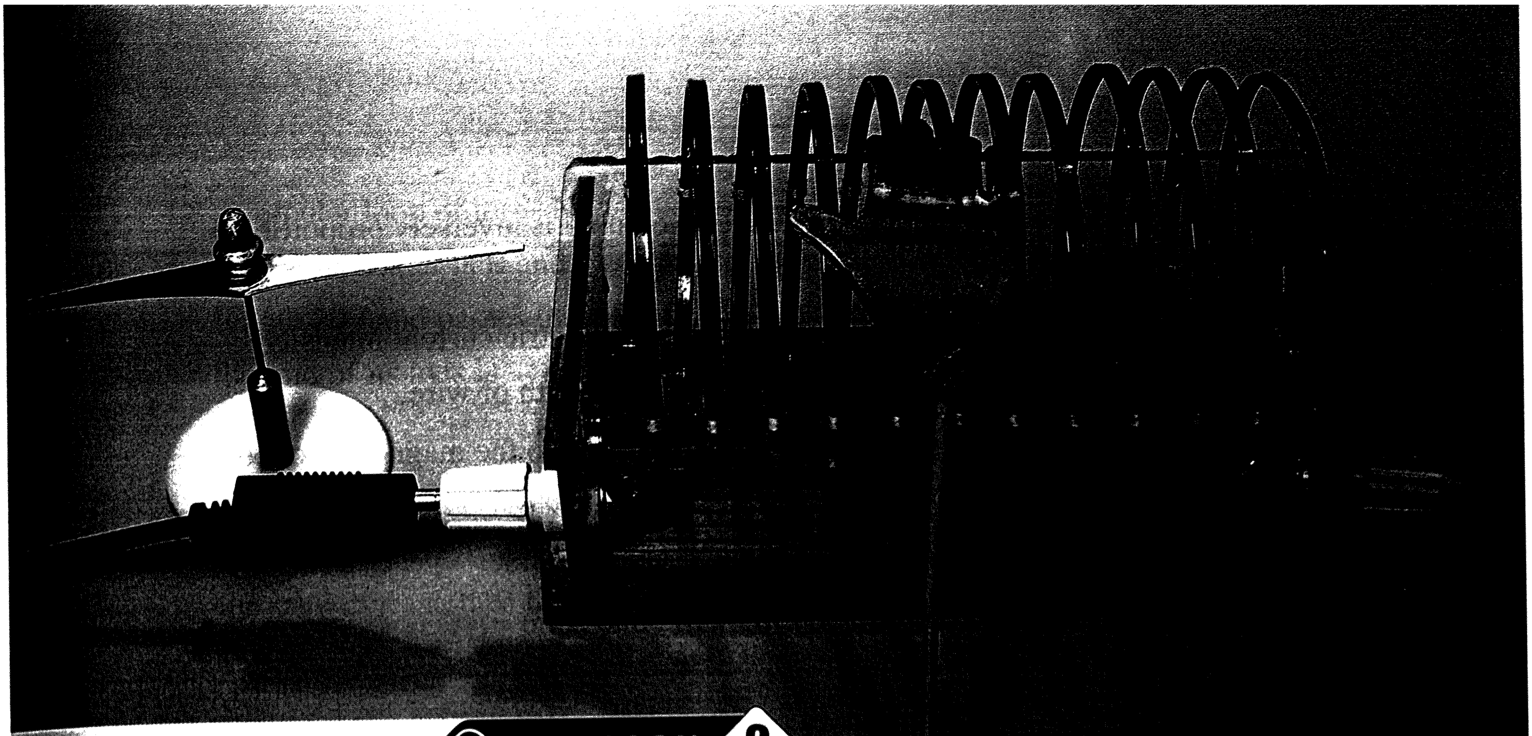


(a) $2\,\phi_m$ (b) $\frac{2}{3}\phi_m$ (c) $\frac{1}{2}\phi_m$

(60° , 10.53° , 15.52°)

22. In the opposite figure two straight parallel wires a, b carrying electric currents I, 2 I respectively as shown. If the flux density produced from them at point x is 10^{-6} T, calculate the flux density at point y.





QUESTIONS ON

Chapter 2

LESSON 2

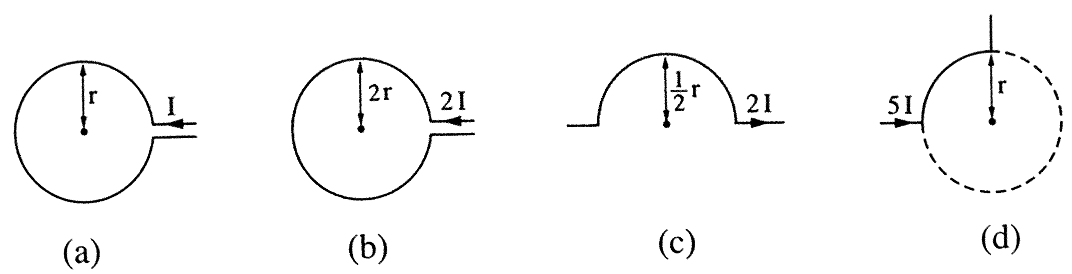
Following of the Magnetic Effect of the Electric Current

1 Choose the correct answer of the given answers :

1. The magnetic flux density at the center of a circular loop increases by ....
   a. increasing its radius.
   b. decreasing the electric current passing through it.
   c. increasing the number of turns.
   d. all the previous. *(2nd session 01)*

2. The circular loop that carries an electric current is similar to ....
   a. a short bar magnet.
   b. a horse shoe magnet.
   c. a solid disc magnet.
   d. a ring magnet.

3. In which of the following coils the magnetic flux density at its center is the maximum value ? ....



4. If the magnetic flux density at the center of a circular loop of radius 4π cm is 5×10^{-5} Tesla and the permeability of air is $4\pi \times 10^{-7}$ Weber/A.m. So, the electric current intensity passing through the loop is .... *(Azhar 90)*
   a. 7 A
   b. 7.14 A
   c. 10 A
   d. 17 A

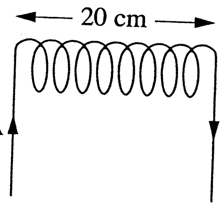
5. The magnetic flux density at a point inside a solenoid is inversely proportional to ....

a. number of turns.
b. the electric current intensity.
c. the length of coil.
d. the length of wire.

6. The magnetic field due to current in a solenoid is similar to the magnetic field of a magnet in the shape of ....

a. a solid disc.
b. long bar magnet.
c. a horse shoe.
d. a ring.

7. In the opposite figure, if the coil of 500 turns , the magnetic flux density at the center of its axis = ...
(Knowing that : $\mu = 4\pi \times 10^{-7}$ T.m /A)

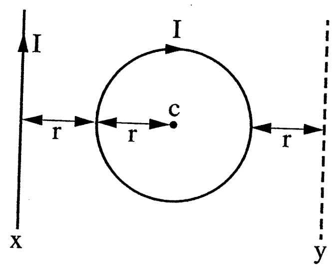


a. $\pi \times 10^{-7}$ T
b. $2\pi \times 10^{-3}$ T
c. $4\pi \times 10^{-3}$ T
d. $8\pi \times 10^{-4}$ T

8. A circular coil formed of one turn carries electric current intensity I, if the magnetic flux density at its center is B_1 and then it is reshaped to another circular coil of N turns and carried the same current intensity, then the magnetic flux density at its center will be ....

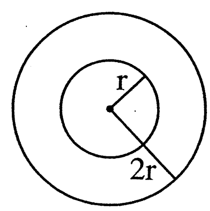
a. NB_1
b. N^2B_1
c. $2NB_1$
d. $2N^2B_1$

9. In the opposite figure a circular wire ring and a straight wire placed at the position x in the same plane of the ring and both carries electric current its intensity I so that the resultant magnetic flux density at the center of the ring c is B and when the wire is moved to position y the magnetic flux density at point c becomes ....



a. 2 B
b. B
c. 0.73 B
d. 1.38 B

10. Two concentric circular loops of radii r and 2 r, made of the same type of wire, lie in the plane of the page, as shown in the opposite figure. The total resistance of the wire loop of radius r is R. What is the resistance of the wire loop of radius 2 r ? ....



a. $\frac{R}{2}$
b. R
c. 2 R
d. 4 R

11. If the magnetic flux density at a point inside a solenoid on its axis is B, then the radius of the solenoid is halved, the new magnetic flux density becomes ....

a. B
b. 2 B
c. 4 B
d. $\frac{1}{4}$B

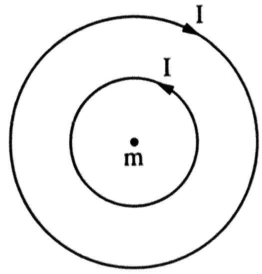
12. A circular loop of turns N_1 radius r passes through it electric current I if the magnetic flux at its center is B and its turns are far away from each other to become a solenoid of length 20 r and passes through it the same current, so the magnetic flux density at the mid of its axis is ………

a. $\frac{B}{20}$ b. $\frac{B}{10}$ c. $\frac{B}{40}$ d. B

13. A circular loop consists of one turn carries electric current, so the magnetic flux density at its center was B_1. If it is reshaped to another circular loop of number of turns N and carries the same current, then the magnetic flux density at the center of the loop B_2 is ………

a. NB_1 b. N^2B_1 c. $2\ NB_1$ d. $2\ N^2B_1$

14. Two concentric metallic rings are placed in the same plane, both carry an electric current of intensity I as in the figure. So the direction of the produced magnetic flux at the center point m is ……… *(1st session 17)*



a. to the right. b. to the left.
c. into the page. d. out of the page.

2 What is meant by...?

1. The clockwise direction rule.
2. Right hand screw rule.
3. Ampere's right hand rule.

3 Give reasons for :

1. The magnetic flux density along the axis of a solenoid increases if a bar of soft iron is inserted inside it. *(2nd session 03)*
2. The magnetic field may not be generated due to direct current passing through solenoid or a circular loop.
3. A rod of wrought iron surrounded by an isolated double wound wire carrying electric current may not be magnetized.

4 What happens in each of the following and explain :

1. Decreasing the radius of a circular loop carrying electric current concerning the magnetic flux density at its center.
2. Flow of direct electric current in a solenoid. *(1st session 14)*
3. Decreasing the number of turns per unit length for a solenoid carrying electric current concerning the magnetic flux density at its axis.
4. The distance between the turns of a solenoid coil is decreased concerning the magnetic flux density at its axis.
5. Flow of electric current in a double coiled solenoid concerning the magnetic flux density at its axis. *(Exp. 15)*

5 Mention one use for each of the following :

1. Right hand screw rule.
2. The clockwise direction rule.

6 Compare between :

1. The magnetic flux density around a straight wire and at the center of a circular loop, each of them carries electric current (in terms of the used mathematical relation).

(2nd session 15)

2. The magnetic flux density at the center of a circular loop and at a point on the axis of solenoid, each of them carries electric current (in terms of the used mathematical rule).

(1st session 06, 09)

7 Miscellaneous questions :

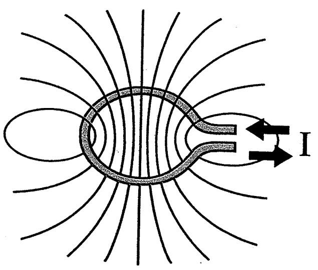
1. Explain how can we increase the magnetic flux density at the center of a circular loop.

(2nd session 08)

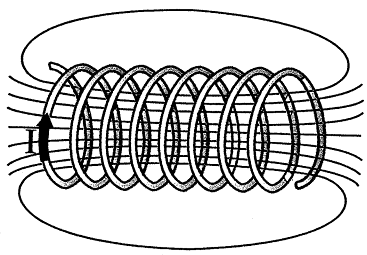
2. **Mention the properties of the magnetic flux lines due to the flow of electric current at :**
   (a) Center of a circular loop.
   (b) Axis of a solenoid coil.

(1st session 12)

3. **Mention the used rule to determine the direction of each of the following , then draw the flux in each case :**
   (a) Magnetic flux due to current in a circular loop.
   (b) Magnetic flux due to current in a solenoid.
4. In the following figures, a copper wire takes different shapes and carries electric current in the shown direction :



(1)

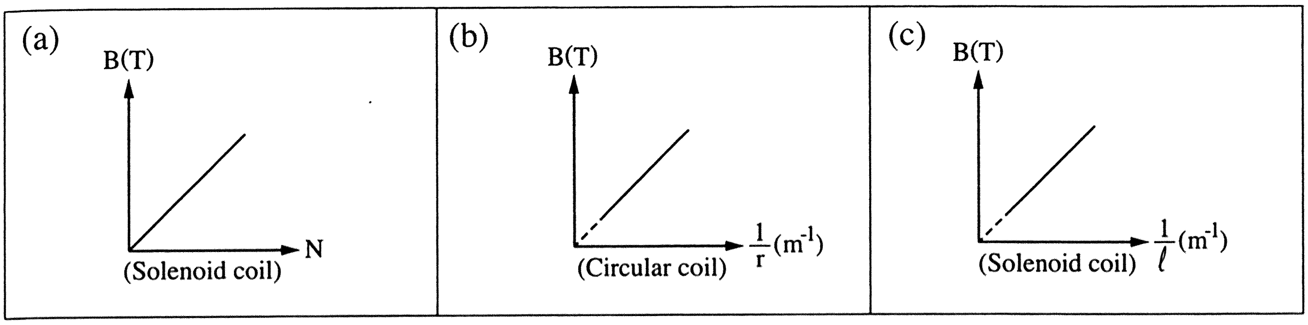


(2)

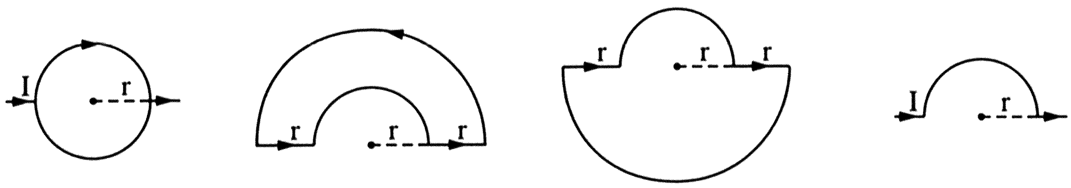
(a) Draw the arrows which indicate the direction of the magnetic field in each case (Using the rules of field direction).

(b) The straight line at the axis of the two figures (1) , (2) indicates ....

5. **Write the mathematical relation and the slope for each of the following graphs :**



6. The following figures show half rings carrying the same electric current (I). Calculate the magnetic flux density (B) in terms of (I , r , μ), then re-arrange the given figures in descending order based on the flux density at their center. *(Olym. 08)*



(a) (b) (c) (d)

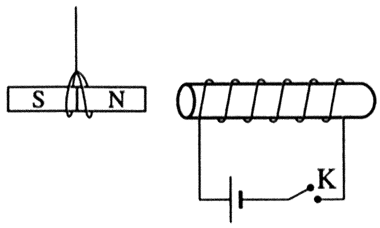
7. Two identical metallic rings, one of copper and another of aluminum (resistivity of copper is less than that of aluminum). Each of them connected to a cell, (the two cells are identical). **Answer the following questions :**

(a) In which ring will the density of magnetic field at the center be greater ? Why ?

(b) If the current flows through the copper ring in clockwise direction. Then the polarity of the cell is reversed, what happens to the direction of magnetic field ? Why ?

8. **In the opposite figure :**

A solenoid is coiled around a plastic cylinder and connected to an electric source where a magnet is hanged near them as shown in the figure :



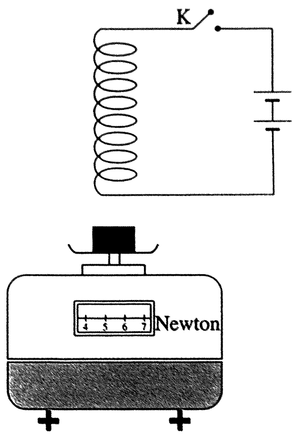
(a) What is the type of force acting on the pole (N) of the magnet when closing switch (K) ?

(b) What will happen when the terminals of the electric source are reversed then closing the switch ?

(c) What will happen when the plastic cylinder is replaced by a cylinder made of a soft iron then closing the switch ?

9. **In the opposite figure :**

A coil is placed over a wrought iron piece on the pan of a scale.



(a) What will happen to the reading of the scale after closing switch (K) in the circuit ?

(b) What will happen to the reading of the scale if the current is reversed in the coil after closing switch (K) ?

10. Explain by drawing how to obtain a solenoid coil carrying DC current and has two similar external poles at its ends. *(Olym. 08)*

11. A solenoid of length (ℓ) and number of turns (N) is connected to a battery of negligible internal resistance its emf (V_B). Mention giving reason what happens to the magnetic flux density at the center of the axis when :

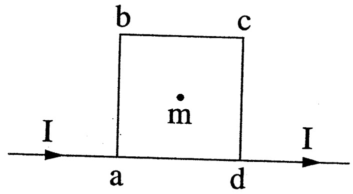
 (a) A cylinder of soft iron is inserted inside the coil.

 (b) The separating distance between each two turns is decreased to its half.

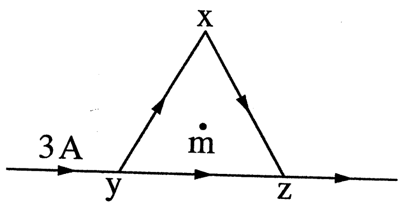
 (c) Half length of the coil is cut and the remaining part is connected to the same battery. *(Exp. 10)*

12. Two solenoids are similar in the shape, thickness and length, one is made of copper and the other is made of aluminum if each one is connected with electric source of e.m.f equals 12 V and its internal resistance is neglected, does the magnetic flux density due to the electric current differ at the middle of each axis ? And why ?

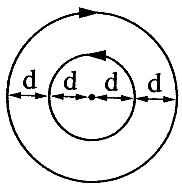
13. **In the opposite figure :** A wire of uniform cross-section area is shaped in the form of a square its side length (ℓ), prove that the magnetic flux density due to the flow of electric current in the direction shown in the figure vanishes at the center of the square (m).



14. **In the opposite figure :**
 If the resistance of each side of the triangle sides is (R), prove that the magnetic flux density at the center of the triangle (m) = zero



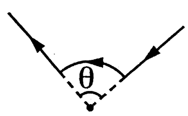
15. Two concentric metallic rings carries the same electric current intensity (I) as in the opposite figure. What is the required change in the current intensity in the inner ring to make the center point a neutral point ? Explain your answer. *(Exp. 17)*



8 Problems :

Guiding notes for solving problems 1

- To determine the magnetic flux density (B) at the center of a circular loop :
 $B = \frac{\mu N I}{2 r}$ (Tesla)
- To calculate the number of turns : $N = \frac{\ell \text{ (Length of coil)}}{2 \pi r}$
 - If the length of the coil (ℓ),where (N is an integer or not).
 - If the coil is a part of a circle as shown in the figure : $N = \frac{\theta}{360}$



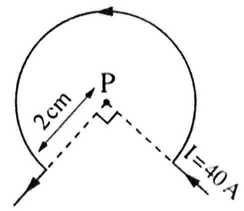
- In case of reshaping a circular loop where the number of turns is changed from N_1 to N_2 and connected to the same source :
 $\frac{N_1}{N_2} = \frac{r_2}{r_1}$ $\therefore \frac{B_1}{B_2} = \frac{N_1 r_2}{N_2 r_1}$, $\frac{B_1}{B_2} = \frac{N_1^2}{N_2^2} = \frac{r_2^2}{r_1^2}$

Use the following constant when needed : ($\mu_{air} = 4\pi \times 10^{-7}$ Wb/A.m)

1. A circular loop of diameter 12.56 cm carries a current of 0.1 A and the number of its turns 100 turns. Calculate the magnetic flux density at the center of the circular loop. ($\pi = 3.14$) *(10^{-4} T)*

2. An electric current passes through a wire of length 26.4 cm bended in a shape of arc of a circle of radius 5.6 cm if the magnetic flux density at the center of the circle 8.25×10^{-6} T. Calculate the electric current intensity. *(0.98 A) (Azhar 89)*

3. **In the opposite figure :**



Find the magnetic flux density at point P and determine its direction. *(9.42×10^{-4} T)*

4. A copper wire of length 50.24 m and cross-sectional area 1.79×10^{-7} m^2 coiled in the form of a circular coil of 200 turns and its radius 4 cm and is connected to a source of electric current of e.m.f 12 V and internal resistance 1 Ω. Knowing that the resistivity of copper = 1.79×10^{-8} Ω.m, **calculate :**

   (a) The electric current passing through the coil.

   (b) The magnetic flux density at the center of the coil. *(1.99 A , 6.25×10^{-3} T) (1st session 13)*

5. A circular loop of radius 10 cm made of a wire of resistivity 10^{-6} Ω.m and cross-sectional area 4×10^{-4} m^2 if it is connected to a source of e.m.f V_B and neglecting its internal resistance and if the magnetic flux density at its center is 1 T, calculate e.m.f of the battery. *(250 V)*

6. Calculate the magnetic flux density at the center of a circular loop of 1 turn, its radius 0.1 m and carrying electric current 10 A. If there is a straight wire carrying electric current of the same intensity, calculate the distance at which the magnetic flux density has the same value. *(6.28×10^{-5} T, 0.032 m)*

7. A straight wire carrying electric current is coiled in the form of a circle consisting of one turn then it is coiled again in a circle consisting of 4 turns with the same electric current, compare between the magnetic flux density in both cases. *($\frac{1}{16}$)*

Guiding notes for solving problems 2

- If we have two circular loops having the same center, laying in the same plane and carrying electric current :

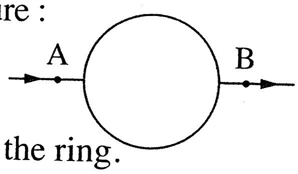
  (a) In the same direction : $B_t = B_1 + B_2$

  (b) In opposite directions : $B_t = B_1 - B_2$ $(B_1 > B_2)$

- In case of two circular loops have the same center and perpendicular to each other :

  $B_t = \sqrt{B_1^2 + B_2^2}$

8. A straight wire of resistance 48 Ω is reshaped as a closed ring of radius (d) then a battery of 6 V is connected to the ends of its diameter as in the figure :
(a) Find the total resistance between the two points (A , B).
(b) Find the electric current passing through the wire of the ring.
(c) Explain why the magnetic flux density vanishes at the center of the ring.



(12 Ω , 0.25 A) (Exp. 15)

9. Two circular coils having the same center carrying two electric currents equal in magnitude and opposite in direction if the radius of the first is 10 cm and the number of its turns is 100 turns and the radius of the second is 20 cm, what is the number of its turns when the magnetic flux density at their centers vanishes ? *(200 turn)*

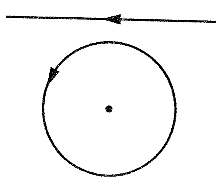
10. Two circular coils have the same center and in the same plane, the radius of the first double that of the second and both are carrying two electric currents in the same direction, where B_1 (for the external coil) > B_2 (for internal coil). If the current is reversed in the external coil , the magnetic flux density decreases to the half at the center, calculate the ratio between the number of their turns. *($\frac{2}{3}$) (Azhar 00)*

11. Two circular coils have the same center if the first carries electric current 7 A, number of turns 400 turn, radius 20 cm and the second carries electric current 10 A, number of turns 500 turn , radius 10 cm if the electric current passing through them in the same direction, find the magnetic flux density at the center of the two coils in the following cases :
(a) When they are in the same plane ?
(b) When one of them rotates 180° ?
(c) When one of them rotates 90° ? *(40.2×10^{-3} T, 22.6×10^{-3} T, 32.6×10^{-3} T)*

Guiding notes for solving problems 3

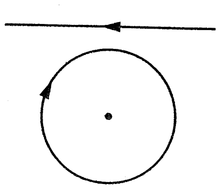
- In case of a circular coil and a straight wire in the same plane and carrying electric current, then if the fields of the coil and the wire are :

(a) **In the same direction :**



$B_t = B_{coil} + B_{wire}$

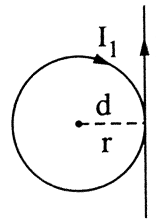
(b) **In opposite directions :**



$B_t = B_{coil} - B_{wire}$ $(B_{coil} > B_{wire})$

$B_t = B_{wire} - B_{coil}$ $(B_{wire} > B_{coil})$

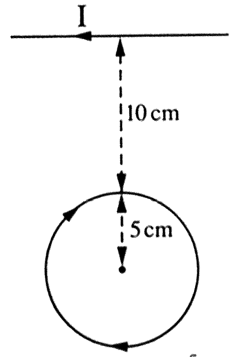
- In case of a circular coil tangent to a straight wire and the total magnetic flux at the center vanishes, so : $B_{coil} = B_{wire}$



$$\frac{\mu I_1 N}{2r} = \frac{\mu I_2}{2\pi d}$$

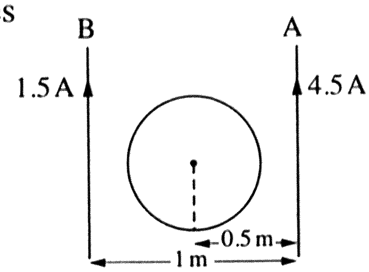
$$NI_1 = \frac{I_2}{\pi}$$

12. A circular coil of 3 turns and radius 5 cm carrying electric current 1 A at a distance 10 cm from a straight wire carrying electric current I as in the figure, **calculate :**
    (a) The value of (I) when the magnetic flux density at the center of the circular coil vanishes.
    (b) The magnetic flux density at the center of the coil when the electric current is reversed.



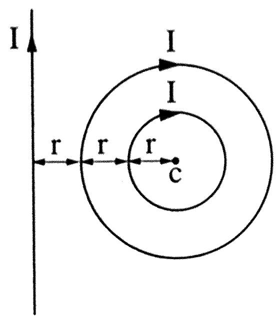
(28.26 A, 7.54 × 10^{-5} T)

13. Two straight wires A , B at a distance 1 m apart. Wire A carries a current of intensity 4.5 A and wire B carries a current of intensity 1.5 A in the same direction. A one turn coil of radius 10 π cm is placed in the same plane of the two wires such that its center is 0.5 m distant apart from wire A as shown in figure. What is the value and direction of the current passing in the circular coil that makes the magnetic flux density at its center equals zero.



(0.6 A) (1st session 15)

14. **In the shown figure :**
    Two concentric metal rings in the same plane each is carrying electric current of intensity I. A long straight wire is placed beside them in the same plane and carries the same current. If the magnetic flux density at their center (c) is 10^{-6} T, calculate the value of the magnetic flux density at :
    (a) Reversing the current of the straight wire only.
    (b) Reversing the current of the internal ring only.
    (c) Doubling the current of the outer ring only. *(8.68 × 10^{-7} T , 2.45 × 10^{-7} T , 1.31 × 10^{-6} T)*



15. An insulated circular loop of 1 turn carries electric current 5 A and at the center of the circular loop a magnetic flux (B) is generated. Calculate the electric current passing through a straight wire and generates the same magnetic flux density as that of the circular loop (B) at a point at a distance from the wire equals the radius of the loop. (π = 3.14)

(15.7 A) (Azhar 01)

16. An insulated long straight wire in a vertical position is placed such that it becomes a tangent to an insulated circular coil consisting of one turn and its plane is in the plane of the magnetic meridian of the Earth. At the center of the coil there is a magnetic needle moving freely in the horizontal plane. Calculate the intensity of the electric current which if passes in the wire it does not cause any deflection to the needle when a current of intensity 0.42 A passes in the circular coil. ($\pi = 3.14$) *(1.32 A) (Sudan 07 - Egy. 89)*

17. Suppose that an electromagnet uses a coil of diameter 1.2 m made from copper wire of cross-sectional area 2.56 mm^2. The power supply produces 120 V at a maximum power output of 4000 Watt. (Resistivity of copper = 1.65×10^{-8} Ω.m)
   (a) How many turns are needed to run the power supply at maximum power ? *(148 turn)*
   (b) What is the magnetic field strength at the center of the coil ? *(5×10^{-3} T)*
   (c) If you use a greater number of turns and the same power supply (the voltage remains at 120 V), will a greater magnetic field strength result ? Explain.

Guiding notes for solving problems 4

- To determine the magnetic flux density (B) at a point at the axis inside of a solenoid :

$$B = \mu \frac{N I}{\ell} = \mu n I \ (T)$$

When the turns are touching each other along the rod, the length of the coil : $\ell = N \times 2 \grave{r}$
(Where : n is the number of turns per unit length , $\grave{r}$ is the radius of the wire)

18. A solenoid of length 20 cm and 200 turns carries electric current 0.5 A. Find the magnetic flux density at the middle of the axis. If :
   (a) The medium is air.
   (b) An iron rod is inserted inside the coil.
   (Where : $\mu_{air} = 2 \times 10^{-3}$ Wb/A.m) *(6.28×10^{-4} T , 1 T)*

19. Calculate the electric current intensity that passes through a solenoid of length 0.5 m and number of turns 1000 turns where the magnetic flux density at the middle of its axis is 0.04 T. *(15.9 A)*

20. A solenoid of length 0.6 m is carrying electric current 10 A if the magnetic flux density produced in the middle of its axis is 0.05 T. **Calculate :**
   (a) Number of turns per unit length.
   (b) Number of turns. *(3980.89 turns/m , 2388.53 turns)*

21. A solenoid of length 0.22 m and cross sectional area 25×10^{-4} m^2 consists of 300 turns. Calculate the electric current intensity in the coil if the magnetic flux density in the middle of its axis is 1.2×10^{-3} Wb/m^2 , then calculate the total magnetic flux passing through the coil. *(0.7 A , 3×10^{-6} Wb)*

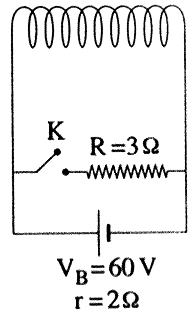
22. A solenoid of 100 turns and length 50 cm and the resistance of each turn is 0.01 Ω and is connected to a source of e.m.f 2 V and its internal resistance is negligible. Calculate the magnetic flux density in the middle of its axis, then calculate the magnetic flux density if the number of turns became 50 turns and is connected to the same source.

(5.03×10^{-4} T , 1.01×10^{-3} T)

23. A solenoid of length 20 cm, number of turns 100 turns and its resistance 6 Ω and is inserted in electrical circuit as shown in the figure, calculate the magnetic flux density at the middle of its axis in case of :

(a) Opening switch (K).

(b) Closing switch (K).



(4.71×10^{-3} T , 3.14×10^{-3} T)

24. An insulated wire of diameter 0.2 cm, if it is coiled around an iron rod of permeability 2×10^{-3} Wb/A.m such that the turns are tangent to each other if the electric current passing through the coil is 5 A. Calculate the magnetic flux density at the middle of its axis. *(5 T) (Olym. 08)*

25. The following table shows the relation between magnetic flux density (B) at a point inside a solenoid and the current intensity (I) through the solenoid :

I (A)	1	2	3	4
B (T)	4×10^{-4}	8×10^{-4}	12×10^{-4}	16×10^{-4}

(a) **Draw the graphical relation between** the current intensity (I) on x-axis and the magnetic flux density (B) on y-axis.

(b) **From the graph find** the number of turns in one meter of the solenoid.

(318.18 turn/m) (2^{nd} session 17)

Guiding notes for solving problems 5

- When the turns of the circular coil are moved a distance away from each other, so it becomes a solenoid.

  To compare between them : $\frac{B_{circular}}{B_{solenoid}} = \frac{\ell_{solenoid}}{2r_{circular}}$

26. A solenoid of length 10 cm, number of turns 56 turns is carrying electric current such that the magnetic flux density at the center of its axis is 14×10^{-5} T, **calculate :**

(a) The electric current passing through it.

(b) The magnetic flux density at its center if the turns are compressed to be a circular loop of diameter 20 cm. *(0.199 A , 7×10^{-5} T)*

27. A circular coil of diameter 12 cm carries an electric current which generates a magnetic field at its center. If the coil is stretched uniformly in the direction of its axis such that it forms a solenoid and the same current flows through it. Calculate the length of the solenoid which makes the magnetic flux density at a point inside it along its axis = $\frac{1}{2}$ of that at the center of the circular coil. *(0.24 m) (1st session 99)*

28. A circular coil of a diameter 22 cm and number of turns 49 turns carrying an electric current which is generating a magnetic field of density at the center of the coil equals 7×10^{-5} T, **calculate :**

(a) The electric current intensity passing through the coil.

(b) The magnetic flux density at a point at its axis if its turns are stretched away from each other to become of length 11 cm. *(0.25 A, 13.98×10^{-5} T) (1st session 01)*

29. A solenoid of length 20 cm carrying electric current which generate a magnetic field of density 4×10^{-3} T at any point on its axis, its turns are pressed uniformly. If its diameter is 10 cm, calculate the magnetic flux density at the center of the coil in this case. *(8×10^{-3} T) (Azhar 11)*

Guiding notes for solving problems 6

- If two solenoids have the same axis and carrying two electric currents :
  In the same direction : $B_t = B_1 + B_2$
  In the opposite direction : $B_t = B_1 - B_2 \quad (B_1 > B_2)$
- If a wire is placed perpendicular on axis of a solenoid coil and electric current passed through each of them, then the magnetic flux density at a point on the solenoid axis and at a certain distance from the straight wire is : $B_t = \sqrt{B^2_{(wire)} + B^2_{(coil)}}$

30. A straight wire carrying electric current 5 A is placed perpendicular on the axis of a solenoid of 10 turns, its length 15 cm carrying electric current $\frac{7}{22}$ A , calculate the magnetic flux density at the axis of the coil and at a distance 5 cm from the wire.
(3.34×10^{-5} T)

31. A solenoid of length 50 cm and number of turns 100 turns carrying electric current 2 A is placed in the middle of a circular coil where the center of the circular coil coincides with the axis of the solenoid and the plane of the circular coil is perpendicular to the axis of the solenoid if the number of turns of the circular coil is 20 turns and carrying electric current 1 A, its radius is 15 cm, calculate the magnetic flux density at the common center if the two currents are :

(a) In the same direction.

(b) In opposite directions. *(5.87×10^{-4} T, 4.19×10^{-4} T)*

32. Two solenoids one of them is inside the other such that their axis coincide together if the number of turns per unit length of the first coil is 10 turns and the second is 20 turns and the electric current in the inner one 2 A and the external one is 4 A, calculate the magnetic flux density at a point inside them on the axis :

(a) If the two electric currents are in the same direction.

(b) If the two electric currents are in opposite directions. *(125.6×10^{-6} T, 75.36×10^{-6} T)*

33. An insulated metallic wire of radius 0.4 mm is wound around an iron cylinder of diameter 4 cm to form a solenoid its turns are tangent to each other, if the solenoid is connected to a battery of emf ($V_B = 6$ V) and negligible internal resistance, the current passing through the circuit is 1.5 A. (The resistivity of the material is 1.6×10^{-8} Ω.m and the magnetic permeability of iron is 0.002 Wb/A.m) ($\pi = \frac{22}{7}$)

Calculate :

(a) The magnetic flux density at a point along the axis of the solenoid.

(b) Number of turns of the solenoid. *(3.75 T , 100 turns)*

34. A circular ring of radius 5 cm carries electric current of 10 A.

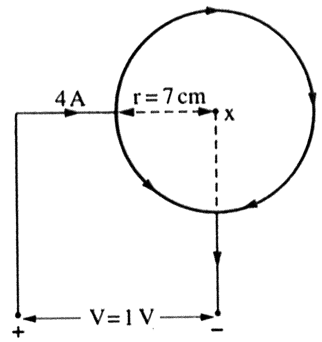
(a) Calculate the magnetic field intensity at the center of the ring.

(b) If the ring is bent such that each half ring becomes perpendicular to the other half, calculate the magnetic field intensity at the center. *(1.26×10^{-4} T, 8.9×10^{-5} T)*

35. In the opposite figure electric current is passing through a ring its center x and the cross-section area of the wire which forming it 0.02 cm^2, **calculate :**

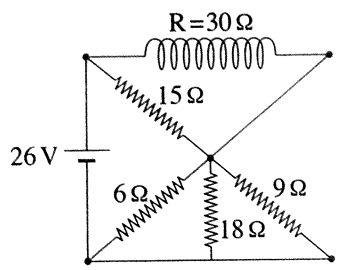
(a) The resistivity of the material of the wire.

(b) The magnetic flux density at the center of the ring.

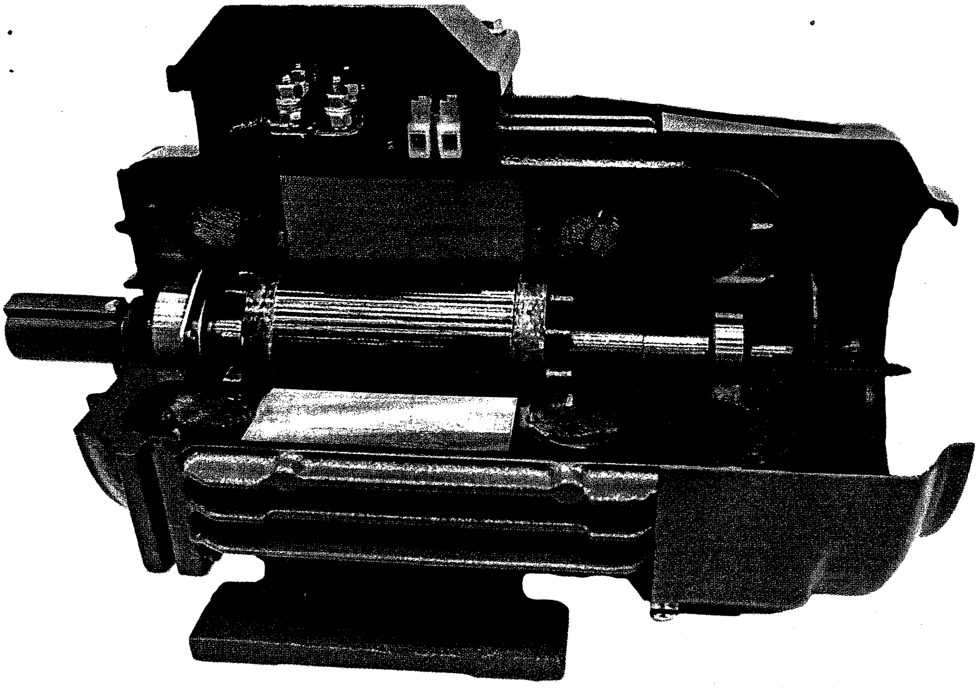


(6.06×10^{-6} Ω.m, 0)

36. In the shown circuit, if the number of turns per unit length of the coil is 150 turn/meter, Calculate the magnetic flux density at the center of its axis.



(1.26×10^{-4} T)



QUESTIONS ON **Chapter 2** LESSON 3

The Magnetic Force and the Torque

1 Write down the scientific term for each statement of the following :

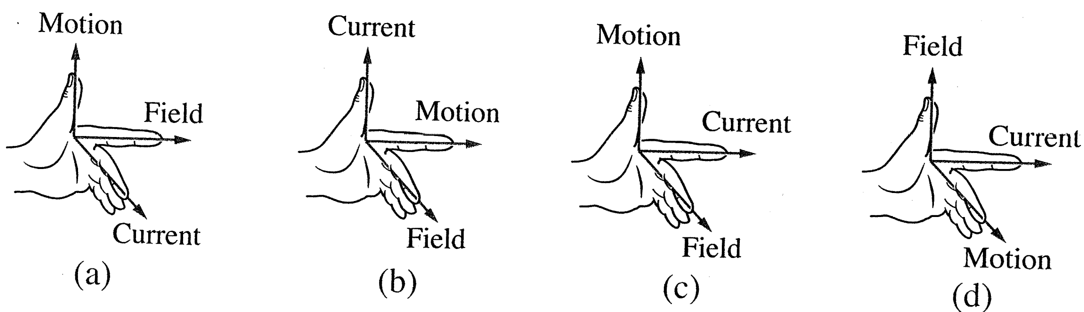
1. It is the force acting on a wire of length 1 m carrying current 1 A placed perpendicular to a magnetic field at that point.
2. It is the magnetic flux density which generates a force of 1 N on a wire of 1 m length carrying current of 1 A perpendicular on the field.

(1st session 12 , 15 - Exp. 14 , 16 - 2nd session 14)

3. It is the torque acting on a coil carrying electric current which its plane is parallel to a magnetic flux density of 1T.

2 Choose the correct answer of the given answers :

1. The .... rule is used to determine the direction of the force due to magnetic field acting on a straight wire carrying current and is placed perpendicular to the magnetic flux lines.
   a. Fleming's left hand b. Fleming's right hand
   c. Ampere's right hand d. Ampere's left hand
2. The figure .... represents Fleming's left hand rule.



3. The direction of the force acting on a wire carrying an electric current perpendicular to the direction of the magnetic flux is ....

a. in the same direction of current.

b. in the opposite direction of current.

c. perpendicular to the direction of current and parallel to the flux.

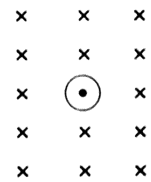
d. perpendicular to the direction of the magnetic flux and electric current.

4. The magnetic force acting on a wire carrying an electric current and placed in a magnetic field vanishes when the wire is ....

a. perpendicular to the field. b. parallel to the field.

c. making angle 60° with the field. d. making angle 30° with the field.

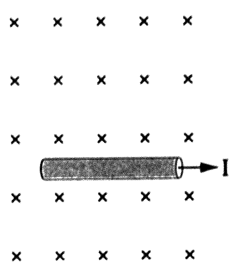
5. In the opposite figure, a wire carrying an electric current (I), its direction is outside the page and is placed in a magnetic field of density (B) and its direction is inside the page. If the length of the wire is (ℓ), then the acting force equals ....



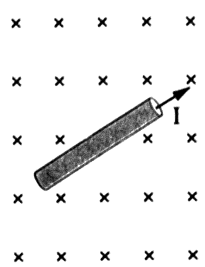
a. $BI\ell$ b. $\frac{1}{2} BI\ell$

c. $\sqrt{2} BI\ell$ d. 0

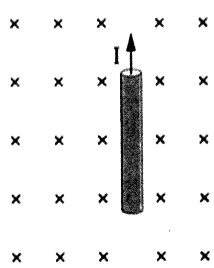
6. In the following figures, the wire that is exposed to the larger magnetic force is ....



(1)



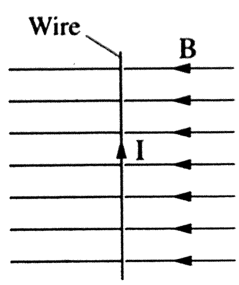
(2)



(3)

a. (1) b. (2) c. (3) d. all the previous.

7. In the opposite figure, a wire carries an electric current (I) perpendicular to the magnetic flux density (B)



i. The direction of the acting force on the wire is ....

a. right side of the page. b. left side of the page.

c. upward. d. downward.

ii. If the length of the wire is 2 m, carries electric current 50 A and the magnetic flux density is 0.4 T. So, the acting force on that wire is ....

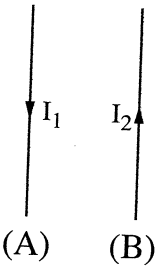
a. 40 N. b. 28 N. c. 19 N. d. 10 N.

8. The mutual force between two parallel wires, the distance between them (d) carrying two electric currents I_1 , I_2 equals ....

a. $\frac{\mu I_1 \ell}{2 \pi I_2 d}$ b. $\frac{\mu I_1 I_2 \ell}{2 \pi d}$

c. $\frac{2 \mu d}{\mu I_1 I_2 \ell}$ d. $\frac{2 \pi I_2 d}{I_1 \ell}$

9. In the opposite figure, two wires (A) and (B) are carrying two electric currents I_1 , I_2 where $I_2 < I_1$, so the magnetic flux densities are B_1 , B_2 respectively :



i. The magnetic flux density between the two wires equals ....

a. $B_1 + B_2$ b. $B_1 - B_2$ c. $\frac{B_1 + B_2}{2}$ d. $B_2 - B_1$

ii. The neutral point between two wires lies ....

a. outside the wires near to (B). b. between the two wires near to (A).

c. between two wires near to (B). d. in the middle between them.

iii. The direction of the acting force on wire (B) is ....

a. inside the page. b. outside the page.

c. to the left side of the page. d. to the right side of the page.

iv. The force between two wires (A) , (B) is a .... force.

a. attraction b. repulsion

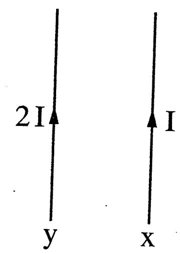
c. centripetal c. no correct answer

v. If the wire (A) carries an electric current 4 A and the wire (B) carries an electric current 2 A, if they have the same length, the ratio between the force acting on the wire (B) to the force acting on the wire (A) is .... one.

a. more than b. less than

c. equals d. more than or equal to

10. In the opposite figure, the ratio between the force acting on wire x to that acting on wire y is ....



a. $\frac{1}{1}$ b. $\frac{2}{1}$

c. $\frac{1}{2}$ d. $\frac{0}{1}$

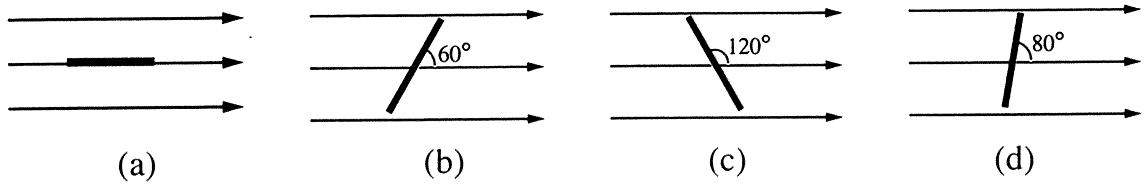
11. The torque (τ) acting on a coil carrying an electric current and placed in a uniform magnetic field becomes maximum when the plane of the coil is .... the direction of the field.

(2^{nd} session 00)

a. perpendicular to b. parallel to

c. inclined with angle 30° to d. no correct answer

12. Which of the following positions for the coil expresses the minimum torque value when the electric current passes through it ? ....



13. The torque equals ....

a. one of the two forces / the distance between them

b. one of the two forces × the distance between them

c. one of the two forces ÷ the distance between them

d. one of the two forces – the distance between them

14. The magnetic dipole moment $|\overrightarrow{m_d}|$ equals ....

a. IN b. IAN c. IA/N d. IN/A

15. A coil of cross-sectional area 0.001 m^2 carrying an electric current 10 A is placed in a magnetic field of density 2 T and inclined by angle 60° on the field. So, the torque acting on it equals 1 N.m.

i. The number of turns equals .... turns.

a. 15 b. 50 c. 100 d. 200

ii. The maximum value of torque is ....

a. 2 N.m. b. 1.5 N.m. c. 1 N.m. d. 0.5 N.m.

iii. The magnetic dipole moment of a coil equals ....

a. 2 $A.m^2$ b. 1.5 $A.m^2$ c. 1 $A.m^2$ d. 0.5 $A.m^2$

16. A conducting circular loop of radius r carries a constant current I. It is placed in a uniform magnetic field B such that B is perpendicular to the plane of circular loop. The magnetic torque acting on the circular loop is ....

a. IrB b. 2π IrB c. zero. d. πIr^2B

17. Two circular coils carrying currents having the same number of turns, the two coils of radii 3 cm and 6 cm and they have equal magnetic dipole moments. The ratio between the currents through the coils is ....

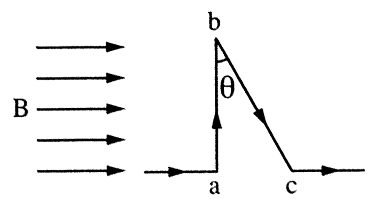
a. 1 : 1 b. 1 : 2 c. 2 : 1 d. 4 : 1

18. In the opposite figure :

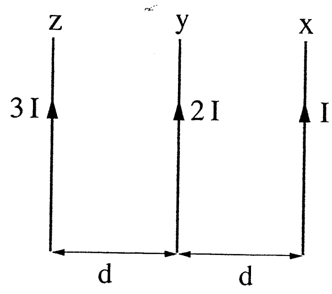
If the magnetic force acting on the side ab is F , then the force acting on the side bc ....

a. less than F b. greater than F

c. equals F d. equals F sine θ



19. In the shown figure the ratio between the magnetic force acting on one meter of the wire x to that acting on one meter of the wire z $\left(\frac{F_x}{F_z}\right)$ equals ....



a. $\frac{1}{1}$

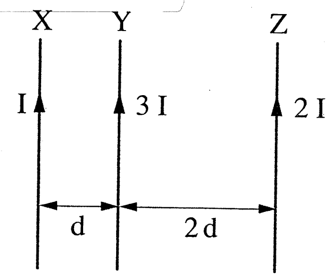
b. $\frac{1}{2}$

c. $\frac{7}{15}$

d. $\frac{1}{9}$

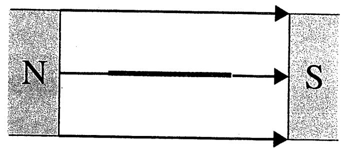
20. The opposite figure shows three long wires (X , Y , Z), which of them is not affected by a magnetic force ? ....

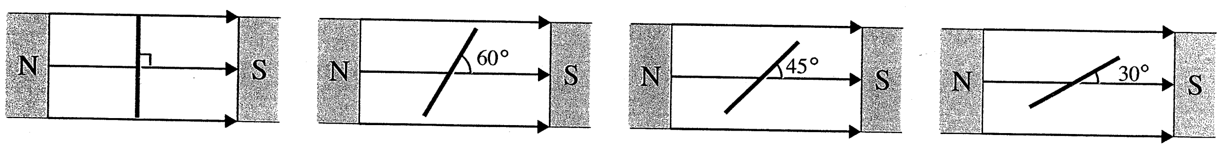
(1sd session 17)



a. X b. Y c. Z

21. The opposite figure shows a lateral view of a coil that carries an electric current in a magnetic field. If the coil is affected by a torque (τ), which of the following positions of the coil makes the torque $= \frac{\tau}{2}$? .... *(2nd session 17)*





(a) (b) (c) (d)

3 What is meant by...?

1. The magnetic flux density at a point = 0.4 Tesla *(1st session 05, 07 - Sudan 10)*
2. The magnetic dipole moment of a coil = 200 $A.m^2$ *(Exp. 16)*

4 Give reasons for :

1. Movement of a straight wire carrying an electric current placed perpendicular to a magnetic flux.
2. A straight wire carrying a current placed in a magnetic field may not move. *(1st session 03, 07)*
3. Two straight parallel wires attract each other if the electric current passing through them are in the same direction.
4. Two straight parallel wires repel each other if the electric current passing through them are in opposite directions. *(Azhar 98)*
5. If an electric current passed through both of a solenoid and a straight wire which coincides with the axis of the coil, the wire will not be affected by a magnetic force. *(2nd session 99)*
6. • A rectangular coil carrying DC electric current in a magnetic field may not move. *(2nd session 09)*

- A torque may not be generated on a rectangular coil carrying electric current in a magnetic field.

7. The torque acting on a rectangular coil carrying a current between two magnet poles decreases as the coil rotates from the position in which the plane of the coil parallel to the magnetic field till it becomes perpendicular to the field.

5 What are the factors affecting each of the following :

1. The force acting on a wire carrying an electric current in a magnetic field. *(1st session 11- Azhar 11)*
2. The magnetic force acting on a straight wire carrying an electric current and placed perpendicularly in a uniform magnetic field. *(1st session 14)*
3. The torque acting on a coil carrying an electric current and placed in a magnetic field. *(1st session 12)*
4. The magnetic dipole moment of a coil. *(2nd session 15, 17)*

6 Mention the conditions for each of the following :

1. The attraction force between two parallel wires carrying electric currents. *(2nd session 07- Sudan 08)*
2. The repulsion force between two parallel wires made from copper carrying an electric current. *(Exp. 15)*
3. Vanishing of the torque acting on a coil carrying electric current and placed in a magnetic field.

7 What happens in each of the following and explain :

1. Flow of electric current in two parallel wires in the same direction. *(1st session 11- Sudan 13 - Exp. 16)*
2. Flow of electric current in two parallel wires in opposite directions. *(1st session 14)*
3. Placing a wire carrying electric current perpendicular to a uniform magnetic field. *(2nd session 08)*
4. Placing a wire carrying electric current parallel to a uniform magnetic field.
5. The plane of a coil carrying electric current is perpendicular to the magnetic field concerning the magnetic dipole moment acting on the coil.

8 Compare between Ampere's right hand rule and Fleming's left hand rule (in terms of usage).

(Aug. 98 - 1st session 03, 11, 13, 14 - 2nd session 01 , 13)

9 When does each of the following values equal zero ?

1. The force acting on a straight wire carrying electric current and placed in a uniform magnetic field. *(Azhar 04, 11- Sudan 14 - Exp. 16)*
2. The torque acting on a coil carrying electric current and placed in a uniform magnetic field. *(2nd session 12 - 1st session 14 - Exp., Sudan 16)*

10 Miscellaneous questions :

1. **Mention the physical quantities that are measured by the following units and mention the equivalent units :**

(a) N/A^2 *(Sudan 15)*
(b) N/A.m *(1^{st} session 01, 03 , 06 , 13)*
(c) N.m *(Exp. 15)*
(d) N.m/A
(e) $N.m.T^{-1}$
(f) $A.m^2$ *(Sudan 13- Exp. 15, 16)*

2. Mention the used rule to determine the direction of force due to magnetic field acting on a straight wire carrying electric current.

3. **Prove that :**

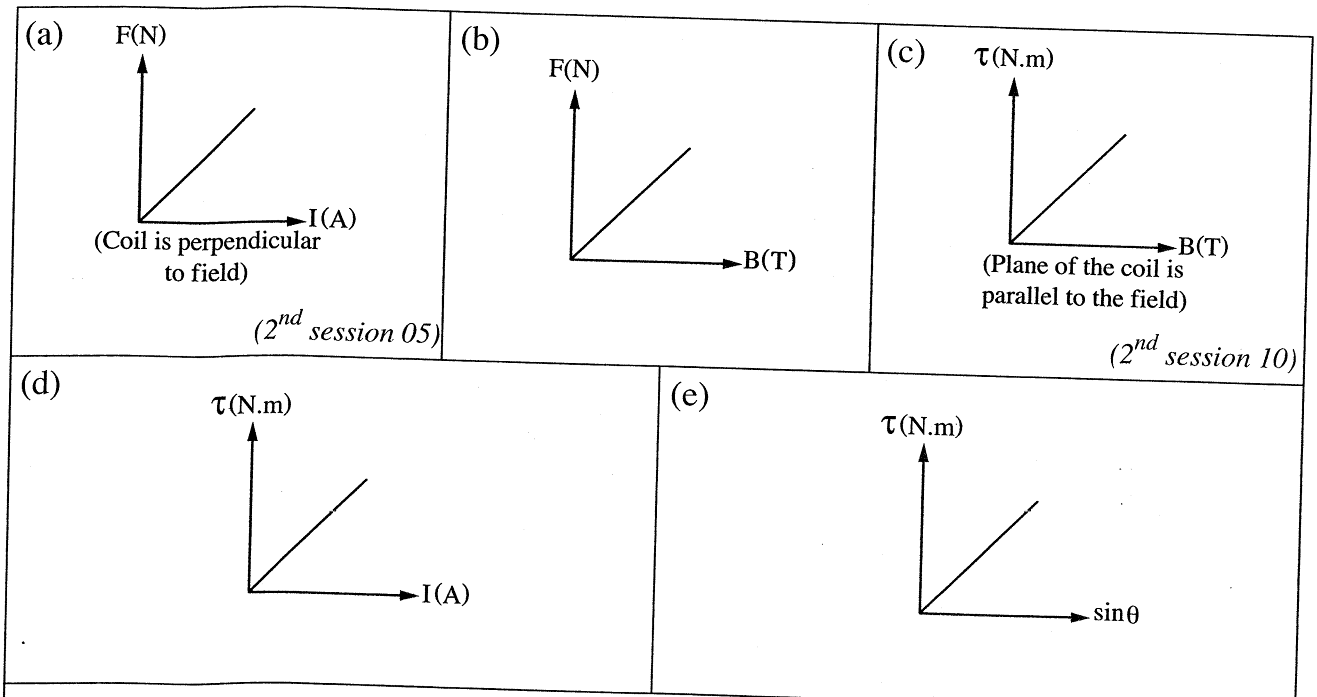
(a) Wb = N.m/A

(b) The force (F) acting on a long wire of length (ℓ), carrying current (I) and placed perpendicular to a magnetic field of flux density (B) is determined by the relation : $F = BI\ell$

(c) The torque (τ) acting on a rectangular coil of face area A, number of turns (N), carrying a current (I) and placed parallel to a magnetic field of flux density (B) is $\tau = BIAN$

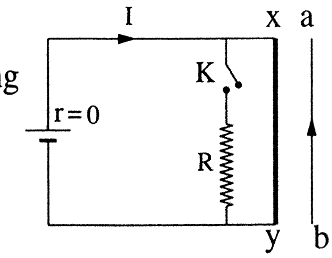
(May 97 – Sudan 07 – Azhar 08)

4. **Write the mathematical relation and the slope for each of the following graphs :**



Where : (F) is the magnetic force on the wire, (I) is the current, (B) is the magnetic flux density, (τ) is the torque, (θ) is the angle between the normal of the coil and magnetic field.

5. **In the opposite figure :**



If the resistance of the wire (xy) is (R) and the electric current passing through the circuit is (I) then in case of opening switch (K).

(a) What is the type of the mutual electromagnetic forces between two wires (xy) and (ab) ?

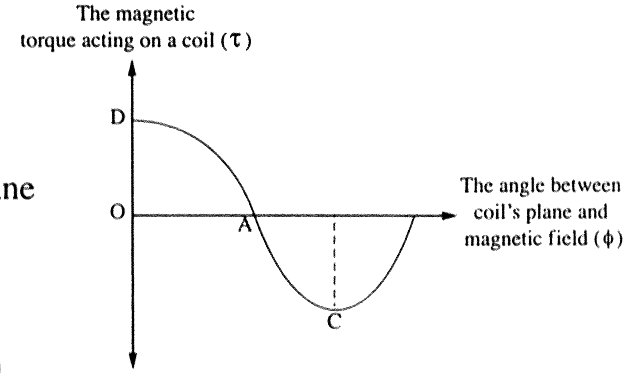
(b) At closing switch (K), what will happen to these electromagnetic forces ?

6. A wire is made of iron of length (ℓ) carrying electric current of intensity (I) and is placed in a magnetic field of density (B) which is perpendicular to it, a magnetic force (F) is produced and acts on the wire if the wire is replaced by another one made of copper and is connected with the same source, does the value of the magnetic force differ ?

7. Mention one use for Fleming's left hand rule. *(1st session 05 - Exp. 10)*

8. Mention the measuring unit of the magnetic dipole moment.

9. The opposite figure represents the relation between the magnetic torque acting on a flat coil (τ) which rotates in a uniform magnetic field and the angle (ϕ) between the coil's plane and the magnetic flux lines.



Answer the following questions :

(a) Describe the position of coil's plane with respect to the magnetic field at points A and C.

(b) The value of the magnetic torque acting on the coil (τ) at points A and C.

(c) If the coil reaches the half maximum value of magnetic torque from zero position, so the angle between magnetic dipole moment and magnetic field is ....

a. 45°   b. 30°   c. 60°   d. 90°

(d) If the coil rotates from point D by angle 30°, describe the position of coil's plane with respect to the magnetic field and mention the value of the magnetic torque acting on the coil (τ).

10. When does the magnetic force on a wire carrying an electric current in a magnetic field become maximum value ? *(2nd session 17)*

11. Explain why a rectangular coil that is placed perpendicularly in the direction of a magnetic field is not affected by a torque when a current passes through it even if its sides are being affected by a magnetic force. *(Exp. 17)*

11 Problems :

Guiding notes for solving problems 1

- To determine the force (F) due to magnetic field acting on a straight wire carrying current : $F = BI\ell \sin\theta$ (N)

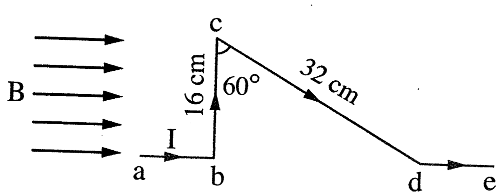
  (Where : θ is the angle confined between the direction of the field and the current passing through the wire)

  (a) If the wire is parallel to the direction of the magnetic flux :
  $F = BI\ell \sin 0 = 0$ (The acting force on the wire vanishes)

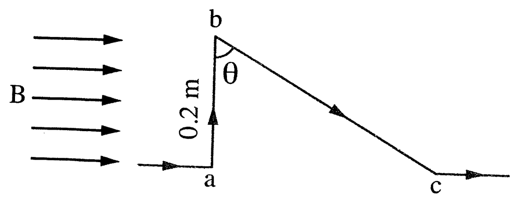
  (b) If the wire is perpendicular to the direction of the magnetic flux :
  $F = BI\ell \sin 90 = BI\ell$ (The acting force on the wire is maximum value)

Use the following constant if needed : ($\mu_{air} = 4\pi \times 10^{-7}$ Wb/A.m)

1. Calculate the magnetic force acting on a straight wire of length 50 cm carrying electric current of intensity 2 A placed perpendicular to a magnetic flux of density 0.2 T. *(0.2 N)*
2. A metallic straight wire of length (ℓ) and cross-sectional area 10 mm^2, the resistivity of its material 2.8×10^{-8} Ω.m is connected to a battery of e.m.f 3 V of negligible internal resistance :
   (a) Find the value of the magnetic force which acts on the wire when placed perpendicular to a magnetic field of density 10^{-3} Tesla.
   (b) What will happen to the force acting on the wire if the radius increased to the double.
   (1.07 N , 4.28 N) (Exp. 15)
3. A wire carrying electric current of intensity 10 A is placed perpendicular to a magnetic field of density 0.1 Tesla, calculate the acting force per unit length of the wire. *(1 N/m)*
4. A straight wire of length 30 cm carrying electric current of intensity 0.4 A is placed perpendicular to the direction of a magnetic field so it is acted upon by a force of 3×10^{-4} N, calculate the magnetic flux density then the acting force on the wire in the same field when the angle between them is 30°.
   (25×10^{-4} T , 1.5×10^{-4} N) (2^{nd} session 02)
5. **In the opposite figure :**
   If the electric current intensity passing in the wire is 5 A and the flux density is 0.15 T , calculate the force acting on parts ab , bc , cd , de.



6. **In the opposite figure :**
   If the electric current intensity passing in the wire is 2 A and the magnetic flux density is 0.1 T , calculate the force acting on the parts ab , bc.



7. A wire of length 10 cm carrying electric current of 5 A is placed in a magnetic field of density 1 Wb/m^2, calculate the acting force on the wire when it makes an angle with the direction of the magnetic flux equals :

(a) 0° (b) 45° (c) 90° (d) 135° (e) 180°

(0 , 0.354 N , 0.5 N , 0.354 N , 0)

8. If an electric current of intensity 10 A passing through a wire of length 0.5 m placed in a magnetic field of density 2 T, calculate the acting force on the wire in the following cases :
(a) The wire is parallel to the magnetic flux lines.
(b) The angle between the wire and the magnetic flux lines is 30°
(c) The wire is perpendicular to the magnetic flux lines. *(0, 5 N , 10 N) (Aug. 97)*

9. A straight wire of length 30 cm carrying an electric current of intensity 4 A, how to put this wire in a magnetic field of density 5 T to be acted upon by a force 3 N. *(30°)*

10. A metal wire is coiled in the shape of a circular loop of radius 7 cm and its number of turns 4 turns, when an electric current passes through it, a magnetic field of density 3.52×10^{-5} Wb/m^2 is produced at its center if the coil became a straight wire carrying the same current and is placed in a magnetic field of density 1.5 Wb/m^2 and made angle 30° with the direction of the field. Calculate the acting force on the wire.

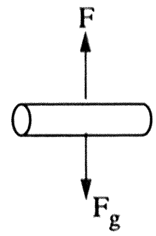
(1.294 N) (2^{nd} session 04)

Guiding notes for solving problems 2

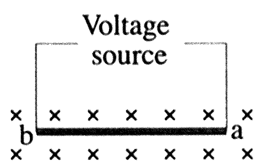
- If a wire carrying electric current is hanged in a horizontal position and perpendicular to a horizontal magnetic field :

$\because F = F_g$ $\therefore BI\ell = mg$

$BI\ell = \rho V_{ol} g$ $\therefore BI\ell = \rho A \ell g$ $BI = \rho \pi r^2 g$

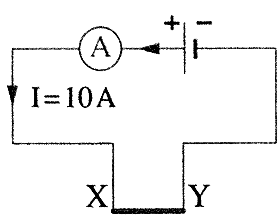


11. A wire (ab) is placed horizontally in a magnetic field of density 0.2 T, where the direction of the magnetic field is into the page and perpendicular on the wire. Find the value and the direction of the current that if passed through the wire generates a magnetic field causes the wire to be apparently weightless.



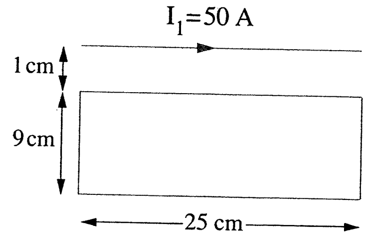
(From b to a , 1 A)

12. A wire made of aluminum (XY) of cross-sectional area 0.1 cm^2 is held horizontally while its terminals are in contact to the ends of an electric circuit as shown in the opposite figure, calculate the density of the magnetic flux which keeps the wire suspended without any external support and show the direction of the magnetic flux.
(Knowing that : $\rho_{Al} = 2700\ kg/m^3$, $g = 10\ m/s^2$)

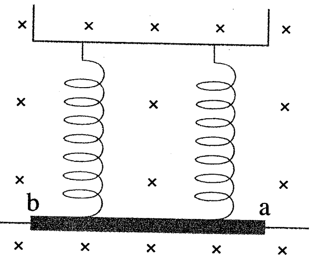


(27×10^{-3} T) (1^{st} session 08)

13. The opposite figure represents a long straight wire carrying electric current of intensity 50 A in x-direction. A rectangular coil of one turn with dimensions 25 cm, 9 cm and mass 4.5 g is placed under the wire in the same plane. Calculate the magnitude and direction of electric current that should pass in the coil to remain suspended vertically in its position in the air. (Where : $g = 10\ m/s^2$) *(200 A)*



14. A metallic rod (ab) of length 0.4 m and mass 50 g is suspended by two insulated springs of negligible masses in a magnetic field density of 0.2 T as in the opposite figure where the rod is working as a part of the electric circuit, **find :**



(a) The magnitude and the direction of electric current intensity in the rod if the tension force in the springs equals zero.

(b) The tension force in each spring if the direction of the current is reversed.

(Where : the acceleration due to gravity = $10\ m/s^2$) *(6.25 A , 0.5 N)*

Guiding notes for solving problems 3

- To determine the mutual force between two parallel wires the distance (d) between them and carrying two electric currents (I_1 , I_2) :

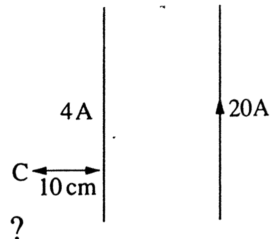
$$F = \mu \frac{I_1 I_2 \ell}{2\pi d} \ (N)$$

- If I_1 , I_2 are in the same direction, the mutual force is an attraction force.
- If I_1 , I_2 are in opposite directions, the mutual force is a repulsion force.

15. A straight wire is carrying electric current of intensity 5 A, calculate the magnetic flux density produced due to flow of an electric current in the wire at a point in air at a vertical distance 10 cm from the wire and if another wire is placed at this point of length 50 cm and carrying electric current of intensity 2 A, calculate the acting force on this wire due to the field. ($\frac{\mu}{2\pi} = 2 \times 10^{-7}$ Weber/A.m) *(10^{-5} T , 10^{-5} N) (2nd session 13)*

16. Two straight parallel wires the distance between them in air is 2 m , an electric current passes in the same direction in each of them, if the magnetic flux density is vanished at a point at the middle of the distance between them and the acting force an one meter of each of them is 4×10^{-5} N, calculate the electric current intensity passing through each wire. *(20 A , 20 A) (Azhar 11)*

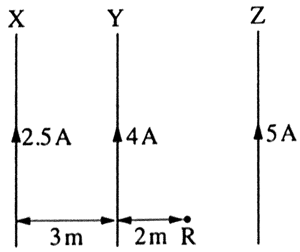
17. **In the opposite figure :** Two parallel wires carry currents one of them carries a current 20 A and the other carries a current 4 A. A magnetic needle was placed at point C and did not deflect.



(a) Determine the direction of current I, then explain your answer.

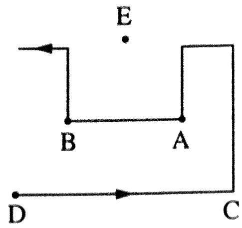
(b) Calculate the mutual force per unit length between the two wires ? And mention its kind.

18. **In the opposite figure :** Three parallel wires, X , Y and Z on the same plane, carry currents in the direction shown in the diagram. Calculate the force per unit length acting on wire Z, if the total magnetic flux density at point R is zero.



19. **In the opposite figure :**

Two horizontal wires AB and DC are in one vertical plane, the wire AB of length 1 m and mass 5 gm and free to move vertically, **calculate :**



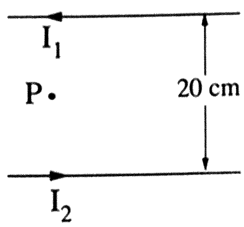
(a) The resultant force on wire AB and its direction when it is at height 2 cm from the wire CD where the electric current intensity passing through them is 50 A.

(b) The distance between the two wires at equilibrium.

(c) The resultant of the flux density at point E which is at distance 2 cm from the wire AB at equilibrium. (Where : $g = 10\ m/s^2$)

(0.025 N , 0.01 m , 1.67×10^{-4} T)

20. Two parallel straight wires the distance between them is 20 cm. The first wire carries a current (I_1) and the second caries a current ($I_2 = 10$ A) in the direction as in the opposite figure. If the total magnetic flux at the point (P) in the middle of the distance between the two wires is 6×10^{-5} T, calculate the mutual force between them if their lengths were 50 cm. *(10^{-4} N) (Exp. 17)*



Guiding notes for solving problems 4

- To determine the force by which two parallel wires act on a wire parallel to them :
  - Calculate the magnetic flux density on the first wire related to the third wire position :

$$B_{13} = \frac{\mu I_1}{2 \pi d_{13}}$$

  - Calculate the magnetic flux density on the second wire related to the third wire position :

$$B_{23} = \frac{\mu I_2}{2 \pi d_{23}}$$

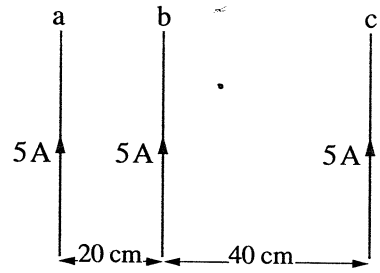
  - Then calculate the resultant magnetic flux : $B_t = B_{13} \pm B_{23}$
  - After that calculate the resultant force on the third wire : $F = B_t I_3 \ell_3$

21. **In the opposite figure :**

Three parallel wires, find the acting force on one meter of the wire (b) when the electric current in the two wires a , c are :

(a) In the same direction.

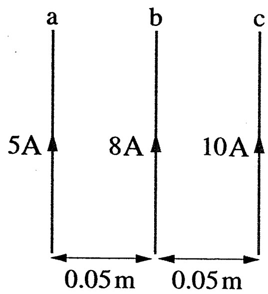
(b) In opposite directions.



(12.5×10^{-6} N , 37.5×10^{-6} N)

22. Two straight parallel wires the distance between them is 10 cm , a current of intensity 2 A passes in the first while 3 A in the second in the same direction, find the neutral point between the two wires and if we reversed the direction of the two currents in the two wires and a third wire of length 10 cm carrying electric current 5 A is placed parallel to them at the previous neutral point, what is the value of the acting force on the wire ? *(4 cm , 10^{-5} N)*

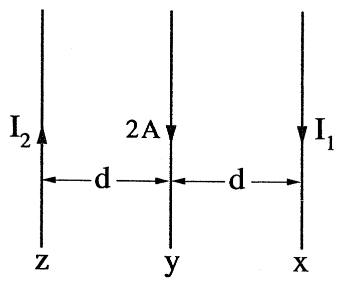
23. **In the opposite figure :** Three straight parallel wires (a), (b), (c) the length of each of them is one meter and carrying electric current of intensity 5 A, 8 A, 10 A respectively in the direction as shown in the figure if the wire (b) is at distance 0.05 m from each of (a) , (c). Calculate the acting magnetic force on the wire (b).



(16×10^{-5} N) (1^{st} session 10)

24. **In the opposite figure :**

Three parallel straight wires are in the same plane, if you know that the magnetic force acting on one meter of the wire y is F and when reversing the current of wire x, the force acting on unit length of the wire y becomes $\frac{1}{2}$ F , calculate the ratio between the two currents $\frac{I_1}{I_2}$ where $I_1 > I_2$



($\frac{3}{1}$)

Guiding notes for solving problems 5

- To determine the torque (τ) acting on a coil carrying electric current in a magnetic field : $\tau = BIAN \sin \theta$ (N.m)

(Where : θ is the angle confined between the perpendicular to the plane of the coil and the magnetic flux lines)

- If the plane of the coil is parallel to the direction of the magnetic flux :

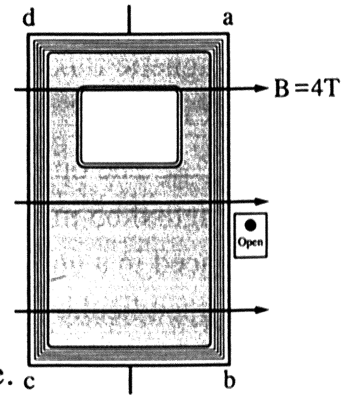
$\tau = BIAN \sin 90 = BIAN$ (Torque is maximum value)

- If the plane of the coil is perpendicular to the direction of the magnetic flux lines :
  $\tau = BIAN \sin 0 = 0$ (Torque vanishes)
- To determine the magnetic dipole moment : $|\vec{m}_d| = IAN = \dfrac{\tau}{B \sin \theta}$

25. A coil of 500 turns carrying electric current of intensity 10 A is placed in a magnetic field of density 0.25 Tesla if its cross-sectional area is 0.2 m^2, calculate the torque acting on the coil when the angle between the normal of the coil and the field is 30° *(125 N.m)*

26. Find the minimum electric current which is passing through a coil of motor to produce a torque of 20 N.m. If you know that the number of turns is 200 turns, cross-sectional area is 300 cm^2 and the magnetic flux density is 0.4 Tesla. *(8.33 A)*

27. One of the inventors wants to design a door that opens automatically as shown in the figure where the door rotates around its axis at the center when an electric current of intensity 1 A passes in the coil surrounding it where the cross-sectional area of the door is 2 m^2.



(a) Determine the direction of the current in side (ab) when the door opens such that the direction of (ab) is outside the page.
(b) Calculate the number of turns that produces a torque equals 400 N.m. *(50 turn)*

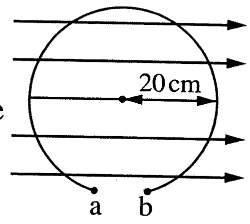
28. A coil of 200 turns and cross-sectional area 0.2 m^2 carrying electric current of intensity 10 A was placed in a magnetic field of density 0.4 T, **calculate :**
(a) The acting torque when the angle between the plane of the coil and the field is 60°.
(b) The maximum torque and determine the position of the coil related to the field.
(80 N.m , 160 N.m) (1st session 04)

29. A rectangular coil of dimensions 20 cm, 10 cm and of 200 turns is placed in a uniform magnetic field of magnetic flux density of 0.4 Tesla. A current of 3 Amperes is passed through the coil, calculate the torque acting on the coil in the following cases :
(a) When the coil plane is inclined by angle 60° to the direction of the field.
(b) When the coil plane is perpendicular to the direction of the field.
(c) When the coil plane is parallel to the direction of the field.
(2.4 N.m, 0, 4.8 N.m) (1st session 09)

30. A straight wire of length 10 cm carrying electric current of intensity 10 A is placed perpendicular to a magnetic field of intensity 10 T. Calculate the force acting on it and how to reshape this wire to get the maximum torque ? Calculate the value of the torque and what is the position of the reshaped wire with respect to the field in this case.
(10 N , 0.0796 N.m)

31. A battery of e.m.f 14 V, its internal resistance is neglected connected to a circular coil of radius 10 cm if the resistivity of the wire material is 7×10^{-7} Ω.m and the radius of the wire is 1 mm, calculate the torque acting on the coil when it was placed parallel to a magnetic field of density 0.5 T. ($\pi = 3.14$) *(1.57 N.m)*

32. A metal ring in the shape of a circle with a gap of resistance 0.1 Ω if it was connected with a battery of e.m.f 9 V between a , b find the torque acting on the ring due to a magnetic field of density 0.4 T where its direction is in the same plane of the coil. ($\pi = 3.14$)

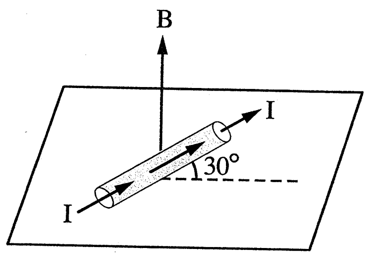


(4.522 N.m)

33. A circular coil has number of turns (N) and radius 10 cm, if the magnetic flux density at its center is 2×10^{-4} T due to the flow of electric current, calculate the magnetic dipole moment for it. *(1 A.m^2)*

34. A circular coil of cross-sectional area 10 cm^2 carries a certain electric current where the magnetic flux density at its center is $\pi \times 10^{-5}$ T. Calculate the magnetic dipole moment for it. *(8.9×10^{-4} A.m^2)*

35. The opposite figure shows a free moving wire of length 0.65 m carries an electric current of intensity 12 A placed in a uniform magnetic field of flux density 0.2 T perpendicular to the plan containing the wire, calculate the force acting on the wire and mention the rule used to determine its direction. *(1.56 N)*



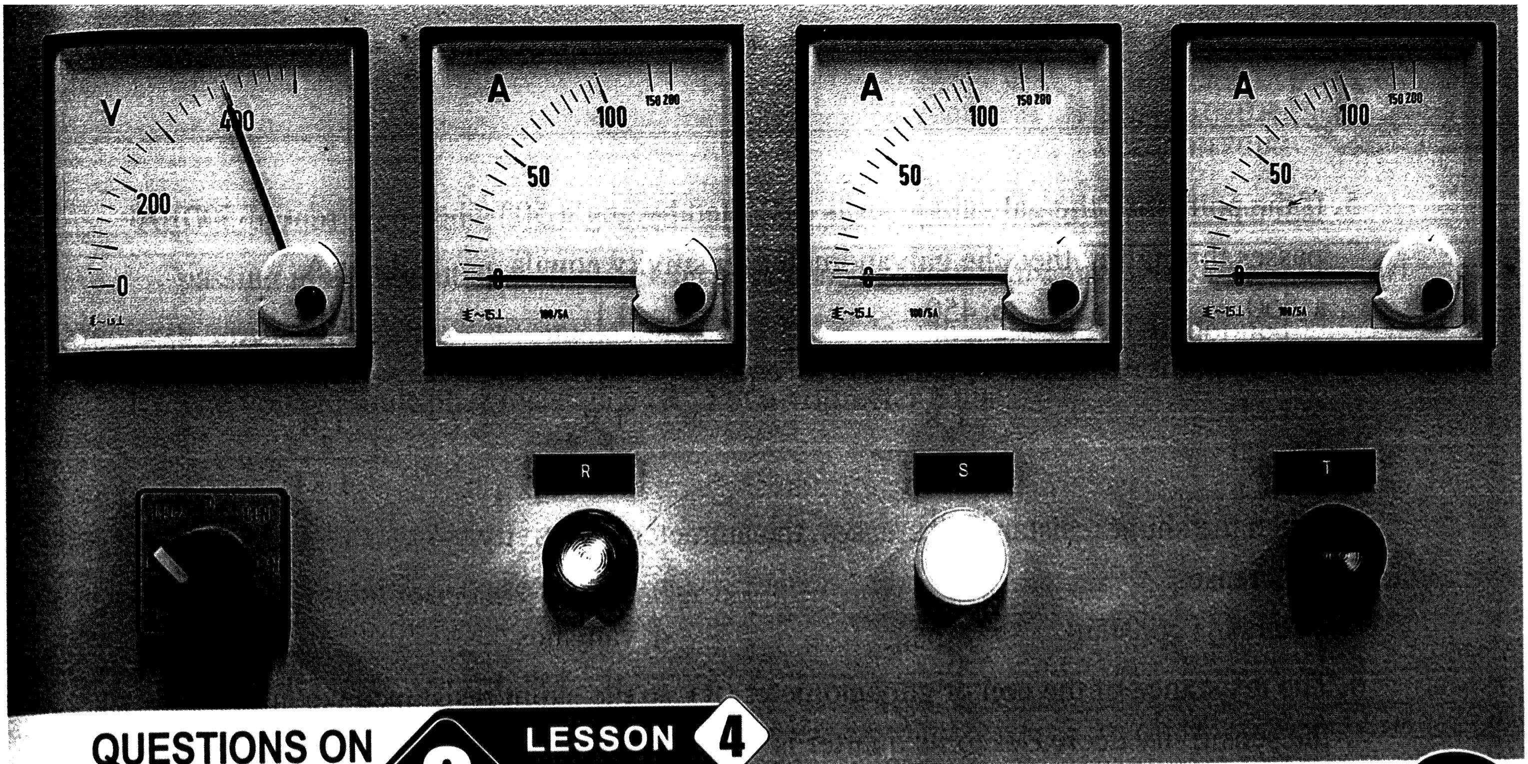
36. A solenoid of length 1.6 m and its number of turns is 500 turns, carries electric current of 3 A, inside it another circular coil its number of turns 10 turns and its cross-section area is 0.01 m and carries electric current of 0.4 A, calculate the torque required to keep the axis of the circular coil perpendicular to the axis of the solenoid and at its center. ($\mu = 4\pi \times 10^{-7}$ Wb/A.m) *(1.48×10^{-6} N.m)*

37. A circular loop of one turn of radius 10 cm carries a current of 10 A. A flat coil of radius 0.8 cm, having 50 turns and a current of 1.25 A, is concentric with the loop.

(a) Calculate the magnetic flux density that the loop produces at its center.

(b) Calculate the magnitude of the torque acting on the coil ? Assume that the planes of the loop and coil are perpendicular and that the magnetic field due to the loop is essentially uniform. *(6.28×10^{-7} T, 7.888×10^{-9} N.m)*

38. A flat circular coil with 10 turns of wire has a diameter of 2 cm and carries a current of 0.5 A, it's mounted inside a long solenoid that has 200 turns on its 25 cm length. If the current in the solenoid is 2.4 A. Calculate the torque required to hold the coil with its axis perpendicular to the solenoid. *(3.8×10^{-6} N.m)*



QUESTIONS ON LESSON 4

Chapter 2 The Measuring Instruments

1 Write down the scientific term for each statement of the following :

1. A device that is used to indicate the existence of very weak currents in any circuit, measuring its intensity and determine its direction. *(Azhar 01)*
2. The angle of deflection of the galvanometer needle from the zero position when current intensity of unity passes through its coil. *(Aug. 98 – 1st session 11, 14 - Exp. 16)*
3. A small resistance connected in parallel with a galvanometer to convert it to an ammeter.
4. A large resistance connected in series with a galvanometer to convert it to voltmeter. *(Sudan 15)*

2 Choose the correct answer of the given answers :

1. The two magnetic concave poles in the moving coil galvanometer act to make the magnetic flux lines in the form of ....

   a. circles. b. parallel lines. c. radii. d. curves.

2. To control the movement of the coil in the galvanometer .... are used.

   a. pairs of spring coils b. agate bearings
   c. light pointer d. all the previous

3. The moving coil galvanometer is used to measure .... electric currents. *(1st session 15)*

   a. weak AC b. strong AC c. weak DC d. strong DC

4. The sensitivity of galvanometer equals ....

   a. $\theta . I$ b. $\frac{\theta}{I}$ c. $\frac{I}{\theta}$ d. $\theta + I$

5. If the pointer of the galvanometer is deflected by angle 50° when a current of 500 μA passes through it, then the galvanometer sensitivity equals .... deg/μA.

a. 550 b. 450 c. 0.1 d. 10

6. The shunt resistance of ammeter R_s equals ....

a. $\frac{I - I_g}{I_g R_g}$ b. $\frac{I_g R_g}{I - I_g}$ c. $\frac{I_g R_g}{I}$ d. $\frac{I_g R_g}{I + I_g}$

7. When the shunt resistance decreases, the ammeter sensitivity ....

a. increases. b. decreases.
c. remains constant. d. vanishes.

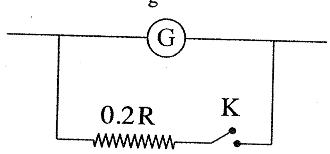
8. The resistance of the coil of galvanometer (R), so the shunt resistance when the sensitivity decreases to its quarter is .... *(Sudan, Olympics, 1st session 08 - Exp. 14)*

a. R b. $\frac{R}{2}$ c. $\frac{R}{3}$ d. $\frac{R}{4}$

9. When a shunt resistance is connected to a galvanometer coil so the total resistance of the device .... *(Azhar 08)*

a. decreases. b. increases.
c. doesn't change. d. vanishes.

10. In the opposite figure :
When switch K is closed the device sensitivity decreases to .... its value.



a. half b. fifth c. $\frac{1}{6}$ d. $\frac{1}{4}$

11. If the ratio between the resistance of the ammeter and that of the galvanometer is $\frac{1}{10}$, then the ratio between the shunt resistance to the galvanometer resistance is ....

a. $\frac{1}{10}$ b. $\frac{10}{1}$ c. $\frac{1}{99}$ d. $\frac{1}{9}$

12. The ratio between the shunt resistance and the ammeter resistance as a whole is .... one.

a. greater than b. equals
c. less than d. undefined *(Azhar 93 - Sudan 17)*

13. If the multiplier resistance in voltmeter is ten times that of the galvanometer, then ....

a. $V = 10\ V_g$ b. $V = 9\ V_g$ c. $V = 0.1\ V_g$ d. $V = 11\ V_g$

14. A galvanometer of resistance 100 Ω and its maximum current 0.01 A is required to be converted into voltmeter, then :

i. The multiplier resistance that makes it measure potential difference up to 5 V is ....

a. 5 Ω. b. 100 Ω. c. 400 Ω. d. 500 Ω.

ii. The value of the maximum potential difference it can measure when it is connected to potential multiplier of 900 Ω is ....

a. 0.9 V. b. 9 V. c. 10 V. d. 90 V.

15. The ratio between the electric current intensity passing in the voltmeter coil and that passing in the potential multiplier which is connected to it is always ·········· one. *(Azhar 94)*

a. greater than b. equals c. less than d. undefined

16. The voltage multiplier resistance (R_m) of a voltmeter equals ··········

a. $\frac{V + R_g I_g}{I}$ b. $\frac{V - I_g R_g}{I_g}$ c. $\frac{V - I_g R_g}{I}$ d. $\frac{V - I}{R_g I_g}$

17. The equivalent resistance of ammeter is ··········

a. $R_g + R_s$ b. $R_g - R_s$ c. $\frac{R_g R_s}{R_g + R_s}$ d. $\frac{R_g + R_s}{R_g R_s}$

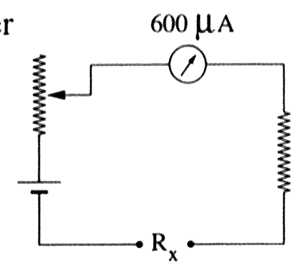
18. The equivalent resistance of voltmeter is ··········

a. $R_g + R_m$ b. $R_g R_m$ c. $R_g - R_m$ d. $\frac{R_g R_m}{R_g + R_m}$

19. The ohmmeter pointer deflects to the maximum scale when the ohmmeter circuit is closed so, the measured value is ·········· *(Azhar 11)*

a. very large. b. very small. c. vanished. d. no correct answer.

20. In the opposite circuit, the full scale deflection of a galvanometer pointer is 600 μ A at touching the ends of the circuit ($R_x = 0$) if a resistance (R_x) was inserted which equals the double of the total resistance of the circuit. So, the maximum deflection of of the galvanometer equals ··········



a. 200 μA. b. 300 μA. c. 600 μA. d. 1200 μA.

21. If the unknown measured resistance by ohmmeter is the double of the total resistance of the device so the pointer of the device deflects to ·········· scale. *(Azhar 09)*

a. half b. quarter c. $\frac{1}{3}$ d. double

22. If a resistance of 200 Ω makes the ohmmeter deflects to $\frac{1}{2}$ the scale, then the resistance that makes it deflect to $\frac{1}{3}$ the scale is ··········

a. 300 Ω. b. 400 Ω. c. 600 Ω. d. 500 Ω.

23. A sensitive galvanometer scale is divided into 20 divisions. Its pointer deflects to half its scale when a current of 0.1 mA passes through its coil. So the device sensitiviy equals ·········· *(Exp. 17)*

a. 20 μA/division. b. 10 μA/division. c. 5 μA/division. d. 2 μA/division.

3 What is meant by ... ?

1. The galvanometer sensitivity = 0.6 deg/μA *(Azhar 11)*
2. A galvanometer sensitivity = 5 deg/mA *(Sudan 17)*
3. The shunt resistance of ammeter = 3 Ω
4. The voltage multiplier resistance of voltmeter = 1000 Ω *(Sudan 17)*

4 Give reasons for :

1. The moving coil galvanometer has two concave magnetic poles. *(1st session 02, 07, 14 - 2nd session 10 - Sudan 12, 14)*
2. The coil of the moving coil galvanometer is attached to a pair of spiral springs. *(2nd session 08 - Experimental 14)*
3. The coil of the moving coil galvanometer is attached to a pair of agate bearings.
4. Mounting a soft iron cylinder inside the coil of the galvanometer. *(Azhar 93)*
5. The scale of the moving coil galvanometer is regular and its zero scale is in the middle of the graduation. *(1st session 17)*
6. The moving coil galvanometer isn't suitable to measure high electric currents.
7. The moving coil galvanometer isn't suitable to measure alternating currents. *(2nd session 14)*
8. When the moving coil galvanometer is used as ammeter, a resistor of small resistance is connected in parallel with its coil.
9. When the moving coil galvanometer is used as a voltmeter, a resistor of a high resistance is connected in series with its coil.
10. The ammeter is connected in series in the circuit.
11. The voltmeter is connected in parallel between two ends of the conductor.
12. The scale of ohmmeter is opposite to the scale of ammeter. *(Egypt 85 - 1st session 15)*
13. The scale of ohmmeter is irregular while the scale of ammeter is regular. *(Azhar 98 , 00 - 2nd session 15)*
14. The cell connected to the ohmmeter should have a constant e.m.f.
15. Connecting a large standard resistor in the ohmmeter circuit.

5 Define :

1. Galvanometer sensitivity. *(May 97 - Azhar 04)*
2. The shunt resistance. *(Experimental 14)*
3. The multiplier resistance.

6 Explain the scientific base for each of the following :

1. • 🕮 Moving coil galvanometer. *(2nd session 01 - 1st session 99, 04 , 05 - Sudan 14)*
   • Direct current ammeter. *(1st session 14)*
   • The voltmeter.
2. 🕮 The shunt resistance of ammeter.
3. 🕮 The multiplier resistance of voltmeter.
4. Measuring resistance using the ohmmeter. *(Exp. 16)*

7 What are the results of each of the following :

1. Passing large DC current (more than I_g) inside the galvanometer. *(Exp. 14)*
2. Passing AC inside the galvanometer coil.
3. The shunt resistance which is connected to galvanometer decreases concerning the sensitivity of the device.
4. The multiplier resistance which is connected to the galvanometer increases concerning the sensitivity of the device.
5. • There is no high standard resistance in ohmmeter circuit.
   • There is no variable resistance in ohmmeter circuit. *(2nd session 14)*

8 Mention the function of each of the following :

1. The moving coil galvanometer. *(2nd session 01 - Sudan 13 - Experimental 14, 16)*
2. The two magnetic concave poles of the moving coil galvanometer. *(Sudan 10 - 2nd session 17)*
3. The spiral springs in the moving coil galvanometer. *(1st session 00 - 2nd session 09, 15 - Azhar 11 - Exp. 16)*
4. The soft iron cylinder inside the coil of the galvanometer.
5. The agate bearings in the moving coil galvanometer.
6. Ammeter.
7. Voltmeter.
8. Ohmmeter. *(1st session 17, 14 - August 97 - 2nd session 12 - Sudan 16)*
9. • The small resistor connected in parallel with the moving coil galvanometer. *(1st session 05)*
   • Shunt resistance in ammeter. *(1st session 17)*
10. • The multiplier resistance in the voltmeter. *(1st session 99 , 11 - 2nd session 13 - Exp. 16)*
    • The large resistance connected in series in the moving coil galvanometer. *(1st session 09)*
11. A standard resistor in ohmmeter. *(Azhar 96)*

12. Variable resistor in ohmmeter circuit. *(Azhar 11 - Experimental 14)*

9 Compare between each of the following :

1. Ammeter, voltmeter and ohmmeter (in terms of : the resistor connected to the coil – way of connection – used law – function – scale). *(Egypt 84 - Experimental 14)*
2. Shunt resistance and the multiplier resistance (in terms of : way of connection – function). *(1st session 07 - 2nd session 06, 08, 12, 14 - Sudan 12, 14)*
3. Digital measuring instruments and analog measuring instruments.

10 Miscellaneous questions :

1. Explain by drawing the structure of the sensitive galvanometer and mention the idea of its working.
2. • Mention one instrument which its idea of working depends on the magnetic effect of the electric current. *(2nd session 14)*
   • Mention one application for the magnetic torque. *(1st session 15)*
3. Mention the mathematical relation between the angle of deflection of the moving coil galvanometer (θ) and the electric current intensity (I) and draw a graph between them. *(1st session 05)*
4. What are the mathematical relation used to calculate the value of the voltage multiplier resistance which is required to be connected to the coil of the galvanometer to convert it into voltmeter.
5. **Write the physical quantities that is determined by using the following mathematical relations :**

   (a) $\frac{I_g R_g}{I - I_g}$ (b) $\frac{V - V_g}{I_g}$ (c) $\frac{R_s}{R_s + R_g}$ (d) $\frac{R_g}{R_g + R_m}$

6. If you have a moving coil galvanometer of resistance R_g Ω and the maximum current that can pass through the coil is I_g Ampere. Explain how the sensitive galvanometer is converted to be used as :

   (a) Ohmmeter to measure the value of an unknown resistance. *(2nd session 04, 07)*

   (b) Voltmeter to measure a potential difference V bigger than V_g (deduce the used law). *(2nd session 07 - Azhar 08 - Sudan 10 , 11 - 1st session 15)*

   (c) Ammeter to measure the electric current intensity $I > I_g$ (deduce the used law). *(2nd session 00 , 15 - 1st session 01)*

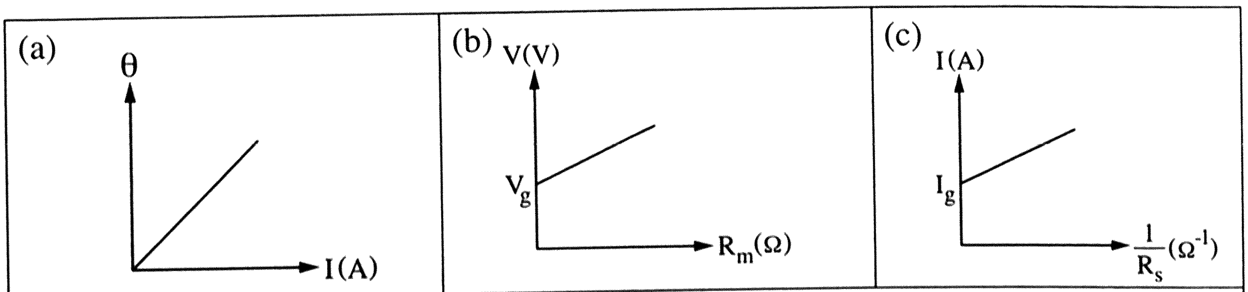
7. If you have a moving coil galvanometer. Explain how you can use it to measure each of the following. Explain your answer by drawing.

(a) Electric current intensity. (b) Electromotive force of an electric cell.

(c) Electrical resistance.

8. Explain how the ohmmeter can be used to measure an unknown resistance by a practical method, when the value of resistance vanishes ? Then draw in a simple method the scale of ohmmeter.

9. **Write the mathematical relation and the slope equivalent for each of the following graphs :**

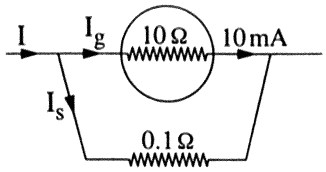


(Where : θ is the deflection angle of galvanometer coil, I is the electric current intensity , V is the potential difference , I_g is the maximum current of the galvanometer coil, V_g is the potential difference between two ends of the galvanometer, R_m is the multiplier resistance, R_s is the shunt resistance).

10. **Prove that :**

(a) $R_s = \frac{I_g R_g}{I - I_g}$ (b) $R_m = \frac{V - V_g}{I_g}$

11. **In the opposite figure :**



(a) The resistance 0.1 Ω is called ...., its importance is ....

(b) The potential difference between the two ends of the milliammeter when the electric current intensity is 10 mA equals ....

(c) The potential difference between the two ends of the resistance 0.1 Ω equals ....

(d) The maximum value of the electric current that can be measured by using this device in this case equals ....

12. Explain with drawing the structure of the ohmmeter and the idea of its working and the reason for its unequal divisions.

13. Explain how the ohmmeter can be used to measure the value of unknown resistance practically, then draw a simple diagram for the scale of the ohmmeter.

14. A sensitive coil galvanometer is connected by a shunt resistance (X) of 0.2 Ω, if the shunt resistance is replaced by another one (Y) of 0.02 Ω. In which case the ammeter can measure a higher range of current intensity ? And why ? *(1st session 17)*

11 Problems :

Guiding notes for solving problems 1

⇒ **The moving coil galvanometer :**

The galvanometer sensitivity : $= \frac{\theta}{I}$ (deg / μ A)

(Where θ is the deflection angle of the galvanometer, I is the electric current intensity passing through the coil)

Electric current intensity (I)

= Galvanometer sensitivity for each division × Number of divisions

1. A galvanometer coil of cross-sectional area 60 cm^2 is hanged in a magnetic field of density 0.1 T if the number of its turns 600 turns. Calculate the electric current intensity required to generate torque equals 1 N.m. *(2.778 A)*
2. Calculate the sensitivity of the galvanometer its pointer deflects to 30° when the electric current passing through it equals 15 mA. *(2×10^{-3} deg/μA)*
3. Calculate the maximum electric current measured by galvanometer when it is graduated into 100 divisions and each division indicates 0.1 mA. *(0.01 A)*
4. A moving coil galvanometer deflects to half the scale when an electric current of 200 μ A passes through it. Calculate the number of divisions of the galvanometer if each division 0.08 mA. *(5 divisions)*
5. A galvanometer its scale is divided into 20 divisions, the sensitivity of each division is 200 μ A. calculate the electric current intensity required to deflect the galvanometer pointer to half the scale. *(2×10^{-3} A) (Azhar 89)*

Guiding notes for solving problems 2

⇒ **Ammeter :**

To determine the shunt resistance (R_s) : $R_s = \frac{V_g}{I - I_g} = \frac{I_g R_g}{(I - I_g)} \Omega$

The ammeter sensitivity : $\frac{R_s}{(R_s + R_g)} = \frac{I_g}{I}$ (Where I is the total electric current)

6. A galvanomcter reads up to 5 A and has a resistance of 0.1 Ω. If we want to increase its reading 10 times, what is the value of the required shunt resistance ? *(0.0111 Ω)*
7. Galvanometer of resistance 54 Ω, gives full scale deflection for a current of 1 A. It is desired to use it to measure a current of intensity 10 A. What is the shunt resistance required and how it can be connected to its coil ? *(6 Ω) (May 97)*

8. The maximum current of a moving coil galvanometer can read is 500 μA and its pointer deflects to the maximum scale when the potential difference between its two ends is 0.04 V. How it can be converted to ammeter to measure 500 mA ? *(0.08 Ω) (2nd session 02)*

9. A galvanometer of resistance 30 Ω, the maximum current that can be measured is 0.01 A. It is required to convert it into an ammeter. **Calculate :**
(a) The shunt resistance to measure electric current of 1 A.
(b) The total resistance of ammeter.
(c) The maximum current can be measured when the shunt resistance equals 0.1 Ω.
(0.303 Ω , 0.3 Ω , 3.01 A)

10. 🕮 A galvanometer of resistance 54 Ω if it was connected to a shunt resistance (A) , then 0.1 of the total current passes through its coil but if it was connected to another shunt resistance (B), the electric current passing through it becomes 0.12 of the total current. Calculate the values of the two resistances (A) , (B). *(6 Ω , 7.36 Ω)*

11. Ammeter deflects to its maximum scale if an electric current of 200 mA passed through it and when the ammeter reading is 50 mA the potential difference between its two ends becomes 0.04 V. What can be done to measure high electric current up to 2 A ?
(0.089 Ω) (Sudan 90)

12. A galvanometer has a coil of resistance 8 Ω. It measures current intensity of maximum value 200 mA. Find the value of the resistance required to be connected in parallel with the coil to convert it into an ammeter suitable to measure current intensity of maximum value one Ampere. If another resistance of the same magnitude is connected in parallel with the previous resistance, then find the maximum current intensity to be measured in such a case. *(2 Ω , 1.8 A) (May 98)*

13. A sensitive galvanometer when connected to a shunt of 1 Ω it measures a maximum current of 8×10^{-3} A and when connected to a shunt of 0.1 Ω it measures a maximum current of 71×10^{-3} A , **calculate :**
(a) The resistance of the galvanometer coil.
(b) The maximum current can be measured by the galvanometer coil.
(7 Ω , 10^{-3} A)

14. 🕮 A shunt of resistance 0.1 Ω decreases the ammeter sensitivity to the tenth, find the resistance of the shunt that decreases the sensitivity of that ammeter to the quarter.
(0.3 Ω)

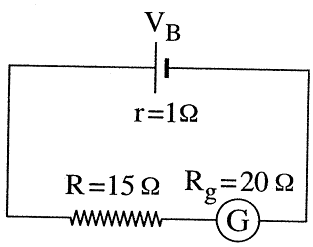
15. The maximum deflection angle for a moving coil galvanometer from zero position is 80°, when electric current of intensity 30 mA passes through it, its angle of deflection from the zero position becomes 60°, **calculate :**
(a) The sensitivity of the galvanometer.
(b) The maximum current that can pass through the galvanometer coil.
(c) The maximum current that can be measured by the device when its coil is connected to a shunt of resistance 0.01 Ω. *(2 deg/mA , 0.04 A , 4.04 A) (2nd session 15)*

16. A galvanometer of resistance 21 Ω and each division of its scale is equivalent to 25 mA. If its coil is connected to a shunt of resistance 0.07 Ω, calculate the electric current intensity denoted by each division. *(7.525 A) (Azhar 98)*

17. Calculate the shunt resistance required to decrease the sensitivity of ammeter of a resistance 24 Ω to the quarter and find the value of the total equivalent resistance for the ammeter and the shunt together. *(8 Ω , 6 Ω) (1st session 04)*

18. A shunt resistance of 0.1 Ω decreases the ammeter sensitivity to $\frac{1}{10}$, calculate the shunt resistance to decrease the sensitivity to the quarter. *(0.3 Ω)*

19. The opposite circuit consists of a battery (V_B of internal resistance 1 Ω) connected to a fixed resistor 15 Ω and a galvanometer of resistance 20 Ω, find the ratio between the two currents passing in the circuit before and after connecting the galvanometer coil with a shunt resistor of 5 Ω.

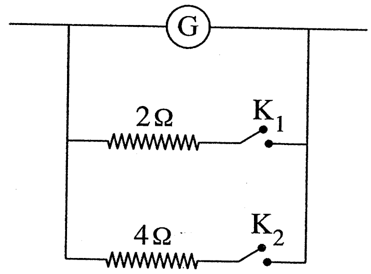


($\frac{5}{9}$) (2nd session 07)

20. The resistance of a galvanometer is 10 Ω and the maximum current that can be measured by the galvanometer is 40 mA, it is connected to a shunt resistance (R_s) in electric circuit that contains resistance 8 Ω and electric cell of emf equals 1.5 V, its internal resistance is neglected when the circuit is closed the pointer of the galvanometer deflects to $\frac{3}{4}$ of its scale graduation. Calculate the value of the shunt resistance. *(2.5 Ω) (Azhar 11)*

21. **In the opposite figure :**

When switch K_1 only is closed, the sensitivity of the device decreases to the quarter and becomes capable of measuring a current of intensity 0.5 A, calculate the maximum current it can measure and also the device resistance when :

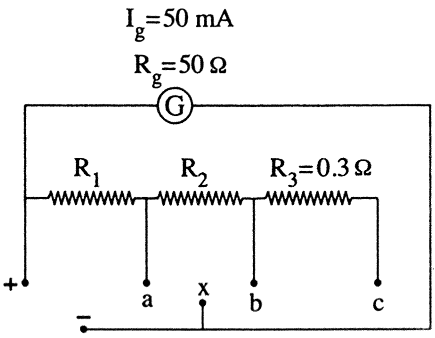


(a) Closing switch K_2 only.

(b) Closing switches K_1 , K_2 together. *(0.31 A , 2.4 Ω , 0.69 A , 1.09 Ω)*

22. Electric circuit consists of a battery of negligible resistance and resistors box of 350 Ω and galvanometer connected to a shunt of resistance of 20 Ω. If the shunt is replaced with another of resistance 30 Ω, then to keep the galvanometer deflection constant the resistor box should be changed to 450 Ω, calculate the resistance of the galvanometer. *(40 Ω)*

23. The opposite figure shows the structure of an ammeter. When x is connected to a the device reads up to 25.05 A and when x is connected to b the device reads up to 5.05 A. Calculate the value of R_1, R_2, then calculate the maximum reading when connecting x to c. *(0.1 Ω , 0.4 Ω , 3.175 A)*



Guiding notes for solving problems 3

⇒ **Voltmeter :**

To determine the potential difference between the two ends of the galvanometer coil (V_g) : $V_g = I_g R_g$

(Where I_g is the electric current needed to deflect the pointer of the galvanometer to the maximum of the scale)

To determine the total potential difference (V) :

$V = I_g (R_g + R_m) = V_g + I_g R_m$

To determine the multiplier resistance (R_m) :

$$R_m = \frac{V - V_g}{I_g}$$

Voltmeter sensitivity :

$$\frac{R_g}{(R_g + R_m)} = \frac{V_g}{V}$$

24. A sensitive galvanometer of resistance 0.1 Ω, deflects to its maximum when an electric current of intensity 1 mA passes through its coil, calculate the multiplier resistance (R_m) which is required to convert it into a voltmeter to measure a maximum potential difference of 5 V. *(4999.9 Ω) (Egy. 96)*

25. An electric current of intensity 0.02 A passes through a galvanometer and gives a full scale deflection when the potential difference between its two ends is 5 V, **calculate :**

(a) The value of the multiplier resistance to measure a potential difference equals 150 V.

(b) The resistance of the coil of the galvanometer. *(7250 Ω , 250 Ω)*

26. A galvanometer gives full scale deflection when a current of 50 μA passes through it, **calculate :**

(a) The value of the total resistance for each of the galvanometer and the multiplier resistance to be converted into a voltmeter to read 10 V at full scale deflection.

(b) The value of the multiplier resistance if you know that the resistance of the galvanometer coil is 1 kΩ. *(200×10^3 Ω , 199×10^3 Ω)*

27. A sensitive galvanometer its coil consists of 100 turns, the cross-sectional area of each turn is 5 cm^2 and gives full scale deflection when an electric current of intensity 0.4 mA passes through it and the magnetic flux density acting on it equals 0.4 T if the plane of the coil makes an angle 60° with the magnetic flux lines, **calculate :**

(a) The torque acting on the coil.

(b) The resistance of the galvanometer coil if connected to a multiplier of 4000 Ω to be a voltmeter measures maximum potential difference 5 V.

(4×10^{-6} N.m , 8500 Ω) (2nd session 14)

28. An electric circuit contains a resistance of 10 Ω was connected in parallel with voltmeter of resistance 50 Ω when an electric current of intensity 0.6 A passes in the circuit it gives full scale deflection, calculate the voltmeter reading and when the voltmeter coil is connected in series with a resistance of 4950 Ω, calculate the maximum potential difference that can be measured by the voltmeter in that case.

(5 V, 500 V) (2nd session 99)

29. Electric circuit contains a constant resistance of 6 Ω, its terminals are connected to a voltmeter, its resistance 30 Ω. When a current of 0.2 A passes in the circuit, the needle of the voltmeter gives full scale deflection. If a resistance of 144 Ω is connected in series to the voltmeter, what will be its reading ? And what is the maximum potential difference it can measure in this case ? *(1.16 V, 5.8 V) (2nd session 01)*

30. A voltmeter of resistance 500 Ω , each division of its scale denotes 0.1 V , explain how it can be used such that each division of its scale denotes 1 V. *(4500 Ω) (Azhar 96)*

31. 🕮 A galvanometer of resistance 5 Ω measures maximum electric current 20 mA, calculate the maximum current if it was connected with a shunt resistance equal 0.1 Ω , then calculate the value of the multiplier resistance which can be connected to the galvanometer to convert it into voltmeter to measure potential difference equals 5 V.

(1.02 A , 245 Ω) (1st session 12)

32. A moving coil galvanometer of resistance 40 Ω gives full scale deflection when a current of 5 mA passes in its coil. How can it be modified for measuring :

(a) Maximum current of intensity 20 A.

(b) A potential difference of maximum value 10 V.

(0.01 Ω , 1960 Ω) (1st session 06 - 2nd session 05, 11)

33. A sensitive galvanometer, the resistance of its coil is 4 Ω, measures a maximum current of 1 mA, its coil is connected in parallel to a resistance of 1 Ω to form one device and that device is connected in series to a resistor of 999.2 Ω to form a voltmeter. Calculate the maximum potential difference that can be measured by this voltmeter. *(5 V) (Aug. 98)*

34. The resistance of a moving coil galvanometer is 18 Ω. **Calculate :**

(a) The value of the shunt resistance that allows $\frac{1}{3}$ of the total current to pass through the galvanometer coil.

(b) The value of the multiplier resistance that allows the galvanometer to measure potential difference 10 times the potential difference between the ends of its coil.

(9 Ω , 162 Ω) (2nd session 10)

35. Galvanometer of resistance 40 Ω, measures maximum electric current of 20 mA, find the value of the shunt resistance that is required to convert it into ammeter to measure maximum electric current 100 mA and if the galvanometer coil was connected to multiplier resistance of 210 Ω, calculate the maximum potential difference that can be measured. *(10 Ω , 5 V) (1st session 03)*

36. A moving coil galvanometer when connected to a shunt of resistance 0.5 Ω it becomes capable of measuring current intensity of maximum 0.11 A and when it is connected to a voltage multiplier of resistance 245 Ω it becomes capable of measuring a potential difference of maximum 2.5 V. **Calculate :**

(a) The maximum current that can be measured by the galvanometer coil (I_g).

(b) The galvanometer resistance. *(0.01 A , 5 Ω)*

37. Electric circuit contains electric cell of 10 V and negligible internal resistance, connected to two resistors 16 Ω, 40 Ω in series and when a voltmeter is connected in parallel with the resistor 40 Ω its pointer deflected to 6 V, calculate the resistance of the voltmeter. If the maximum reading of the voltmeter was 7.5 V, explain how it can be converted into ammeter to measure maximum current of 5 A. *(60 Ω , 1.54 Ω)*

38. A sensitive galvanometer can measure current intensity up to maximum value I_g Multiplier resistors are connected with it (each at a time) to convert it into a voltmeter. The following table shows records of maximum voltage that can be measured by the voltmeter (V) by volts and its total resistance (R) by ohm.

V (Volt)	100	150	200	250	300
R (Ω)	500	750	1000	1250	1500

(a) **Draw the graphical relation between** (V) on y-axis and (R) on x-axis.

(b) **From the graph find** the range of the galvanometer (I_g). *(0.2 A) (1st session 17)*

Guiding notes for solving problems 4

⇒ **Ohmmeter :**

The maximum electric current passing through the coil before connecting it to external resistance can be determined from the relation :

$$I_g = \frac{V_B}{(R_g + R_c + R_v + r)} = \frac{V_B}{\grave{R}}$$

(Where R_c is the standard resistance , R_v is the variable resistance)

After connecting the external resistance (R_{ex}), we use the following relation :

$$I = \frac{V_B}{(R_g + R_c + R_v + r + R_{ex})} = \frac{V_B}{(\grave{R} + R_{ex})}$$

39. A milliammeter of resistance 4 Ω has a coil capable of carrying a current of 16 milli-Amperes. It is desired to use it as an ohmmeter using an electric cell of 1.5 V having internal resistance 1.75 Ω.

(a) Calculate the value of the required standard resistor.

(b) Calculate the external resistance needed to make the pointer deflect to 10 milli-Amperes.

(c) The electric current intensity passing through it if connected to an external resistance of 300 Ω.

(88 Ω , 56.25 Ω , 3.8 × 10^{-3} A) (2nd session 08)

40. Galvanometer of coil resistance 250 Ω and full scale deflection at 400 μ A is connected to an electric cell of emf (1.5 V) and a fixed resistance 3000 Ω and variable resistance (R_v), **find :**

(a) The value obtained from the variable resistor to form an ohmmeter.

(b) The value of the resistance that if connected to the terminals of the ohmmeter causes the pointer to deflect to quarter of the scale.

(500 Ω , 11250 Ω) (1st session 07- Sudan 12- Exp. 14)

41. The pointer of ohmmeter deflects to $\frac{1}{4}$ of its scale when it is connected to a resistance of 300 Ω. What is the value of the resistance which when measured makes the pointer deflects $\frac{1}{6}$ of its scale ?

(500 Ω)

42. Ohmmeter consists of ammeter, standard resistance and a battery of e.m.f 6 V and it deflects to the maximum scale when an electric current of 1 mA passes through it, calculate the value of the resistance that when connected with the ohmmeter it deflects the pointer to :

(a) half its scale.

(b) quarter its scale.

(c) three quarters its scale.

(6000 Ω , 18000 Ω, 2000 Ω)

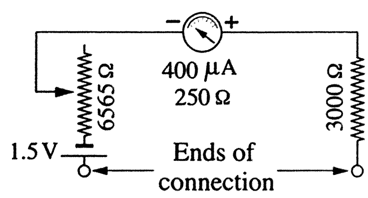
43. A sensitive galvanometer of resistance 50 Ω gives full scale deflection if a current of 40 mA passes through it, it is required to modify it into an ohmmeter by connecting it with standard resistance and dry cell of e.m.f 3 V (neglecting the internal resistance), calculate each of the following :

(a) The value of the used standard resistance.

(b) The value of the external resistance that makes the pointer deflects to $\frac{1}{4}$ the scale.

(25 Ω , 225 Ω) (1st session 13)

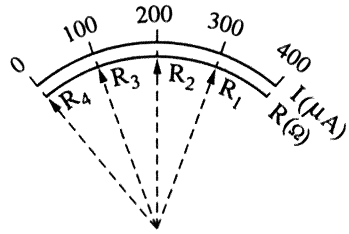
44. Using the internal ohmmeter circuit shown in the figure and the shown data :



Explain the purpose for the variable resistor (6565 Ω) and calculate value of the resistance taken from it to verify that purpose.

(500 Ω) (Egypt 92)

45. **In the opposite figure :**



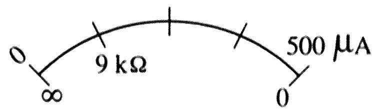
The ohms scale is added to the ammeter scale if the total internal resistance of the ohmmeter is 3750 Ω and the maximum current intensity 400 μ A.

(a) Calculate the value of the resistors R_1 , R_2 , R_3

(b) What do you expect the value of R_4 will be ? And why ?

(1250 Ω , 3750 Ω , 11250 Ω)

46. The opposite figure represents equal divisions of the ohmmeter scale.



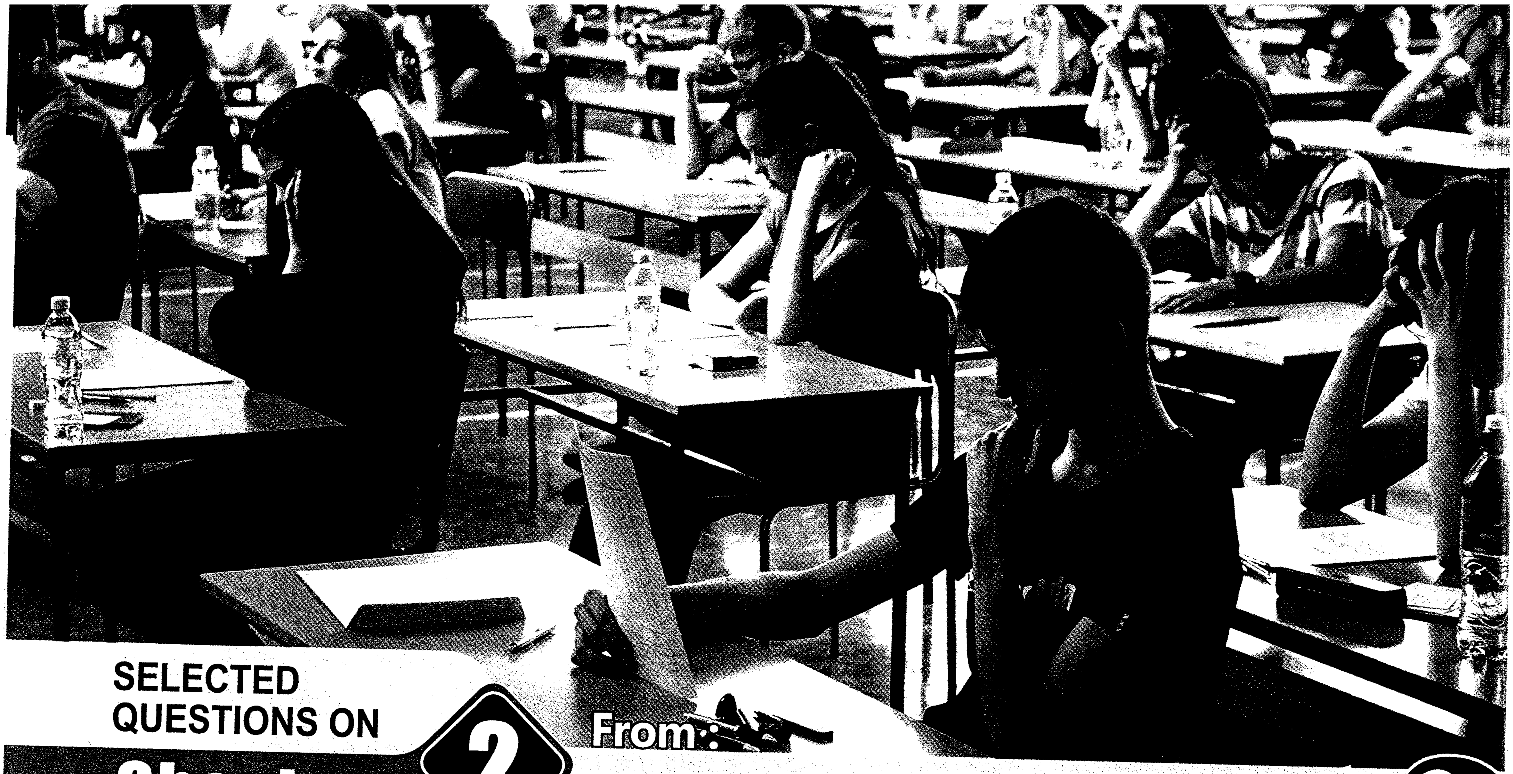
Use the shown data to find :

(a) The ohmmeter resistance.

(b) The electromotive force of the dry cell in ohmmeter.

(3000 Ω , 1.5 V) (Exp. 15)

47. Ohmmeter when connected to a resistor 300 Ω, its pointer deflects to quarter its scale. Calculate the resistance that makes its pointer deflects to $\frac{1}{6}$ its scale. *(500 Ω)*



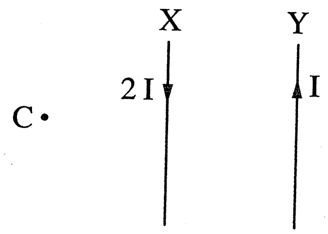
SELECTED QUESTIONS ON

Chapter 2

From :

- **Student Evaluation Guide (2017).**
- **Booklet Models of the Ministry of Education.**

1 Choose the correct answer of the given answers :



1. Two currents I, 2 I pass through two parallel wires as in the figure, when the wire (Y) moves away from wire (X) the magnetic flux density at point C .... *(Booklet 1)*
   a. decreases. b. doesn't change. c. increases.

2. An electric current passes through a circular coil so a magnetic field of flux density (B) is produced at the center of the coil, when that electric current increases to the double and the diameter of the coil increases to the double without changing the number of turns, so the magnetic flux density at the center of the coil equals ....
   a. B b. 2 B c. $\frac{B}{2}$

3. To determine the polarity of a circular coil which passes through it an electric current, ... is used.
   a. Fleming's left hand rule
   b. Fleming's right hand rule
   c. clockwise rule

4. The magnetic flux density increases at the middle of the axis of a solenoid when .... increases.
   a. radius b. number of turns c. length

5. The direction of the acting force on a wire which carries an electric current and is placed perpendicular on the direction of the magnetic flux is perpendicular on ....
   a. direction of the current and parallel to the direction of flux.
   b. the directions of flux and current.
   c. the direction of flux and parallel to the direction of current.

6. The resultant of the acting torque on the galvanometer's coil when its pointer settles in front of a certain reading equals ....
   a. BIAN b. 2 BIAN c. zero.
7. When the scale of a sensitive galvanometer is divided into 20 divisions and its pointer deflected to its middle when an electric current of intensity 0.1 μA passes through its coil, so the galvanometer's sensitivity equals ....
   a. 20 μA/division. b. 10 μA/division. c. 5 μA/division. d. 2 μA/division.
8. If 2 % of the current in the circuit passes through a galvanometer's coil of resistance R_g, so the shunt resistance equals ....
   a. $\frac{R_g}{50}$ b. $\frac{R_g}{49}$ c. 49 R_g d. 50 R_g
9. A galvanometer is converted into ammeter to read 0.03 A by using shunt resistance 4 R_s and reads 0.06 A by using shunt resistance R_s, what is the maximum current that can be carried by a galvanometer in case of no shunt resistance? ....
   a. 0.08 A. b. 0.04 A. c. 0.02 A. d. 0.01 A.

2 What would happen in the following cases, mention the reason :

1. Placing a rod of wrought iron inside a solenoid that carries DC current.
2. Passing an electric current in a rectangular coil placed parallel to the magnetic field.
3. Replacing two spring coils in the galvanometer by another two of less torque concerning the galvanometer's sensitivity. *(Booklet 1)*
4. Connecting ammeter in parallel between the two ends of an ohmic resistance in a closed electric circuit concerning the effect of potential difference between their ends.

3 Compare between each of the following :

1. The neutral point position between two parallel straight wires carrying different electric current and the position of neutral point is outside them (in terms of the direction of the current in each of them).
2. The magnetic flux density at a point on the axis of a solenoid that carries an electric current before and after stretching its turns away from each other.
3. The galvanometer before and after converting it into an ammeter (in terms of the sensitivity of the device).
4. The galvanometer before and after converting it into an ammeter (in terms of the resistance of the device). *(Booklet 4)*
5. Analog measuring devices and digital measuring devices (in terms of the way of reading). *(Booklet 4)*

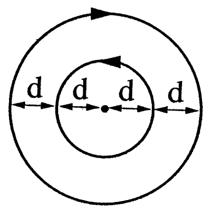
4 When each of the following values equal zero?

1. The flux density at the common center of two metallic rings and in one plane if the diameter of the first is double that of the second and an electric current passes through each of them. *(Booklet 1)*

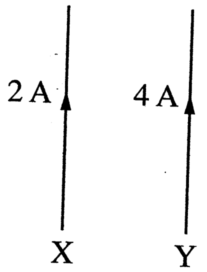
2. The current intensity passing through ohmmeter's circuit.
3. The deflection of the pointer of ohmmeter's device from zero position on its scale.

5 Miscellaneous questions :

1. **Mention the mathematical relation which expresses each of the following :**
   (a) The magnetic flux passing through a certain area concerning the flux density. *(Booklet 3)*
   (b) The mutual force between two parallel straight wires carrying two different electric current.
   (c) Galvanometer's sensitivity.
   (d) Shunt resistance in ammeter.
   (e) Calculating unknown resistance by knowing the resistance of ohmmeter which is connected to it.
2. **How can we :**
   (a) Obtain a point where the flux density between two parallel straight wires carrying an electric current in one direction is vanished where one of the two wires moves away quarter the distance between them.
   (b) Get a large possible force acting on a straight wire carrying an electric current in a magnetic field.
   (c) Decrease the galvanometer's sensitivity to half its value.
3. Determine the case in which the magnetic flux density at the center of a circular coil carrying an electric current is vanished. *(Booklet 2)*
4. Two circular copper rings have the same center and carry the same electric current (I) as in the figure, what is the change required to the electric current in the internal ring to make the common center be the neutral point of the two rings? Explain your answer. *(Booklet 4)*



5. Mention one factor affecting the mutual force between two straight wires carrying two electric currents.
6. Which one is bigger, the force of wire (X) acting on wire (Y) or the force of wire (Y) acting on wire (X)? And why?

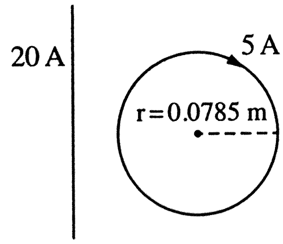


7. Explain why a rectangular coil placed perpendicular on the direction of the magnetic field isn't affected by a torque when an electric current passes through it. Although its sides are affected by a magnetic force. *(Booklet 4)*
8. Mention the function of the constant resistance in the ohmmeter.

6 Problems :

1. In the opposite figure :

An isolated connecting wire and a metallic ring are placed in the plane of the page if the resultant of the generated magnetic flux density due to passing an electric current in each of them at the center of the ring equals zero.
(Knowing that : $\pi = 3.14$)

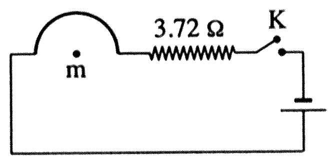


(a) Calculate the distance between the wire and the center of the ring.

(b) Find on the drawing the direction of the current in the wire.

2. In the opposite circuit :

A wire in the form of half of a circular ring, its radius is 3.14 cm and is connected in series to a resistance of 3.72 Ω and they are connected by wires of negligible resistance to a source of emf equals 24 V and internal resistance 2 Ω. When the switch (K) is closed if the flux density at the center is m due to passing of electric current in half the circuit = 2.4×10^{-5} T (Knowing that : $\pi = 3.14$), **calculate :**



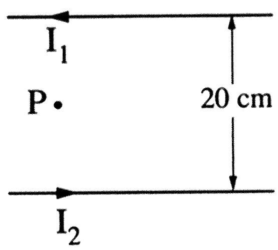
(a) The current intensity passes through the circuit.

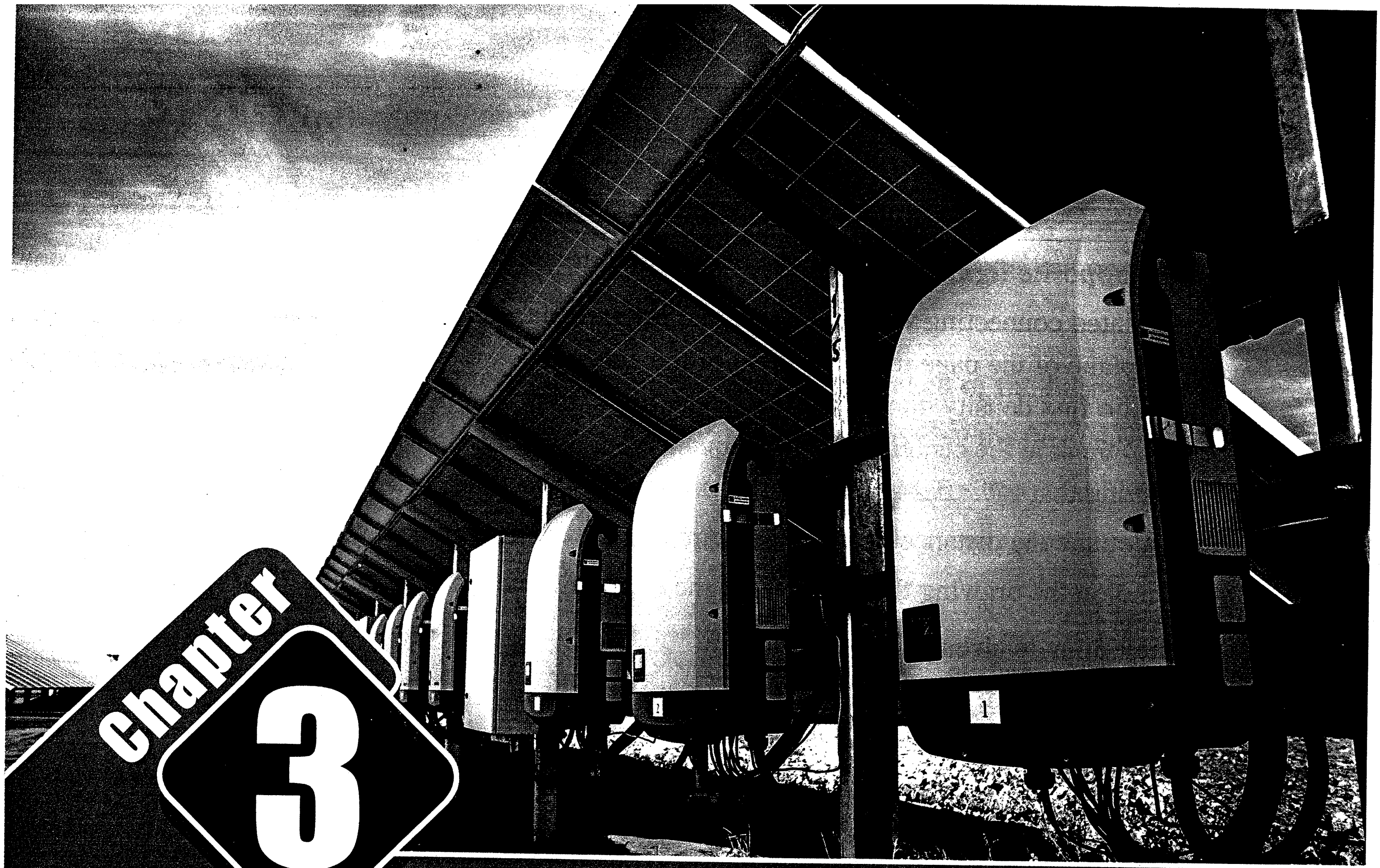
(b) The resistance of the wire of the ring.

(c) The resistivity of the wire's material if the radius of the wire is 0.1 mm.

(2.4 A , 4.28 Ω , 1.36×10^{-6} Ω.m)

3. Two parallel straight wires, the distance between them in air is 20 cm, a current of intensity (I_1) passes through the first wire and a current of intensity 10 A passes through the second wire in the direction shown in the figure if knowing that the total flux density at point (P) at the middle between the two wires is 6×10^{-5} T, calculate the mutual force between them if the length of each is 50 cm. (Knowing that the magnetic permeability coefficient of air is $4\pi \times 10^{-7}$ Wb/A.m) *(10^{-4} N)(Booklet 3)*





Chapter 3

Electromagnetic Induction

Questions on :

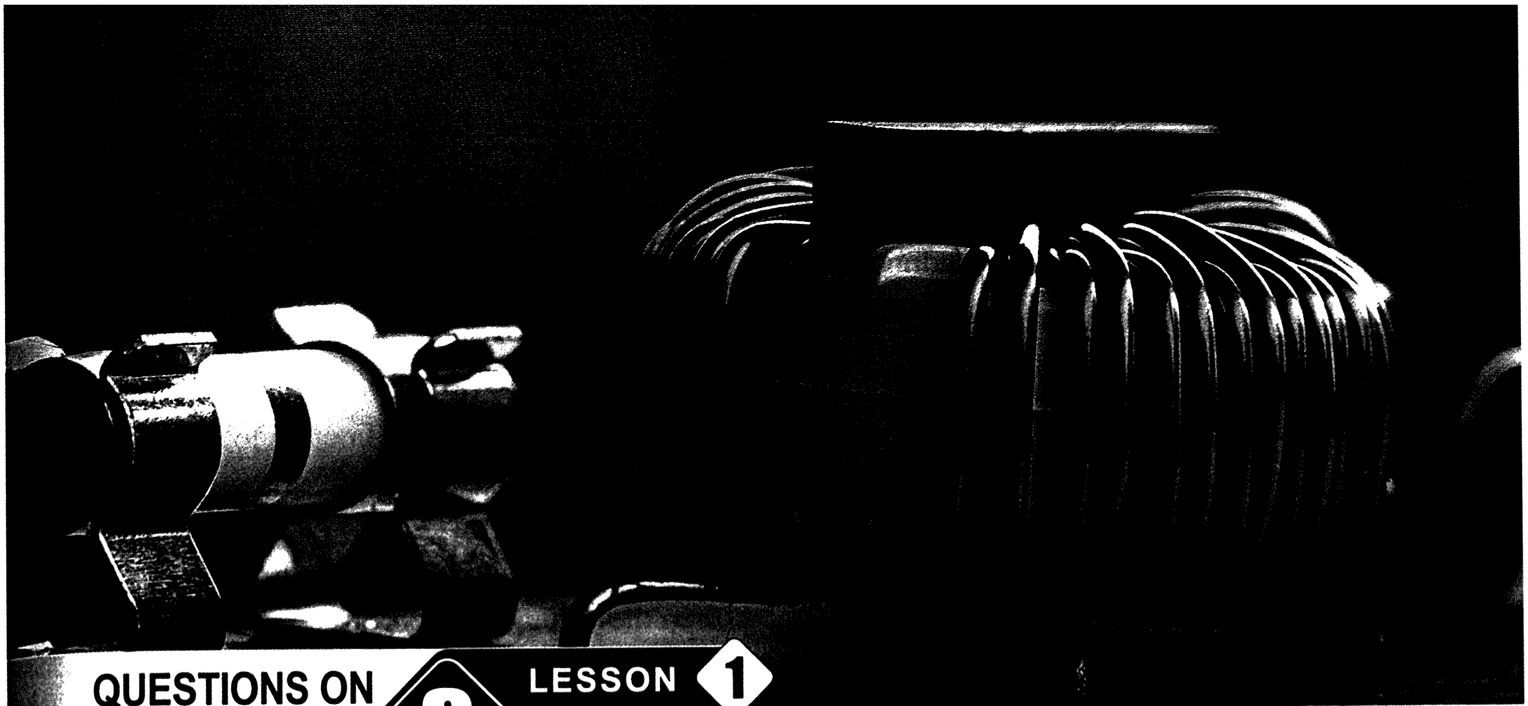
Lesson 1
- Faraday's Law.
- The Induced Electromotive Force Produced in a Straight Wire.

Lesson 2
- Mutual Induction between Two Coils.
- Self Induction of the Coil.

Lesson 3 Electric Generator (Dynamo).

Lesson 4
- The Electric Transformer.
- The Electric Motor.

Selected Questions on Chapter 3 from :
- Student Evaluation Guide (2017).
- Booklet Models of the Ministry of Education.



QUESTIONS ON **Chapter 3** LESSON 1

• Faraday's Law.
• The Induced Electromotive Force Produced in a Straight Wire.

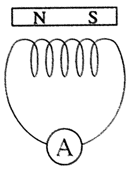
?

1 Write down the scientific term for each statement of the following :

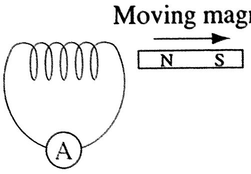
1. Phenomenon of generation of induced electromotive force and induced current in a conductor as a result of the variation of the magnetic flux lines that intercepted by the conductor.
2. The induced current must be in a direction such as to oppose the change producing it.
(May 98 - Azhar 11 - 1st session 12, 15 - Sudan 14)
3. The magnitude of the induced electromotive force is directly proportional to the time rate by which the conductor intercepts the lines of the magnetic flux linked with it and also the number of turns of the coil (the rate of change of the flux).
4. The magnetic flux that when penetrates perpendicularly one turn of a coil then vanishes gradually and uniformly within 1 sec., it produces induced emf of 1 Volt.

2 Choose the correct answer of the given answers :

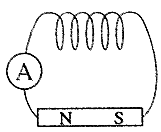
1. Using a coil, a magnet and a sensitive ammeter.
Which of the following figures shows the method of obtaining an induced electric current ? ....



(a)



(b)



(c)

2. 📖 The pointer of a galvanometer needle whose terminals are connected to a solenoid coil will be deflected if one withdraws the magnet quickly from the coil because ....

a. the number of the coil turns is very large.

b. the coil intercepts the lines of the magnetic flux.

c. the number of turns of the coil is suitable.

d. the number of turns of the coil is small.

3. If the number of turns of a coil is 20 turns and when a magnet is brought close to it the flux increases by 0.2 Wb within 0.02 s, then the value of the produced emf is ....

a. 20 V. b. 0.2 V. c. 1 V. d. 200 V.

4. 📖 The needle of the galvanometer whose terminals are connected to a solenoid coil deflects on the withdrawal of the magnet in a direction opposite to that which occurs on plunging the magnet into the coil because ....

a. an induced current is generated in a direction opposite to that on plunging the magnet.

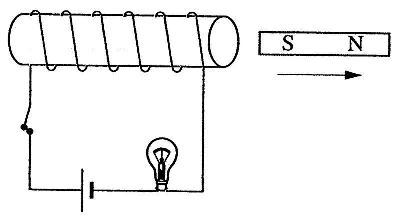
b. an electric current is generated.

c. the number of the magnetic flux lines decreases.

d. the number of the magnetic flux changes.

5. In the opposite figure :

When moving the magnet in the shown direction the light intensity of the lamp .... *(1st session 14)*

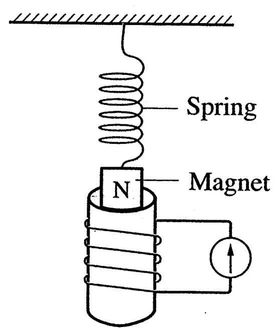


a. increases. b. decreases.

c. vanishes. d. remains constant.

6. In the opposite figure :

A magnet is suspended in a spring free to move in and out of a coil connected to a galvanometer having its zero in the middle of its scale, when the magnet moves up and down, the galvanometer reading ....



a. swings from left to right and vice versa. b. stops at left.

c. stops at right. d. stops at zero.

7. Which of the following relations represent Faraday's law for the electromagnetic induction ? ....

a. $emf = \frac{N\Delta (BA \tan \theta)}{\Delta t}$

b. $emf = \frac{N\Delta (BA \sin \theta)}{\Delta t}$

c. $emf = \frac{-N\Delta (BA \tan \theta)}{\Delta t}$

d. $emf = \frac{-N\Delta (BA \sin \theta)}{\Delta t}$

8. 📖 The induced emf generated in a coil on plunging a magnet into or withdrawing it out of the coil differs according to the difference in ....

a. (the intensity of electric current - the length of the wire - the number of the lines of flux).

b. (magnet strength - the velocity with which the magnet moves - the number of turns of the coil).

c. (cross-sectional area - mass per unit length of the coil - the type of the material of the wire).

d. (flux density - time - electric current intensity).

9. The following cases represent the change in flux through a circular coil of N turns, which of them causes the maximum emf ? ....

a. Changing of flux from 2 Wb to 2.1 Wb within 10^{-4} s.

b. Changing of flux from 0.2 Wb to 4 Wb within 0.2 s.

c. Changing of flux from 1 Wb to 20 Wb within 10 s.

d. Changing of flux from 0.01 Wb to 0.02 Wb within 0.2 s.

10. Which of the following will cause an induced current in a coil of wire ? ....

a. A magnet resting near the coil.

b. The constant field of the Earth passing through the coil.

c. A magnet being moved into or out of the coil.

d. A wire carrying a constant current near the coil.

11. Doubling the diameter of a loop of wire produces which kind of change on the induced emf, assuming all other factors remain constant ? ....

a. The induced emf is increased four times.

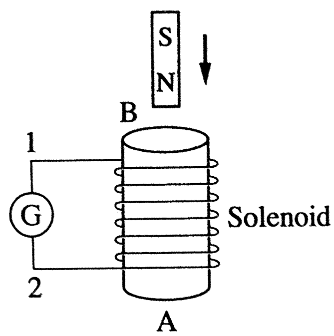
b. The induced emf is increased to its double value.

c. The induced emf is decreased to its half value.

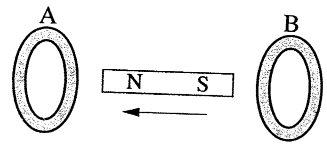
d. The induced emf is unchanged.

12. A bar magnet is dropped through a solenoid connected to a galvanometer, as shown in the opposite figure. Which choice of the following is correct ? .... *(1st session 17)*

	Current direction through the galvanometer	The magnetic pole formed at A
a.	From 1 to 2	North
b.	From 1 to 2	South
c.	From 2 to 1	North
d.	From 2 to 1	South



13. A bar magnet is moving along the common axis of two coils A and B towards A. Current is induced in ....



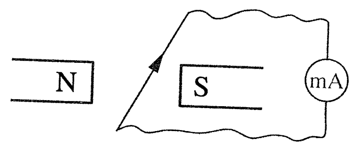
a. only A.

b. only B.

c. both A and B in same direction.

d. both A and B in opposite direction.

14. For the electric current to flow in the direction as shown in the figure the wire should move ....

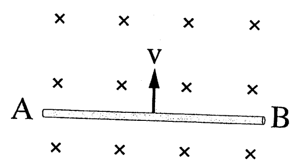


a. upwards. b. downwards.

c. towards the North pole. d. towards the South pole.

15. In the opposite figure :

If the wire moved perpendicular to the magnetic flux lines in the shown direction, then the potential of point A .... the potential of point B. *(Sudan 15)*



a. greater than b. less than c. equals d. different

16. The induced emf generated in a straight wire intercepting the lines of magnetic flux equals ....

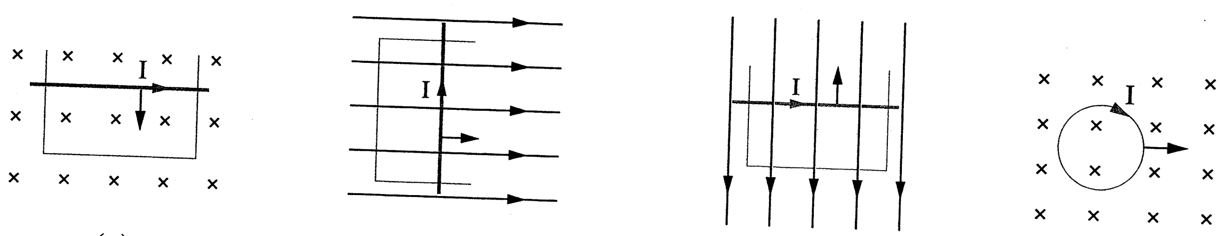
a. BIv b. $-B\ell v \sin\theta$ c. $B\ell v$ d. BIv sin θ

17. The direction of the induced current in a straight wire intercepting the magnetic flux is determined by using .... rule.

a. hour hands b. Fleming's left hand

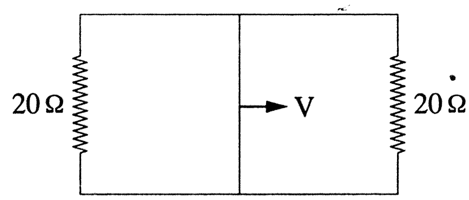
c. Fleming's right hand d. Ampere's right hand

18. Which of the following figures expresses correctly the generation of induced current ? ....



(a) (b) (c) (d)

19. A rectangular loop with a sliding rod of length 2 m and resistance 2 Ω. The rod moves in a uniform magnetic field of 3 T perpendicular to the plane of the loop. The external force required to keep the rod moving with constant velocity of 2 ms^{-1} is ....

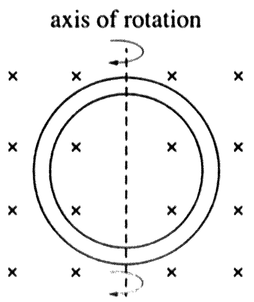


a. 2 N. b. 4 N. c. 6 N. d. 8 N.

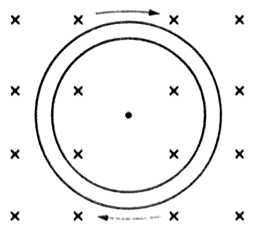
20. An airplane is flying horizontally at a speed of 1800 km/hour. If the wing span is 25 m and Earth's magnetic field at the location is 4×10^{-4} T and the angle of dip is 30°. The potential difference developed between the tips of its wings is ....

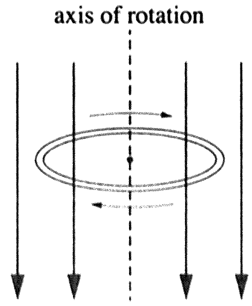
a. 2.5 mV. b. 25 mV. c. 250 mV. d. 2500 mV.

21. The proper position for the movement of a metallic ring to produce induced emf based on the rules of the electromagnetic induction is represented by figure ....

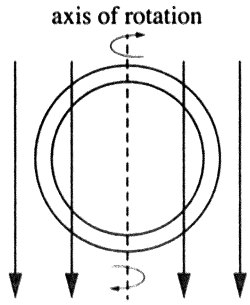


(a)


(b)

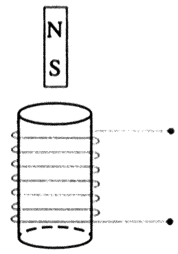


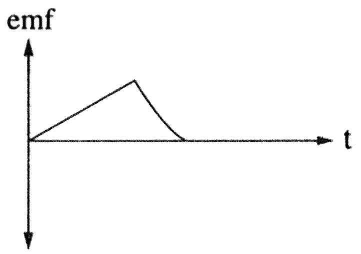
(c)



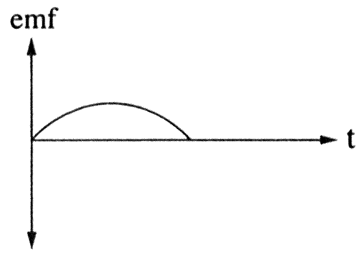
(d)

22. Which of the following graphs expresses the relation between the induced emf generated across the coil and time during falling of the magnet through the coil till it gets out from the other side ? ....

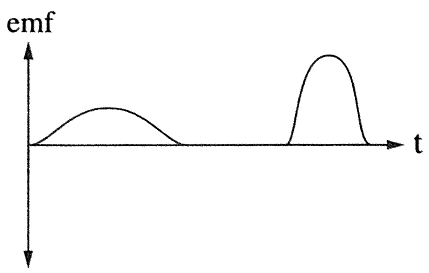




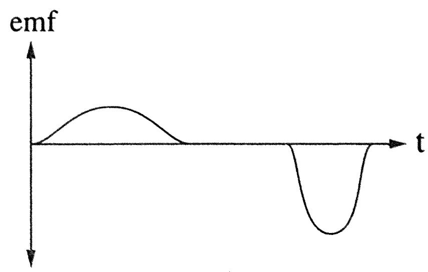
(a)



(b)



(c)



(d)

3 Give reasons for :

1. Induced emf is generated between the terminals of a wire moving and intercepting perpendicularly the magnetic flux lines.
2. The induced emf may not be generated between the terminals of a wire moving in a magnetic flux. *(May 97 - Exp. 14)*
3. The induced emf generated in a coil increases when its core is made of soft iron. *(2nd session 00,04)*

4 Define :

1. Electromagnetic induction.
2. The induced current.
3. Faraday's law for the induced emf.
4. Lenz's rule. *(Egypt 09)*
5. Weber.
6. Fleming's right hand rule.

5 What are the factors affecting each of the following and their relation with each :

1. The induced emf generated in a coil intercepting the magnetic flux. *(2nd session 14)*
2. The induced emf generated in a straight wire intercepting the magnetic flux. *(1st session 15)*

6 What happens in the following cases, giving reasons :

1. A magnet is plunged inside a coil, its terminals are connected to a sensitive galvanometer then settled in inside the coil.
2. A straight wire moves perpendicular on a uniform magnetic field.
3. Doubling the speed of a wire moving perpendicular on a uniform magnetic field concerning the induced emf.

7 Mention one use (or application) for each of the following :

1. Lenz's rule. *(1st session 14 - 2nd session 17)*
2. Fleming's right hand rule. *(May 98 - 2nd session 00 , 04)*

8 Compare between each of the following :

1. Ampere's right hand rule and Fleming's right hand rule (in terms of the usage). *(2nd session 11 - 1st session 13)*
2. Fleming's right hand rule and Fleming's left hand rule (in terms of the usage). *(2nd session 13)*
3. Right hand screw rule and Fleming's left hand rule (in terms of the usage). *(1st session 15)*

9 Miscellaneous questions :

1. **Write the physical quantities determined by the following mathematical relations :**

(a) $-N\frac{\Delta\phi_m}{\Delta t}$ (b) $-B\ell v \sin\theta$

2. **What is meant by the negative sign and the numerical value in each of the following :**

(a) emf $= -20 \frac{\Delta\phi_m}{\Delta t}$ (b) emf $= -0.5\ \ell v \sin\theta$

3. State Faraday's law of the induced emf generated in a coil, then how to verify this practically ?

4. Write the mathematical relation expressing the induced emf generated in a straight wire moving inside a uniform magnetic flux. *(Sudan 14)*

5. Mention Lenz's rule and how it can be applied in an example for generating the induced electric currents.

6. Prove that the induced emf generated between the terminals of a wire moving perpendicular to a uniform magnetic field is determined by the relation : emf $= -B\ell v$ *(2^{nd} session 14)*

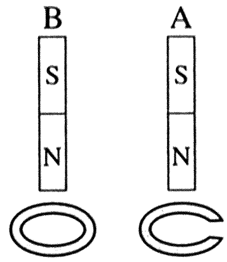
7. Mention the condition for vanishing of the induced electric current in a straight wire moving in a uniform magnetic field. *(1^{st} session 11)*

8. If a current is passing through a coil, deduce an equation relating the induced emf in a coil and the rate of change of the current in the coil.

9. **Explain an experiment to clarify each of the following :**
   - Electromagnetic induction (Faraday's experiment).
   - Generating an induced electric current in a coil.
   - Converting mechanical energy into electric energy.

10. **In the opposite figure :**

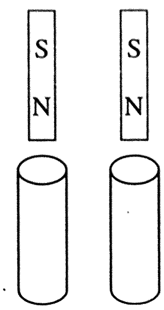
Two similar magnets are falling freely from the same height on two iron rings one is opened and the other is closed, which of the two magnets reach the ground first ? Explain your answer. *(Olym., 1^{st} session 08)*



11. (a) State Faraday's law of electromagnetic induction. *(1^{st} session 17)*

(b) Describe an experiment to demonstrate Faraday's law.

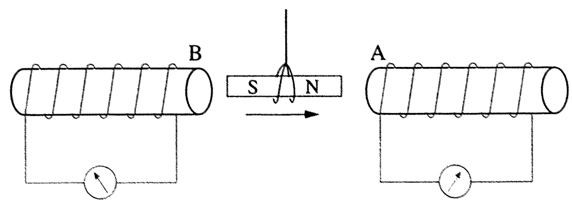
(c) A hollow copper pipe and a hollow glass pipe, with identical dimensions, were arranged as shown in the diagram. A student measured the time it took a strong magnet to fall through each cylinder. It took much longer for the magnet to fall through the copper pipe. Explain why.



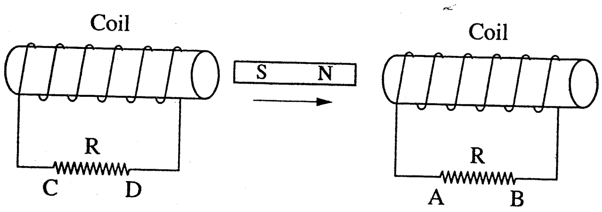
12. If the magnet was moving in the direction shown in the figure, **mention :**

(a) Types of magnetic poles formed at A , B.

(b) Name of the rule used to determine the types of poles. *(2^{nd} session 14)*



13. **In the opposite figure :**



(a) Explain why, when a bar magnet moving towards the right or left induces an emf in the two coils.

(b) Find the direction of the induced currents through the resistors AB and CD in the following cases :

1 - When the magnet is moving towards the right.

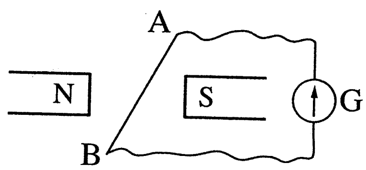
2 - When the magnet is moving towards the left.

14. Two identical loops, of copper and aluminum are in a uniform magnetic field perpendicular to their planes (resistivity of copper is less than that of aluminum). If they are removed from the field rapidly within the same time interval.

(a) The induced emf generated in the copper loop is .... the induced emf generated in the aluminum loop. ① greater than ② less than ③ equal to

(b) In which loop the induced current will be greater ? Why ?

15. **In the opposite figure :**



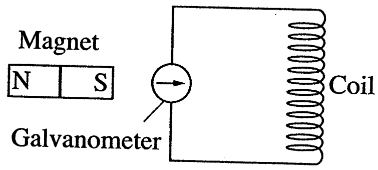
The wire AB is moved quickly downwards between the poles of the magnet.

(a) What happens for the sensitive galvanometer ?

(b) What happens for the sensitive galvanometer pointer if the wire AB moved quickly upwards ?

(c) How does the wire AB move in the field without affecting the galvanometer?

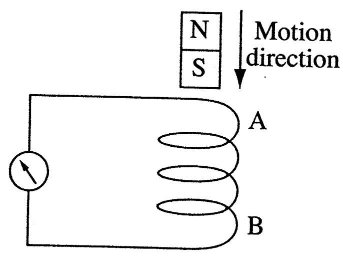
16. If you have a magnet and a coil connected to a sensitive moving coil galvanometer as in figure :



(a) How do you use them to show the electromagnetic induction phenomenon ?

(b) How can you check the flow of induced electric current ?

17. **From the opposite figure :**



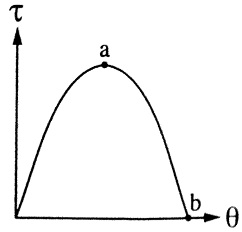
(a) What is the type of the magnetic pole formed at the terminal (B) of the coil ?

(b) What is the effect of inserting an iron cylinder inside the coil on the magnitude of instantaneous deflection of the galvanometer needle ? Explain.

(c) On the drawing determine the direction of the induced electric current generated in the coil and what is the name of the rule which determines the direction of that current ?

(2^{nd} session 01 , 11)

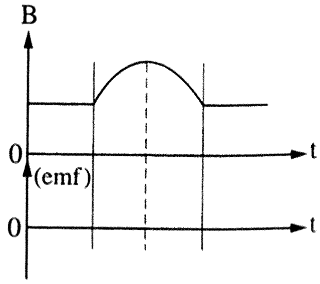
18. The opposite figure represents a graphical relation between the torque (τ) acting on rectangular coil of (N) turns and cross-section area (A) and rotating in a uniform magnetic field of flux density (B) and (θ) the angle between the normal to the plane of the coil and the magnetic flux lines.



(a) Find the value of (θ) and (τ) at point (a).

(b) Find the value of (θ) and (τ) at point (b).

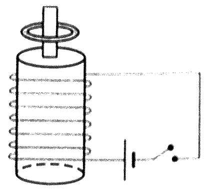
(c) If the magnetic flux density (B) intercepting the coil is changed versus time as in the opposite figure, copy the drawing to your answer sheet and draw on the same drawing the change in the induced emf generated versus time in the coil given that the coil is stable. *(1st session 08)*



19. Show by drawing, a wire of length (ℓ) is placed perpendicular to a uniform magnetic field of flux density (B), then the wire get to move perpendicularly on the field with velocity (v) over two conductor rods which are connected to a milli-ammeter then prove that the value of the induced emf generated across the wire is given by the relation emf = $-B\ell v$

(2nd session 03 - 1st session 10)

20. A metallic ring of aluminum is placed around the shaft of a strong electromagnet's core. When the circuit of the electromagnet is closed the ring jumped up for a long distance, explain.



10 Problems :

Guiding notes for solving problems 1

⇒**Faraday's law :**

- To determine the induced (emf) generated in a coil by electromagnetic induction :

$$emf = -N\frac{\Delta\phi_m}{\Delta t} \text{ (V)}$$

- To determine the change in the magnetic flux ($\Delta\phi_m$) :

$$\Delta\phi_m = \Delta B A \text{ (Wb)}$$

- To determine the change in the magnetic flux ($\Delta\phi_m$), when the plane of the coil is normal to the flux lines then :
  - The coil is turned 90° or becomes parallel to the flux or removed from the flux or the flux vanished, then :

    $$\Delta\phi_m = BA - 0 = BA$$

  - The coil is turned 180° , turned upside down the flux, or the flux direction is reversed, then :

    $$\Delta\phi_m = BA - (-BA) = 2BA$$

  - The coil area is changed : $\Delta\phi_m = B\Delta A$
  - The magnetic flux density is changed : $\Delta\phi_m = A\Delta B$

1. A coil of 100 turns, the cross-sectional area of each is 20 cm^2, is placed perpendicular to a uniform magnetic field of flux density 0.2 T, if the direction of the magnetic flux is reversed within 0.2 s , find the average induced generated emf. *(0.4 V)*

2. A circular coil consists of one turn of radius 22 cm is placed in a magnetic field of flux density 0.05 T , if the plane of the coil was perpendicular on magnetic field then it turned 90° within a time 0.25 s, calculate the average emf generated in this case. *(0.03 V)*

3. A coil of 400 turns, where the area of each turn is 50 cm^2, is penetrated by a magnetic field of flux density 0.2 T, calculate the average induced emf between its terminals if :
   (a) The magnetic flux intercepting the coil is vanished within 0.01 s.
   (b) The coil is turned 180° in the magnetic flux within 0.01 s.
   (c) The coil is turned 360° in the magnetic flux within 0.15 s. *(40 V , 80 V , 0)*

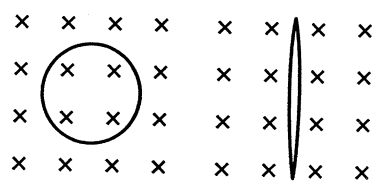
4. A solenoid coil formed of 400 turns, the cross-sectional area of each is 4 cm^2 is placed parallel to a uniform magnetic field of flux density 0.3 T. Calculate the average induced emf generated in the coil when :
   (a) The magnetic flux density increases to 0.1 T within 2 ms.
   (b) The magnetic flux density decreases to 0.4 T within 2 ms. *(16 V , 8 V) (2^{nd} session 13)*

5. A rectangular coil of dimensions 20 cm × 10 cm is formed of 100 turns, its plane is perpendicular to a magnetic field. When this coil is turned $\frac{1}{4}$ turn within time 0.2 s, an induced emf of 0.4 V is generated. Calculate the magnetic flux density. *(0.04 T)*

6. A solenoid induction coil of length 8 cm, number of turns 400 turns and cross-section area 10 cm^2 carries an electric current of 2.1 A, **find :**
   (a) The magnetic flux density at a point on its axis.
   (b) The induced emf when another coil of the same properties turned from parallel to perpendicular position with respect to the first coil within 0.01 s.
   ($\mu = 4\pi \times 10^{-7}$ Wb/A.m) *(1.32×10^{-2} T, 0.53 V) (Azhar 98)*

7. It is noticed that a potential difference of 5.5×10^{-3} V is generated between the terminals of the second hand in a turret clock due to being exposed to a magnetic field perpendicular to it , if you know that the change in area that intercept the magnetic flux due to the rotation of the second hand one complete revolution is $\frac{11}{14}$ m^2. Calculate the affecting magnetic flux density. *(0.42 T) (Azhar 91)*

8. A one turn coil of radius 0.12 m is made of an elastic conducting wire. The coil is placed perpendicular to a uniform magnetic field of density 0.15 T as in figure (a). The turn is pressed from its sides till its area became 3×10^{-3} m^2 as in figure (b) within a time 0.2 s. Calculate the average induced emf generated in the coil within this period of time.


(a) (b)

(31.7×10^{-3} V)

9. A coil of 25 turns is wound on a hollow cylinder of cross-section area 1.8 cm^2 such that the area of each turn equals the cross-section area of the hollow cylinder. The coil is affected by a uniform magnetic field perpendicular to its plane. If the magnetic flux density increased from zero to 0.55 tesla within a time of 0.75 s, **calculate :**

(a) The value of the induced emf in the coil.

(b) The induced electric current intensity in the coil if the resistance of the coil is 3 Ω.

(0.0033 V, 0.0011 A) (2nd session 07)

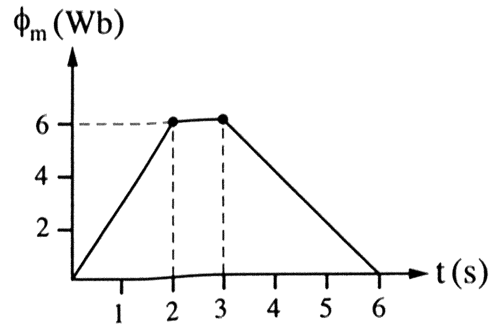
10. A circular coil of cross-sectional area 0.045 m^2, the number of its turns is 150 turn and its resistance is 0.9 Ω. If the plane of that coil is perpendicular to a uniform magnetic flux of density 8×10^{-5} T. Find the amount of electric charge passing in the coil when taking it away from the field within 0.3 s. *(6×10^{-4} C) (Azhar 04)*

11. A search coil with area 2 cm^2 and 50 turns is attached to a sensitive galvanometer and is placed with its plane at right angles to the field between the poles of a magnet. The total circuit resistance is 200 Ω. When the coil is suddenly removed from the field the galvanometer measures a total charge flow of 2.4 μC. Calculate the magnetic flux density of the magnet. *(0.048 T)*

12. A coil of 200 turns, the magnetic flux passing through it has been changed through 6 seconds, using the graphical representation shown in the opposite figure, calculate the average induced emf through :

(a) first two seconds. (b) third second.

(c) the last three seconds.



(600 V, 0, 400V) (1st session 15)

Guiding notes for solving problems 2

- **The induced (emf) generated in a straight wire moving in a magnetic field (emf) :**
  emf = $-B\ell v \sin\theta$
  (Where : θ is the angle confined between the direction of velocity and the direction of magnetic flux).
- For a wire moving normal to a magnetic field then :
  emf = $-B\ell v \sin 90 = B\ell v$ (emf maximum)
- For a wire moving parallel to a magnetic field then :
  emf = $-B\ell v \sin 0 = 0$ (emf vanishes)

13. A rod of copper of length 30 cm moves with a velocity of 0.5 m/s in a magnetic field of density 0.8 Tesla. Calculate the induced emf produced at the terminals of such a rod if it is moved.
(a) Perpendicular to the field. (b) Parallel to the field. *(0.12 V, 0)*

14. When a wire of length 0.4 m is moved perpendicular to a magnetic field of a magnetic flux density 0.7 T, an induced emf of 1 V is generated between its terminals. Calculate the velocity of the wire. *(3.57 m/s)*

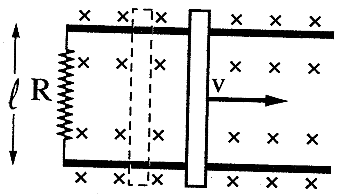
15. A wire of length 0.5 m is intercepting perpendicularly a magnetic field of flux density 0.4 T with a velocity of 20 m/s. If the wire is a part of a closed circuit of resistance 6 Ω, calculate the electric current intensity passing in the wire. *(0.67 A)*

16. An antenna of length one meter is fixed in a motor car, which moves at velocity 80 km/hour in a direction perpendicular to the horizontal component of the Earth's magnetic field. An emf of 4×10^{-4} V is induced in the antenna. In such a case, calculate the horizontal component of the magnetic field for the Earth. *(18×10^{-6} T)*

17. A metallic wire of length 1 m, cross-section area 2.5 cm^2 and resistivity 5×10^{-4} Ω.m is fixed vertically on the body of a car moving with a velocity of 90 km/hr, thus an induced electric current of intensity 25 mA is generated in the wire. Calculate the horizontal component of the magnetic field of the Earth. *(2×10^{-3} T) (Azhar 11)*

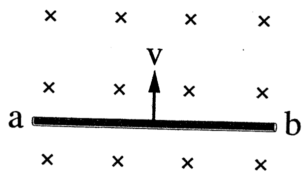
18. An electric circuit consists of a resistor of 3 Ω and two parallel thick wires at 50 cm apart. A metal rod is placed perpendicular to the wires to close the circuit. If the confined area between the wires was perpendicular to the magnetic flux of density 0.15 T, calculate the force required to move the metal rod to acquire a uniform velocity of 200 cm/s. *(3.75×10^{-3} N)*

19. **In the opposite figure if :**
ℓ = 15 cm , R = 25 Ω , B = 0.6 T , v = 8 m/s , ignoring the resistance of the sliding copper rod and the two rails, **calculate :**



(a) The induced emf. (b) The electric current intensity.
(c) The force require to move the rod with a uniform velocity.
(d) The power consumed in the resistance. *(0.72 V , 0.0288 A , 2.59×10^{-3} N, 20.7×10^{-3} W)*

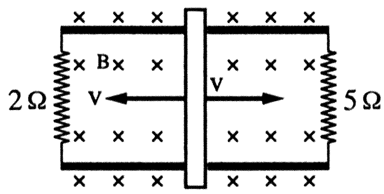
20. The opposite figure shows a metal rod (ab) of length 0.25 m which is moving with a linear velocity of 2 m/s perpendicular to a magnetic field of flux density 0.4 T and its direction is perpendicular inwards to the plane of the paper, if the rod is a part of a closed circuit :



(a) Determine the direction of the current passing through the rod.
(b) What is the name of the rule used to determine the direction of the current intensity?
(c) Find the induced emf generated in the rod. *(0.2 V) (1st session 14)*

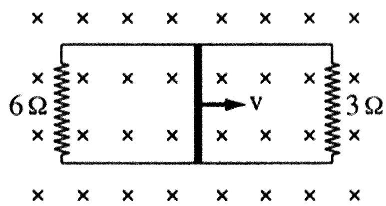
21. A wire of 200 cm length is used to generate an induced emf with two different methods, the first is by moving it perpendicular to a magnetic field of flux density 0.8 T with velocity 100 cm/s and the second by winding it in the form of a coil of radius $\frac{2}{\pi}$ cm then moving a magnet bar inside it generating a flux of 6×10^{-4} Wb within 0.1 minute, calculate the generated emf in both cases. *(1.6 V , 0.005 V)*

22. A conducting rod of length ℓ = 35 cm is free to slide on two parallel conducting bars as shown in the figure. Two resistors $R_1 = 2\ \Omega$ and $R_2 = 5\ \Omega$ are connected across the ends of the bars to form a loop. A constant magnetic field B = 2.5 T is directed perpendicularly into the page. An external agent pulls the rod to the left with a constant speed of v = 8 m/s. **Find :**



(a) The currents in both resistors.
(b) The total power delivered to the resistance of the circuit.
(c) The magnitude of the applied force that is needed to move the rod with this constant velocity. *(3.5 A, 1.5 A, 34.3 W, 4.3 N)*

23. In the opposite figure a closed electric circuit in the form of a rectangle and a conducting rod of 1m length is sliding on it, if the circuit was placed in a uniform magnetic field of density 2 T perpendicular on the plane of the circuit and the resistance of the conducting rod was 2 Ω.



Calculate the required force to slide the conducting rod with a uniform velocity of 2 m/s. *(2 N)*

QUESTIONS ON Chapter 3 LESSON 2

- **Mutual Induction between Two Coils.**
- **Self Induction of the Coil.**

1 Write down the scientific term for each statement of the following :

1. The electromagnetic interaction between two coils which are kept close to each other (or one inside the other) when an electric current with time varying intensity passes in one coil (primary coil), produces in the second one (secondary coil) an induced current in a direction such that to oppose the variation of the current intensity in the primary coil.
2. The induced electromotive force generated in one of the two coils when the electric current intensity in the other coil changes in the rate of 1 Ampere every second.
3. The coefficient of mutual induction between two coils that if the electric current intensity at one of them is changed in the rate of 1 Ampere every second it generates between the ends of the other coil induced emf of 1 Volt.
4. The electromagnetic effect that takes place in a coil such that it resists the change in the electric current passing through it.
5. The magnitude of the induced emf generated in a coil when the electric current intensity passing through it changes in the rate of 1 Ampere/second.
6. The induced electric currents that produced in a metallic piece due to change of the number of magnetic flux lines that cut it.

2 Choose the correct answer of the given answers :

1. A current passes in the primary coil, then this coil is plunged into a secondary coil whose terminals are connected to a galvanometer. The deflection of its needle will be in a direction ....

   a. opposite to the current in the primary coil.
   b. point to the zero reading.
   c. deflects in the same direction of the current in the primary coil.
   d. deflects right and left side of zero scale.

2. Closing the primary coil circuit while it is inside a secondary coil, leads to the generation of .... by mutual induction.

a. an induced forward current　　b. continuous current (DC)

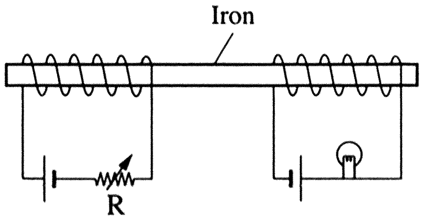
c. an AC current　　d. an induced back current

3. At the moment of opening the circuit of a primary coil inside a secondary coil having a big number of turns, ... is generated in the secondary coil. *(Azhar 11)*

a. big back emf　　b. big forward emf

c. small back emf　　d. small forward emf

4. In the opposite figure , when decreasing the resistance R, the lamp light ....

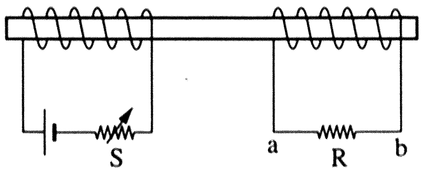


a. decreases momentarily.

b. increases momentarily.

c. stays unchanged.　　d. goes off. *(Olym. 08)*

5. In the opposite figure during increasing the variable resistor (S), the potential of point (a) becomes .... that of point (b).



a. greater than　　b. less than

c. equal to　　d. almost equal

6. Two similar circular loops carry equal currents in the same direction. On moving the coils further apart, the electric current will ....

a. remain unchanged.　　b. increasing in both.

c. increasing in one decreasing in other.　　d. decreasing in both.

7. The slow rate of growth of the current in the solenoid coil is due to the ....

a. production of forward effective current.

b. production of a reverse induced emf resists the original potential difference.

c. production of magnetic flux.　　d. production of an electric field.

8. The coefficient of self induction of a coil is measured in a unit called Henry which is equivalent to ....

a. Volt.s.　　b. Ohm.s.　　c. Ohm/s.　　d. Volt.s.Ampere.

9. When a fluorescent lamp lights the .... energy stored in the coil is discharged in an evacuated tube filled with an inert gas.

a. electric　　b. magnetic　　c. chemical　　d. thermal

10. After a while of the flow of the continuous electric current in an induction coil its intensity becomes constant due to ....

a. generation of electric currents.　　b. generation of eddy currents.

c. vanishing of the self induction.　　d. presence of back currents.

11. The eddy currents are useful in the .... *(2nd session 99 , 11 - Sudan 11)*

a. induction furnaces. b. galvanometer.

c. dynamo. d. transformer.

12. 📖 The ohmic resistors are made of a double wound wires ....

a. to decrease the resistance of the wire. b. to increase the resistance of the wire.

c. to avoid self-induction. d. to eliminate the resistance of the wire.

13. A coil of self inductance 0.1 H, when iron core is put inside it, its self induction becomes ....

a. equal to 0.1 H. b. greater than 0.1 H. c. less than 0.1 H.

d. depend on the value of the AC current intensity passing through it.

14. An air cored coil of self inductance L has N turns of fine insulated copper wire wound on a former of cross-section area A. If the area and number of turns are doubled and the core is a medium of relative permeability 1000, the self inductance of the coil will be ....

a. 8000 L b. 4000 L c. 8×10^{-3} L d. 4×10^{-3} L

15. A solenoid of length ℓ and area A consists of N turns producing an inductance L. If the number of turns is doubled, the inductance will be ....

a. $\frac{L}{4}$ b. $\frac{L}{2}$ c. 2L d. 4L

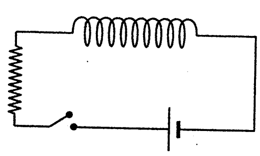
16. If the self inductance of 500 turns coil is 125 mH, then the self inductance of similar coil of 800 turns is .... mH.

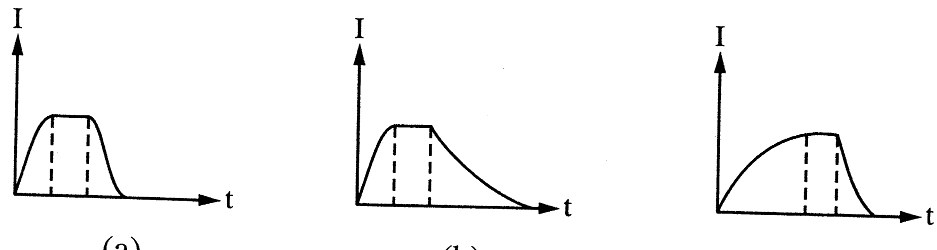
a. 48.8 b. 200 c. 187.5 d. 320

17. Two solenoids A and B have equal number of turns. The length of A is twice that of B and the cross-sectional area of A is half that of B. Other things being similar, the ratio of their inductances L_A/L_B is equal to ....

a. 1 b. 2 c. 4 d. $\frac{1}{4}$

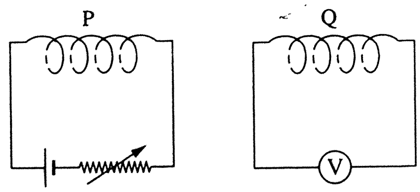
18. The graph that represents the relation between the induced electric current intensity in the shown coil and time when closing and opening the opposite circuit respectively is ....

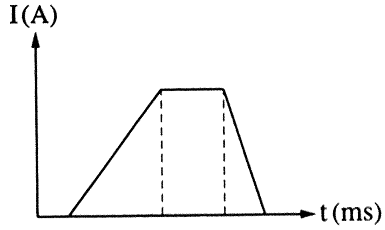


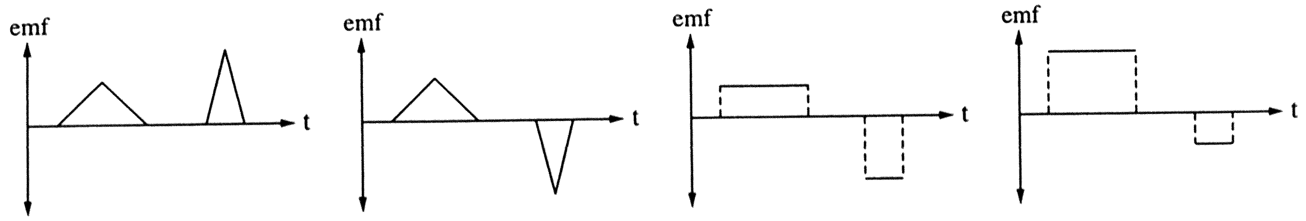


(a) (b) (c)

19. **In the opposite figure :**
Two adjacent solenoids P, Q and the opposite graph represents the relation between the current intensity (I) in the coil P and the time (t), then the graph that represents the induced emf in coil Q with time is ....

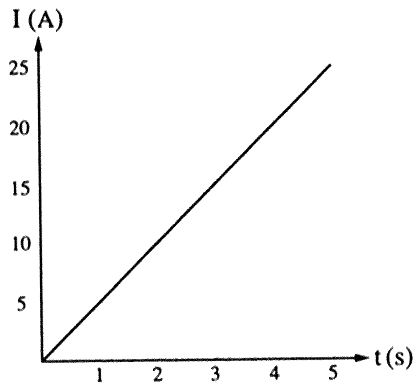


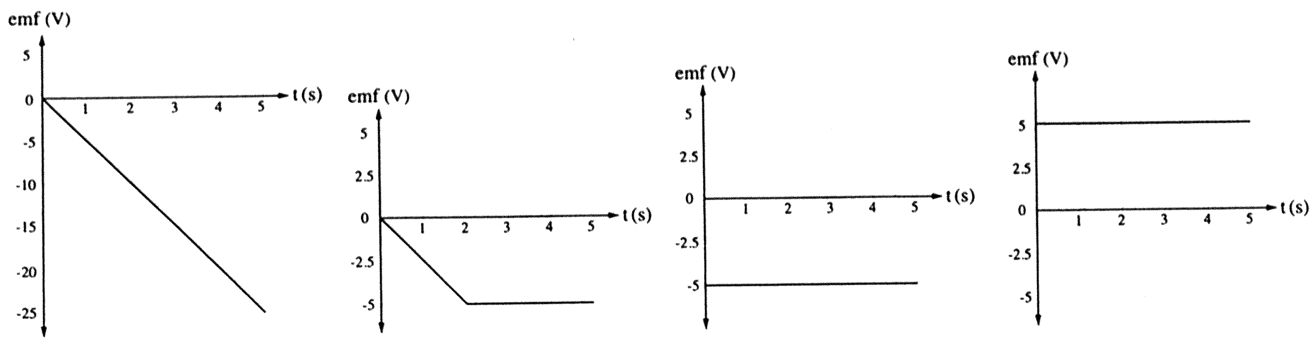




(a) (b) (c) (d)

20. The mutual induction coefficient between two adjacent coils is 1 H, if the current passing through one of the coils changes with time within part of its cycle as in the opposite figure, then the best representation for the induced emf generated in the second coil is figure : ....





(a) (b) (c) (d)

3 What is meant by ... ?

1. Coefficient of the mutual induction between two coils = 0.1 H *(2nd session 04- Sudan 17)*
2. Coefficient of self induction for a coil = 0.3 H
(May 97 , 98 - 1st session 06 , 13 - Azhar, 2nd session 08 - Sudan 08 , 10 , 12)
3. When the electric current passing through a coil changes in the rate of 1 A/s it generates an induced emf = 0.5 V

4 Give reasons for :

1. Standard resistors are made of a double wound wires. *(Egy. 09 - Sudan 15)*
2. 🕮 A bar of soft iron will not be magnetized if a double wound wire carrying a current wound around it.
3. In the experiment of self induction the forward induced emf in the coil is always greater than the back induced emf generated in it.
4. The electric current intensity in a coil does not reach its maximum value at the moment of closing its circuit and does not reach zero at the moment of opening its circuit.
5. The rapid increase of the electric current in a straight wire and the slow increase of it in a coil at the moment of closing the circuit.
6. 🕮 The induced current dies out in a straight wire faster than in a coil with air core and in a coil with air core faster than in a coil wounded around an iron core.
7. When opening the circuit of an electric magnet, a spark arises at the position of current cut.
8. When a high frequency electric current passes through a coil surrounding a metallic piece its temperature rises up to its melting point. *(May 98)*
9. 🕮 The eddy currents are not generated in the metallic blocks unless a magnetic field of variable intensity exists.
10. The rise in temperature of a soft iron cylinder surrounded by a coil connected to alternating current source. *(Sudan 14)*
11. There is an induction coil in the circuit of the flourecent lamp. *(Exp. 17)*

5 Define :

1. 🕮 🗐 Self induction of a coil.
2. 🕮 Coefficient of self induction. *(2nd session 02 , 12)*
3. 🕮 Mutual induction between two coils.
4. 🕮 Coefficient of mutual induction between two coils.
5. 🕮 The Henry. *(Azhar 04)*
6. 🕮 🗐 Eddy currents.
7. 🗐 Electromagnetic induction furnaces.

6 What are the factors affecting each of the following :

1. Coefficient of mutual induction between two coils. *(1st session 02, 15 - Sudan 15, 16)*
2. Coefficient of self induction of a coil. *(2nd session 99, 10 - 1st session 14)*

7 What happens in the following cases, giving reasons :

1. Opening an electric circuit contains a strong electromagnet coil in series with a battery and a switch. *(1st session 13)*
2. The increase of the electric current in an electric coil wound on a core of soft iron concerning the time of its increase.

3. Approaching a coil carrying an electric current to another coil connected to a sensitive galvanometer.
4. Opening the circuit of a primary coil inside a secondary coil connected with a sensitive galvanometer.
5. Increasing the electric current intensity passing through a primary coil inside a secondary coil connected to a galvanometer (its zero scale at the middle). *(2nd session 08)*
6. * The flow of a high frequency electric current in a coil surrounding a metallic piece. *(1st session 01 - 2nd session 05 - Exp. 14)*
   * A metallic piece is exposed to a magnetic field due to a high frequency electric current.
7. * Standard resistors are made of a double wound wires.
   * The flow of an electric current in a coil made of a double wound wires (Concerning the flux density at the axis of the coil). *(Exp. 15)*

8 Explain the scientific idea (scientific base) for each of the following :

1. The fluorescent lamp. *(Sudan 16)*
2. The electromagnetic induction furnaces. *(1st session 02 , 04 , 05 , 11 - 2nd session 07 , 09 , 12 - Sudan 12, 14)*

9 Mention one use (or application) for each of the following :

1. Self induction of a coil. *(Azhar 11- 2nd session, Sudan 15)*
2. Eddy currents. *(1st session 06 , 10, 15 - Azhar 11 - Exp. 15, 16)*
3. Electromagnetic induction furnaces. *(Sudan 16)*

10 Compare between coefficient of self induction and coefficient of mutual induction.

(in terms of the used mathematical relation for each of them) *(2nd session 11)*

11 Miscellaneous questions :

1. **Write the physical quantities that are determined by the following mathematical relations :**

   (a) $-M\frac{\Delta I_1}{\Delta t}$ (b) $\frac{(emf)_2}{\Delta I_1 / \Delta t}$ (c) $-L\frac{\Delta I}{\Delta t}$ (d) $\frac{emf}{\Delta I/\Delta t}$

2. **What is meant by the negative sign and the numerical value in each of the following :**

   (a) $(emf)_2 = -0.4\frac{\Delta I_1}{\Delta t}$ (b) $emf = -0.2\frac{\Delta I}{\Delta t}$

3. **Mention the physical quantities measured in the following units and its equivalent unit :**

   (a) $\Omega.s$ *(1st session 12- Exp. 15)* (b) $T.m^2/s$ *(1st session 13)*
   (c) V.s *(1st session 10, 12 - Sudan 13 , 14 - Exp. 15)* (d) $\Omega.C$
   (e) V.s/A.m *(1st session 14)* (f) $V.s/m^2$ *(2nd session 14)*
   (g) J.s/A.C *(2nd session 14)* (h) Wb/A *(Sudan 15)*

4. 📖 When does the generated induced emf in a coil becomes maximum ? And when does it becomes zero ?

5. Mention the cases of generation of forward induced emf and back induced emf in the secondary coil.

6. Mention only 3 cases for the generation of induced electric current in a secondary coil affected by a primary coil connected to a battery , switch and a rheostat and if the primary coil is connected to AC source how can you increase the induced electric current intensity in the secondary coil more than the primary coil. *(2nd session 02)*

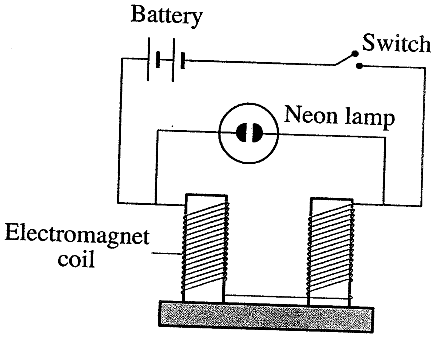
7. **Mention the name of one device that its idea is based on :** *(2nd session 14)*
   (a) Self induction in a coil. (b) Eddy currents.

8. How are eddy currents formed ? And how can they be avoided ? How it can be useful ? What are their disadvantages ?

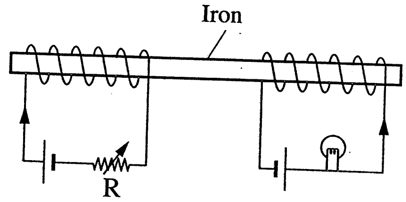
9. **Explain an experiment to clarify each of the following :**
   (a) - The mutual induction between two coils and show how it can be used to clarify Lenz's rule. *(Sudan 11)*
   - The mutual induction between two coils showing the cases of generation of induced electric current in the secondary coil.
   (b) - The self induction in a coil. *(Sudan 14)*
   - The phenomenon of self induction using electromagnet, battery, switch and connecting wires only (draw a diagram for the used electric circuit). *(Exp. 15)*

10. Deduce the equation joining between the induced emf in a coil and rate of change of the electric current passing through it.

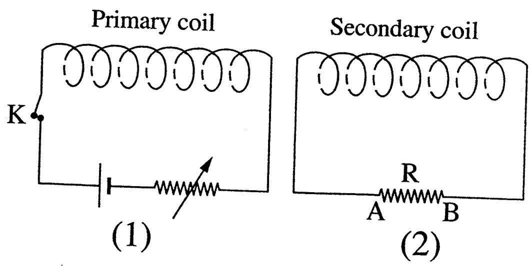
11. **In the opposite figure :**
   (a) What does happen when closing the circuit ?
   (b) What does happen when opening the circuit ?
   (1st session 06)



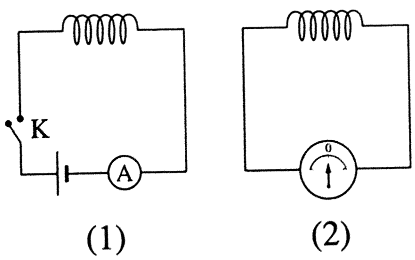
12. **In the opposite figure :**
   What happens instantaneously to the light of the lamp when you increase the resistance R ? Give reasons. *(Sudan 08)*



13. In the opposite figure, two adjacent solenoid coils, one of them is free to move. Mention six methods to generate induced electric current in the secondary coil through the resistance R. *(1st session 15)*



14. **In the opposite figure :**



Coil (1) is connected in series with an electric cell, switch (K) and an ammeter (A), while coil (2) is connected to a sensitive galvanometer having its zero at the middle of the scale. Mention giving reasons what do you observe on the reading of the ammeter and the galvanometer in the following cases :

(a) At the moment of closing the switch (K).

(b) Inserting a soft iron rod in both coils and switching (K) off. *(1st session 07)*

15. If an electric current passes through a coil, deduce the equation which relates the induced emf in this coil to the time rate of current passing through it.

16. What is the effect on the mutual inductance between two coils ?

(a) If a rod of soft iron is inserted into both coils.

(b) If the distance between two coils is decreased.

17. What will happen to the self inductance of a solenoid ?

(a) When the air core inside the solenoid is replaced by iron core.

(b) When the number of turns and the length are doubled keeping the cross-sectional area fixed.

(c) When the separation between each two turns is decreased to its half value.

18. **Prove that :** The self inductance is determined from the relation $L = \frac{\mu A N^2}{\ell}$

12 Problems :

Guiding notes for solving problems 1

- **The mutual induction between two coils :**
- To determine the induced emf generated in the secondary coil by mutual induction $(emf)_2$:

$$(emf)_2 = -M \times \frac{\Delta I_1}{\Delta t} \quad (V)$$

(Where : ΔI_1 is the change in the electric current intensity passing in the primary coil, Δt is the time of that change).

- To determine the coefficient of mutual induction between two coils (M) :

$$M = \frac{(emf)_2}{\Delta I_1 / \Delta t} \quad (H)$$

- In case that time (Δt) is not given :

$$M \Delta I_1 = N_2 \Delta (\phi_m)_2$$

1. Two coils are adjacent when the electric current intensity changes in one of them from 4 A to zero within 0.01 s induced emf of 40 V is generated in the second coil. Calculate the coefficient of mutual induction between the two coils. *(0.1 H) (2nd session 03)*

2. The mutual inductance between two faces of opposite coils is 0.1 H and the intensity of current in one of them is 4 A. If this intensity drops to zero in 0.01 s, find the generated emf induced between the two terminals of the secondary coil. *(40 V)*

3. Ruhmkorff coil, the number of turns of its primary coil is 200 turns, carrying an electric current of 4 A , the length of its soft iron core is 10 cm and its diameter 3.5 cm , its permeability 0.002 Wb/A.m, if the current is cut from the primary coil within 0.01 s, **calculate :**

   (a) The generated emf in the secondary coil if its turns are 10^5 turn.

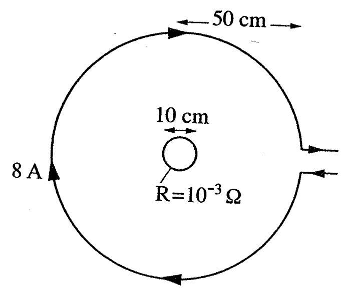
   (b) The coefficient of mutual induction between the two coils. *(1.54×10^5 V , 385 H)*

4. Two adjacent coils X and Y, the number of turns of Y is 2000 turns, if a current of intensity 7 A is passed in coil X and produced magnetic flux 2.5×10^{-4} Wb in coil Y, **calculate :**

   (a) The coefficient of mutual induction between the two coils.

   (b) The average emf in coil Y when the current vanishes in coil X within 0.3 s. *(0.07 H , 1.63 V)*

5. A small circular coil consists of one turn, its radius is 5 cm and its resistance is 10^{-3} Ω. The small coil is placed at the center of a big coil which consists also of one turn of radius 50 cm carrying a uniform AC electric current that changes from zero to 8 A within 10^{-6} s. Calculate the electric current passing in the small coil within this period of time. (considering that the magnetic field of the big coil is uniform about its center).



(79 A)

6. A small coil of resistance 50 Ω and 10 turns, each of area 5 cm^2, is placed at the center of a big circular coil of 7 turns, and radius 11 cm which carries an electric current (I). When the big coil is turned upside down, an electric charge of 20 nano-Coulomb passed through the small coil. Calculate the electric current (I) passing in the big coil. ($\mu = 4\pi \times 10^{-7}$ Wb/A.m) *(2.5 A)*

Guiding notes for solving problems 2

The self induction of a coil :

- To determine the induced generated emf due to self induction (emf) :

$$emf = -L \times \frac{\Delta I}{\Delta t} \quad (V)$$

(Where : $\frac{\Delta I}{\Delta t}$ is the rate of change in the electric current intensity passing in the coil)

- To determine the coefficient of self induction for a coil (L) :

$$L = \frac{emf}{\Delta I/\Delta t} \quad (H)$$

- In case that time (Δt) is not given :

$$L\Delta I = N\Delta\phi_m$$

- To determine the coefficient of self induction for a solenoid (L) :

$$L = \frac{\mu A N^2}{\ell}$$

- To compare between the coefficient of self induction for two solenoid coils :

$$\frac{L_1}{L_2} = \frac{A_1 N_1^2 \ell_2}{A_2 N_2^2 \ell_1}$$

7. A coil formed of 100 turns, its self induction coefficient is 0.03 H and it carries an electric current producing magnetic flux density of 6×10^{-4} Wb. If the electric current passing through the coil is vanished within 0.02 s, **calculate :**

(a) The average induced emf generated in the coil.

(b) The electric current intensity passing in the coil. *(3 V , 2 A) (Azhar 08)*

8. Calculate the coefficient of self induction for a coil in which an emf of 10 V is induced if the passing current changes at a rate of 40 A/s. *(0.25 H)*

9. When the electric current intensity passing through a coil of self inductance 0.005 H changed from 10 A to zero, an induced emf of 5 V is generated between its terminals. Calculate the time of the change in the electric current. *(0.01 s)*

10. An electric current of 5 A passed in an induction coil of 500 turns and produced a magnetic flux of 10^{-4} Wb, if the current is vanished within 0.5 s , **calculate :**

(a) The induced emf generated in the coil.

(b) The coefficient of self induction of the coil. *(0.1 V, 0.01 H) (1st session 00 , 07)*

11. An electric current of 4 A passed in an induction coil of 800 turns and produced a magnetic flux of 2×10^{-4} Wb , if the current is vanished within 0.08 s :

(a) Calculate the induced emf generated in the coil.

(b) Calculate the coefficient of self induction of the coil.

(c) What is the rule used to determine the direction of the induced current in the coil ?

(2 V , 0.04 H, Lenz's rule) (1st session 09)

12. A solenoid coil of 1.1 m length contains 700 turns and its cross-section area is 10 cm^2 carrying an electric current intensity 2 A, **find :**

(a) The magnetic flux density at a point on its axis.

(b) The induced emf generated in the coil if the current vanished within 0.01 s.

(c) The coefficient of self induction of the coil.

(Where : $\mu = 4 \pi \times 10^{-7}$ Wb/A.m) *(1.6×10^{-3} T , 0.112 V , 5.6×10^{-4} H) (Azhar 95 - Exp. 14)*

13. A solenoid coil contains 300 turns, the rate of change of its electric current intensity is 2 A/s. Calculate the rate of change in the magnetic flux produced through the coil if the coil's self inductance is 6×10^{-3} H.

(4×10^{-5} Wb/s)

14. A coil of resistance 15 Ω and self induction coefficient 0.6 H connected to DC source of 120 V. Calculate the rate of increase of the electric current in the following cases :

(a) At the moment of connection.

(b) At the moment of reaching 80% of the maximum value of the electric current.

(200 A/s , 40 A/s)

15. Two adjacent coils A, B consist of 500, 2000 turns respectively. When the electric current in A is changed by 10 A, the magnetic flux in coil A changed by 2×10^{-3} Wb and in coil B changed by 10^{-4} Wb, **find :**

(a) The coefficient of self induction of coil A.

(b) The mutual induction coefficient between the two coils.

(c) The average emf generated in each of the two coils A, B if an electric current of 15 A passing in coil A is cut within a time of 0.3 s. *(0.1 H , 0.02 H , 5 V , 1 V)*

16. A solenoid coil of 500 turns its length 0.4 m and the area of each of its turns 40 cm^2 connected to electric current source, thus electric current of 2 A passed through it. If the current is cut off within 0.1 s, calculate the forward induced emf formed in the coil. (Where : $\mu = 4\pi \times 10^{-7}$ T.m/A, $\pi = 3.14$)

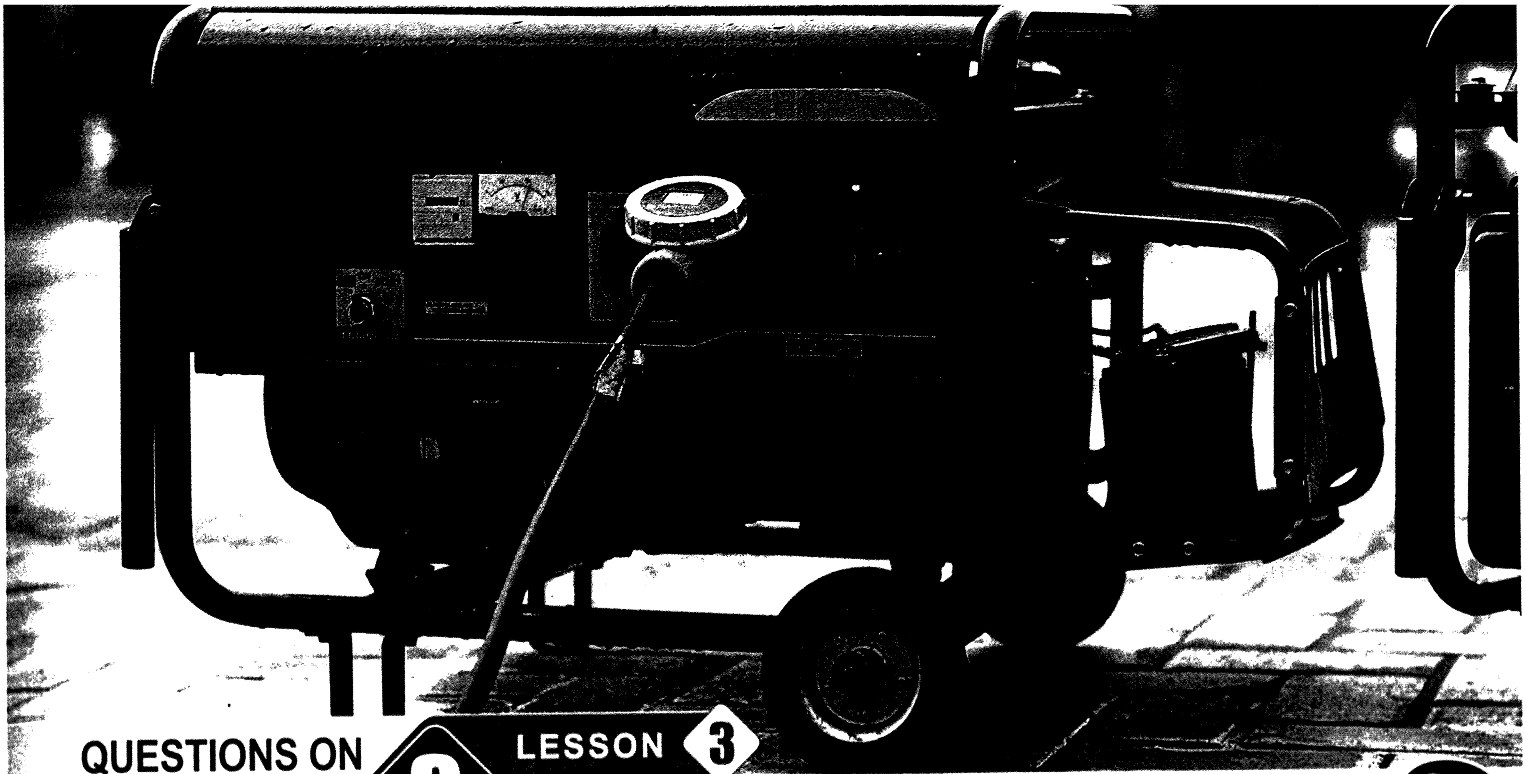
(6.28×10^{-2} V)

17. A solenoid coil of 40 turns its length 10 cm and the area of each of its turns $\frac{70}{22}$ cm^2. Calculate the coefficient of self induction of it if 10 turns are removed from it. (Where : $\mu = 4\pi \times 10^{-7}$ T.m/A)

(6.4×10^{-6} H , 4.8×10^{-6} H)

18. Two solenoid coils , the first is of length ℓ , face area A and number of turns N while the second is of length $\frac{1}{2}\ell$, its face area 2 A and number of turns $\frac{1}{4}$ N. Calculate the ratio between their self induction coefficients.

($\frac{4}{1}$)



QUESTIONS ON **Chapter 3** LESSON 3

Electric Generator (Dynamo)

1 Write down the scientific term for each statement of the following :

1. A device converts the kinetic energy into electric energy.
2. • Electric current changes its magnitude and direction periodically with time.
   • Electric current that changes its intensity periodically from zero to maximum value then back to zero in the first half cycle then reverses its direction and its intensity increases to maximum value then back to zero in the second half cycle and repeats this every cycle.
3. • DC current intensity that generates the same amount of heat which is generated by the AC current when it passes in the same conductor in the same period of time.
   • The value of the unidirectional current that produces the same power as that generated by AC current in a certain resistance. *(Azhar 08 , 11 - Sudan 17)*
4. A hollow metallic cylinder split into two halves isolated from each other replaces the two metallic rings in the AC dynamo.

2 Choose the correct answer of the given answers :

1. The induced emf in the dynamo coil becomes maximum value when the plane of the coil is .... the magnetic flux lines. *(Aug. 97)*
   a. perpendicular to b. parallel to c. inclined in 45° d. inclined in 60°
2. The rate with which the coil intercepts the lines of the magnetic field in the dynamo is maximum when the plane of the coil is .... to the flux lines.
   a. perpendicular b. parallel c. inclined in 30° d. inclined in 60°

3. 📖 The direction of the electric current produced in the dynamo coil can be determined using .... rule.

a. Fleming's left hand b. Lenz's
c. Fleming's right hand d. Ampere's right hand

4. If the number of turns of the dynamo coil is increased to its double and its angular velocity (ω) is decreased to its quarter , then the maximum generated emf ....

(2^{nd} session 10)

a. increased to its double. b. decreased to its half.
c. remains constant. d. increases to its quarter.

5. The average induced emf for a complete revolution for the AC dynamo equals ....

(2^{nd} session 14)

a. emf_{eff} b. $emf_{instantaneous}$ c. emf_{max} d. zero.

6. The average value of the alternating current intensity within a complete revolution equals ....

(Aug. 98 - Exp. 14)

a. I_{eff} b. I_{max} c. zero. d. no correct answer.

7. When a coil rotates in a magnetic field , the direction of the generated effective emf changes every .... cycle.

(2^{nd} session 04)

a. $\frac{1}{4}$ b. $\frac{1}{2}$ c. $\frac{3}{4}$ d. 1

8. The quotient of dividing the maximum induced emf by the effective value of emf equals ....

(Azhar 11)

a. 0.707 b. $\sqrt{2}$ c. $\frac{1}{\sqrt{2}}$ d. no correct answer.

9. ✓ AC dynamo gives $(emf)_{max}$ = 100 V, so the average emf within half cycle equals .... V.

(Olym. 08)

a. 50 b. 70.7 c. 63.6 d. 100

10. The ratio between the number of coils to the number of segments of the hollow metallic cylinder in the unidirectional dynamo equals ....

a. $\frac{1}{2}$ b. 1 c. $\frac{2}{1}$ d. $\frac{3}{1}$

(2^{nd} session 05 - 1^{st} session 07 - Sudan 12)

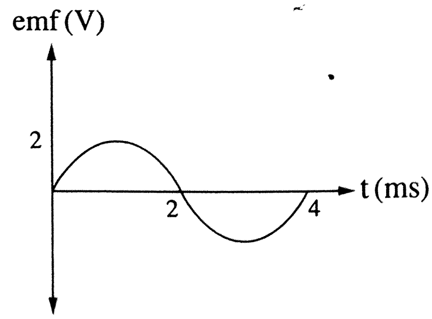
11. ✓ If the period required by the alternating current to rise from zero to half maximum value is t, then the time required to reach the maximum value is .... *(Olym. 08)*

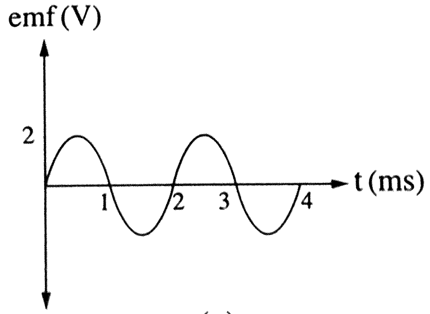
a. t b. 2t c. 3t d. 4t

12. If the generated $(emf)_{max}$ in the dynamo coil was 100 V when the current frequency was f and when the frequency increased by 25 Hz, the $(emf)_{max}$ increased to 150 V, then the frequency value equals ....

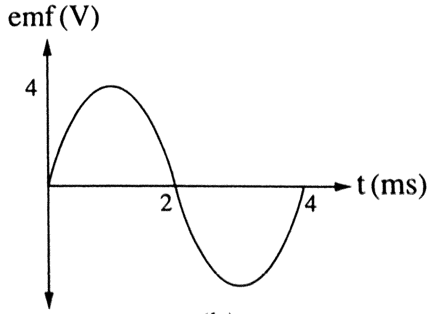
a. 25 Hz. b. 50 Hz. c. 100 Hz. d. 150 Hz.

13. The opposite graph expresses the relation between time and the instantaneous induced emf in a dynamo coil of frequency f, then if the frequency increased to 2f then the graph which is expressing the same relation would be ....





(a)



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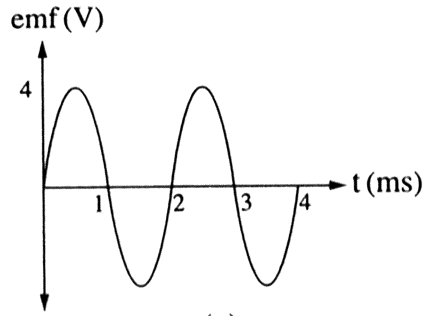

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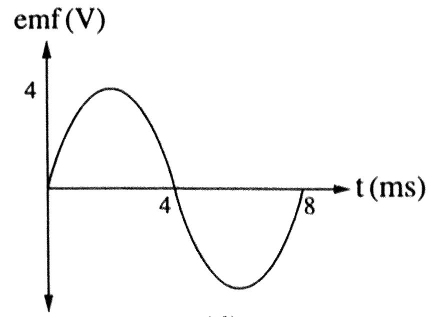
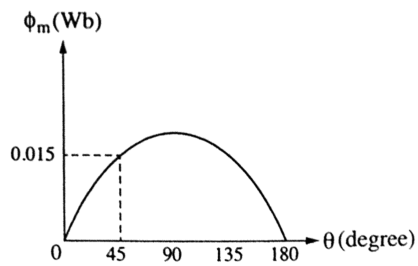


(d)

14. If the time required by the AC current produced from a dynamo to reach from zero to its effective value is 9 ms, then the time required to reach from zero to half its maximum value is .... ms.

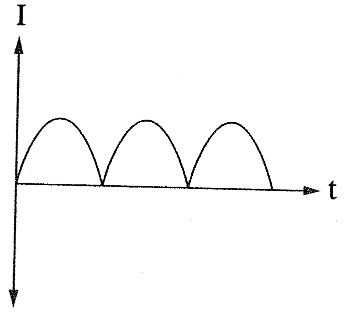
a. 3 b. 6 c. 12 d. 18

15. The opposite graph shows the relation between the magnetic flux which cuts the dynamo coil and the angle between the field and the plane of the coil within half cycle, if the coil consists of 100 turns and rotates in the rate of 1800 cycle per minute, then the maximum emf equals .... volt.

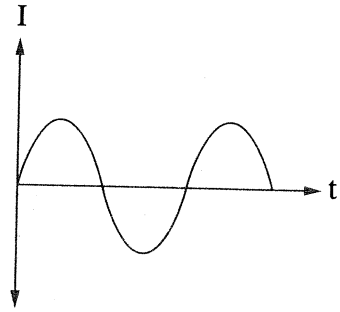


a. 150 b. 200 c. 225.68 d. 400

16. The graph that represents the generated current from a dynamo consisted of number of coils separated by equal small angles is ……… *(1st session 17)*



(a)



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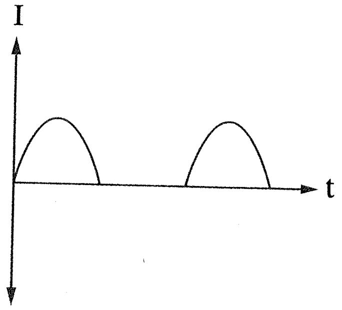

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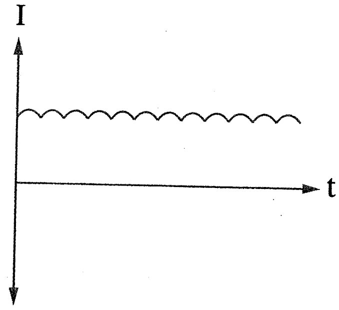


(d)

3 What is meant by :

1. 🕮 The effective value of an AC current = 2.5 A *(1st session 01 , 04 - 2nd session 01 , 11- Sudan 11)*
2. The frequency of the alternating current = 50 Hz

4 Give reasons for :

1. 🗐 The induced emf in the coil of the dynamo is maximum when its plane becomes parallel to the magnetic flux lines.
2. The average induced emf generated in the dynamo coil within $\frac{1}{4}$ cycle = The average induced emf generated in the dynamo coil within $\frac{1}{2}$ cycle. *(Sudan 14 - Azhar 15)*
3. 🗐 The average induced emf generated in the dynamo coil through a complete cycle = zero
4. The average value of the alternating current through a complete cycle of a coil = zero
5. The commutator gives unidirectional current in the dynamo.
6. The terminals of the dynamo coils are connected to hollow metallic cylinder split into a number of segments equals double the number of coils. *(Sudan 08 , 10 - 2nd session 17)*

5 Define :

1. 🕮 The dynamo.
2. 🕮 The AC current.
3. 🕮 The effective value of AC current. *(1st session 12)*

6 What are the results based on each of the following :

1. The number of turns of the dynamo coil is doubled and the number of coil rotations per second is doubled too.

2. Replacing the two metallic rings in the AC dynamo by two insulated halves of a split metallic cylinder. *(1st session 01 , 06 , 11 - 2nd session 09, 15)*
3. The commutator of the dynamo is divided into a number of segments equals to double the number of coils.

7 What is the role of each of the following :

1. The two halves of the split metallic cylinder in the dynamo. *(2nd session 00,02 - 1st session 10, 15 - Sudan 14)*
2. The two carbon brushes in the dynamo.

8 Compare between each of the following :

1. AC and DC current.
2. 🕮 AC generator and DC generator.

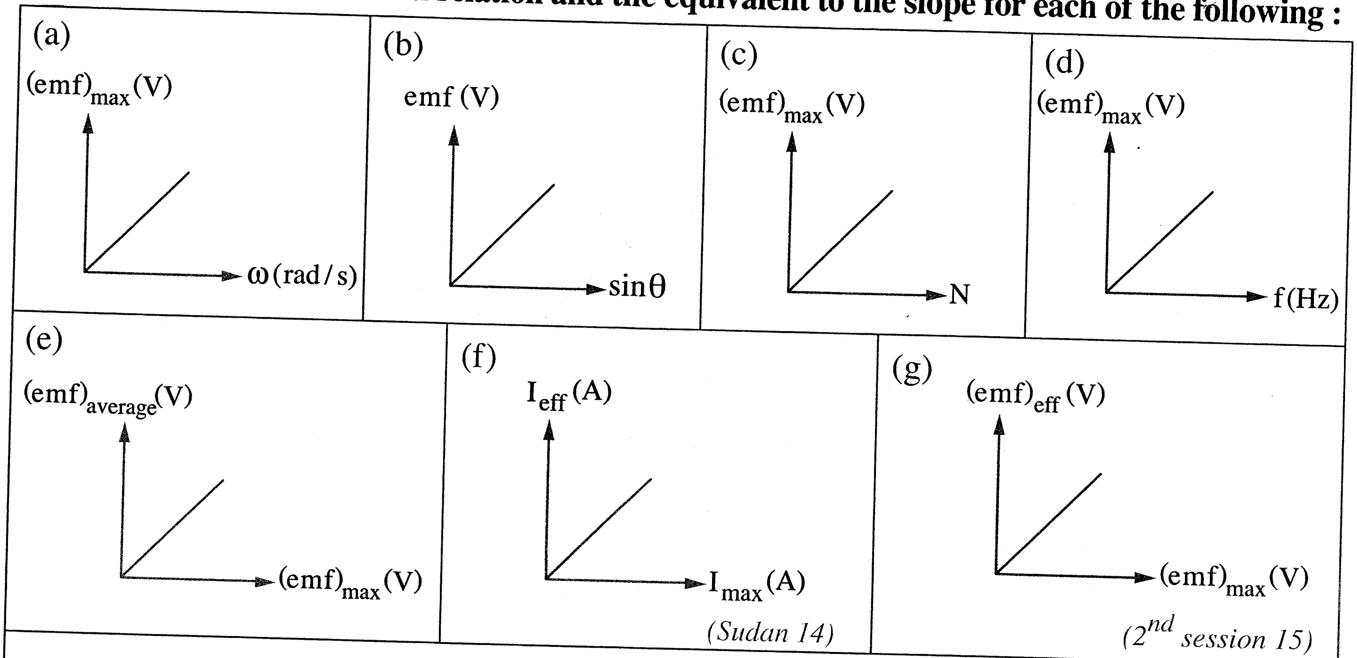
9 When does :

1. The alternating current intensity generated by the dynamo coil become maximum value ? *(Azhar 08)*
2. The alternating current intensity generated by the dynamo coil become zero ? *(Azhar 11)*
3. The average induced emf generated in a coil rotates in a uniform magnetic field = zero ? *(1st session 14 - Sudan 16)*
4. The induced emf generated from a dynamo equal its maximum value ? *(2nd session 17)*
5. The instantaneous emf generated in a dynamo equal the effective emf of the same dynamo ? *(Sudan 17)*

10 Miscellaneous questions :

1. Explain the scientific idea (scientific base) for the electric generator (Dynamo). *(2nd session 01 , 13 - Sudan 11)*
2. Mention one application for the electromagnetic induction.
3. What are the factors affecting the induced emf generated by the AC dynamo coil? *(1st session 00 - 2nd session 04, 15 - Sudan 16)*
4. Mention the mathematical relation used to find :
   (a) The maximum induced emf generated in the dynamo coil. *(2nd session 14)*
   (b) The average of the generated emf in a dynamo's coil within $\frac{1}{4}$ cycle started from the parallel position of the field . *(Sudan 17)*
5. Show how can you obtain a unidirectional current in dynamo coil. *(2nd session 08)*
6. Show by a graph the change in the value of the induced emf in the dynamo coil due to the change in its angle of rotation during a complete rotation.
7. When does the induced emf generated in the dynamo's coil become maximum and equal zero ?
8. **Write the physical quantities that can be determined from the following relations :**
   (a) $NBA\omega$ (b) $2\pi f$ (c) ωt
   (d) $0.707\ I_{max}$ (e) $0.707\ (emf)_{max}$

9. Write the mathematical relation and the equivalent to the slope for each of the following :



Where : (emf) is the instantaneous induced emf, (ω) is the angular velocity, (θ) is the angle between the normal to the coil plane and the field direction, $(emf)_{max}$ is the maximum induced emf, (N) is the number of turns of the coil, (f) is the frequency, $(I)_{eff}$ is the effective value of current intensity, $(I)_{max}$ is the maximum current and $(emf)_{eff}$ is the effective value of emf.

10. **Prove that :**

(a) The instantaneous induced emf generated in the dynamo coil is determined by the relation : $emf = NBA \times (2\pi f) \sin (2\pi ft)$
Where : (N) is the number of turns and (A) is the cross-section area of the coil, where the coil is rotating with a constant frequency (f) Hz in a magnetic flux of density (B) Tesla.
(2^{nd} session 09)

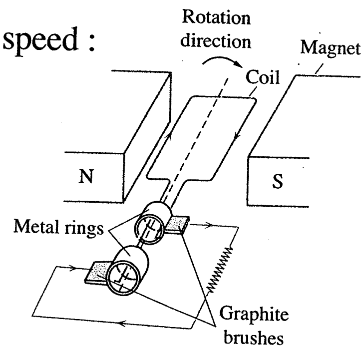
(b) The average emf within half cycle is determined by the relation :

$$(emf)_{average} = \frac{2(emf)_{max}}{\pi}$$

11. Mention the rule or method used to determine the direction of the induced current in the dynamo coil.
(Exp. 15)

12. Show by complete data drawing the structure of the AC dynamo, then mention how it can be converted into DC dynamo.
(May 98)

13. The opposite figure shows AC dynamo rotating with a constant speed :



(a) Write the mathematical equation used to determine :

1- The instantaneous induced emf generated in the coil.

2- The maximum induced emf generated in the coil.

(b) Draw a graph to show the relation between the output voltage and time during a complete rotation starting from the position in the figure.

(c) Show by drawing only, the change in the value of the induced emf with the angle of rotation during half rotation only.

14. Figure (1) shows :

The produced electric current in the external circuit of a dynamo.

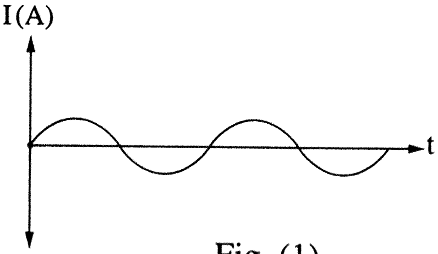


Fig. (1)

Figure (2) shows :

The same current of the same dynamo after a certain modification.

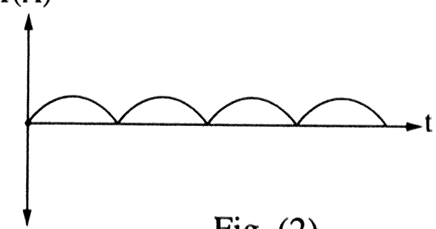


Fig. (2)

(a) What is the difference between the two currents ?

(b) What is the modification on the dynamo ?

(c) Why the ammeter can't be used to measure the resulted current in the first case ? *(1st session 14)*

11 Problems :

Guiding notes for solving problems

⇒**AC Electric generator (Dynamo) :**

- **To determine the instantaneous induced (emf) in the coil (emf) :**

- emf = NBAω sin θ

(Where : θ is the confined angle between the direction of velocity and the direction of the flux density or the angle between the normal to the plane of the coil and the flux lines)

$\omega = \frac{\theta}{t} = \frac{v}{r} = 2\pi f \left(\frac{rad}{s}\right)$, $\left(\pi = \frac{22}{7}\right)$

$\theta = \omega t = 2\pi f t$ $(\pi = 180°)$

$f = \frac{\text{Number of cycles}}{\text{Time (in seconds)}} = \frac{1}{\text{Periodic time (T)}}$

- If the plane of the coil was normal to the flux lines (θ = 0°), the (emf) vanishes :

- emf = NBAω sin θ = 0

- If the plane of the coil was parallel to the flux lines (θ = 90°), the (emf) is maximum :

$(emf)_{max}$ = NBAω sin 90 = NBAω ∴ emf = $(emf)_{max}$ sin θ

- **To determine the average induced emf in a coil $(emf)_{average}$:**
  - $(emf)_{average} = -N \times \frac{\Delta\phi_m}{\Delta t} = -N \times \frac{\Delta BA}{\Delta t}$
  - Average emf through $\frac{1}{4}$ cycle starting from zero position = Average emf through $\frac{1}{2}$ cycle starting from zero position :

    $(emf)_{average} = -NBA \times 4f$
  - Average emf through $\frac{3}{4}$ cycle starting from zero position :

    $(emf)_{average} = -\frac{4}{3}NABf$
  - Average emf through complete cycle = zero
- **To determine the value of $(emf)_{average}$ through $\frac{1}{4}$ or $\frac{1}{2}$ cycle starting from zero position in terms of $(emf)_{max}$:**

  $(emf)_{average} = \frac{2\,(emf)_{max}}{\pi}$
- **To determine the effective value of emf $(emf)_{eff}$:**

  $(emf)_{eff} = \frac{(emf)_{max}}{\sqrt{2}} = 0.707\,(emf)_{max}$
- **To determine the effective value of alternating current $(I)_{eff}$:**

  $(I)_{eff} = \frac{(I)_{max}}{\sqrt{2}} = 0.707\,(I)_{max}$
- **To determine the instantaneous value of alternating current $(I)_{instantaneous}$:**

  $(I)_{instantaneous} = I_{max} \sin\theta$

  (Where : I_{max} is the maximum value of the alternating current)
- The number of times the AC current reaches maximum value per second (starting from zero position) = 2f
- The number of times the AC current reaches zero per second = 2f + 1

1. 🕮 A coil of a dynamo consists of 800 turns each of cross-section area 0.25 m^2. It rotates at a rate of 600 revolutions per minute, in a field of magnetic flux density 0.001 Tesla. Calculate the induced emf when the angle made between the normal to the coil and the magnetic flux is 30° *(6.286 V)*
2. 🕮 A rectangular coil of 100 turns, with dimensions 0.2 m × 0.4 m rotates with a uniform speed of 500 revolutions per minute in a uniform field of magnetic flux density 0.1 Tesla. The axis of rotation in the plane of the coil is perpendicular to the field. Calculate the maximum emf induced in the coil. *(41.9 V)*

3. If the maximum induced emf in a dynamo coil is 66 V and rotates with frequency 25 Hz in a magnetic field of flux density 0.07 T and the cross-section area of that coil is 600 cm^2, what is the number of turns of that coil? *(100 turn)*

4. If you have a dynamo, the number of turns of its coil is 100 turns, its cross-sectional area is 0.025 m^2 and it rotates with 700 turns every minute in a magnetic field of flux density 0.3 Tesla, $\left(\pi = \frac{22}{7}\right)$. Calculate the induced emf when :

   (a) The plane of the coil is perpendicular to the direction of the magnetic flux lines.

   (b) The angle between the perpendicular to the plane of the coil and the flux lines = 90°, then calculate the effective value for the induced emf. *(0 , 55 V , 38.885 V) (2nd session 06)*

5. AC dynamo, its coil is composed of 350 turns and its cross-sectional area is 200 cm^2. If rotates with a uniform speed of 50 cycle per second in a uniform magnetic field of flux density 0.5 Tesla, **calculate :**

   (a) The maximum value of induced emf generated in the coil of the dynamo. $\left(\pi = \frac{22}{7}\right)$

   (b) The instantaneous induced emf after a time of $\frac{1}{600}$ s from the position where the plane of the coil is perpendicular to the magnetic flux lines. *(1100 V , 550 V) (1st session 05)*

6. A dynamo coil of 400 turns, the area of each is 4 cm^2, rotates in a magnetic flux density of 0.05 Tesla in the rate of 25 cycle per second. Calculate the average induced emf within $\frac{1}{4}$ cycle. *(0.8 V)*

7. A dynamo coil of 100 turns, the area of each is 200 cm^2, rotates in a magnetic flux such that it completes one revolution in 0.8 s and the average induced emf generated through $\frac{1}{4}$ cycle equals 0.4 V. Calculate the magnetic flux density. *(0.04 T)*

8. A coil of AC dynamo, its dimensions 5 cm, 10 cm composed of 420 turns is placed in a uniform magnetic field of flux density 0.4 Tesla such that the plane of the coil was perpendicular to that field. If the rate of rotation of the coil is 1000 cycle per minute **calculate :**

   (a) The induced emf in each of the following positions :

   1- After $\frac{1}{4}$ cycle of the first position. 2- After 150° of the first position.

   (b) The average induced emf through $\frac{1}{4}$ cycle from the first position.

   (88 V , 44 V , 56 V) (Egy. 89)

9. AC dynamo its coil is composed of 200 turns, the cross-sectional area of each is 6×10^{-2} m^2. If it rotates in a magnetic field with a speed of 1800 cycle per minute. If the magnetic flux density was 0.1 Tesla. **Calculate :**

   (a) emf in the coil in the following positions :

   1- The plane of the coil is perpendicular to the field.

   2- The plane of the coil is parallel to the field.

   3- The plane of the coil is inclined by angle 60° on the direction of the field.

(b) The average induced emf in the following positions :

1- Through quarter cycle from the perpendicular position to the field.

2- Through half cycle from the perpendicular position to the field.

3- Through complete cycle starting from zero position.

(0 , 226.286 V , 113.143 V , 144 V , 144 V , 0)

10. A coil formed of 400 turns, the area of each is 3×10^{-2} m^2, rotates in the speed of 3000 cycle/minute in a magnetic field of flux density 0.04 T. **Calculate :**

(a) The maximum emf.

(b) emf after 0.01 s from the vertical position.

(c) emf after 0.01 s from the horizontal position. *(150.857 V , 0 , 150.857 V)*

11. A dynamo coil of cross-section area 4×10^{-2} m^2 and 70 turns rotates with a speed of 3600 cycle/minute in a magnetic field of flux density 0.5 Tesla. It started motion when its plane was perpendicular to the field. **Calculate :**

(a) The maximum emf.

(b) emf after $\frac{1}{720}$ s from the starting of motion. *(528 V, 264 V) (1st session 10)*

12. AC dynamo its coil is formed of 420 turns, the area of each is 3×10^{-3} m^2. It rotates in a magnetic field of flux density 0.5 T. If the coil started rotation from the position when its plane was perpendicular to the flux lines and reached to the maximum induced emf after a time of $\frac{1}{200}$ s $\left(\text{Where : } \pi = \frac{22}{7}\right)$. **Calculate each of :**

(a) The maximum induced emf.

(b) The time of reaching half the maximum value of emf. *(198 V, $\frac{1}{600}$ s) (1st session 14)*

13. AC dynamo, its coil is formed of 100 turns, the area of each is 0.05 m^2, rotates in a magnetic field of flux density 0.1 T which generates maximum induced emf of 157 V. If $\pi = 3.14$, **calculate :**

(a) The angular velocity.

(b) The frequency of the electric current generated in the coil.

(c) The average induced emf through $\frac{1}{4}$ cycle from the maximum value position.

(314 rad/s , 50 Hz , 100 V) (2nd session 11)

14. AC dynamo, its coil is formed of 200 turns, the area of each is 2×10^{-2} m^2. It rotates in a magnetic field of flux density 0.1 T. Which generates emf of effective value 88.8 V. **Calculate :**

(a) The maximum value for the emf.

(b) The angular velocity.

(c) The current frequency $\left(\text{where : } \pi = 3.14\right)$. *(125.6 V , 314 rad/s , 50 Hz) (Sudan 14)*

15. A rectangular coil, its face area is 70 cm^2 , rotates about its axis in a magnetic field of flux density 1 tesla such that it makes 300 rotations in half a minute. If the number of its turns was 100 turns, **calculate :**

(a) The maximum emf.

(b) The effective emf.

(c) The time taken from the start of rotation from the perpendicular position till the emf reaches 22 V.

(d) The periodic time. *(44 V , 31.108 V , 8.333 × 10^{-3} s , 0.1 s)*

16. The maximum emf for an AC source is 200 V, connected to a resistance of 50 Ω, **calculate :**

(a) The maximum value of the current intensity.

(b) The effective value of current intensity. *(4 A , 2.828 A) (1^{st} session 06)*

17. AC dynamo is connected to a resistance of 8 Ω that produced heat energy of 200 J within a time period of 1 s. Find the maximum value for both of the electric current intensity and the potential difference between the resistor terminals. *(7.072 A , 56.576 V)*

18. A dynamo coil is formed of 100 turns each of resistance 0.01 Ω. When it starts rotation with a frequency of 50 Hz it consumes electric energy of 2 J within one rotation. **Calculate :**

(a) The maximum induced emf.

(b) The average emf within $\frac{1}{4}$ rotation. (knowing that : $\pi = 3.14$) *(14.14 V , 9 V)*

19. If the effective current intensity in an electric circuit (I_{eff}) is 2.828 A, **calculate :**

(a) The maximum current (I_{max}).

(b) The instantaneous induced electric current intensity when the angle (θ) confined between direction of the coil velocity and direction of the magnetic flux density equals 30° *(4 A , 2 A) (1^{st} session 06)*

20. AC current has an effective value 3.535 A and frequency 50 Hz, **calculate :**

(a) Its periodic time.

(b) The maximum value for the current intensity.

(c) The instantaneous value for the electric current intensity when the coil makes with the magnetic flux angle 60°

(d) The instantaneous electric current intensity after $\frac{1}{200}$ s from start of rotation of the coil.

(0.02 s , 5 A , 2.5 A , 5 A)

21. If the maximum induced emf in the coil of a dynamo is 200 V, what should be its instantaneous value when :

(a) The coil reaches $\frac{1}{12}$ of one cycle since the moment at which the emf = zero

(b) The plane of the coil is parallel to the field.

(c) The angle between the perpendicular to plane of the coil and the flux lines = 30°

(d) The plane of the coil is inclined by an angle 60° on the field.

(e) The plane of the coil is perpendicular to the field. *(100 V , 200 V , 100 V , 100 V , 0)*

22. If the AC emf is given by the relation : emf = 200 sin 18000 t. (where : π = 3.14)

Calculate :

(a) The maximum value of the emf.

(b) The effective value for emf.

(c) The current frequency.

(d) The angular velocity.

(e) The periodic time.

(f) The emf value after 5 ms starting from the position in which the plane of the coil is perpendicular to the field.

(g) The consumed energy in a resistance of 20 Ω during one cycle only for the alternating current. *(200 V , 141.4 V , 50 Hz , 314 rad/s , 0.02 s , 200 V , 19.994 J) (2nd session 12)*

23. AC dynamo coil of side length 40 cm, width 30 cm and number of turns 300 turns generates a current of frequency $\frac{50}{11}$ Hz and the effective value of the induced generated emf is $200\sqrt{2}$ V. **Calculate :**

(a) The maximum induced emf.

(b) The magnetic flux density.

(c) The maximum induced emf when the coil rotates around an axis parallel to its length in a speed of 3 m/s. *(2nd session 08)*

(d) The maximum value of the electric current intensity in the previous case if the coil resistance is 20 Ω. *$\left(400\ V,\ \frac{7}{18}\ T,\ 280\ V,\ 14\ A\right)$ (Azhar 02)*

24. AC electric generator rotates with the rate of 20 rotation every 0.4 s and gives a current of maximum value 5 A. What is the position of the plane of the coil with respect to the magnetic flux lines when it gives this value ? Then calculate :

(a) The periodic time.

(b) The number of times it reaches 5 A during 1 s.

(c) The number of times it reaches zero during 1 s.

(d) The angular velocity of the coil.

(e) The instantaneous electric current intensity when the time is 5 ms.

(f) The effective value of the electric current.

(g) The confined angle between the direction of the magnetic flux lines and the perpendicular to the plane of the coil when the instantaneous value equals the effective value of the alternating electric current intensity.

(0.02 s , 100 times , 101 times , 314.286 rad/s , 5 A , 3.535 A , 45°)

25. AC dynamo has a coil consists of 800 turns and the area of each is $\frac{7}{11} \times 10^{-2}$ m^2. It moves in a uniform magnetic field of flux density 0.03 T, if the maximum induced emf it can generate is 48 V, **calculate :**

(a) The frequency of the produced induced current $\left(\text{where : } \pi = \frac{22}{7}\right)$.

(b) The maximum induced emf when the periodic time of the coil becomes 0.01 s.

(50 Hz , 96 V)

26. If you have a dynamo which has a coil of 100 turns each of area 0.025 m^2 that rotates 700 turn per minute in a magnetic field of flux density 0.3 T, $\left(\pi = \frac{22}{7}\right)$, calculate the induced emf when :

(a) The plane of the coil becomes perpendicular on the magnetic flux lines.

(b) The angle between the normal to the plane of the coil and the flux lines is 90°, then calculate the effective value of the induced emf. *(0 , 55 V , 38.885 V)*

27. When AC dynamo is connected to a resistor of 8 Ω, a thermal energy of 200 J is produced within a time of 1 s. Find the maximum value for each of the electric current intensity and the potential difference between the ends of the resistor. *(7.072 A , 56.58 V)*

28. A dynamo coil consists of 100 turns each of resistance 0.01 Ω, when it rotates with a frequency of 50 Hz, it consumes electric energy of 2 J within one cycle, **calculate :**

(a) The maximum induced emf.

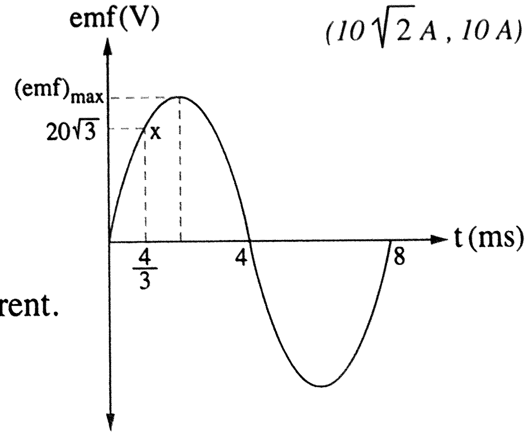
(b) The average emf within $\frac{1}{4}$ cycle $\left(\text{where : } \pi = \frac{22}{7}\right)$ *(14.14 V , 9 V)*

29. If the effective electric current intensity in AC circuit is 10 A, calculate the instantaneous current intensity in the following cases :

(a) After $\frac{1}{4}$ cycle of the zero position.

(b) After $\frac{1}{8}$ cycle of the zero position. *(10$\sqrt{2}$ A , 10 A)*

30. The opposite graph shows the relation between the instantaneous induced emf generated in a dynamo and the time, **calculate :**



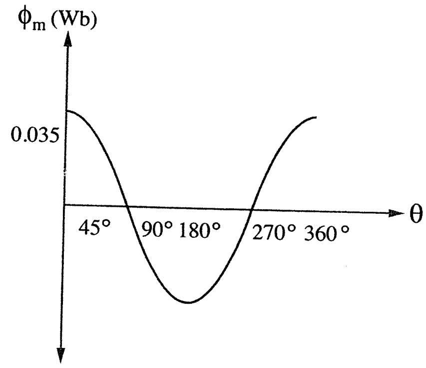
(a) The maximum value for the emf of the AC current.

(b) The instantaneous value of emf for the AC current after $\frac{4}{3}$ ms from point x.

(c) The effective value of the AC current intensity if the coil resistance is 10 Ω.

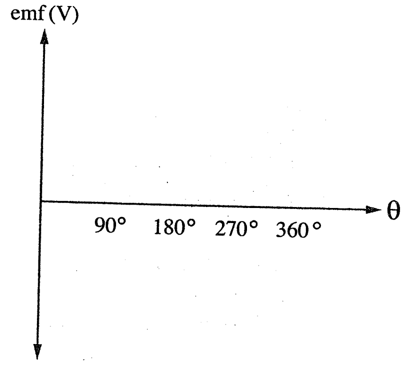
(40 V , $20\sqrt{3}$ V , 2.828 A)

31. The opposite graph shows the change of the magnetic flux (ϕ_m) within a complete cycle of the coil of the dynamo that consists of 8 turns and its frequency 50 Hz, study the graph then answer the following questions :



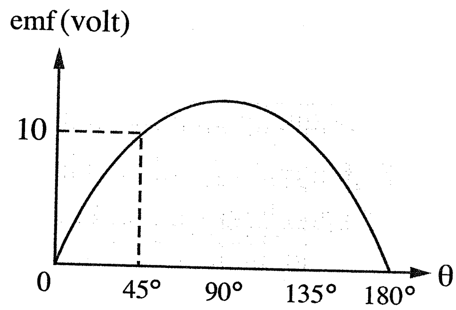
(a) Find the induced emf generated in the coil at quarter the periodic time.

(b) Draw in the opposite graph sheet the relation between the induced emf generated in the coil of the dynamo and the angle (θ) within a complete cycle with the help of the previous graph.

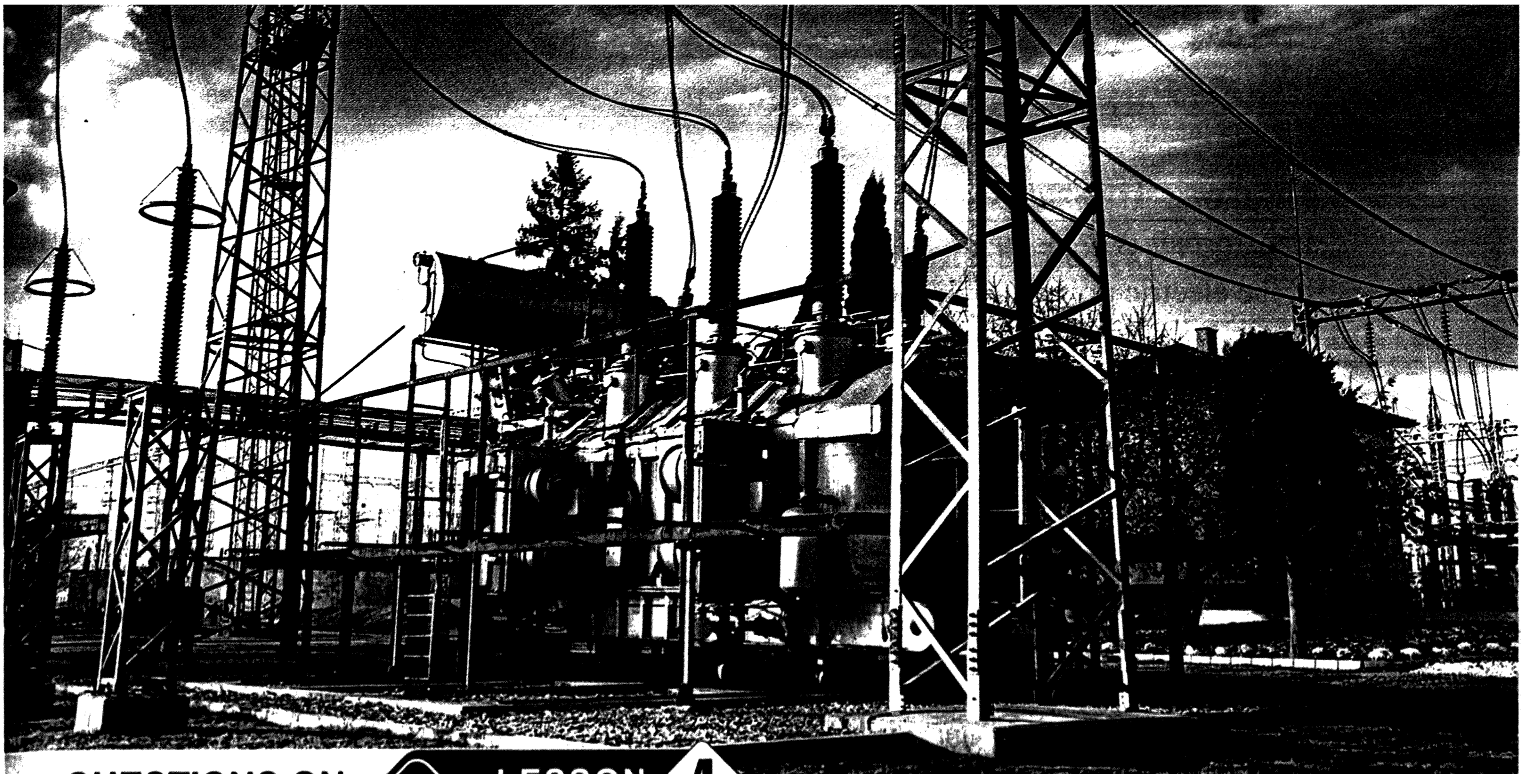


(123.2 V)

32. The opposite figure shows the relation between the induced emf in a dynamo's coil and the angle between the normal of the coil and the magnetic flux direction (θ), find the maximum value of the induced emf.



($10\sqrt{2}$ V) (1^{st} session 17)



QUESTIONS ON **Chapter 3** LESSON 4

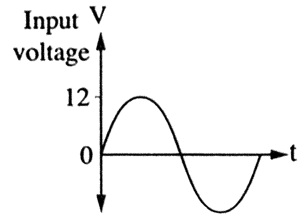
• The Electric Transformer.
• The Electric Motor.

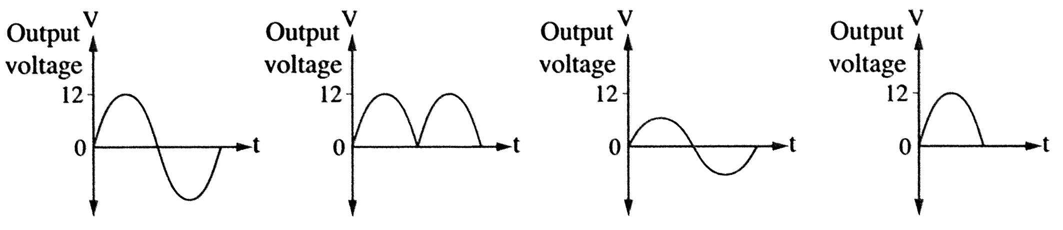
1 Write down the scientific term for each statement of the following :

1. A device used to step up or step down the alternating voltage.
2. • The ratio between the electric energy generated in the secondary coil to that consumed in the primary coil in the same time.
   • The ratio between the electric energy gained from the electric transformer to the energy given to the primary coil.
3. • Transformer in which energy has no losses.
   • Transformer in which the energy generated in the secondary coil equals the energy consumed in the primary coil.
4. A device used to convert the electric energy into mechanical energy.

2 Choose the correct answer of the given answers :

1. The opposite figure shows the potential difference at the input of a step down transformer, therefore the potential difference at the output is ....





(a) (b) (c) (d)

2. The physical quantity that increases in the secondary coil of an ideal step down transformer is .... *(Exp. 15)*
   a. the electric power.
   b. the current intensity.
   c. the current frequency.
   d. the magnetic flux.

3. Which of the following choices describes the parts of the step up transformer ? ....

	Input voltage	Core	Primary coil	Secondary coil
a.	DC	Solid	100 turns	10 turns
b.	DC	Soft iron	10 turns	100 turns
c.	AC	Soft iron	100 turns	10 turns
d.	AC	Soft iron	10 turns	100 turns

4. The transformer efficiency of 80% means ....
   a. energy losses 80%
   b. power of the secondary coil is 20%
   c. energy losses 20%
   d. power of the primary coil is 20%

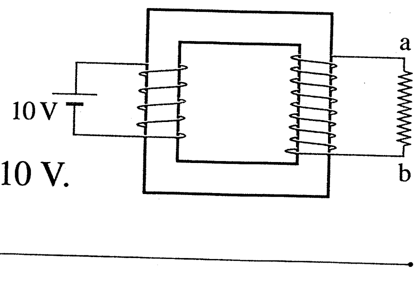
5. A step up transformer is used to raise the potential difference from 120 V to 3000 V and the electric current passing in its primary coil is 2 A and the current passing in its secondary coil is 0.06 A, the efficiency of that transformer equals .... *(1st session 10)*
   a. 75%
   b. 80%
   c. 85%
   d. 90%

6. In ideal step up transformer :
   i. The ratio between the power in the primary coil and the power in the secondary coil is .... one.
   a. greater than
   b. less than
   c. equals
   d. zero
   ii. The ratio between the current of the primary coil to the current of the secondary coil is .... one.
   a. greater than
   b. less than
   c. equal to
   d. zero

7. A transformer of efficiency 90% draws an input power of 4 kW. An electrical appliance connected across the secondary draws a current of 6 A. The impedance of device is ....
   a. 60 Ω.
   b. 50 Ω.
   c. 80 Ω.
   d. 100 Ω.

8. A transformer has an input of 110 DC Volts, with 100 turns on the primary coil and 10 turns on the secondary coil. What is the output emf ? ....
   a. 110 Volts.
   b. 1100 Volts.
   c. 11 Volts.
   d. 0 Volts.

9. In the opposite figure, the potential difference between the points a , b is ....



   a. less than 10 V.
   b. greater than 10 V.
   c. equals 10 V.
   d. equals 0 V.

10. A step up transformer of efficiency 80%, the ratio between the number of turns of the primary coil to that of secondary coil is 1 : 16, so the ratio between the frequency of current in its primary coil and its secondary coil is ....

a. 1 : 16 b. 8 : 10 c. 16 : 1 d. 1 : 1

11. From the disadvantages of the eddy currents in the electric transformer ....

a. losing electric energy in the form of heat energy in the iron core.

b. losing electric energy to move the molecules of the iron core.

c. decreasing the efficiency of the transformer.

d. answer (a), (c) together.

12. The back induced electromotive force in the coil of the electric motor acts to, ...

a. increases the electric current passing in the coil.

b. decreases the electric current intensity passing in the coil.

c. increases the speed of rotation of the coil.

d. stabilizes of the speed of rotation of the coil.

13. The rotation of the electric motor coil continue because of .... *(1st session 01)*

a. the mutual induction. b. the inertia.

c. the self induction. d. the electromagnetic induction.

3 What is meant by :

The efficiency of a transformer = 80% *(Aug. 98 - Azhar 08 - Sudan 12)*

4 Give reasons for :

1. The core of an electric transformer is made of thin sheets of siliconic wrought iron insulated from each other. *(1st session 02 - 2nd session 06 , 09)*
2. The soft iron cylinder in the ammeter is not divided into insulated sheets. *(Sudan 15)*
3. Coils of the electric transformer are made of copper wires. *(2nd session 14)*
4. There is no ideal transformer (its efficiency 100%).
5. • The electric transformer is not suitable to step up or step down DC emf. *(1st session 12)*
   • The electric transformer does not work when connecting its primary coil to DC source. *(2nd session 02)*
6. The electric transformer consumes no energy when its secondary coil circuit is opened although its primary coil is connected to electric current source. *(Azhar 95)*
7. The electric transformer works at closing the circuit of its secondary coil.

8. The electric power is transferred from the electric power stations to the consumer at very high potential difference and low electric current.

9. Step up transformers are used at the electric power stations. *(2nd session 12, Exp. 16)*

10. The step down transformer increases the current and the step up transformer decreases the current.

11. The continuous rotation of the electric motor in the same direction. *(2nd session 12)*

12. • The coil of the electric motor doesn't stop when the graphite brushes touch the insulating material between two halves of the metallic cylinder.
 • The continuous rotation of the motor coil in spite of being perpendicular to the magnetic field lines. *(Sudan 15)*

13. To increase the power of a motor, several coils separated by small angles are used.

14. The speed of rotation of the motor coil is uniform.

15. The wrought iron core in the electric motor is made of thin sheets insulated from each other. *(2nd session 17)*

5 Define :

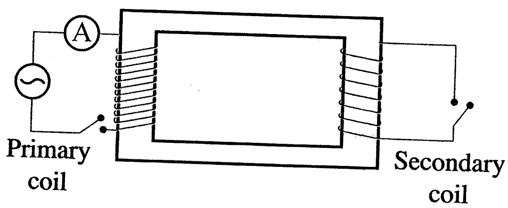
1. The electric transformer.
2. Efficiency of the electric transformer. *(Sudan 14)*
3. The ideal transformer.
4. The electric motor.
5. The back emf in the motor.

6 Explain the scientific idea (scientific base) for each of the following :

1. The electric transformer. *(1st session 99 , 01 , 05 , 13 - Sudan 11 , 14)*
2. The electric motor. *(1st session 02 - 2nd session 07 , 10, 12 , 13)*

7 What happens when, giving reasons :

1. Using DC emf in the primary coil of electric transformer. *(2nd session 08)*
2. Closing the circuit of the primary coil and opening the circuit of the secondary coil in the drawn transformer in front of you. *(1st session 04)*



3. Transferring AC current for long distances away without raising the potential difference before its transferring. *(2nd session 17)*

8 Mention one application for each of the following :

1. The mutual induction between two coils. *(2nd session 10, 15 - 1st session 12, 15)*
2. The torque due to flow of electric current in a coil that can rotate in a magnetic field.

9 What is the role of each of the following :

1. The electric transformer. *(1st session 09 - Exp. 14, 16)*
2. The wrought iron core in the electric transformer. *(2nd session 15 - Exp. 16)*
3. The step up transformer at the electric power stations. *(Azhar 98 - Sudan 10 - 2nd session 15)*
4. The step down transformer at places of electric power distribution.
5. The electric motor. *(1st session 11)*
6. The moment of inertia in the electric motor. *(1st session 17)*

10 Compare between each of the following :

1. Step down transformer and step up transformer (in terms of number of turns of the secondary coil and the primary coil). *(1st session 06 - 2nd session 11 - Sudan 14)*
2. The moving coil galvanometer and the electric motor (in terms of : its usage - direction of the electric current when connected to a battery). *(Exp. 15, 16)*
3. 🕮 The dynamo and the motor (in terms of : the usage).

11 When does ... ?

1. The efficiency of the transformer be less than 100% *(1st session 14)*
2. The electric current intensity passing in the primary coil of electric transformer connected to AC source = zero *(Sudan 14)*

12 Miscellaneous questions :

1. **Mention the name of the device that its working depends on the following and give one of its uses :** *(Sudan 08 , 10)*
   (a) The mutual induction between two coils.
   (b) • The force acting on a wire carrying an electric current placed in a magnetic field.
   • The acting torque on a rotatable coil carrying an electric current and is placed in a magnetic field.
2. 🕮 Describe the structure of the electric transformer ? Then explain the principle of its operation.
3. Mention three cases only to generate induced electric current in a secondary coil due to the effect of a primary coil connected to a battery, switch and a rheostat and if this primary coil is connected to AC electric source, then how can you increase the induced electric current intensity in the secondary coil more than the primary ?

4. Draw a diagram including data for a step down transformer. Then mention three reasons for the electric energy losses in the transformer and the precautions that can be taken to reduce the effect of each.

(Aug. 97)

5. **Deduce the mathematical relation between each of the following :**

(a) The two electromotive forces in the electric transformer and the number of turns of the two coils.

(b) The electric current intensities in the two coils of the electric transformer and number of turns of the two coils.

6. Write the physical quantity that can be determined from the relation : $\frac{V_s I_s}{V_P I_P} \times 100$ *(Exp. 14)*

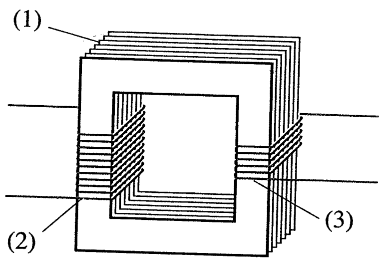
7. Mention one of the factors through which, the electric energy losses in the transmission lines can be reduced.

(Exp. 15)

8. How the electric transformer is used to transfer the alternating electric energy long distances from power stations to places of distribution?

9. How the eddy currents are formed in the electric transformer and how they can be avoided ?

10. The opposite figure shows the structure of a step up transformer :

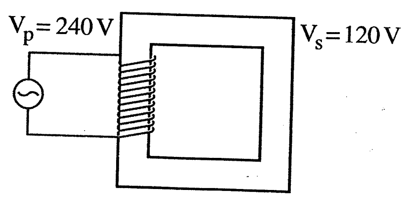


(a) Write the labels 1, 2, 3

(b) Explain how the electromagnetic induction takes place in the electric transformer.

(c) Does the electric transformer work on AC or DC current ? And why ?

11. **In the opposite figure :**



(a) Complete the drawing of the transformer circuit.

(b) What is the number of turns of the secondary coil if the number of turns in the primary coil is 1000 supposed that the efficiency is 100%?

(c) What are the reasons that decreases the efficiency ?

12. Explain with drawing how is the electric motor work through a complete cycle when it is connected to the suitable potential.

13. Mention the modifications that can be done to the electric motor to keep its torque constant.

(Azhar 08 - Exp. 16)

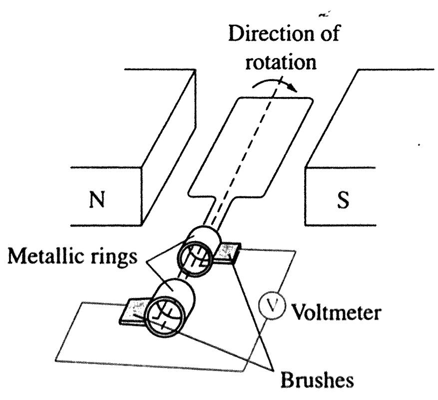
14. Explain the rule or method used to determine the direction of rotation of the electric motor.

(Exp. 15)

15. The opposite figure shows a simple dynamo, a student wanted to change it into a DC motor, so he replaced the voltmeter with a battery and a switch but when he closed the switch the motor did not rotate such as the normal motors :

(a) What is the reason ?

(b) How to help the student to make the motor rotate just as the normal motors ? Explain by drawing.



(1^{st} session 04)

13 Problems :

Guiding notes for solving problems 1

⇒ **The electric transformer :**

- To determine the transformer efficiency (η) :

$$\eta = \frac{V_s I_s}{V_P I_P} \times 100 = \frac{V_s N_P}{V_P N_s} \times 100$$

- For the ideal transformer (efficiency 100%) :

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$$

- Power in primary coil = Power in secondary coil

$$V_p I_p = V_s I_s$$

- For a transformer formed from more than one secondary coil :

$$\eta\ V_p I_p = (V_s I_s)_1 + (V_s I_s)_2 + ...$$

- To determine if the transformer is step up or step down :
- Step up transformer : $V_p < V_s$, $N_p < N_s$, $I_p > I_s$
- Step down transformer : $V_p > V_s$, $N_p > N_s$, $I_p < I_s$
- Power at the electric station = VI
- Power lost in wires = I^2R

1. A transformer of 300 Watt is connected to AC source of potential difference 200 V and the current in its secondary coil is 5 A.

(a) Calculate the potential difference across its secondary coil and mention if it's a step up or step down transformer.

(b) What is the factor controlling the output voltage ? *(60 V)*

2. 📖 A step down transformer of efficiency 90% has a primary coil voltage of 200 V and a secondary 9 V. If the intensity of the current in the primary is 0.5 A and the number of turns of the secondary is 90 turns, what is the intensity of the current in the secondary coil and what is the number of turns of the primary coil? *(10 A , 1800 turns)*

3. 📖 A step down transformer is connected to an AC source of 2500 V gives a current of 80 A to its secondary coil. The ratio between number of turns of the primary and the secondary coils is 20 : 1. Assuming that its efficiency is 80%, find the emf induced across the two terminals of the secondary and find also the current intensity in the primary coil. *(100 V , 4 A)*

4. A step down transformer works at the end of the transmission lines to drop the emf from 3000 V to 120 V. If the power of that transformer is 15 kW and its efficiency 80% while the number of turns of the primary coil is 4000 turns, **calculate :**
   (a) Number of turns of the secondary coil.
   (b) Current intensity in both coils. *(200 turns , 125 A , 6.25 A)*

5. A step down transformer of efficiency 100% is used to light a device of power 48 W at a potential difference 24 V. If the power source applied voltage to the transformer is 200 V, the number of turns of its secondary coil is 600 turns. **Calculate :**
   (a) The number of turns of primary coil.
   (b) The current intensity passing in the secondary coil.
   (c) The current intensity passing in the primary coil.
   (5000 turns , 2 A , 0.24 A) (2^{nd} session 00 - 1^{st} session 11)

6. It's required to use a step up transformer to raise the voltage from 10 V to 50 V.
   (a) Is that possible using DC or AC voltage ? And why ?
   (b) Calculate the number of turns of the secondary coil if the number of turns of the primary coil is 80 turns supposing that its efficiency is 100%
   (c) Suggest the suitable materials required to make the core of the transformer and both the primary and secondary coil. *(400 turns) (2^{nd} session 07)*

7. A step down transformer of efficiency 80%, works on AC source of emf 200 V to give 8 V. If the number of turns of the primary coil is 1600 turns and the current intensity passing through it is 0.2 A.
   (a) **Calculate :**
   1- The number of turns of the secondary coil.
   2- The current intensity in the secondary coil.
   (b) Why there is no 100% efficiency transformer ? *(80 turns , 4 A) (2^{nd} session 06)*

8. A step down transformer works on AC source of emf 240 V. If the number of turns of its primary coil is 5000 turns and the number of turns of its secondary coil is 250 turns and its efficiency is 75 %

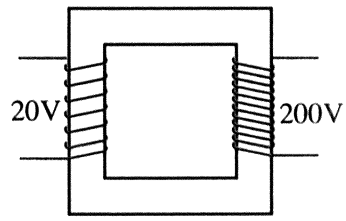
(a) Calculate the emf generated in the secondary coil.
(b) Mention three ways to improve the efficiency of any electric transformer.

(9 V) (1st session 03 - Sudan 11)

9. An electric transformer converts 220 V into 17.6 V and the ratio between the number of turns of its coils is 10 : 1. Calculate the efficiency of the transformer. *(80 %) (Azhar 93)*

10. An ideal electric transformer, the number of turns of its coils are 800, 400 turns, connected to an AC source of emf 100 V. Calculate the maximum and the minimum emf can be obtained using this transformer. *(200 V , 50 V) (2nd session 13)*

11. The opposite figure shows a step down transformer :



(a) Why does the iron core of the transformer is made of insulated lamina?
(b) If the number of turns of the primary coil 640 turns and the efficiency of the transformer 80%, calculate the number of turns of the secondary coil. *(80 turns) (2nd session 05)*

12. An electric transformer works on potential difference 220 V and has two secondary coils one is connected to an electric fan working on (6 V, 0.4 A) while the other is connected to a recorder working on (12 V, 0.35 A). If the number of turns of its primary coil is 1100 turns, **calculate :**

(a) The number of turns of both secondary coils.
(b) The electric current intensity of the primary coil when operating the fan and the recorder together. *(30 turns , 60 turns , 0.03 A) (1st session 08)*

13. TV set works on AC potential difference, its maximum value is 550 V and its frequency is 50 Hz which is supplied by a step up transformer, its primary coil is connected to AC dynamo, its coil dimensions 20 cm , 10 cm and its flux density 0.14 tesla such that its number of turns equals half number of turns of the primary coil of the transformer. Calculate the number of turns of the secondary coil of the transformer. (Assuming the efficiency of the transformer = 100%). *(1250 turns)*

14. A step down transformer, the number of turns of its primary coil is 5000 turns and the number of turns of its secondary coil is 250 turns. If the potential of its primary coil is 240 V :

(a) Calculate the induced emf between the terminals of its secondary coil.
(b) If induced back emf of 4 V is generated in the secondary coil due to change of the current intensity in the primary coil by the rate of 5 A/s. Calculate the mutual induction coefficient between the two coils. *(12 V , 0.8 H) (2nd session 10)*

15. An electric power of 200 kW is required to be transferred from the power station to one of the plants through a transmission line its resistance 0.5 Ω. If the potential difference at the power station is 1000 V, **calculate :**

(a) The electric current intensity in the transmission line.
(b) The drop in voltage.
(c) The lost power in the transmission line. *(200 A , 100 V , 2×10^4 W)*

16. The electric power is transmitted from a power station through cables (wires) of total resistance 200 Ω. If the electric generator supplies the station with electric power of 400 kW, calculate the power lost in cables due to heat at :

(a) Potential difference 2×10^4 V.

(b) Potential difference 5×10^5 V. *(8×10^4 W , 128 W)*

17. One of the power stations generates is 10^5 kW and it works at potential difference of 5×10^4 V. If it's required to transfer electric energy to distribution places at 1000 km away from the power station through transmission wires of resistance 0.25 Ω for every 1 km. Is it better to transfer the electric energy at the same potential difference of the power station or to raise it to 5×10^6 V before transmission ? *(It is prefer to raise 5×10^6 V)*

18. An ideal electric transformer, its secondary coil is connected to an electric bulb of resistance 10 Ω and consumes electric energy of 3000 J within 5 minutes, if the induced emf of electric source connected to the primary coil is 200 V, **calculate :**

(a) The electric current intensity passing in the primary coil.

(b) The electric current intensity passing in the secondary coil.

(c) The potential difference between the terminals of the secondary coil, then determine the type of the transformer. *(0.05 A , 1 A , 10 V) (2nd session 15)*

19. An ideal transformer works on a primary potential difference of 240 V, if the number of turns of the secondary coil is double that of the primary coil and the current intensity of the primary coil is 3 A, then :

(a) Mention the type of that transformer.

(b) **Calculate each of :**

1- Potential difference at the ends of the secondary coil.

2- Electric current intensity in the secondary coil.

3- The produced electric power. *(480 V , 1.5 A , 720 W) (1st session 15)*

20. A primary coil of a transformer is connected with an AC source which has a varying effective voltage. The voltages across its primary (V_1) and its secondary coil (V_2) have been recorded in the following table (with neglecting the effect of temperature changes during the operation) :

V_1 (v)	1	1.5	2	2.5	3
V_2 (v)	0.9	1.35	1.8	2.25	2.7

(a) Draw a graph that represents the relation between the voltages across the secondary coil (V_2) on vertical axis and the voltage across the primary coil (V_1) on the horizontal axis.

(b) From the graph find the slope of the line and the efficiency of the transformer.

(c) At one time we found that the power which is produced in the secondary coil is 360 W, so what is the power that is provided by the source in this case ?

(0.9 , 90 % , 400 W) (2nd session 17)

SELECTED QUESTIONS ON

Chapter 3

From :
- **Student Evaluation Guide (2017).**
- **Booklet Models of the Ministry of Education.**

1 Write down the scientific term for each statement :

1. A process of converting AC current (variable intensity and direction) into unidirectional current of constant intensity.
2. Rule is used to determine the direction of torque acting on a coil of electric motor.

(Booklet 4)

2 Choose the correct answer of the given answers :

1. By increasing the flux lines which is cutting the secondary coil, the generated effective emf is ·········· emf.

   a. reverse b. forward c. frequent

2. By decreasing the flux lines which is cutting the secondary coil, the generated effective emf is ·········· emf.

   a. reverse b. forward c. frequent

3. The average induced emf generated in a coil when it rotates around its axis 180° starting from the perpendicular position on the magnetic flux lines = ··········

   a. zero. b. $\frac{2NAB}{\Delta t}$ c. $\frac{NAB}{\Delta t}$

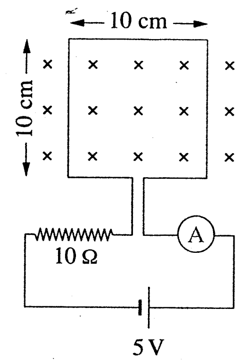
4. The average induced emf generated in a coil when it rotates around its axis 180° starting from the parallel position of the magnetic flux lines = ··········

   a. zero. b. $\frac{2NAB}{\Delta t}$ c. $\frac{NAB}{\Delta t}$

5. The direction of the induced current in the induction coil is determined by using ·········· rule.

   a. Fleming's right hand b. Lenz c. Fleming's left hand

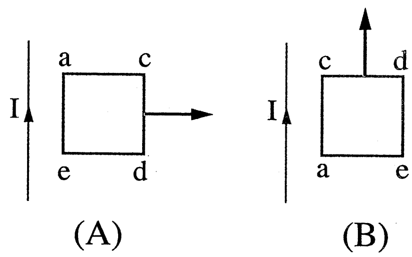
6. The circuit shown in the figure is placed in a magnetic field where its direction is into the page, if the value of the field is decreased by rate 150 T/s, so the reading of ammeter becomes ....



a. 0.15 A. b. 0.35 A.

c. 0.5 A. d. 0.65 A.

7. In the shown figure, two coils move in a magnetic field due to passing an electric current (I) through a long wire as shown in the two figures A, B, so the induced current in the two coils and its direction are ....



a. (A) anticlockwise, (B) clockwise.

b. (A) zero, (B) clockwise.

c. (A) clockwise, (B) clockwise.

d. (A) clockwise, (B) zero.

8. At the moment in which the coil of AC dynamo is parallel to the direction of the magnetic flux, the magnetic flux through the coil (ϕ_m) and the induced emf in the coil are .... *(Booklet 4 - Exp. 17)*

	ϕ_m	**emf**
a.	maximum	zero
b.	zero	maximum
c.	maximum	maximum
d.	zero	zero

9. When the angle between the plane of the coil and the direction of the magnetic flux is 60°, so the induced emf will be ....

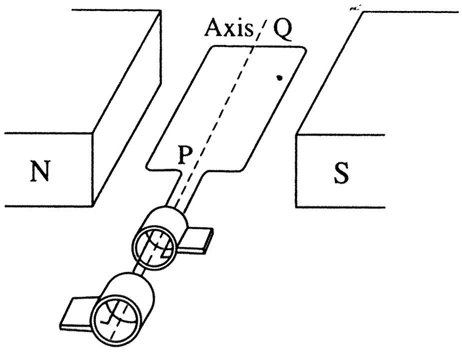
a. $\frac{\sqrt{3}}{2}$ from maximum. b. half the maximum value.

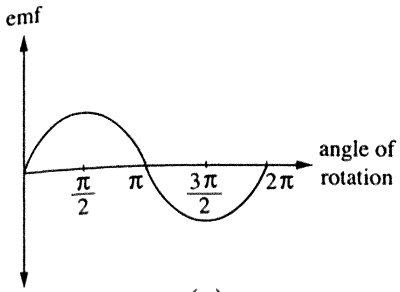
c. equal to the maximum. d. equal to the effective value.

10. When the effective emf of a dynamo's coil is 50 Volts, the average emf through $\frac{1}{4}$ cycle from thc parallel position to the field equals .... Volts.

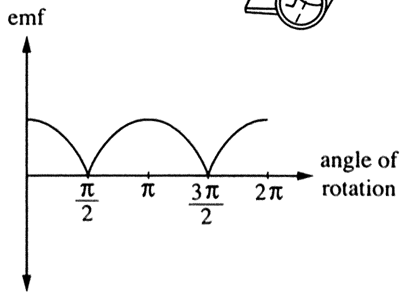
a. 141.42 b. 70.7 c. 45 d. 50

11. A rectangular coil rotates between two magnetic poles, if the coil rotates around the axis PQ from the position shown in the figure, which of the following figures represent the change of the induced emf in the coil to complete one cycle ? ....

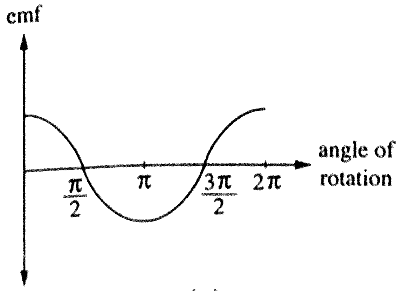




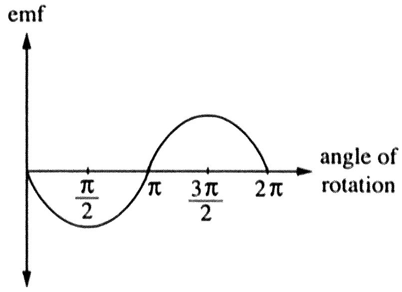
(a)



(b)



(c)



(d)

3 What are the factors affecting each of the following :

1. The intensity of eddy currents.
2. The direction of the current generated in the dynamo's coil. *(Booklet 4)*
3. The effective value of induced emf through dynamo's coil. *(Booklet 3)*
4. The efficiency of electric transformer.
5. The direction of the motion of the coil of electric motor.
6. The power of electric motor. *(Booklet 2)*

4 What happens in the following cases :

1. When the length of the coil is increased to the double only concerning the coefficient of self induction (L).
2. When the plane of dynamo's coil gets perpendicular to the magnetic flux lines concerning the rate of cutting the dynamo's coil to the magnetic flux lines.
3. When the two brushes of AC dynamo are displaced by 90° such that the line between them is perpendicular on the magnetic flux lines without any change in the structure of dynamo.
4. When the coil of motor becomes perpendicular on the direction of magnetic field during its rotation.

5 What are the results of each of the following :

1. Connecting the primary coil of step down transformer to lamp (x) and DC source and connecting lamp (y) between two ends of secondary coil. *(Exp. 17)*
2. There is high potential difference between two terminals of fluorescent lamp.
3. Generation of induced emf through motor's coil during its rotation between two poles of a magnet.
4. Replacing two isolated halves of a cylinder of motor's coil with two metallic rings.

6 Compare between each of the following :

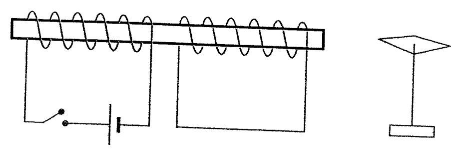
1. The average effective emf in a coil of AC dynamo through a quarter cycle and half a cycle if starting its motion from zero position (in terms of : the law).
2. Step up transformer and step down transformer (in terms of the value of current through each of two primary and secondary coils).
3. The role of the splitted cylinder into two isolated halves in each of dynamo and motor. *(Booklet 2)*
4. The reason of using more than one coil in each of the DC dynamo and the electric motor. *(Booklet 2)*

7 When are the following values equal zero ?

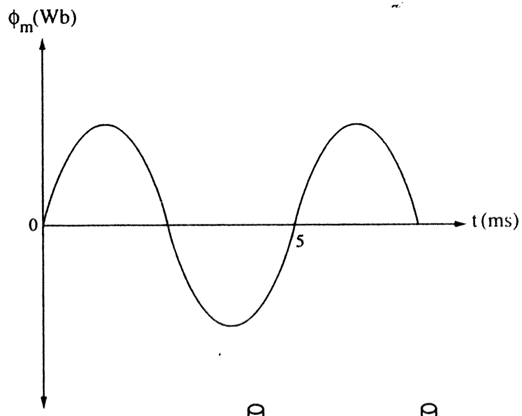
1. The induced emf in a solenoid connected to DC voltage source at the moment of closing its circuit.
2. The induced emf generated in a straight wire moving in a magnetic field.
3. The average emf generated in a dynamo's coil during the rotation.
4. The magnetic flux through the dynamo's coil.
5. The instantaneous emf in a dynamo's coil during the rotation.

8 Miscellaneous questions :

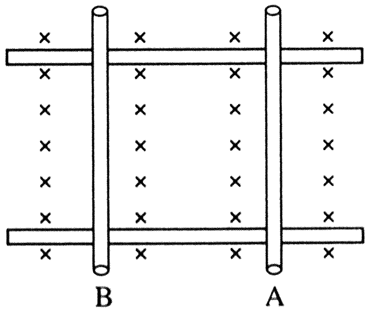
1. Show by drawing with full details one of the cases of Faraday's experiment in the electromagnetic induction :
   Representing : - The direction of the motion between the magnet and the coil.
   - The direction of the induced current in the coil.
   - The polarity of the terminals of the coil.
2. In the opposite figure, what is the type of the magnetic pole of the magnetic needle which approaches to coil (B) in the following cases :
   (a) At the moment of closing the circuit of coil (A).
   (b) At the moment of approaching coil (A) from coil (B).
   (c) At the moment of moving coil (A) away from coil (B).
   (d) At the moment of opening the circuit of coil (A).



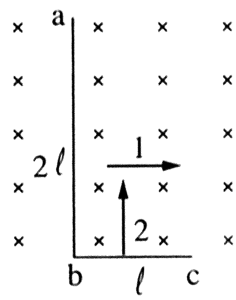
3. The following figure represents the relation between the magnetic flux which penetrates a coil moving with constant velocity in a uniform magnetic field and time, draw on the same figure the relation between the induced emf between the terminals of the coil and time with explanation. *(Booklet 2)*



4. In the opposite figure, two metallic rods (A), (B) slide on two parallel wires perpendicular on a uniform magnetic field, if the magnetic field starts to decrease gradually, describe the motion of rods, explain your answer.



5. In the opposite figure, abc wire is in form of a right angle, the length of its sides ℓ, 2 ℓ and is placed in a magnetic field of density (B) its direction is down to the page where the plane of the wire is perpendicular to the field, calculate the generated emf through the wire by in terms of B, ℓ, v if the wire moves with velocity v m/s in a direction :

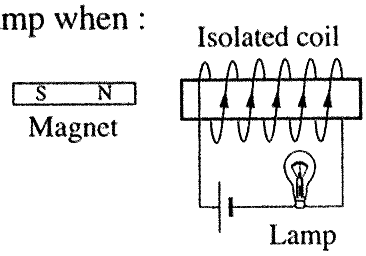


(a) Number (1) towards the right of the page normal to ab.

(b) Number (2) up in the plane of the page normal to bc.

(c) In a direction normal to the plane of the wire parallel to the field downwards the page.

6. In the opposite figure, what will happen to the illumination of lamp when :

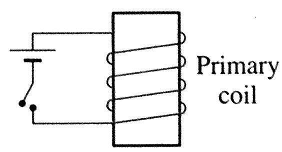


(a) Approaching the magnet in the direction of the coil.

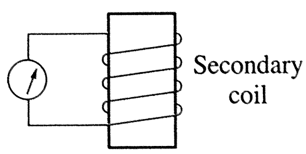
(b) Putting is a magnet inside the coil for a while.

(c) Removing the magnet away from the coil.

7. In the opposite figure, at the moment of closing the circuit of the primary coil. *(Booklet 3)*

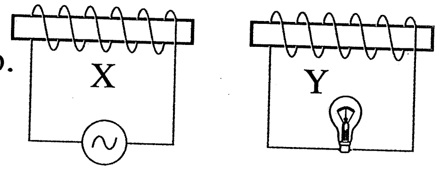


(a) Draw the directions of current and the magnetic flux (magnetic poles) through the primary coil and mention the used rule.



(b) Draw the directions of current and the magnetic flux (magnetic poles) through the secondary coil and mention the used rule.

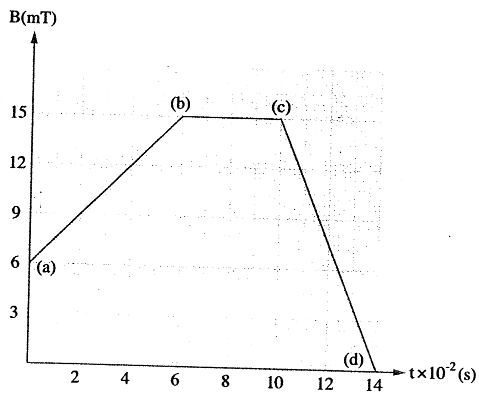
8. **Give reason for :** There is an induction coil in fluorescent lamp circuit.
9. Describe the position of the dynamo's coil with respect to the magnetic flux when the intensity of instantaneous current : *(Booklet 1)*
   (a) maximum. (b) half the maximum. (c) equals the effective value.
10. **Write down the used mathematical relation to calculate each of the following :**
    (a) The induced emf through a straight wire moves in a magnetic field.
    (b) The emf generated in a secondary coil due to the change of current intensity through the primary coil which is adjacent to the secondary coil. *(Booklet 2)*
    (c) The efficiency of electric transformer. *(Booklet 2)*
11. **What is meant by :** The effective emf of AC current = 15 Volts. *(Booklet 1)*
12. In the opposite figure, the coil (X) is connected to AC dynamo and the coil (Y) is connected to illuminated lamp. What will happen to illumination of the lamp when :



    (a) increasing the frequency of dynamo.
    (b) inserting a rod of wrought iron in each of the two coils. *(Exp. 17)*
13. In a step up transformer when the potential difference between the terminals of the secondary coil is greater then the potential difference between the terminals of the primary coil, does this contradict the law of conservation of energy ? Explain your answer.
14. **What is meant by :** A transformer loses 10% of its energy when it transfers from the primary coil to the secondary coil. *(Booklet 3)*
15. Mention the importance of a reverse emf in a motor.

9 Problems :

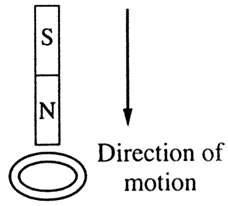
1. A coil of cross-section area 0.04 m^2 and number of turns 150 turns, its plane is perpendicular to a variable magnetic field according to the graphical representation shown in the figure, calculate the average induced emf through the coil in each stage of the changing stages.



(– 0.9 V , 0 , 2.25 V)

2. **In the opposite figure :**

A circular coil consists of 200 turn and is placed horizontally, the north pole of the magnet moves perpendicular on the coil, so the flux changes from 2.5×10^{-3} Wb to 8.5×10^{-3} Wb through 0.4 S :

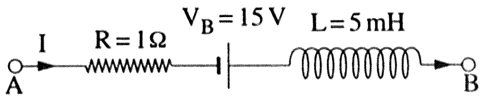


(a) Calculate the average effective generated emf.

(b) Show on the drawing the direction of the induced current through the coil and mention the used rule.

(c) What will happen to the generated emf if the magnet is dropped down through the coil with greater velocity ? And why ? *(3 V)*

3. **In the circuit shown in the figure :**



If the current intensity was 5 A and this intensity decreases by rate 10^3 A.S^{-1}.

Find the potential difference between two points A, B. *(15 V)*

4. A rectangular coil of surface area 70 cm^2 and number of turns 100 turns rotates around its axis through a magnetic field of density 1T and makes 300 turn each $\frac{1}{2}$ minute.

Find : *(Booklet 3)*

(a) The maximum emf generated through the coil.

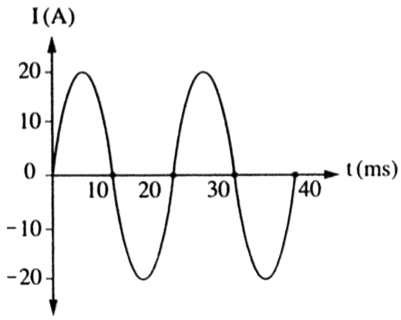
(b) The effective emf generated through the coil.

(c) The period starting from the perpendicular position of the coil till the emf reaches + 22 Volts.

(d) The period starting from the perpendicular position till the emf reaches – 22 Volts.

$\left(44\ V,\ 31.11\ V,\ \frac{1}{120}\ S,\ \frac{7}{120}\ S\right)$

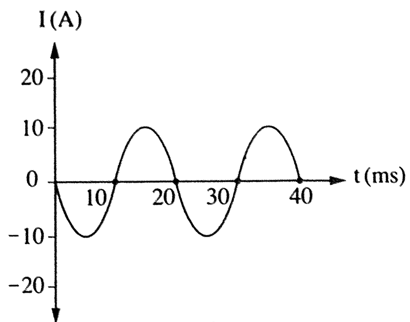
5. The opposite figure represents the change of generated electric current from AC dynamo with time :



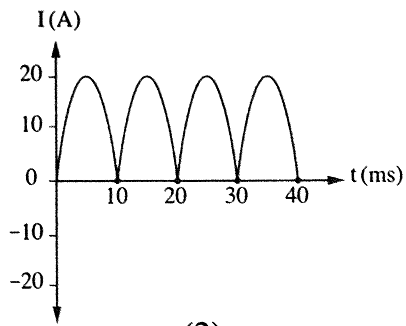
(a) Find the angular velocity of the dynamo's coil.

(b) Find the effective value of this current.

(c) Explain how can you from this current to obtain the two currents represented by the two figures (1), (2).



(1)



(2)

(314.29 rad/s, 14.14 A)

6. The power generated from an electric station is 100 kWatt with potential difference 200 Volts at the station and there is an electric transformer at the station, the ratio between number of turns of its coil 1 : 5, find the efficiency of transferring if wires of resistance equals 4 Ω are used to transfer this power.

(60%)

7. The ratio between the number of turns of two coils in an ideal step up transformer 1 : 100 if its primary coil is connected to AC source of 200 Volts.
   (a) Calculate the effective emf through the secondary coil.
   (b) Calculate the ratio between the value of the current through the primary coil to the secondary coil.
   (c) Calculate the power resulted in the secondary coil if the current intensity passes through it is 2 Ampere.
   (d) What will happen if the AC source is replaced by DC source of the same value of emf.

$\left(2 \times 10^4\ V, \frac{100}{1}, 4 \times 10^4\ W\right)$

8. An electric transformer is connected to AC source of 220 V where a current of effective value 10 A passes through its primary coil, if the resulted power through the secondary coil is 1980 W and the induced potential difference between its terminals is 22 V, **find :**
   (a) The efficiency of the transformer. *(Booklet 4 - Exp. 17)*
   (b) The resistance of the circuit of the secondary coil. *(90%, 0.24 Ω)*

9. Figure (1) represents a coil rotates between two magnetic poles in an electric generator and the two ends T_1 , T_2 are connected to external electric circuit while figure (2) represents the change of the induced emf of the same generator with time :
   (a) Which of the points shown in figure (2) (A or B or C) represents the induced emf through the coil when it passes through the normal position of the field ? Explain your answer.
   (b) Find the time taken by the coil to change the induced emf from 45 V to 22.5 V for the first time.
   (c) If the velocity of rotation of the coil increases, what is the effect of that on each of :
   1- The maximum value of induced emf.
   2- The periodic time. *(0.5 ms)*

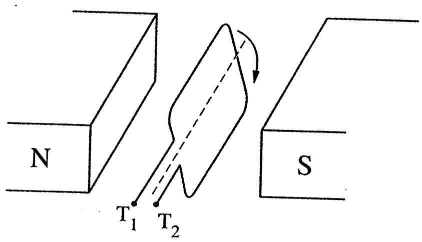


Figure (1)

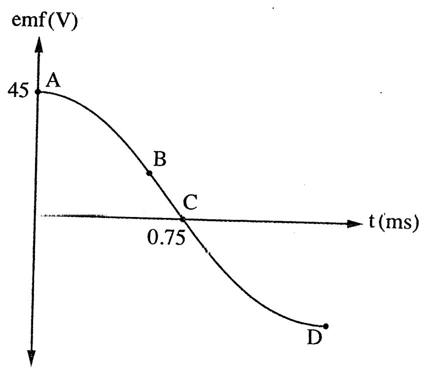


Figure (2)

Chapter 4

Alternating Current Circuits

⊙ **Questions on :**

Lesson 1 Alternating Current Circuits.

Lesson 2 Following AC Circuits.

Lesson 3
- The Oscillating Circuit.
- The Resonant Circuit.

⊙ **Selected Questions on Chapter 4 from :**
- Student Evaluation Guide (2017).
- Booklet Models of the Ministry of Education.

QUESTIONS ON **Chapter 4** LESSON 1

Alternating Current Circuits

1 Write down the scientific term for each statement of the following :

1. The number of vibrations (complete cycles) made by the AC current in one second.
2. The time taken by the alternating current to make one complete oscillation.
3. • A device used to measure AC or DC current intensity based on the thermal expansion of a wire made of platinum and iridium alloy that is heated due to the flow of the electric current through it.
   • A device used to measure the effective value of AC current.
4. The opposition to the flow of the AC current through the coil due to its self-inductance.
5. Two parallel metallic plates separated by an insulator and stores the electric energy in the form of an electric field.
6. The ratio between the electric charge accumulated on one of the two plates of the capacitor to the potential difference between them.
7. The opposition to the flow of AC current in a capacitor due to its capacitance.

2 Choose the correct answer of the given answers :

1. Frequency of the current used in Egypt is ....

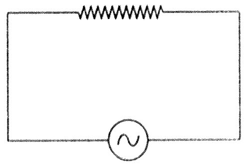
   a. 60 Hz. b. 100 Hz. c. 50 Hz. d. 70 Hz.

2. From the processes which AC current can't be used is ....

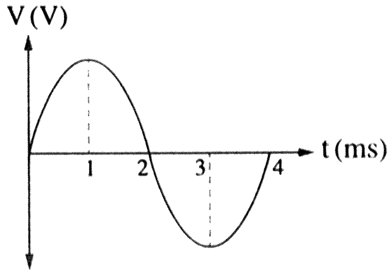
   a. lighting lamps. b. electrolysis.
   c. operating the air-condition. d. all the previous.

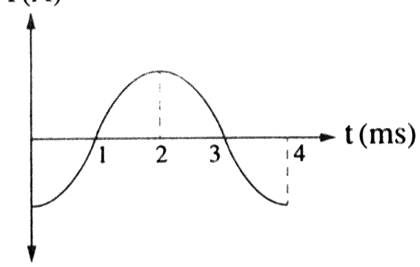
3. The scale of the hot wire ammeter is non-uniform because the heat quantity generated in the wire is directly proportional to ....
a. the wire resistance.
b. the potential difference between the wire terminals.
c. the current intensity passing in the wire.
d. square of the electric current intensity passing in the wire.

4. In the opposite circuit, the potential difference is ....
a. in phase with the current intensity.
b. leads the current intensity by phase angle 90°
c. lags the current intensity by $\frac{3}{4}$ cycle.
d. numerically equals the current intensity.

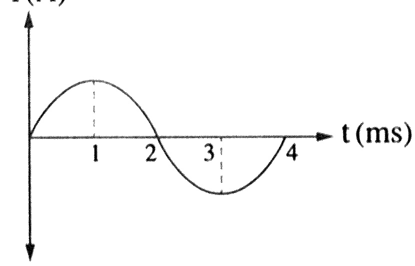


5. If the potential difference (V) between the terminals of an induction coil connected to AC source is represented by the opposite graph, then the graph representing the current intensity (I) passing in it is ....

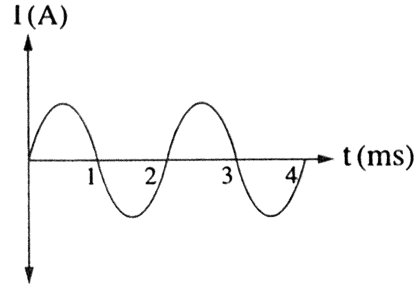




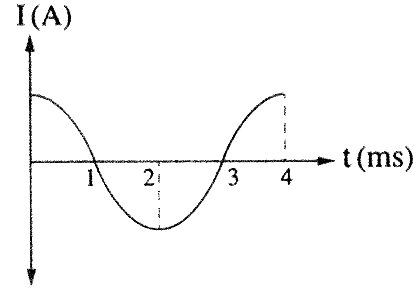
(a)



(b)



(c)



(d)

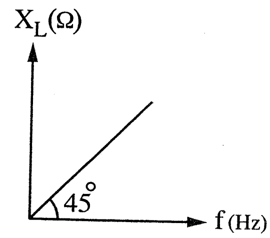
6. AC current of frequency 50 Hz passes in an induction coil of zero resistance and self inductance 0.2 H, then its inductive reactance is ....
a. 31.4 Ω. b. 6.28 Ω. c. 0.628 Ω. d. 62.86 Ω.

7. Induction coil, its inductive reactance is 1000 Ω. If the value of each of its self inductance and frequency of the current passing through it is doubled, then its inductive reactance becomes ....
a. 2000 Ω. b. 500 Ω. c. 250 Ω. d. 4000 Ω.

8. AC current of intensity 100 mA is passing in an induction coil of zero ohmic resistance and self inductance 0.1 H. If the current frequency is 50 Hz, then the potential difference at the terminals of the coil is equal to ....

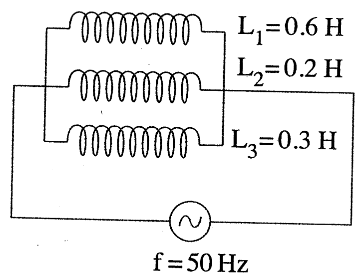
a. 3.14 V. b. 31.4 V. c. 314 V. d. 3140 V.

9. If the opposite graph represents the relation between the value of the inductive reactance of a coil of zero resistance and the frequency of the current passing through it, then the self induction coefficient of this coil is ....



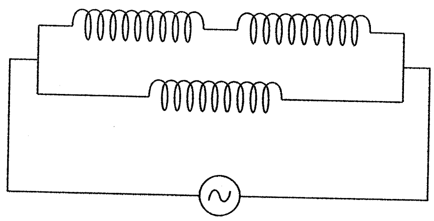
a. 3.14 H. b. 6.28 H.
c. 0.159 H. d. 1.59 H.

10. In the electric circuit shown in the figure there are three coils of zero resistance away from each other and connected in parallel, then the total network inductive reactance is ....



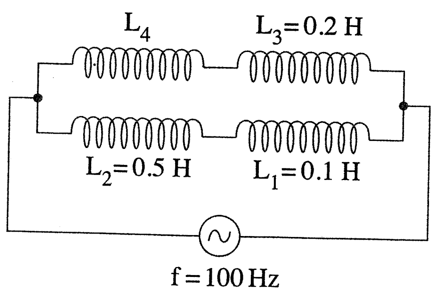
a. 0.1 Ω. b. 6.28 Ω.
c. 31.4 Ω. d. 100 Ω.

11. In the electric circuit shown in the figure, if the coils are similar and the self induction coefficient for each is 0.3 H and the total self-inductive reactance is 12.56 Ω, then by ignoring the ohmic resistance and the mutual induction between the coils the current frequency is .... ($\pi = 3.14$)



a. 50 Hz. b. 60 Hz.
c. 20 Hz. d. 10 Hz.

12. In the electric circuit shown in the figure, if the self-inductive reactance of the network is 251.2 Ω, then the value of L_4 is .... ($\pi = 3.14$)

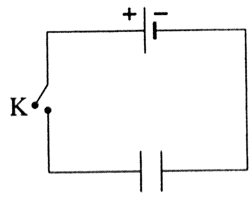


a. 0.5 H. b. 2 H.
c. 1 H. d. 0.8 H.

13. An inductive coil is connected with an AC dynamo. If the frequency of rotation of the dynamo's coil increased to its double the peak value of the current, with neglecting the ohmic resistance for the coil and the dynamo, would .... *(Sudan 17)*

a. increase to its double.
b. decrease to its half.
c. not change.
d. no correct answer.

14. In the circuit shown in the figure : At closing the switch K, the value of the electric current intensity passing in the circuit ....



a. increases as time passes.
b. decreases then increases.
c. vanishes at the completion of charging the capacitor.
d. increases and decreases sinusoidally.

15. If the potential difference between the plates of a capacitor is 1 V and its capacitance is 3 μF, then the accumulated charge on one of its plates is ....

a. 3 mC
b. 0.03 mC
c. 0.003 mC
d. 0.333 mC

16. When connecting a capacitor to AC source then ....

a. the current and voltage will have the same phase.
b. the current leads the voltage by 90°
c. the current lags the voltage by 90°
d. the current vanishes after a short time.

17. If a capacitor of capacitance $\frac{7}{22}$ μF is connected to AC source of frequency 50 Hz, then the capacitive reactance of the capacitor is ....

a. 500 Ω.
b. 2 Ω.
c. 100 Ω.
d. 10^4 Ω.

18. A capacitor of constant capacitance is directly connected to AC source of frequency (f). If the current frequency is increased three times, then its capacitive reactance ....

a. increases 3 times.
b. increases nine times.
c. decreases to its third.
d. remains unchanged.

19. When a capacitor of capacitance C is connected to an AC source of frequency f, its capacitive reactance becomes 50 Ω. If its capacitance is increased to the double, then its capacitive reactance becomes ....

a. 25 Ω.
b. 100 Ω.
c. 200 Ω.
d. remains unchanged.

20. Dynamo's coil of zero resistance is connected directly to a capacitor, if the rotation frequency of the coil increased to the double then:

i. The capacitive reactance of the capacitor ....

a. increases to the double.
b. decreases to the half.
c. increases four times.
d. remains unchanged.

ii. The maximum current intensity passing in the circuit ....

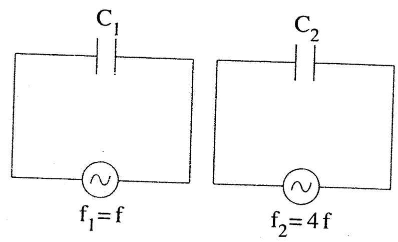
a. increases to the double.

b. decreases to the half.

c. increases four times.

d. remains unchanged.

21. The opposite figure shows two circuits, each contains AC source and a capacitor, if : $\frac{(X_C)_1}{(X_C)_2} = \frac{2}{3}$, then ....



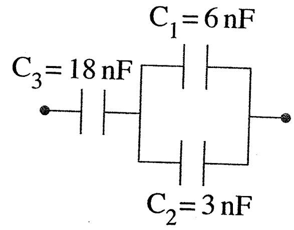
a. $\frac{C_1}{C_2} = \frac{3}{4}$

b. $\frac{C_1}{C_2} = \frac{6}{1}$

c. $\frac{C_1}{C_2} = \frac{8}{3}$

d. $\frac{C_1}{C_2} = \frac{1}{12}$

22. In the opposite figure the network total capacitance of capacitors is ....



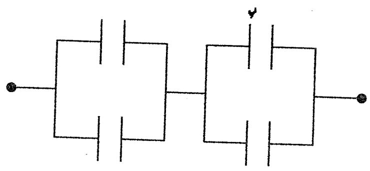
a. 20 nF

b. 21 nF

c. 16 nF

d. 6 nF

23. In the opposite figure if the capacitance of each capacitor is 1 pF , then the total capacitance is ....



a. 4 pF

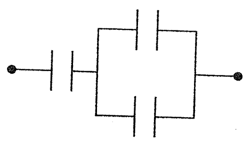
b. 2 pF

c. $\frac{1}{2}$ pF

d. 1 pF

24. In the opposite figure :

If the capacitance of each capacitor is (C), then the total capacitance is ....



a. 1.5 C

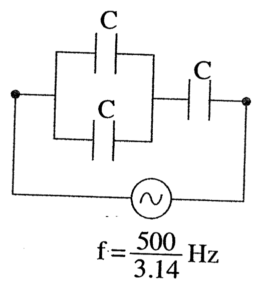
b. 3 C

c. $\frac{2}{3}$ C

d. C

25. In the opposite figure :

If all capacitors have the same capacitance and the total capacitive reactance 50 Ω, then the capacitance of each capacitor (C) equals .... ($\pi = 3.14$)



a. 2 μF

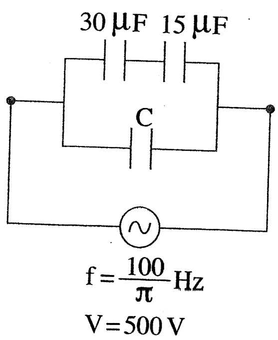
b. 6 μF

c. 12 μF

d. 30 μF

26. In the opposite figure :

If the effective value of the current passing in the circuit is 2 A, then the capacitor capacitance (C) is equal to ....



a. 15 μF

b. 10 μF

c. 20 μF

d. 50 μF

3 What is meant by :

1. The current frequency = 50 Hz
2. The inductive reactance of an induction coil = 50 Ω *(Exp. 16)*
3. The capacitance of a capacitor = 5 μF
4. The capacitive reactance of a capacitor = 600 Ω

4 Give reasons for :

1. The hot wire ammeter can be used in measuring the AC and the DC current intensity. *(Exp. 16)*
2. The thermal effect of the AC current is used as scientific base for the hot wire ammeter.
3. The hot wire ammeter is connected in series in the electric circuit.
4. The stretched wire between two screws in the hot wire ammeter is made of platinum and iridium alloy.
5. A resistor (R) is connected in parallel with the platinum and iridium wire in the hot wire ammeter.
6. There is a zero error in the measurement of the hot wire ammeter.
7. The wire in the hot wire ammeter is stretched on a plate made of a metal having the same expansion coefficient of the wire but isolated from it.
8. The hot wire ammeter scale is non-uniform. *(1^{st} session 00, 17)*
9. • The potential difference and the current intensity in a non-inductive resistance have the same phase.
   • In the non-inductive resistance, the current and potential grow together up to maximum value and drop together to zero.
10. The flow of AC current in an induction coil of zero resistance does not cause loss in electric power.
11. • At very high frequencies, the flow of the electric current in the induction coil almost vanishes.
    • The inductive reactance of induction coil reaches very high values at very high frequencies.
12. The inductive reactance of a coil carrying AC current of constant frequency increases by increasing the number of its turns.
13. The inductive reactance of a coil increases when we plunge a soft iron rod inside it and pass the same AC current in it.
14. When connecting a network of induction coils in parallel together, their equivalent inductive reactance is less than that of each of them.
15. When connecting a capacitor to a DC source, the electric current passes for a very short time then vanishes.

16. The capacitive reactance of a capacitor does not cause energy loss.
17. • When AC current of high frequency passes in a capacitor the circuit becomes almost closed.
 • The capacitive reactance of a capacitor decreases when the frequency of the current passing through it increases.
18. When connecting a network of capacitors in parallel together, their equivalent capacitive reactance is less than that of each of them.
19. The inductive reactance for DC current in a coil is zero while the capacitive reactance for DC current equals infinity.

5 Define :

1. AC current.
2. Frequency of AC current.
3. The periodic time of the AC current.
4. The inductive reactance of a coil.
5. The capacitor.
6. Capacity of a capacitor.
7. The capacitive reactance of a capacitor.

6 What are the factors that affect each of the following :

1. Deflection angle of the hot wire ammeter.
2. The inductive reactance of an induction coil. *(Exp. 16)*
3. The capacitive reactance of a capacitor. *(1st session 17)*

7 What happens in the following cases :

1. • Flow of DC current in the hot wire ammeter.
 • Flow of AC current in the hot wire ammeter.
2. Cutting current from a circuit containing hot wire ammeter.
3. Cutting of the silk thread in the hot wire ammeter.
4. Flow of AC current in an ohmic resistance concerning its temperature.
5. Flow of AC current of high frequency in a capacitor concerning the value of X_C
6. Flow of AC current of very high frequency in an induction coil concerning the value of X_L
7. Inserting a core of wrought iron inside a solenoid concerning the inductive reactance of the coil. *(Exp. 16)*
8. Connecting a capacitor to DC source.
9. Flow of AC current in a capacitor concerning the phase angle between the voltage and the current.
10. Increasing the frequency of AC passing in a capacitor circuit concerning the value of X_C
11. Increasing the capacitance of a capacitor that AC current is passing in its circuit concerning the value of X_C

8 Mention one use (or function) for each of the following :

1. AC current.
2. DC current.
3. Hot wire ammeter. *(1st session 17 - 2nd session 99)*
4. Platinum and iridium wire in the hot wire ammeter.
5. The silk thread in the hot wire ammeter.
6. The pulley in the hot wire ammeter.
7. The spring in the hot wire ammeter.
8. The resistance (R) connected in parallel to the platinum and iridium wire in the hot wire ammeter.

9 Compare between :

The hot wire ammeter and the moving coil ammeter (in terms of : idea of working - its use - its scale - the effect of the atmospheric temperature - movement of its pointer).

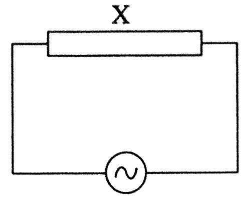
(Exp. 16 - Sudan 16 - 2nd session 16)

10 When does ... ?

1. the potential difference lead the current by 90° in the AC circuit
2. the potential difference lag the current by 90° in the AC circuit
3. • the inductive reactance of a coil equal zero
   • the capacitive reactance of a capacitor equal to infinity

11 Miscellaneous questions :

1. What are the advantages of the AC current ?
2. Show with drawing and labels the structure of the hot wire ammeter, then explain how it works.
3. Mention the scientific principle (base) for the hot wire ammeter.
4. What are the disadvantages of the hot wire ammeter and how can they be avoided ?
5. How can the hot wire ammeter be calibrated ?
6. How can we calculate the total capacitance for many capacitors connected together :
   (a) In series. (b) In parallel.
7. In the electric circuit shown in the figure, what is the phase difference between the current intensity and the total potential difference for AC current if element X is :
   (a) Ohmic resistance.
   (b) Induction coil of zero resistance. (c) Capacitor.



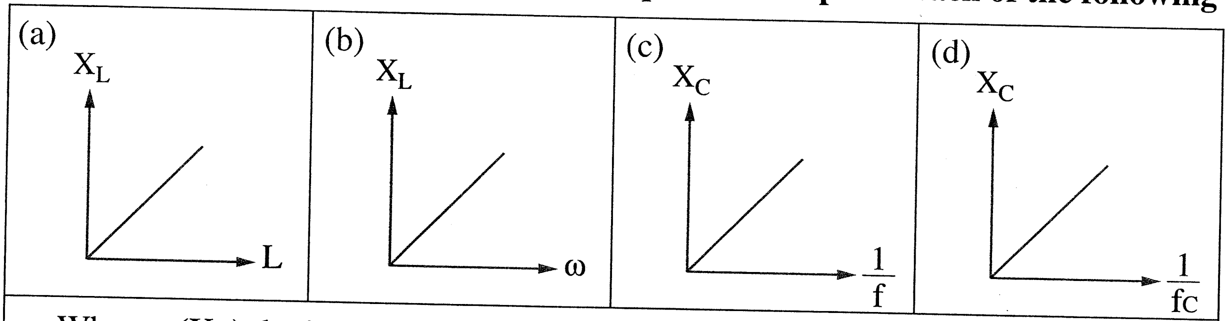
8. An electric AC generator, its coil speed of rotation can be altered and consequently the AC frequency that it generates can be altered as well. Show how the maximum value of the potential difference (V_{max} = NBAω) between its terminals can be changed

when the frequency increases. If a non-inductive ohmic resistance (R) is connected in the generator circuit then replaced with an induction coil its inductance (L) , then the coil is replaced with a capacitor (C) , find the maximum value of the current intensity in each case showing its relation with the current frequency. *(Egy. 92)*

9. **Write down the physical quantities determined by the following mathematical relations :**

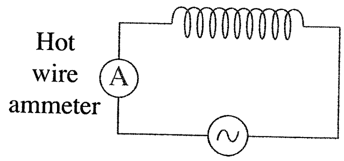
(a) $V_{max} \sin \omega t$ (b) $2\pi f$ (c) ωL (d) $\frac{1}{X_C C}$

10. **Write the mathematical relations and the equivalent slope for each of the following :**



Where : (X_L) the inductive reactance of a coil, (L) the self-induction coefficient of a coil, (ω) the angular velocity, (X_C) the capacitive reactance of a capacitor, (f) frequency, (C) the capacity of capacitor.

11. Induction coil of zero resistance connected to hot wire ammeter and AC source in series, what happens to the hot wire ammeter reading giving reason when :



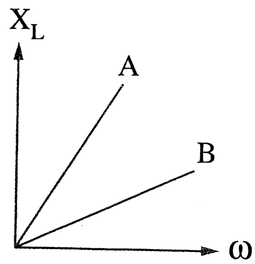
(a) putting a metallic core inside the coil.
(b) replacing the source with another having the same effective value for voltage but with less frequency.
(c) connecting the coil with another similar to it in parallel.
(d) connecting the coil with another similar to it in series.

12. **Explain why :**
(a) The potential difference leads the current in phase by $\frac{1}{4}$ revolution when AC current passes through an induction coil of zero ohmic resistance.
(b) The potential difference lags the current in phase by $\frac{1}{4}$ revolution when AC current passes through a capacitor.

13. **Prove that :** The unit of $\sqrt{\frac{L}{C}}$ is the resistance unit.

14. Show how to increase the range of measurement of the hot wire ammeter ? *(Sudan 17)*

15. Two solenoids (A, B) are connected in series with an AC dynamo which have a changeable angular velocity (ω), from the opposite graph determine which of the two coils have larger inductance ? *(2nd session 17)*



12 Problems :

Guiding notes for solving problems 1

- **To determine the inductive reactance of a coil :**

$X_L = 2\pi f L = \omega L \ (\Omega)$

Where : $L = \dfrac{\mu A N^2}{\ell}$ (H)

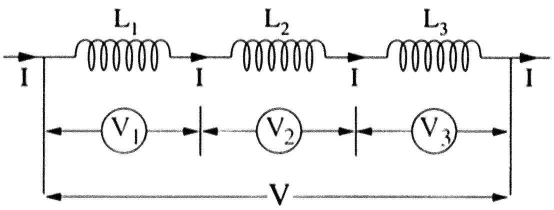
- **To compare between two inductive reactances of two coils :**

$$\frac{(X_L)_1}{(X_L)_2} = \frac{f_1 L_1}{f_2 L_2}$$

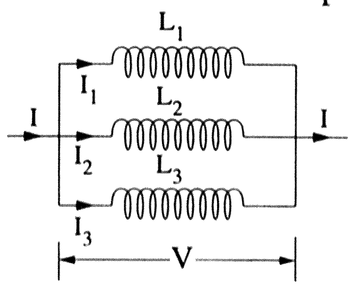
- **To determine the total equivalent inductive reactance for many coils :**

When connecting many inductive coils together (away from each other) then;

If inductors are connected in series :



If inductors are connected in parallel :



Then

Series:

$$L = L_1 + L_2 + L_3 + \cdots$$

$$X_L = (X_L)_1 + (X_L)_2 + (X_L)_3 + \cdots$$

Parallel:

$$\frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \cdots$$

$$\frac{1}{X_L} = \frac{1}{(X_L)_1} + \frac{1}{(X_L)_2} + \frac{1}{(X_L)_3} + \cdots$$

In case of two coils are connected in parallel :

$$L = \frac{L_1 L_2}{L_1 + L_2}$$

$$X_L = \frac{(X_L)_1 (X_L)_2}{(X_L)_1 + (X_L)_2}$$

If the self induction coefficients for all coils are equal and number of coils (n) :

Series:

$$L = n L_1$$

$$X_L = n (X_L)_1$$

Parallel:

$$L = \frac{L_1}{n}$$

$$X_L = \frac{(X_L)_1}{n}$$

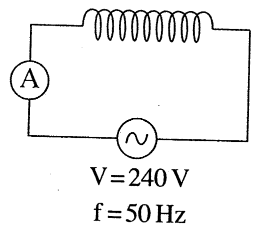
- **To determine the electric AC current intensity in a circuit containing an induction coil of zero resistance :** $I = \dfrac{V_L}{X_L}$

1. An induction coil of zero resistance and self inductance 0.7 H is connected to AC current source of emf 120 V and frequency 50 Hz, **calculate :**
   (a) The inductive reactance of the coil.
   (b) The electric current intensity passing in the circuit. *(220 Ω , 0.55 A)*

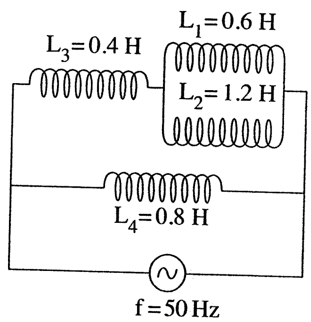
2. When an electric current of frequency (f) passes through an induction coil of zero ohmic resistance its inductive reactance becomes 12 Ω and if the frequency increased by 20 Hz its inductive reactance becomes 18 Ω, calculate the current frequency in both cases, then calculate the self induction coefficient for the coil. *(40 Hz , 60 Hz , 0.048 H)*

3. The self induction coefficient of a coil of zero resistance is 2 H. The coil is connected to AC source of maximum voltage $100\sqrt{2}$ V and frequency 40 Hz, calculate its inductive reactance and the current effective value in the circuit. *(502.9 Ω , 0.2 A)*

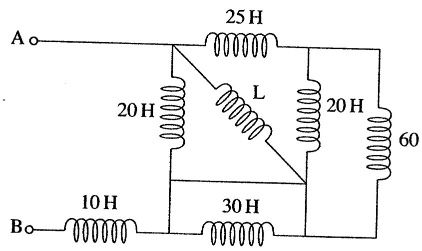
4. **In the circuit shown in the figure :**
   If the reading of the hot wire ammeter is 4 A, calculate the self induction coefficient (Knowing that the ohmic resistance is neglected). *(0.191 H)*



5. **In the circuit shown in the figure :**
   Calculate the total inductive reactance , ignoring the mutual induction between the coils. *(125.7 Ω)*

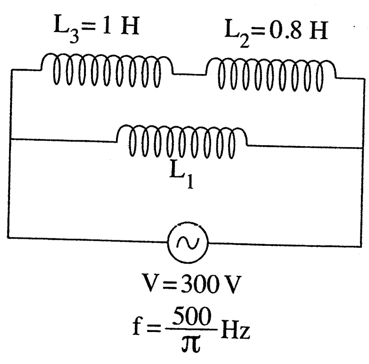


6. If the equivalent inductance in the opposite circuit is 18 H Calculate the value of L (neglect the mutual induction between the coils). *(20 H)*



7. Three induction coils, each of zero resistance, the self induction coefficient of them is $L_1 = L$, $L_2 = 2L$, $L_3 = 3L$ When they are connected to an AC source of frequency $\frac{500}{11}$ Hz, the value of their total inductive reactance was $200\,\pi L$ Ω, explain by drawing how were they connected together ?
   ((2,3) in parallel, the group in series with (1))

8. **In the circuit shown in the figure :**
   If the electric current intensity passing in the circuit is 0.5 A find L_1 *(0.9 H)*



9. A solenoid coil of 100 turns, the area of each is 10 cm^2 and its length 25 cm, is connected to AC source of frequency $\frac{200}{\pi}$ Hz , calculate the inductive reactance of the coil when :

(a) The core of the coil is air of permeability $4\,\pi \times 10^{-7}$ T.m/A.

(b) The core of the coil is iron of permeability 3×10^{-3} T.m/A. *(0.02 Ω , 48 Ω)*

10. A coil its number of turns (N) , its length (ℓ) , its face area is (A) and another coil its number of turns (2 N) , its length (2 ℓ) , its face area is (2 A). Calculate the ratio between their self inductance ignoring the mutual induction between them. *($\frac{1}{4}$)*

11. A network of similar induction coils are connected together in a circuit carrying AC current of frequency 50 Hz. When they are connected in series their inductive reactance was 50 Ω and when they are connected in parallel it was 2 Ω, **calculate :**

(a) The number of coils.

(b) The inductive reactance for each coil.

(c) The self induction coefficient for each of them.

(Ignoring the ohmic resistances and the mutual induction between them)

(5 coils, 10 Ω , 31.8×10^{-3} H)

12. Calculate the inductive reactance of a coil consists of one layer its number of turns 300 turns wound around a cylinderical iron rod of permeability 0.002 Wb/A.m and its radius 2.1 cm, its length 15 cm connected to an electric source of 50 Hz. *(521.7 Ω) (Egy. 79)*

Guiding notes for solving problems 2

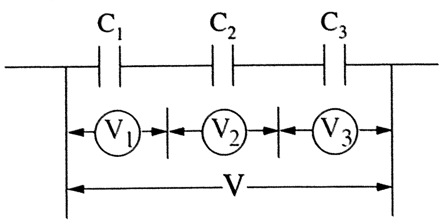
- **To determine the capacitance of a capacitor :** $C = \frac{Q}{V}$ (F)

- **To determine capacitive reactance of a capacitor :** $X_C = \frac{1}{2\,\pi\,f\,C} = \frac{1}{\omega\,C}$ (Ω)

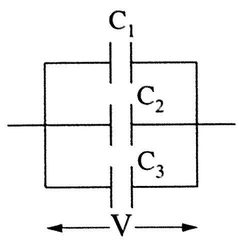
- **To compare between two capacitive reactances of two coils :** $\frac{(X_C)_1}{(X_C)_2} = \frac{f_2 C_2}{f_1 C_1}$

- **To determine the equivalent capacitive reactance for many capacitors :**

If the capacitors are connected in series :



If the capacitors are connected in parallel :



Series	Parallel
$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots$	$C = C_1 + C_2 + C_3 + \cdots$
$X_C = (X_C)_1 + (X_C)_2 + (X_C)_3 + \cdots$	$\frac{1}{X_C} = \frac{1}{(X_C)_1} + \frac{1}{(X_C)_2} + \frac{1}{(X_C)_3} + \cdots$
In case of two capacitors are connected in series :	**In case of two capacitors are connected in parallel :**
$C = \frac{C_1 C_2}{C_1 + C_2}$	$C = C_1 + C_2$
$X_C = (X_C)_1 + (X_C)_2$	$X_C = \frac{(X_C)_1 (X_C)_2}{(X_C)_1 + (X_C)_2}$

If the capacitance for all capacitors are equal and their number is (n) :

Series	Parallel
$C = \frac{C_1}{n}$	$C = nC_1$
$X_C = n\,(X_C)_1$	$X_C = \frac{(X_C)_1}{n}$

- **To determine the AC current intensity in a circuit containing a capacitor :** $I = \frac{V_C}{X_C}$

13. Two capacitors , their capacitances are 24 μF , 48 μF. Find their total capacitance if they are:

(a) Connected in series. (b) Connected in parallel. *(16 μF , 72 μF)*

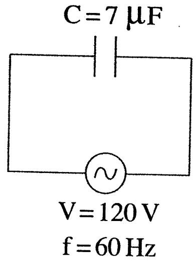
14. A capacitor its capacitance 200 μF connected to AC source of frequency 60 Hz and its emf is 20 V, **calculate :**

(a) The capacitive reactance of a capacitor.

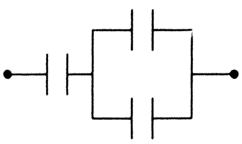
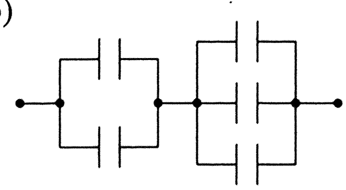
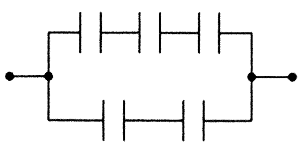
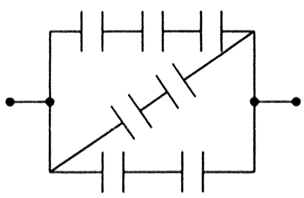
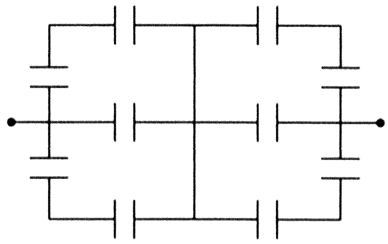
(b) The current intensity. *(13.26 Ω , 1.5 A)*

15. **In the circuit shown in the figure :** calculate the electric current intensity.

(0.317 A)

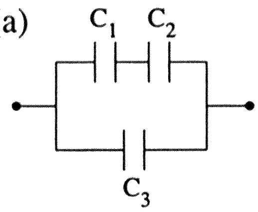
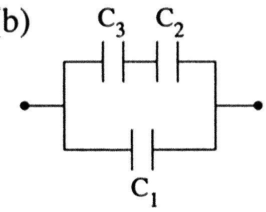
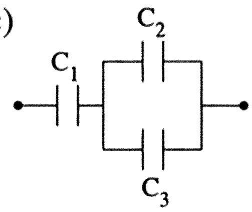
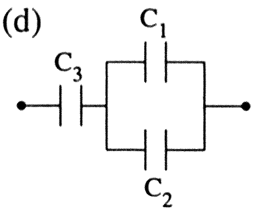


16. **In the following electric circuits calculate the total capacitance of the capacitors network :**

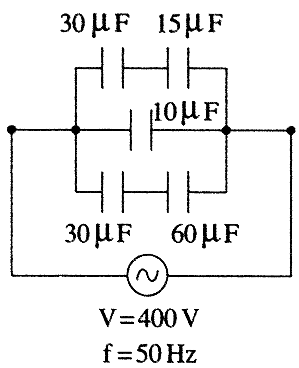
(a)  Capacity of each capacitor $= 5\ \mu F$ *(3.3 μ F)*	(b)  Capacity of each capacitor $= 12\ nF$ *(14.4 n F)*	(c)  Capacity of each capacitor $= 24\ pF$ *(20 pF)*
(d)  Capacity of each capacitor $= 10\ \mu F$ *(13.3 μ F)*	(e)  Capacity of each capacitor $= 3\ \mu F$ *(3 μ F)*	

17. Three capacitors, the capacity of each is $14\ \mu F$ connected together in parallel to an AC source of frequency 50 Hz. Calculate the total capacitive reactance. *(75.76 Ω)*

18. Three capacitors C_1, C_2, C_3 are connected in series together, so the equivalent capacitance was $1\ \mu F$. If $C_1 = \frac{1}{3} C_3$, $C_1 = \frac{2}{3} C_2$, find their equivalent capacitance when connecting them as in the following figures :

(a)  ($7.2\ \mu F$)	(b)  ($4\ \mu F$)	(c)  ($\frac{18}{11}\ \mu F$)	(d)  ($\frac{30}{11}\ \mu F$)

19. **In the circuit shown in figure :** Calculate the total current intensity passing in the electric source. *(5.03 A)*

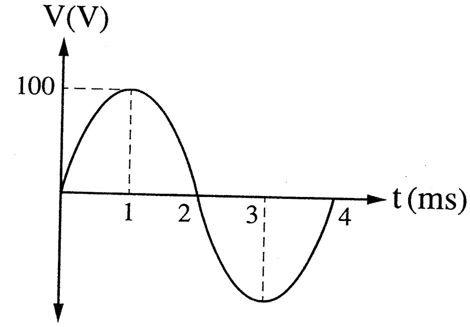


20. A capacitor of capacitance $\frac{7000}{11}$ μF is connected to AC source of 20 V and frequency 50 Hz, **calculate :**

(a) The capacitive reactance of the capacitor.

(b) The electric current intensity passing in the circuit. *(5 Ω , 4 A)*

21. **In the opposite graph :** The emf of the dynamo coil changes as time passes, if that dynamo is connected to a capacitor of capacitance 2 μF. Calculate the effective value of the total current passing in the source. *(0.22 A)*



22. Three capacitors, their capacitances are 10 , 20 , 30 μF. They are connected in series with an electric source of emf 200 V and frequency 42 Hz, **calculate :**

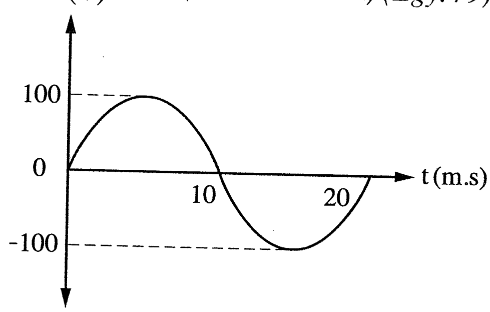
(a) The total capacitive reactance.

(b) The electric current intensity passing in the circuit. *(695.02 A , 0.29 Ω) (Azhar 78)*

23. A group of 2 capacitors of $\frac{7}{22}$ μF each are connected in parallel then the group is connected in series to capacitor of $\frac{7}{22}$ μF and electric source of emf 10 V and frequency 50 Hz, calculate the total current intensity in the circuit.

(6.67×10^{-4} A) (Egy. 79)

24. The opposite graph represents the change in the electromotive force generated in AC dynamo coil revolves with angular velocity (ω) and connected to inductive coil of non-ohmic resistance.

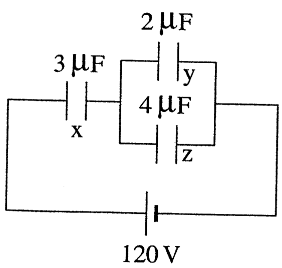


(a) Find the AC frequency in the circuit.

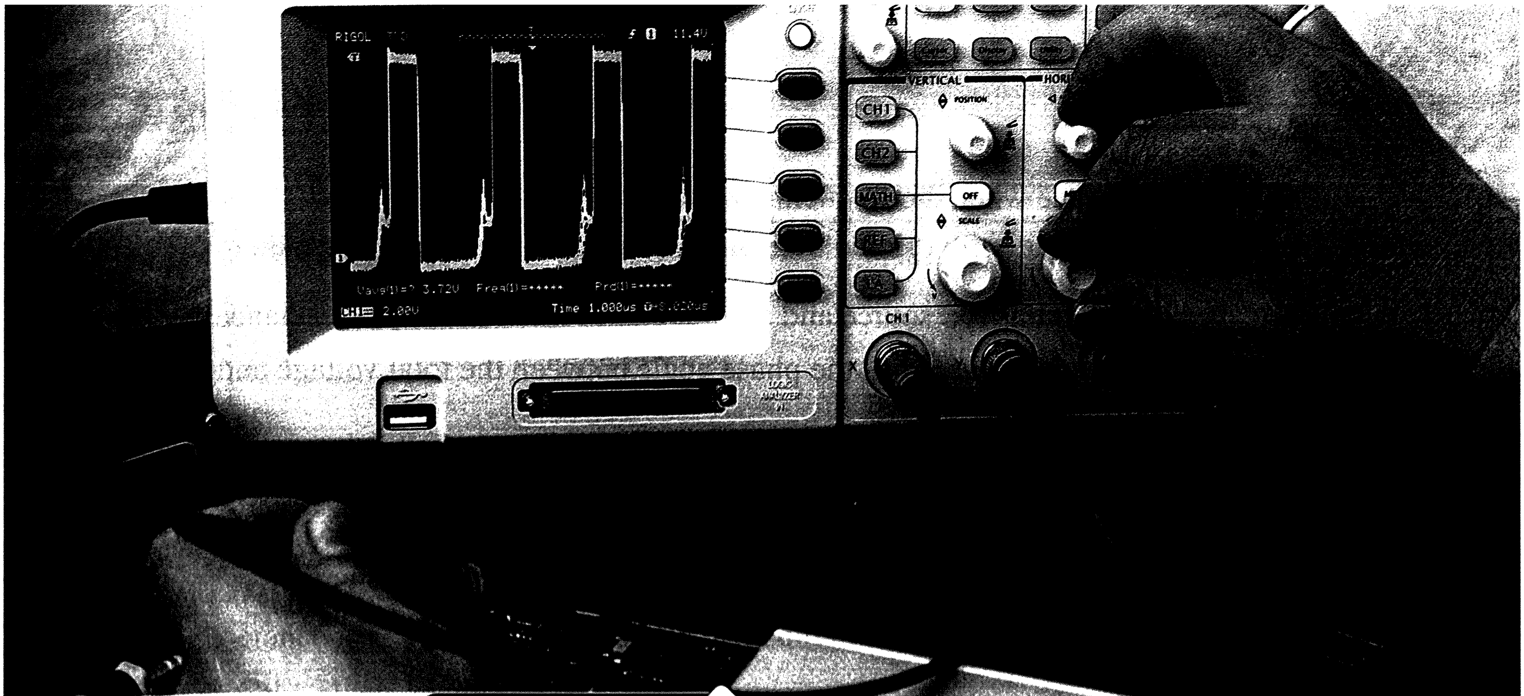
(b) Draw the graph that represents the change in the electromotive force generated in the AC dynamo coil through 20 milli second when it revolves with angular velocity (2 ω).

(c) Find the ratio between the current in the circuit before and after increasing the angular velocity of the dynamo. *(50 Hz , 1)*

25. In the shown electric circuit, calculate the electric charge on one of the plates of each capacitor and the potential difference between the terminals of each capacitor.



(240×10^{-6} C , 80×10^{-6} C , 160×10^{-6} C , 80 V, 40 V , 40 V)



QUESTIONS ON **Chapter 4** LESSON 2

Following AC Circuits

1 Write down the scientific term for each statement of the following :

The equivalent of the resistance, inductive reactance and capacitive reactance in AC circuit.

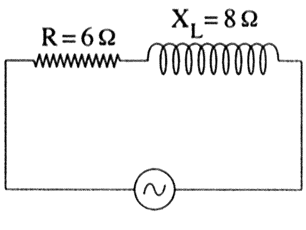
2 Choose the correct answer of the given answers :

1. AC circuit contains resistor (R) and an induction coil of zero resistance (L) connected in series , so the potential difference (V_L) ....

a. lags V_R by 90° b. leads V_R by 90°

c. leads V_R by 180° d. lags V_R by 180°

2. In the opposite circuit :



i. The total impedance (Z) is equal to ....

a. 2 Ω. b. 48 Ω.

c. 14 Ω. d. 10 Ω.

ii. The phase angle between the total voltage and current equals .... approximately.

a. 36° b. 64°

c. 48° d. 53°

3. Induction coil of resistance 12 Ω and its inductive reactance when a current of frequency (f) passes through it is 18 Ω then :

i. Its total impedance in this case is ....

a. 20.1 Ω. b. 16.3 Ω. c. 21.63 Ω. d. 36.2 Ω.

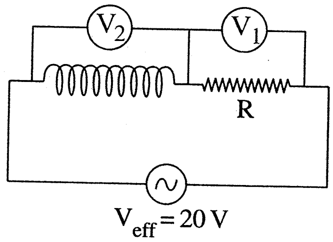
ii. Its total impedance when the frequency increases to 2f ....

a. 37.95 Ω. b. 22 Ω. c. 36 Ω. d. 19.99 Ω.

4. Electric circuit contains AC source and an induction coil its inductive reactance double its ohmic resistance , thus the phase angle between the total voltage and the current is ....

a. 26.56° b. 60° c. 30.7° d. 63.4°

5. In the circuit illustrated in the opposite figure :

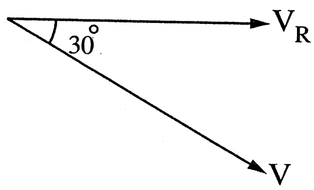


If the reading of V_1 is 10 V, then the reading of V_2 is ....

a. $10\sqrt{3}$ V. b. 10 V.

c. 15 V. d. $10\sqrt{2}$ V.

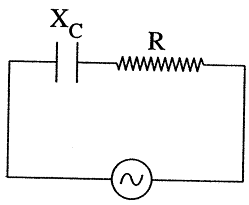
6. If the vectors of voltage (V_R), (V) in a circuit containing an ohmic resistance , a capacitor and an AC source connected together in series as illustrated in figure , then ....



a. $\frac{V_C}{V_R} = \frac{\sqrt{3}}{3}$ b. $\frac{R}{X_C} = \frac{\sqrt{3}}{3}$

c. $\frac{Z}{R} = \frac{2\sqrt{3}}{3}$ d. no correct answer.

7. In the circuit illustrated in figure :



When a current of frequency f passes in the circuit then ($X_C = R$) , thus if the frequency is increased to 2 f, then the impedance ....

a. increases to its double. b. decreases to half.

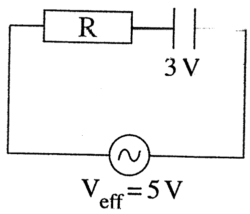
c. becomes 1.11 R. d. no correct answer.

8. AC circuit contains resistor (R) and capacitor (C) connected in series, then V_R ....

a. lags V_C by 90° b. leads V_C by 90°

c. leads V_C by 180° d. lags V_C by 180°

9. In the AC circuit illustrated in figure :



If the effective potential difference through the capacitor (C) is 3 V, then the voltagc through the resistor (R) equals ....

a. 1 V. b. 2 V.

c. 3 V. d. 4 V.

10. When AC current of frequency 500 Hz passes through a capacitor of capacitance $\frac{7}{22}$ μF which is connected to a non-inductive ohmic resistance 1000 Ω , then :

i. The total impedance ....

a. 1414.2 Ω. b. 2000 Ω. c. $\frac{7000}{22}$ Ω. d. 5×10^4 Ω.

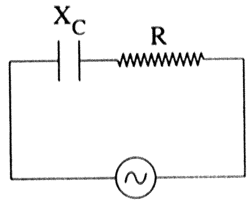
ii. The total voltage lags the current by phase angle ....

a. 50° b. 45° c. 90° d. 63.75°

11. AC circuit contains an ohmic resistance (R) and an induction coil its inductive reactance is (3 R) and a capacitor its capacitive reactance is (2 R) connected in series, then the phase angle equals ....

a. 30° b. 45° c. 0° d. 90°

12. In the circuit illustrated in the opposite figure if the capacitive reactance X_C equals three times the ohmic resistance (R), then the impedance (Z) equals ....



a. $\sqrt{2}$ R. b. R.

c. $\sqrt{10}$ R. d. 4 R.

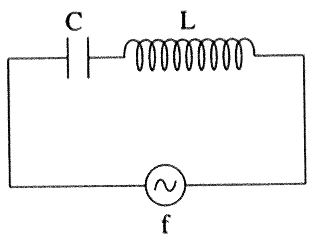
13. AC circuit containing an induction coil (L) of zero resistance and a capacitor (C) connected in series, so the phase difference V_L ....

a. leads V_C by 90° b. lags V_C by 90°

c. in phase with V_C d. leads V_C by 180°

14. In the electric circuit illustrated in figure :

$X_{C_1} = 2X_{L_1}$ when the frequency of the current is (2 f) , if the current frequency decreased to (f), then ....



a. $X_{C_2} = 2\,X_{L_2}$ b. $X_{C_2} = X_{L_2}$

c. $X_{C_2} = 8\,X_{L_2}$ d. $X_{C_2} = 4\,X_{L_2}$

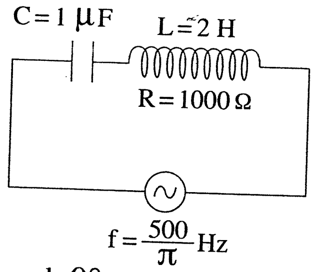
15. In RLC circuit connected in series the total voltage leads the current when ....

a. $X_L = X_C$ b. $X_L = 0$ c. $X_L < X_C$ d. $X_L > X_C$

16. AC circuit consists of resistance (R), an induction coil L and a capacitor (C) connected in series , if $X_C = 2X_L = 2$ R, then the total potential difference ....

a. leads V_R by 90° b. leads V_R by 45° c. lags V_R by 90° d. lags V_R by 45°

17. In the circuit illustrated in the figure :



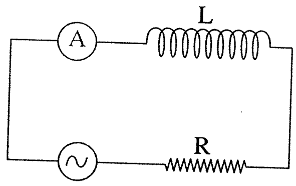
i. The total impedance is ....

a. 1000 Ω.
b. 2000 Ω.
c. 5000 Ω.
d. $1000\sqrt{2}$ Ω.

ii. The phase angle between the total voltage and current is ....

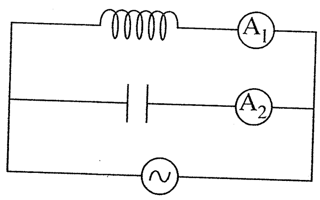
a. 90°
b. 30°
c. 45°
d. 0°

18. When adding a capacitor in series in the opposite circuit it have been noticed that the hot wire ammeter reading has not been changed. In this case the reactance of the capacitor would be .... the reactance of the coil. *(1st session 17)*



a. half
b. equal
c. double
d. three times as

19. When replacing the source in the opposite circuit with another of the same voltage and higher frequency, which of the following choices are correct ? .... *(2nd session 17)*



	The hot wire ammeter reading (A_1)	The hot wire ammeter reading (A_2)
a.	Increases	Decreases
b.	Decreases	Increases
c.	Decreases	Decreases
d.	Increases	Increases

3 What is meant by :

1. The impedance of RC circuit = 200 Ω
2. The impedance of RLC circuit = 500 Ω

4 Give reasons for :

1. It is practically impossible to produce an induction coil of zero resistance.
2. If an induction coil has an ohmic resistance is connected to AC source then the total potential difference leads the current intensity by angle θ where (90° > θ° > 0°).
3. If a capacitor is connected to an ohmic resistor and AC source in series then the current leads the total voltage by phase angle θ where (90° > θ° > 0°).
4. The real consumed power in RLC circuit is that consumed through the ohmic resistance.

5 Define the impedance.

6 What are the factors affecting each of the following :

1. Impedance of AC circuit containing an induction coil and a resistor.
2. Impedance of AC circuit containing a capacitor and a resistor.
3. Impedance of AC circuit containing a resistor, an induction coil and a capacitor.

7 What happens in the following cases :

1. Connecting an ohmic resistance to an induction coil and AC source concerning the phase angle between the current and the total voltage.
2. Connecting an ohmic resistance to a capacitor and AC source concerning the phase angle between the current and the total voltage.

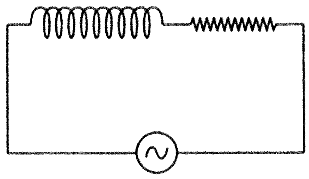
8 Compare between RC and RL circuits (in terms of : total impedance - phase angle).

9 When does ... ?

1. The potential difference lead the current by 45° in AC circuit containing an induction coil and a resistor
2. The potential difference lag the current by 45° in AC circuit containing a capacitor and a resistor
3. The impedance of AC circuit that contains a capacitor and induction coil of zero resistance equal zero

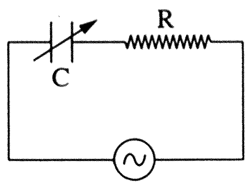
10 Miscellaneous questions :

1. **Write the law that determines both of the total voltage and the total impedance in the following circuits :**
   (a) RL (b) RC (c) RLC
2. **Clarify how can you determine the phase angle between the current and the total voltage in the following circuits :**
   (a) RL (b) RC (c) RLC
3. **In the circuit illustrated in the figure :**



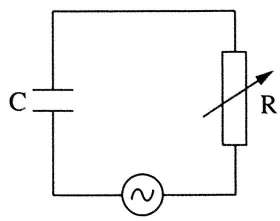
   Find the ratio between the ohmic resistance and the inductive reactance of the coil if the phase angle between the total voltage and the current :
   (a) 30° (b) 60° (c) 45°

4. **In the circuit illustrated in the opposite figure :**

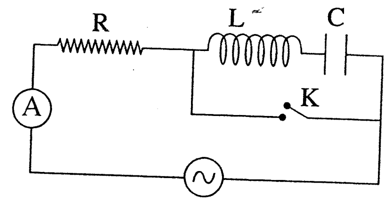


   If the phase angle between the current and the total voltage is 30°
   Explain how the capacitance of the capacitor can be changed such that :
   (a) The phase angle becomes 60°
   (b) The phase angle becomes 15°

5. A dynamo of a negligible ohmic resistance and frequency f is connected in series with a capacitor of capacity C and variable resistor R as in the figure. The variable resistor is adjusted till the phase angle between the current in the circuit and the total voltage is 60°. Show that the relation between C, R and f can be given by :
   $(2 \pi fCR)^2 = 0.33$

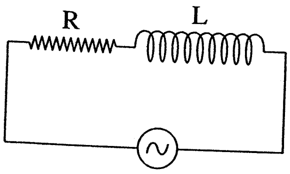
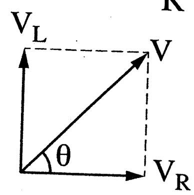


6. The opposite circuit is in resonance case, what will happen to the hot wire ammeter reading in the circuit when closing switch K ? and why ? *(2nd session 17)*



11 Problems :

Guiding notes for solving problems 1

RL circuit	Potential difference (V)	Impedance (Z)	Phase angle between the current and voltage (θ)
	$V = \sqrt{V_R^2 + V_L^2}$	$Z = \sqrt{R^2 + X_L^2}$	$\tan(\theta) = \frac{V_L}{V_R}$ $\tan(\theta) = \frac{X_L}{R}$  (θ) is positive

- **To determine the total current intensity :** $I = \frac{V}{Z} = \frac{V_R}{R} = \frac{V_L}{X_L}$
- **In case of a circuit contains an induction coil, an ohmic resistor and DC source :**

$I = \frac{V_B}{R}$ $\quad X_L = 0 \quad Z = R$

1. AC current of frequency 50 Hz passes through a resistor 12 Ω and an induction coil of inductance $\frac{1}{44}$ Henry. Find the impedance of the circuit. *(13.96 Ω)*
2. Induction coil of self inductance $\frac{7}{44}$ H and its inductive reactance 50 Ω, if its ohmic resistance was 30 Ω , calculate the current frequency and also the coil impedance. *(50 Hz , 58.31 Ω)*
3. Induction coil of self inductance 280 mH is connected in series to a resistor of 200 Ω through an AC source of frequency 100 Hz and potential difference 95 V, **calculate :**
   (a) The inductive reactance of the coil.
   (b) The circuit impedance.
   (c) The electric current intensity passing in the circuit. *(176 Ω , 266.41 Ω , 0.357 A)*
4. The inductive reactance of a coil operating a circuit regulator is 40 Ω and its resistance 30 Ω, connected to AC source of 5 V, **calculate :**
   (a) The total impedance of the coil.

(b) The current intensity passing through the coil.

(c) The phase angle. *(50 Ω , 0.1 A , 53.13°)*

5. Induction coil of self inductance 0.1 H and ohmic resistance 12 Ω , is connected to AC source its effective emf is 100 V and frequency is 50 Hz, **calculate :**

(a) The inductive reactance of the coil.

(b) The total impedance of the coil.

(c) The current intensity passing through the circuit.

(d) The phase angle between the current and voltage. *(31.43 Ω , 33.64 Ω , 2.97 A , 69.1°)*

6. A resistor of 15 Ω is connected in series with an induction coil of zero resistance and an AC source of emf 60 V and its internal resistance is negligible. If the potential difference between the resistor terminals is 45 V, calculate the inductive reactance of the coil and the potential difference at its ends. *(13.229 Ω , 39.686 V) (Azhar 97)*

7. A coil is connected to a DC source of emf 11 V, the current intensity passing through it was 2.2 A and when it is connected to an AC source of frequency 50 Hz and its emf 13 V, the electric current intensity passing through it was 1 A, calculate the self induction coefficient of the coil. *(0.038 H) (Egy. 89)*

8. Calculate the value of current passing through an induction coil of self inductance $\frac{7}{275}$ Henry and ohmic resistance 6 Ω, if the coil is connected to :

(a) An alternating power supply of emf 6 Volts and frequency 50 Hz.

(b) A direct power supply of emf 6 V and negligible internal resistance. *(0.6 A , 1 A) (Egy. 78)*

9. AC source of emf 100 V and frequency 50 Hz is working in a circuit containing non-inductive ohmic resistance of 30 Ω and an induction coil of zero resistance its self induction coefficient $\frac{7}{35}$ H connected in series, **calculate :**

(a) The current intensity passing in the circuit.

(b) The phase angle.

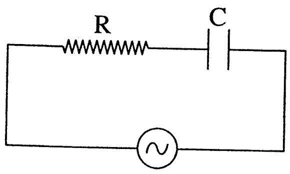
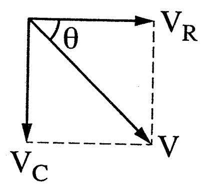
(c) The potential difference across the circuit constituents. *(1.44 A , 64.49° , 43.2 V , 90.52 V)*

10. Electric circuit consists of AC source of emf 200 V and frequency $\frac{800}{\pi}$ Hz and an induction coil connected in series with a resistor 300 Ω and when the current passes the potential difference at the resistor terminals becomes 120 V, find the self induction coefficient of the coil. *(0.25 H)*

11. Calculate the self induction coefficient for the coil that can be connected in series to an electric lamp the resistance of its filament is 44 Ω and electric source of frequency 42 Hz and emf 220 V so that the filament does not melt even if it does not stand for more than 4 A. *(0.125 H) (Azhar 95)*

12. Induction coil its self induction coefficient 2 H is connected in series to a resistor of 1950 Ω and an AC source of frequency $\frac{500}{\pi}$ Hz, so the phase angle between the current and voltage became 45°, calculate the ohmic resistance of the coil. *(50 Ω)*

Guiding notes for solving problems 2

RC circuit	Potential difference (V)	Impedance (Z)	Phase angle between the current and voltage (θ)
	$V = \sqrt{V_R^2 + V_C^2}$	$Z = \sqrt{R^2 + X_C^2}$	$\tan(\theta) = \frac{-V_C}{V_R}$ $\tan(\theta) = \frac{-X_C}{R}$  (θ) is negative

- **To determine the total current intensity :**

$$I = \frac{V}{Z} = \frac{V_R}{R} = \frac{V_C}{X_C}$$

- **In case of a circuit contains a capacitor, an ohmic resistor and DC source :**

A momentary current passes in the circuit until the capacitor charges then vanishes.

$I = 0$ $\quad X_C = \infty$ $\quad Z = \infty$

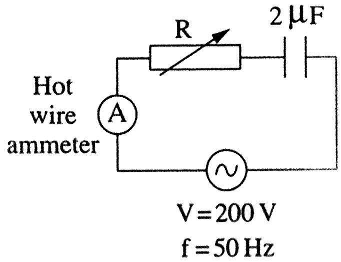
13. A circuit consists of a capacitor of capacitance 2 μF and a resistor 100 Ω connected in series with an AC source its emf is 12 V and its frequency 50 Hz, **calculate :**
(a) The capacitive reactance of the capacitor.
(b) The total impedance.
(c) The electric current passing in the circuit.
(d) The potential difference across the capacitor.
(e) The phase angle. *(1590.91 Ω , 1594.05 Ω, 7.53×10^{-3} A , 11.98 V , −86.4°)*

14. AC source of emf 200 V and frequency 50 Hz is connected to a lamp (25 W, 100 V) and a capacitor of $\frac{100}{3\pi}$ μF. Does the lamp light or its filament burn ? Prove what you say.
(The filament melts and cuts off) (Azhar 92)

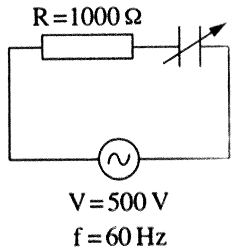
15. AC source of emf 200 V and frequency 50 Hz connected to a lamp of power 5 W and the potential difference across it 20 V in series with a capacitor, find the capacitance of the capacitor that is required to operate the lamp. *(3.997×10^{-6} F)*

16. AC circuit consists of a capacitor of capacitance 5 μF and a resistor 50 Ω, connected in series to AC source of emf 120 V and frequency 60 Hz, **calculate :**
(a) Total impedance.
(b) Phase angle between the current and total voltage. *(532.65 Ω , –84.6°)*

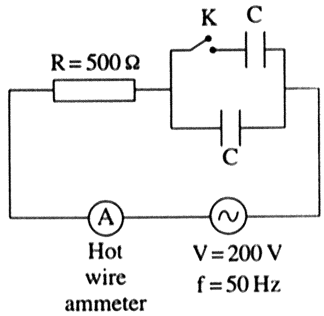
17. **From the circuit illustrated in the figure, calculate :**
The value of the resistance (R), if the effective value of current intensity passing in the circuit is 0.02 A. *(9872.64 Ω)*



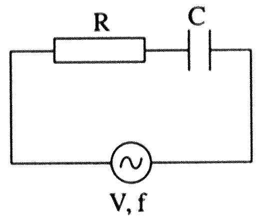
18. From the circuit illustrated in the figure, calculate the capacitance value of a capacitor at which :
(a) The current becomes 0.25 A.
(b) The phase angle between the current and total voltage becomes 45° *(1.53×10^{-6} F , 2.65×10^{-6} F)*



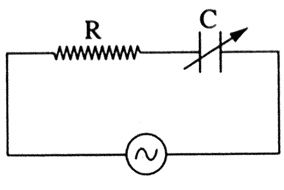
19. **In the circuit illustrated in the figure :**
If the effective current passing in the circuit when opening the switch K is 0.2 A, calculate the effective current in case of closing the switch K. *(0.3 A)*



20. **In the circuit illustrated in the figure :**
If the phase angle between the current and total voltage is 45° calculate the phase angle between them when :
(a) The capacitor is connected in series to another capacitor of capacitance C
(b) The resistor is connected in series to another resistor of resistance R. *(–63.4° , –26.57°)*

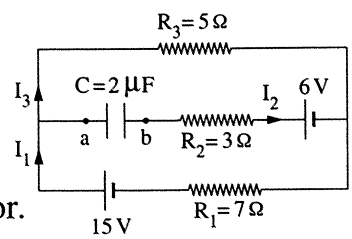


21. In the electric circuit shown in the figure, if the phase angle between the current and the total voltage is 30° when the capacitance of the capacitor is C_0, illustrate how to change the capacitance for the phase angle to become :
(a) 45° (b) 75°



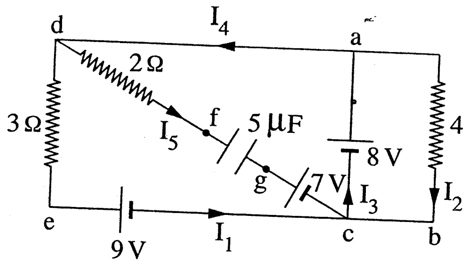
$\left(\frac{C_o}{\sqrt{3}} , 0.155\, C_o\right)$

22. Using the electric circuit shown in the figure find each of the following when the capacitor is fully charged :
(a) I_1 , I_2 , I_3
(b) The charge accumulated on one of the plates of the capacitor.



(1.25 A , 0 , 1.25 A, 0.5 μ C)

23. Using the electric circuit shown in the figure, calculate each of the following when the capacitor is fully charged :

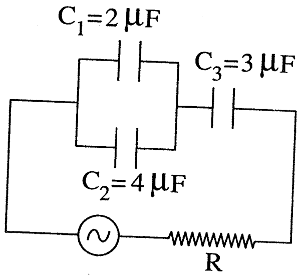


(a) I_1 , I_2 , I_3 , I_4 , I_5

(b) The charge accumulated on one of the plates of the capacitor, then determine the negative plate of the capacitor.

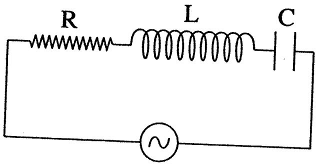
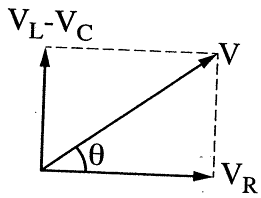
(– 0.33 A, 2 A, 1.67 A , – 0.33 A, 0, 5.05 × 10^{-6}C)

24. If the emf maximum value is $220\sqrt{2}$ V and the current of the source is rising from 0 to 0.1 I_{max} within 0.1 ms and the phase angle between the total voltage and current is 60°, calculate the value of the effective electric current passing through the circuit and also the consumed power.



(0.38 A, 41.59 W)

Guiding notes for solving problems 3

RLC circuit	Potential difference (V)	Impedance (Z)	Phase angle between the current and voltage (θ)
	$V = \sqrt{V_R^2 + (V_L - V_C)^2}$	$Z = \sqrt{R^2 + (X_L - X_C)^2}$	$\tan(\theta) = \frac{V_L - V_C}{V_R}$ $\tan(\theta) = \frac{X_L - X_C}{R}$  (θ) is positive $X_L > X_C$ (θ) is negative $X_L < X_C$

25. AC source, its effective voltage 50 V and its frequency $\frac{500}{\pi}$ Hz, is connected in series to a resistance of 300 Ω, a coil of negligible ohmic resistance that its self induction coefficient is 0.9 H and a capacitor of capacitance 2 μF, **calculate :**

(a) The circuit impedance.

(b) The electric current intensity passing in the circuit. *(500 Ω , 0.1 A) (Azhar 01)*

26. Electric circuit is composed of an ohmic resistance 40 Ω, an induction coil of self inductance $\frac{21}{11}$ H and a capacitor of capacitance $\frac{1}{97200}$ F connected in series to an AC source of frequency 60 Hz and emf 150 V, **calculate :**

(a) The circuit impedance.

(b) The phase angle.

(c) The electric current intensity passing in the circuit. *(464 Ω , 85° , 0.32 A)*

27. Electric circuit is composed of an ohmic resistance 15 Ω, an induction coil of self inductance 0.08 H and a capacitor of capacitance 30 μF, all connected in series with an AC source where the angular velocity of the used voltage is 500 rad.s^{-1}, does the current lead or lag the used voltage ? And what is the angle ? *(−60.65°)*

28. A resistor of 12 Ω, an induction coil of zero resistance of self induction coefficient 0.15 H and a capacitor of capacitance 100 μF are connected together in series with an AC source of 100 V and its frequency 50 Hz, **calculate :**

(a) The total impedance of the circuit.

(b) The electric current intensity passing in the circuit.

(c) The voltage across each part of the circuit.

(d) The phase difference between the total voltage and the current.

(19.46 Ω , 5.14 A , 61.68 V , 242.3 V , 163.55 V , 51.93°)

29. A circuit consists of a non-inductive ohmic resistance 100 Ω and an induction coil of self induction coefficient of 0.5 H, a capacitor of capacitance 15 μF, all are connected in series to an AC source 200 V of frequency 50 Hz, **calculate :**

(a) The total impedance of the circuit.

(b) The electric current intensity passing through the circuit.

(c) The voltage across each part of the circuit. *(114.12 Ω , 1.75 A , 175 V , 274.995 V , 371.21 V)*

30. A resistor of 6 Ω, a capacitor of capacitive reactance 80 Ω and a coil of self inductance 0.28 H are connected together in series to an AC power supply of voltage 20 V and frequency 50 Hz. **calculate :**

(a) The potential difference between the capacitor plates.

(b) The phase angle.

(c) The maximum value of current intensity passing in the circuit.

(160 V , 53.13° , 2.83 A) (1st session 01)

31. A circuit consists of a capacitor of reactance 30 Ω, a resistor of 44 Ω and a coil of inductive reactance 90 Ω and resistance 36 Ω connected in series with an AC source of frequency 60 Hz and voltage 200 V, **calculate :**

(a) The current of the circuit.

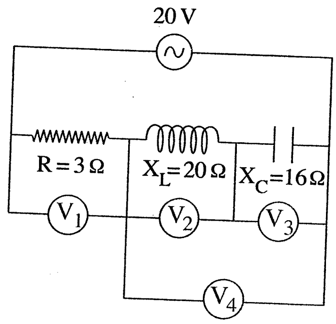
(b) The potential difference across each element in the circuit. *(2 A , 88 V , 193.87 V , 60 V)*

32. Electric generator consists of a coil of 500 turns, the cross-section area of each is $\frac{7}{11}$ m^2, placed in a uniform magnetic field of flux density 5×10^{-4} T, rotates at frequency of 50 Hz, its terminals are connected to a capacitor of capacitive reactance 110 Ω and a coil of inductive reactance 80 Ω with an ohmic resistance 40 Ω, by ignoring the internal resistance of the generator, **calculate :**

(a) The maximum induced emf generated in the induction coil.

(b) The effective value of the AC current in the circuit. *(80 V , 0.707 A) (1st session 99)*

33. **From the circuit illustrated in the figure, find :**



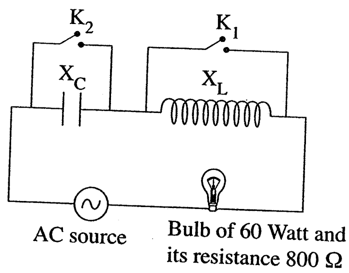
(a) The total impedance for the circuit.

(b) The electric current intensity passing in the circuit.

(c) The reading of each of the four voltmeters.

(5 Ω , 4 A , 12 V , 80 V , 64 V , 16 V) (1st session 99)

34. The circuit illustrated in the figure contains an AC supply of frequency 50 Hz and emf 220 V, a capacitor of capacitance 4 μF and an induction coil of inductance 2.530977 H. **Find :**



(a) The capacitive reactance.

(b) The inductive reactance.

(c) What happens to the glowing of the electric bulb when only K_1 is switched on? Find the impedance.

(d) What happens to the glowing of the electric bulb when only K_2 is switched on? Find the impedance.

(e) What happens to the glowing of the electric bulb when K_1, K_2 are switched on? Find the impedance.

(f) What happens to the glowing of the electric bulb when K_1, K_2 are switched off? Find the impedance. *(795.45 Ω , 795.45 Ω , 1128.16 Ω , 1128.16 Ω , 800 Ω , 800 Ω)*

35. Electric circuit consists of a capacitor of capacitive reactance of 80 Ω and an induction coil of self inductance 0.28 H and an ohmic resistance in the form of a wire of length 12 cm and cross-section area 7×10^{-5} m^2 and resistivity 35×10^{-6} Ω.m all connected in series with an AC source of negligible resistance and frequency 50 Hz and the effective value of its emf is 20 V, **Calculate :**

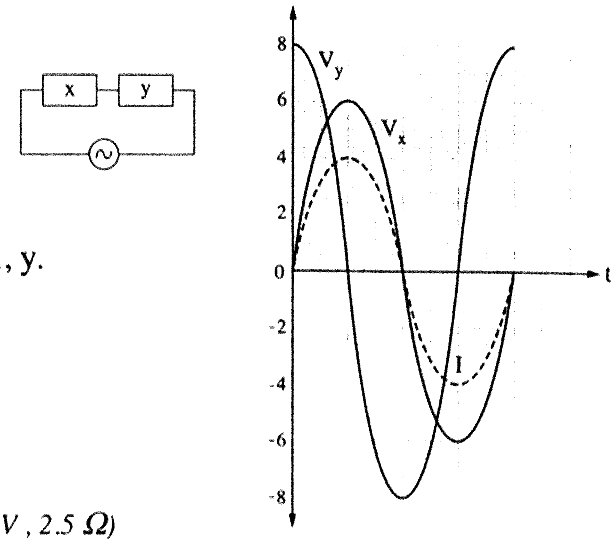
(a) The maximum current intensity in the circuit.

(b) The potential difference between the ends of each of the capacitor and the coil.

(2.828 A , 160 V , 176 V) (Egy. 89)

36. A coil of self inductance $\frac{7}{220}$ H and ohmic resistance 4 Ohm is connected in series with a capacitor of capacitive reactance 5 Ω and a variable ohmic resistance, all are connected to AC electric source of emf 13 V and frequency 50 Hz. If the current intensity passing in the coil musn't exceed 1 A, calculate the minimum value for the ohmic resistance that is connected in series in the circuit which can be safely used in this circuit. (Neglect the internal resistance of the source) *(8 Ω) (Sudan 90)*

37. The opposite figure shows an AC circuit that contains two components x, y and the graph shows the change of (V_x), (V_y) and (I) with time (t).



(a) Determine the type of each component x, y.

(b) Calculate :

i. The phase angle.

ii. The emf of the source.

iii. The impedance of the circuit.

(53.13° , 7.07 V , 2.5 Ω)

38. A coil of inductance 0.06 H is connected with a capacitor of capacitance 5 μF in series and an AC generator of 30 V and 400 Hz, if the ohmic resistance of the circuit is 90 Ω **find** :

(a) The inductive reactance of the coil and the capacitive reactance of the capacitor.

(b) The impedance of the circuit

(c) The current intensity

(d) The phase angle between current and voltage.

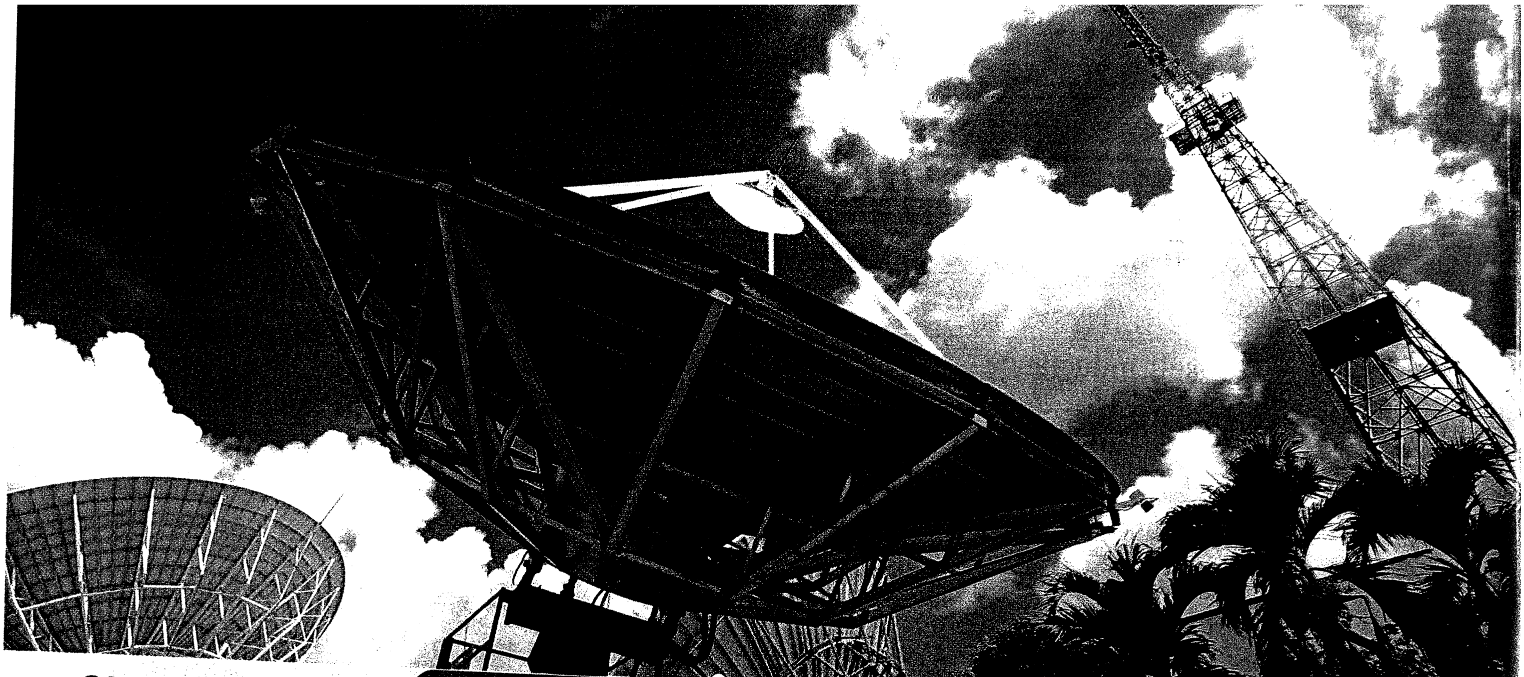
(e) The dissipated power in the circuit.

(150.86 Ω, 79.55 Ω, 114.83 Ω, 0.26 A, 38.39°, 6.084 W) (Exp. 16, 17)

39. An AC source of frequency 50 Hz is connected in series with an inductor of reactance 318.18 Ω, a capacitor of capacitance 5 μF and an ohmic resistance 15 Ω, Calculate :

(a) The phase angle between voltage and current in the circuit.

(b) The capacitance of the capacitor C_2 that should be connected with the capacitor C1 to make the phase difference between voltage and current in the circuit = zero, and determine the method of connecting the two capacitors with each other. *(– 87.3°, 5 μF) (Sudan 17)*



QUESTIONS ON **Chapter 4** LESSON 3

- **The Oscillating Circuit.**
- **The Resonant Circuit.**

1 Write down the scientific term for each statement of the following :

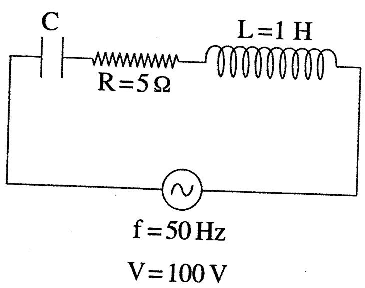
1. Electric circuit in which the stored energy is exchanged between induction coil in the form of magnetic field and the capacitor in the form of electric field.
2. Electric circuit used in the wireless receivers.
3. It is the frequency at which the inductive reactance equals to the capacitive reactance.

2 Choose the correct answer of the given answers :

1. In the resonance circuit ....
   a. the electric charge is exchanged between the battery and the capacitor.
   b. the electric energy is exchanged between the coil and the capacitor.
   c. the electric energy of the circuit increases.
   d. none of the above.

2. Frequency of the resonance circuit is determined from the relation ....
   a. $f = LC$ b. $f = \frac{1}{2\pi LC}$
   c. $f = \frac{1}{2\pi\sqrt{LC}}$ d. $f = \frac{1}{4\pi^2 LC}$

3. In the circuit illustrated in the opposite figure :
   If the current is 20 A , then :
   i. The capacitance of capacitor (C) is ....
   a. 10^{-5} μ F b. 5 F
   c. 10^{-5} F d. 98596 F



ii. The potential difference across the coil is ....

a. 6285.7 V. b. 50 V. c. 0 V. d. no correct answer.

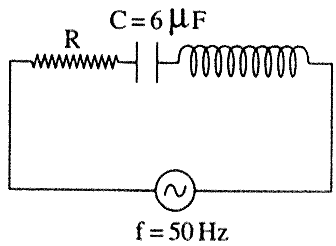
4. When iron core is plunged into a coil of self inductance 0.1 H then its self inductance becomes, ...

a. equals 0.1 H. b. greater than 0.1 H.

c. less than 0.1 H.

d. it depends on the value of AC current intensity passing through it.

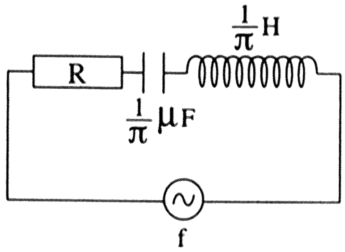
5. **In the illustrated circuit :** If the impedance of the circuit equals R, then the self induction coefficient of the coil is ....



a. 6 H. b. 1.69 H.

c. 60.731 H. d. can't be determined.

6. **In the opposite figure :**



The circuit shows AC source of variable frequency (f) and constant voltage, then the voltage across the resistance R reaches maximum value at frequency ....

a. 0 b. 100 Hz.

c. 250 Hz. d. 500 Hz.

7. The resonance circuits are used in ....

a. generating mechanical waves. b. wireless receivers.

c. remote sensing. d. no correct answer.

8. In RLC circuit connected in series the resonance frequency is determined through ....

a. the resistance R.

b. the self induction coefficient of the coil.

c. capacitance of a capacitor only.

d. (b) and (c) are correct.

9. RLC circuit contains a capacitor of 1 μF, a resistor of 15 Ω and induction coil of self inductance 0.1 H, then the resonance frequency of this circuit is ....

a. 50 Hz. b. 503.1 Hz. c. 1.99×10^{-3} Hz. d. 15×10^{-5} Hz.

10. A resonance circuit , the capacitance of its capacitor increased to the double and the self inductance of its coil decreased to its eighth, then the frequency of this resonance circuit ....

a. increases to its double. b. decreases to its half.

c. becomes four times its original value. d. becomes quarter its original value.

11. In a resonance circuit if the frequency is increased to its double which of the following cases keeps the resonance state of the circuit ....

a. increasing the capacitance of the capacitor to its double.

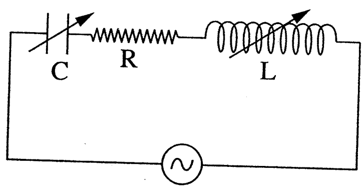
b. increasing the capacitance of the capacitor to its double and decreasing the self induction coefficient to its half.

c. increasing the capacitance of the capacitor to its double and increasing the self induction coefficient to its double.

d. decreasing the capacitance of the capacitor to its half and decreasing the self induction coefficient to its half.

12. In the illustrated figure :

If the circuit is in a state of resonance then the capacitance of the capacitor increased to the double then the new frequency that keeps the state of resonance is ....



a. 500 Hz.

b. $25\sqrt{2}$ Hz.

c. 50 Hz.

d. no correct answer.

13. In the resonance circuit the current becomes maximum if ....

a. the capacitive and inductive reactances become equal.

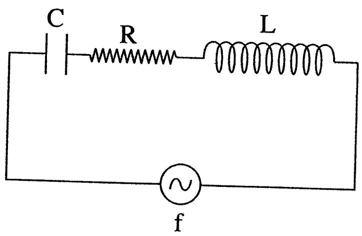
b. the total voltage and current are in phase.

c. the total resistance is the ohmic resistance.

d. all the previous.

14. In the circuit illustrated in the opposite figure :

Which of the following choices causes resonance ? ....



a.

f	C	L
1000 Hz	1 μ F	1 H

b.

f	C	L
100 Hz	10 μ F	10 H

c.

f	C	L
400 Hz	2 μ F	2 H

d.

f	C	L
500 Hz	$\frac{7}{22}$ μ F	$\frac{7}{22}$ H

15. The phase angle in case of resonance is determined from the relation ....

a. $\tan\theta = \frac{X_L + X_C}{R}$

b. $\tan\theta = \frac{R}{X_L - X_C}$

c. $\tan\theta = 0$

d. $\tan\theta = \frac{R}{X_L + X_C}$

16. In RLC circuit connected in series, resonance state is reached when ....
a. $R = X_L - X_C$ b. $X_L = X_C$ c. $X_L > X_C$ d. $X_L < X_C$

17. In the wireless receiving circuit, a maximum current passes in the circuit if the frequency of the AC source is .... the frequency of the circuit.
a. greater than b. less than c. equal to d. double

3 What is meant by :

The resonance frequency in RLC circuit = 500 Hz *(1st session 00)*

4 Give reasons for :

1. In the resonance circuit, the charging and discharging process stops after a while.
2. To keep the charging and discharging process in the resonance circuit, the capacitor should be fed extra charges from time to time.
3. • In case of resonance in AC circuit the current intensity becomes maximum value.
   • In case of resonance in AC circuit the current intensity and total voltage are in phase.
   • Resistance of the resonance circuit equals its ohmic resistance. *(Egy. 92)*

5 Define :

1. The oscillating circuit. *(Sudan 16)*
2. Resonance circuit.

6 What are the factors affecting each of the following :

1. Frequency of an oscillating circuit.
2. Frequency of the resonance in RLC circuit. *(1st session 17)*

7 What happens in the following cases :

1. Connecting a charged capacitor to an induction coil of zero resistance.
2. An RLC circuit in a state of resonance concerning the phase angle between the current and the total voltage.
3. The current intensity through the tuning circuit if the ohmic resistance is connected to another equal resistance in parallel.
4. Tuning the circuit by increasing the value of the variable resistance.
5. The resonant frequency in a circuit consisting of ohmic resistance, an inductive coil and a variable capacitor connected in series when the capacitance of the capacitor is doubled.

8 Mention the scientific principle (scientific idea) for each of the following :

1. Oscillating circuit. *(Exp. 16)* 2. Wireless reception circuits.

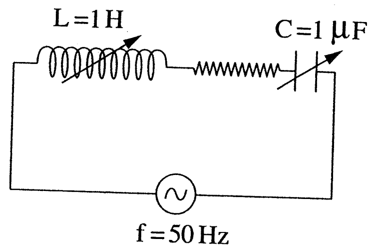
9 Compare between RLC circuit in case of resonance and RLC circuit not in resonance case (in terms of total impedance).

10 When does ... ?

1. the process of charging and discharging in the oscillating circuit continue
2. • the effective electric current intensity in the RLC circuit become maximum
   • the phase difference between the total voltage and current vanishe in the RLC circuit
   • the impedance of RLC in AC circuit equal the ohmic resistance
3. the resonance circuit in a wireless receiver can pick up frequency of a certain channel

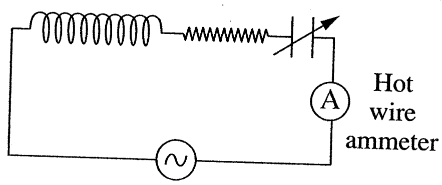
11 Miscellaneous questions :

1. The effective value of the electric current in the opposite circuit can be made maximum in three different methods without changing the emf of the source or the resistance, explain these methods.

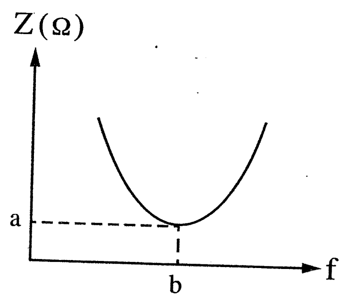


2. **In the opposite figure :**

   If the circuit is in a state of resonance, explain what happens to the hot wire ammeter reading in case of :



   (a) Increasing the frequency of the source at constant potential difference.
   (b) Increasing the capacitance of a capacitor at constant potential difference and frequency.
   (c) Increasing the potential difference at constant frequency.
3. Describe the construction of the tuning circuit and explain its operation in the radio receiver device.
4. Clarify the most important properties of resonance circuit then mention a practical application for it.
   (Sudan, Exp. 16)
5. Describe the structure of the resonance circuit and explain its operation in the wireless reception device.
6. The opposite graph shows the relation between the impedance for series RLC circuit and the variable frequency of AC source.

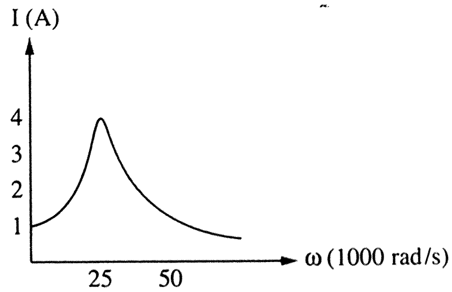


   (a) What does point (a) represent ?
   (b) What does point (b) represent ?
   (c) If the applied frequency was less than the frequency at point (b). Is this circuit capacitive or inductive ? And why ?
   (d) If the applied frequency was greater than the frequency at point (b). Will the phase angle between the total voltage and current be positive or negative or zero ? And why ?

7. The opposite figure shows the relation between the current (I) and the angular frequency (ω) for a series RLC circuit, where the inductance of the coil is 200 mH and the maximum voltage is 8 V. Calculate :

(a) The capacitance of the capacitor (C).

(b) The value of resistance (R).

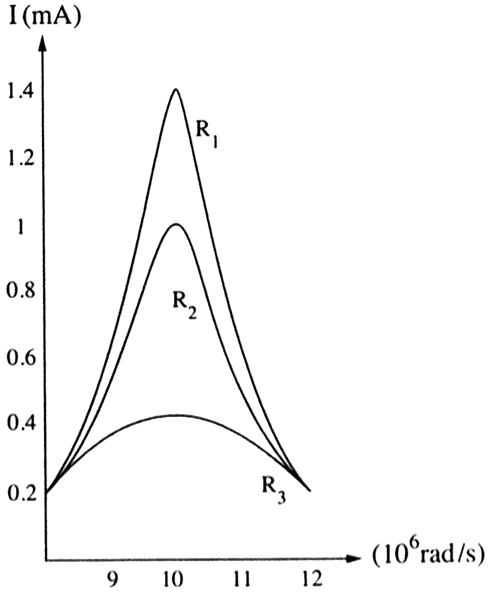


8. The opposite graph shows the relation between the effective value of current (I (mA)) and the angular velocity ($\omega \times 10^6$ (rad/s)) for a series RLC circuit for three values of R. Given that L = 5 mH and the effective value of AC voltage of the source is 5 mV.

(a) Which graph has greatest resistance ? Why ?

(b) Calculate the value of each resistance.

(c) Calculate the value of the capacitance.



12 Problems :

Guiding notes for solving problems :

- **In case of a resonance circuit :**

$X_L = X_C$, $V_L = V_C$,

Minimum impedance Z = R

Maximum current intensity : $I = \frac{V}{R}$

Voltage and current are having the same phase : $\theta = 0°$

Frequency of resonance circuit : $f = \frac{1}{2\pi\sqrt{LC}}$

To compare between the frequency of two different resonance circuits : $\frac{f_1}{f_2} = \sqrt{\frac{L_2C_2}{L_1C_1}}$

If ($L_1 = L_2$)	If ($C_1 = C_2$)
$\frac{f_1}{f_2} = \sqrt{\frac{C_2}{C_1}}$	$\frac{f_1}{f_2} = \sqrt{\frac{L_2}{L_1}}$

1. Find the frequency of the resonance circuit in a wireless receiving circuit contains an induction coil of self inductance 2 μH and a capacitor of capacitance 8 μF.

(39.77×10^3 Hz) (Azhar 79)

2. Find the frequency of a resonance circuit contains an induction coil of self inductance 50 μH and a capacitor of capacitance 500 pF. *(100.6×10^4 Hz)*

3. A telegram wire of length 200 km, its capacitance with the Earth 0.014 μF for every kilometer, carries AC current of frequency 5000 Hz, find the induction coefficient in a coil load so that the impedance becomes minimum value. *(3.6×10^{-4} H)*

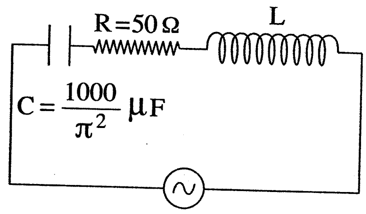
4. A resonance circuit consists of a capacitor of capacitance 30 μF receives a wave of frequency 750 kHz, if the coil is replaced with another of self inductance 5 times that of the 1st coil and the capacitance of the capacitor increased by 32 μF, calculate the frequency of the wave that can be received and its wavelength, then calculate the self inductance of the coil each time. (Velocity of the electromagnetic waves 3×10^8 m/s)
(2.33×10^5 Hz , 1.29×10^3 m , 1.5×10^{-9} H , 7.5×10^{-9} H)

5. A resonance circuit its frequency is 6×10^5 Hz and the capacitance of its capacitor is 50 μF, its induction coil is replaced with another its self inductance 6 times that of the 1st and the capacitance is increased by 25 μF, calculate the frequency of the circuit in this case.
(2×10^5 Hz) (Azhar 90)

6. A tuned circuit in a radio receiver consists of an induction coil of inductance 10 mH, a resistance 50 Ω and a capacitor of variable capacitance. When wireless waves of frequency 980 kHz hit the antenna and generate a voltage 10^{-4} V across the circuit. Find the capacitance of capacitor and the current value at resonance.
(2.635×10^{-12} F , 2×10^{-6} A) (Egy. 83)

7. Induction coil of self inductance 0.08 H and of resistance 30 Ω is connected to AC source of 10 V and frequency 80 Hz, find the current intensity passing through the coil and the phase angle. How can you make the phase angle decrease to zero without changing the current intensity passing through the coil at the same AC source?
(0.2 A , 53.3° , 49.43 μF , 20.18 Ω)

8. In the AC circuit illustrated in figure, the potential difference across the capacitor = That across the coil terminals = 22 V. If the frequency of the used source is 50 Hz, **calculate :**



(a) The self induction coefficient of the coil.
(b) The current intensity passing in the circuit.
(c) emf of the AC source.
(0.1 H , 0.7 A , 35 V) (2nd session 00)

9. A capacitor of capacitance 0.4 μF, a coil of inductance 0.4 H and a resistance of 10 Ω and a lamp are connected together in series with AC voltage source 0.01 V, **calculate :**
(a) The resonance frequency.
(b) The maximum value for current.
(c) The voltage across C at resonance (Ignoring the resistance of the lamp).
(397.7 Hz , 1.41×10^{-3} A , 1 V)

10. A resistance of 20 Ω, an induction coil of self inductance 5 mH and a capacitor are connected in series with an AC source of emf 200 V and its frequency 49 Hz, so the current and potential difference are found in phase, calculate each of the capacitive reactance and intensity of the current passing in the circuit. *(1.54 Ω , 10 A) (Azhar 00)*

11. A resistance 20 Ω, a capacitor of capacitance 10 μF and an induction coil are connected all in series with an AC source 200 V its frequency 50 Hz, so the current and potential difference are found in phase, **calculate :**
(a) Capacitor reactance.
(b) Coil reactance.
(c) Intensity of the current passing in the circuit.
(d) The coefficient of the self induction of the coil. *(318.18 Ω , 318.18 Ω , 10 A , 1 H)*

12. A circuit consists of a coil of inductive reactance 250 Ω, a resistance 100 Ω, a capacitor of variable capacitance and AC power supply of emf 200 V and frequency $\frac{1000}{44}$ Hz. Given that the current passes through the circuit reached its maximum value, **find :**
(a) The capacitive reactance that caused the current to reach its maximum.
(b) The potential difference between the terminals of the coil and between the capacitor plates in this case. *(28×10^{-6} F , 500 V , 500 V) (Azhar 84)*

13. A resonance circuit consists of resistance 100 Ω, a coil of inductive reactance 125 Ω and a capacitor of capacitance C, all are connected in series to an AC source its voltage 220 V and its frequency $\frac{280}{11}$ Hz, **calculate :**
(a) The capacitance of the capacitor that made the value of the current intensity passing through the circuit is maximum.
(b) The potential difference between the terminals of each of the coil and the capacitor. *(5×10^{-5} F , 275 V , 275 V) (Egy. 96)*

14. An electric circuit consists of a resistor of 4 Ω, a coil of self inductance 0.5 H, a capacitor of variable capacitance connected in series with an AC source its emf 100 V, its frequency 50 Hz, **calculate :**
(a) The capacitance of the capacitor that makes resonance.
(b) The electric current intensity passing in the circuit that makes resonance.
(c) The voltage across each of the coil and the capacitor in this case.
(2.02×10^{-5} F , 25 A , 3928.57 V , 3928.57 V)

15. A wireless transmission circuit contains a resonance circuit which consists of an induction coil of self inductance $\frac{49}{121}$ mH and a capacitor where the potential difference between its plates is 9 V, when one of its plates is loaded with a charge of 36 mC, **calculate :**
(a) Frequency of the resonance circuit.
(b) Reactance of each of the coil and the capacitor. *(125 Hz , $\frac{7}{22}$ Ω , $\frac{7}{22}$ Ω)*

16. Electric circuit consists of an AC source of emf 100 V and frequency 50 Hz connected in series with a resistor of 25 Ω, induction coil and a capacitor of capacitance 100 μF so the current and potential difference are in phase, **calculate :**

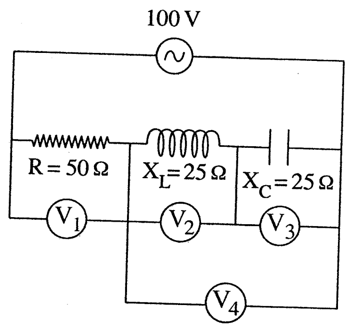
(a) The coil reactance.

(b) Current intensity.

(c) Phase angle in this case.

(31.82 Ω , 4 A , 0°) (Azhar 89)

17. Using the electric circuit illustrated in figure and the given data, find the reading of each of the four voltmeters.



(100 V , 50 V , 50 V , 0) (Egy. 93)

18. AC circuit consists of a source of frequency 50 Hz, a capacitor of capacitance $\frac{700}{22}$ μF, an ohmic resistance 50 Ω and an induction coil with negligible ohmic resistance all are connected in series. When the potential difference between parts of the circuit is measured, it's found that the potential difference across the capacitor is equal to that across the induction coil = 20 V, **find :**

(a) The coefficient of self induction of the coil.

(b) The electric current intensity passing in the circuit.

(c) The maximum value of the emf of the source.

(d) The phase angle between the potential difference and the current in this circuit.

($\frac{7}{22}$ H , 0.2 A , 14.14 V , 0°) (Egy. 90)

19. Draw an electric circuit contains AC source of emf 220 V, a capacitor of capacitive reactance 800 Ω, a coil of inductive reactance 800 Ω, an electric lamp of resistance 600 Ω and a switch all are connected in series , calculate the intensity of the flowing current in each of the following cases :

(a) When closing the circuit.

(b) When removing the capacitor only from the circuit.

(c) When removing the coil only from the circuit.

(d) When removing the capacitor and the coil from the circuit.

What do you conclude from the results ? *($\frac{11}{30}$ A , 0.22 A , 0.22 A , $\frac{11}{30}$ A) (Azhar 80 , 89)*

20. Electric circuit consists of a capacitor of capacitive reactance 160 Ω, coil of self inductance 0.28 H with negligible ohmic resistance and a wire of length 12 m its cross-section area is 7 cm^2 and its resistivity is 35×10^{-5} Ω.m, all are connected in series with AC source of frequency 50 Hz and the effective value of its emf is 20 V, **calculate :**

(a) The total impedance in the circuit.

(b) The current intensity passing in the circuit.

(c) The potential difference between terminals of each of the capacitor and the coil.

(d) The maximum value of the current intensity passing in the circuit when changing the capacitance of the capacitor. *(72.25 Ω , 0.28 A , 44.8 V , 24.64 V , 3.33 A)*

21. A solenoid coil is connected to a DC source of emf 12 V, intensity of the current passing in the circuit was 1 A and when this source is replaced with AC source, the effective value of its potential difference equals to that of the DC source and its frequency 50 Hz, the intensity of current passing in the circuit was 0.6 A and when a capacitor is connected in series to the coil in this circuit the electric current intensity is returned to its previous value in the DC voltage circuit. Ignoring the internal resistance of the two sources, **calculate :**

(a) The self inductance of the coil. (b) Capacitance of the capacitor.

(c) The phase difference between the current and voltage in the final AC circuit.

(0.051 H , 1.99 × 10^{-4} F , 0°) (Egy. 91)

22. A battery of emf 12 V is connected in series with an induction coil, so the current passing in the circuit was 2 A. When the battery is replaced by an AC source the effective value of its potential is 12 V, the current passing in the circuit was 1.2 A and when connecting a capacitor in series with the coil in the second circuit the electric current intensity is returned to its original value in the first circuit (Ignoring the internal resistance of the two voltage sources).

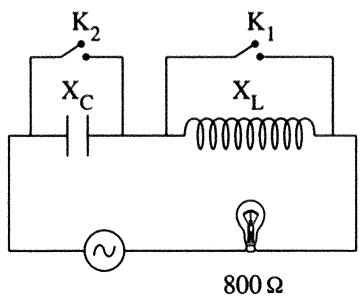
(a) **Calculate :**

1. The ohmic resistance of the coil.
2. The inductive reactance of the coil.

(b) Is the last circuit formed of AC source , coil and a capacitor in a state of resonance? And why?

(6 Ω , 8 Ω , The circuit is in a resonance state because the current intensity is maximum 2 A) (Egy. 95)

23. In the opposite circuit, AC source of frequency 50 Hz and emf 220 V is connected to a capacitor of capacity 4 μF and induction coil of self inductance $\frac{1225}{484}$ H.



(a) Calculate the capacitive reactance.

(b) Calculate the inductive reactance.

(c) Calculate the impedance of the circuit if the two switches K_1 and K_2 are open.

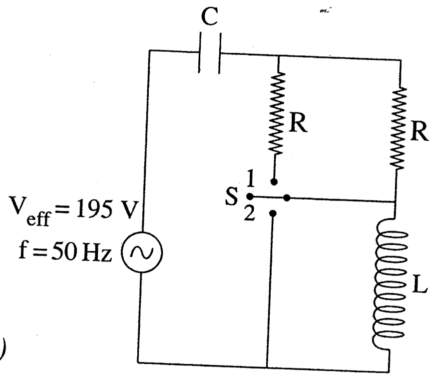
(d) What happens to the light of the bulb when closing K_1 only ? And what is the impedance ?

(e) What happens to the light of the switch when K_2 only is closed ? And what is the impedance ?

(f) What happens to the light of the bulb when K_1 and K_2 are closed? And what is the impedance?

(795.45 Ω, 795.45 Ω, 800 Ω, 1128.16 Ω, 1128.16 Ω, 800 Ω)

24. In the electric circuit shown in the figure, when the switch S is opened in both directions, the electric current intensity becomes 0.025 A and when the switch is closed in the position (1) the electric current intensity becomes 0.015 A, calculate the value of both : L, C, R



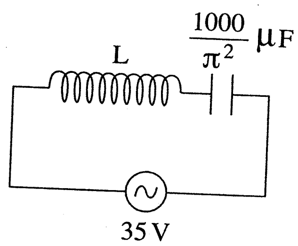
($12.01 \times 10^3\ \Omega$, 6.39×10^{-7} F, 31.69 H)

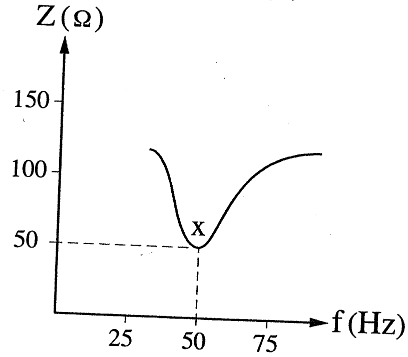
25. In the electric circuit shown in the figure, by changing the frequency of the AC source we obtained the opposite graph :

(a) Calculate the self inductance of the coil.

(b) Does the coil have an ohmic resistance ? Explain your answer.

(c) Calculate the potential difference between the terminals of each of the coil and the capacitor at position x.





(0.1 H, 41.34 V, 22 V)

26. AC source is connected in series in a circuit containing induction coil with negligible resistance, a capacitor and an ohmic resistor of 100 Ω , thus a maximum current is passed and when the source is replaced with another having the same emf and double the frequency of the first the electric current intensity decreased to 0.45 of its original intensity, calculate each of the capacitive and inductive reactances in the first case.

(132.3 Ω, 132.3 Ω)

27. If the impedance of RLC circuit connected to AC source in series is 8 Ω when its frequency is 60 Hz in case of resonance and the impedance of the circuit becomes 0 Ω at frequency 80 Hz, calculate each of the self inductance of the coil and the capacitance of the capacitor.

(0.027 H , 2.58×10^{-4} F)

SELECTED QUESTIONS ON

Chapter 4

From :

- **Student Evaluation Guide (2017).**
- **Booklet Models of the Ministry of Education.**

1 Choose the correct answer from the given answers :

1. AC potential difference leads the current by angle 90° when AC current passes in ·········

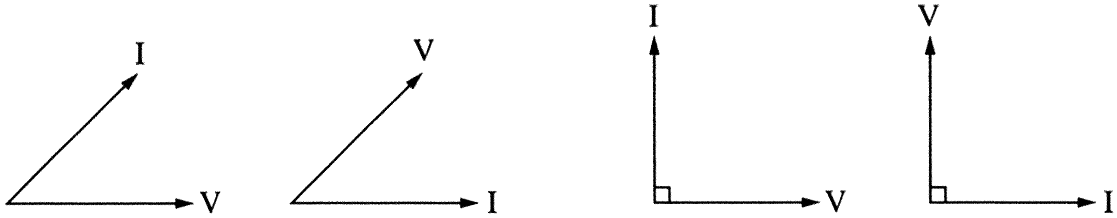
   a. an induction coil of zero resistance. b. ohmic resistance.

   c. capacitor. d. oscillating circuit.

2. If the inductive reactance of a coil is 440 LΩ where (L) is the self induction coefficient of a coil, so the frequency of the current ·········

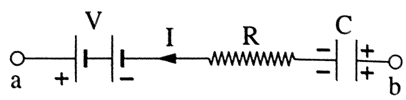
   a. 140 Hz. b. 400 Hz. c. 70 Hz. d. 44 Hz.

3. Which of the figures represent the vectors of voltage and current in a circuit contains a capacitor, an ohmic resistance and an AC source ? ········· *(Booklet 4 - Exp. 17)*



(a) (b) (c) (d)

4. In the circuit shown in the opposite figure if R = 4 kΩ , C = 3 μF, V = 15 V , Q = 12 μC , I = 2 mA, so the potential difference $(V_b - V_a)$ = ·········



   a. 3 V. b. – 19 V. c. – 3 V. d. 27 V.

5. The phase angle between the total voltage and the current in an AC circuit which consists of an induction coil, negligible ohmic resistance, a capacitor and ohmic resistance equals zero when ....

a. $V_L = V_R$　　b. $V_L = V_C$　　c. $Z = X_C$　　d. $Z = X_L$

6. When the phase angle between the total voltage and current in RLC circuit = Zero , the ratio $\frac{X_L}{X_C}$ = ... *(Booklet 3 - Exp. 17)*

a. Zero　　b. 1　　c. $\frac{1}{2}$　　d. 2

7. When the circuit RLC is in case of resonance, the impedance is .... and equals the .... for the circuit.

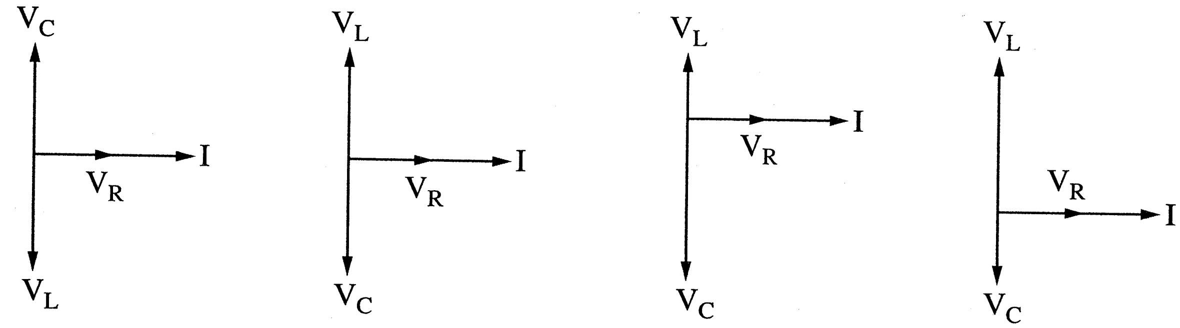
a. minimum – ohmic resistance　　b. maximum – ohmic resistance

c. minimum – inductive reactance　　d. maximum – capacitive reactance

8. The total impedance of an AC circuit consists of an induction coil of ohmic resistance and a capacitor connected in series is minimum when ....

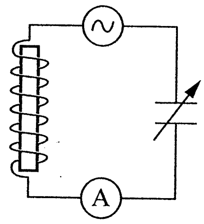
a. $X_L = R$　　b. $X_C = R$　　c. $X_C = X_L$　　d. $Z = X_L$

9. Which of these figures represent a resonance case of RLC circuit ? ....



(a)　　(b)　　(c)　　(d)

10. The figure represents a circuit in a resonance case. When removing the iron core from the coil, the reading of the hot wire ammeter ....



a. decreases.　　b. increases.

c. remains constant.　　d. becomes zero.

2 Give reasons for :

1. It is prefered to use AC current instead of DC current to transfer it from its generation places to its consumption places.
2. When cutting a part from the turns of a solenoid and connecting the others by the same AC source, so its inductive reactance decreases.
3. DC current doesn't pass through the circuit of a capacitor while AC current passes through it. *(Booklet 2 - 2^{nd} session 17)*

3 What are the factors affecting each of the following :

1. The phase angle between the total potential difference and the current in a circuit containing an induction coil of ohmic resistance.
2. The value of the current in AC circuit contains capacitor and ohmic resistance are connected in series. *(Booklet 2)*
3. The impedance in AC circuit contains a capacitor and an inductor that are connected in series.

4 What happens in each of the following cases :

1. When installing a platinum and iridium wire on a metallic plate of different thermal expansion coefficients from the wire's material in the hot wire ammeter.
2. When a rod of soft iron is placed inside an induction coil connected in series with an ohmic resistance in AC circuit.

5 What are the results of each of the following :

1. Decreasing the distances between the turns of a solenoid to half concerning the inductive reactance of the coil.
2. Double winding the wire of a coil concerning the inductive reactance of the coil.
3. When replacing DC current source by AC current source of the same emf in a circuit containing an induction coil and ohmic resistance concerning the current intensity in the circuit.
4. Increasing the capacitance of a capacitor in RC circuit with constant potential difference and frequency concerning the value of current.
5. Connecting a battery with a coil and a capacitor in series concerning the passing of the electric current. *(Booklet 2)*
6. Existence of an ohmic resistance in an oscillating circuit.

6 Mention one application (or use) for each of the following :

1. The electric capacitor.
2. The oscillating circuit.

(Booklet 4 - 1st session 17)

7 Compare between each of the following :

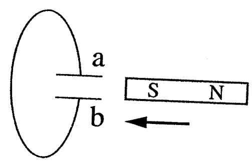
1. Hot wire ammeter and moving coil ammeter (in terms of the reason of moving the pointer on the scale). *(Booklet 1)*
2. The galvanometer and hot wire ammeter (in terms of the theory of working - the function of the spring coil). *(Booklet 1)*
3. The reading of the hot wire ammeter connected to an induction coil and an electric source in a closed circuit when AC current or DC current of the same emf passes through it. *(Booklet 3)*
4. The capacitor and the coil (in terms of the type of the stored energy in each of them when they are connected to an electric source).

5. The capacitive reactance and the inductive reactance (in terms of the effect of increasing the frequency in each of them).
6. The oscillating circuit and the resonance circuit in radio devices (in terms of the function).

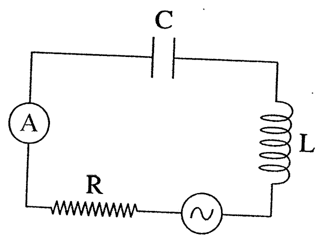
(Booklet 4 - Exp. 17)

8 Miscellaneous questions :

1. **Explain how each of the following points is achieved :**
   (a) The wire of the hot wire ammeter isn't affected by the effect of the temperature.
   (b) Calibration (making a scale) for the hot wire ammeter.
   (c) The pointer of hot wire ammeter is settled when an electric current of a certain value passes through it.
2. Write down the scientific term : The angle included between the phase vectors of total potential difference (V) and AC current intensity (I).
3. When does the value of the capacitive reactance of a capacitor of constant capacitance that is connected to AC source approach zero ? *(Booklet 1)*
4. In the opposite shown figure, a magnetic rod moves inside a metallic ring contains a capacitor, determine the polarity of the capacitor plates a and b. *(Exp. 17)*



5. Prove that the total impedance of a circuit containing an induction coil of zero ohmic resistance and an ohmic resistance connected in series is determined from the relation : $Z = \sqrt{X_L^2 + R^2}$
6. Prove that the total impedance of a circuit containing a capacitor and ohmic resistance of non-induction connected in series is determined from the relation : $Z = \sqrt{R^2 + X_C^2}$
7. Prove that the value $\sqrt{\frac{L}{C}}$ has the same measuring unit of the resistance where (L) is the self induction coefficient of a coil and (R) is the ohmic resistance.
8. Show that the value $\frac{L}{R}$ has the same measuring unit of time. Where (L) is the self induction coefficient of a coil and (R) is the ohmic resistance.
9. Show that the value (RC) has the same measuring unit of time, where (C) is the capacitance of a capacitor and (R) is the ohmic resistance.
10. The shown circuit in the figure is an (RLC) circuit in resonance which is connected to an AC source of constant effective value, show what will happen if the frequency of the source increases for :
    (a) the ohmic resistance (R). *(Booklet 4 - Exp. 17)*
    (b) the reading of hot wire ammeter (A).



11. Show by drawing the method of connecting an oscillating circuit by using DC source.
12. Why the current of an oscillating circuit vanishes after removing an electric source from it ?

13. Mention the condition of energy loss in the oscillating circuit.

14. What is the type of the current passing through an oscillating circuit after removing the electric source from it ?

15. Prove that the frequency of the current in a resonance case is determined from the relation : $f = \frac{1}{2\pi\sqrt{LC}}$

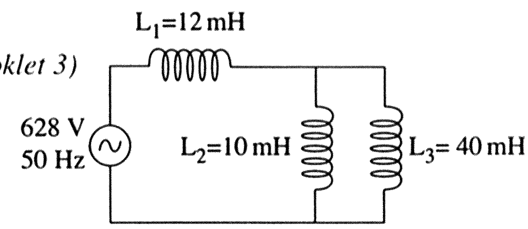
16. How to increase the frequency of the circuit to the double by changing the induction coil only ? *(Booklet 2 - Exp. 17)*

17. **Write down the used mathematical relation to calculate each of the following :**
    (a) The inductive reactance of an induction coil of zero resistance.
    (b) The total inductive reactance of two induction coils are connected in parallel.
    (c) The total current intensity for a circuit contains a coil of ohmic resistance and is connected to AC source.
    (d) The impedance of AC source contains an induction coil of zero resistance and a capacitor.
    (e) The frequency of the current in a resonant circuit.

9 Problems :

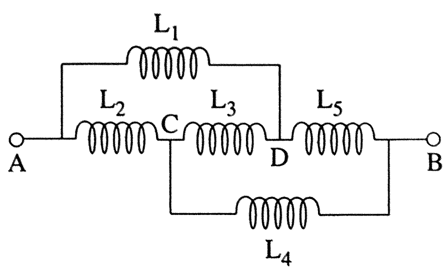
1. An induction coil of zero resistance is connected in series to AC source of emf 260 V and hot wire ammeter. If the reading of ammeter is 2 A, and if knowing that the ratio between the potential difference between the ends of the ammeter and the potential difference between the ends of the coil is $\frac{5}{12}$, calculate the resistance of the hot wire ammeter. *(50 Ω)*
(Exp. 17)

2. The opposite circuit consists of an induction coil of zero resistance and an AC source, **find :** *(Booklet 3)*
    (a) The total impedance of the circuit.
    (b) The total current intensity.
    (c) The current intensity in each coil.
    (Knowing that : $\pi = 3.14$)



(6.28 Ω , 100 A , 100 A , 80 A , 20 A)

3. In the circuit shown in the figure, there are five induction coils if knowing that the self induction coefficient for each of them is 50 mH, find the total induction coefficient between the two points A , B. *(50 mH)*



4. Three capacitors of capacitances 1 , 2 , 3 μF respectively, are connected in series to AC source of 22 V, find the potential difference between the two plates of each capacitor. *(12 V , 6 V , 4 V)*

5. AC source 5 V , 350 Hz is connected to an induction coil of self induction coefficient 680 mH and ohmic resistance 2.2 K Ω in series : *(Booklet 1 - Exp. 17)*

(a) Find the impedance of the circuit for the current.

(b) Express by vectors, the potential difference between the terminals of the source and the potential difference across the coil concerning the vector of current in the circuit.

(2660.45 Ω)

6. An electric lamp of 120 V and 60 Watt is connected to AC source of 240 V of frequency 50 Hz and a capacitor C in series, what is the capacitance of the capacitor which allows passing the maximum current that can be beard by the filament of the lamp.

(7.65×10^{-6} F)

7. An ohmic resistance of 300 Ω is connected in series to a capacitor of reactance 265 Ω and AC source of frequency 100 Hz, if the potential difference across the capacitor = 5 V, **calculate :**

(a) The capacitance of the capacitor.

(b) The current intensity in the circuit.

(c) The potential difference across the terminals of the resistance. *(6×10^{-6} F , 0.019 A , 5.7 V)*

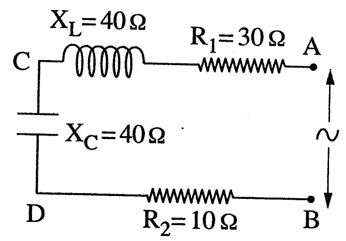
8. AC dynamo gives potential difference between its terminals 30 V and frequency 400 Hz is connected in series to an induction coil of self induction coefficient 0.06 H and capacitor of 5 μF if the ohmic resistance in the circuit is 90 Ω, **calculate :**

(a) The impedance of the circuit. *(Booklet 2)*

(b) The consumed power in the circuit.

(114.83 Ω , 6.084 W)

9. In the opposite figure, two points A , B are connected to AC source of emf 200 V and frequency 50 Hz, **find :**



(a) The current intensity passing through the circuit.

(b) The potential difference between A, C.

(c) The potential difference between C, B.

(d) The lost power in the circuit. *(5 A , 250 V , 206.16 V , 1000 ω)*

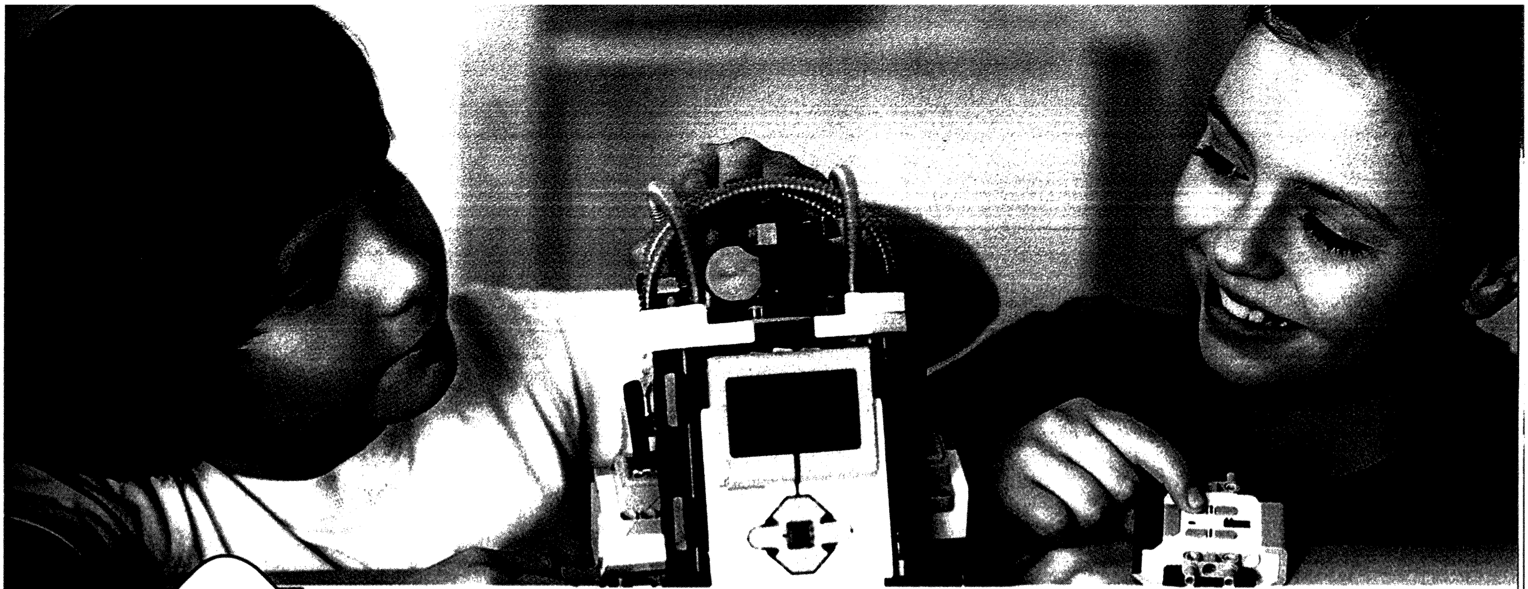
10. A circuit consists of an ohmic resistance 8 Ω connected in series to an induction coil of zero resistance, its self induction coefficient 0.1 H and a capacitor of capacitance 12 μF and AC an dynamo of effective emf equals 220 V and the number of times which the current reaches zero in one second = 101 times starting from the normal position.

(a) Calculate the inductive reactance of the coil.

(b) Calculate the current intensity passing through the coil.

(c) Calculate the phase angle between the total voltage and the current.

(d) What is the modification on the capacitor that is required to reach the maximum effective value of the current ? *(31.43 Ω , 0.94 A , – 88.04° , 1.01×10^{-4} F)*



2

UNIT

Introduction to Modern Physics

Chapter 5 Wave Particle Duality.

Lesson 1 :
- The Blackbody Radiation.
- Thermal Emission and the Photoelectric Effect.

Lesson 2 :
- Compton Effect.
- Wave Particle Duality.
- Electron Microscope.

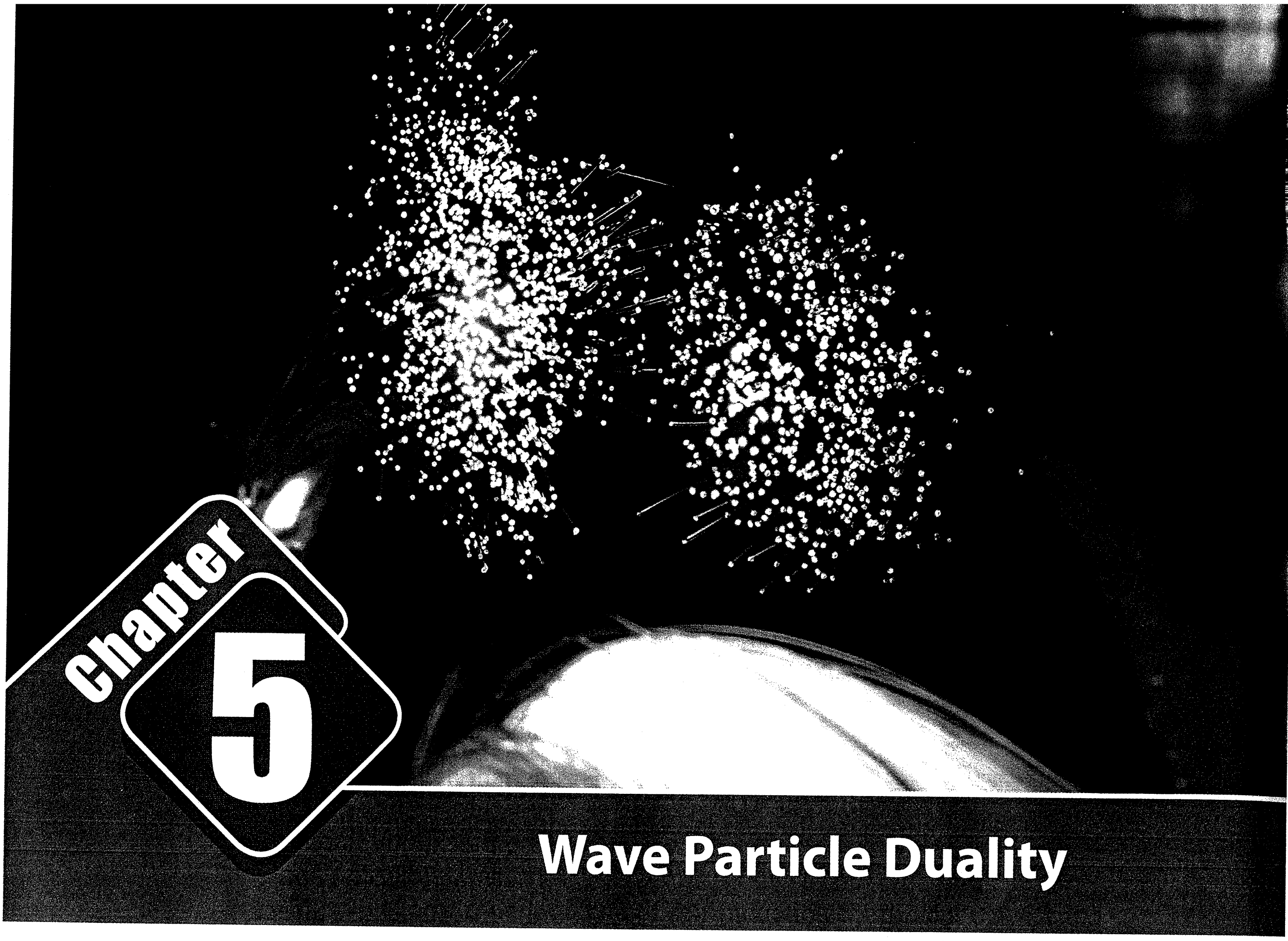
Chapter 6 Atomic Spectra.

Chapter 7 Laser.

Chapter 8 Modern Electronics.

Lesson 1 :
- The Semiconductor Crystal.
- pn Junction.

Lesson 2 :
- The Transistor.
- The Digital and Analog Electronics.



Chapter 5

Wave Particle Duality

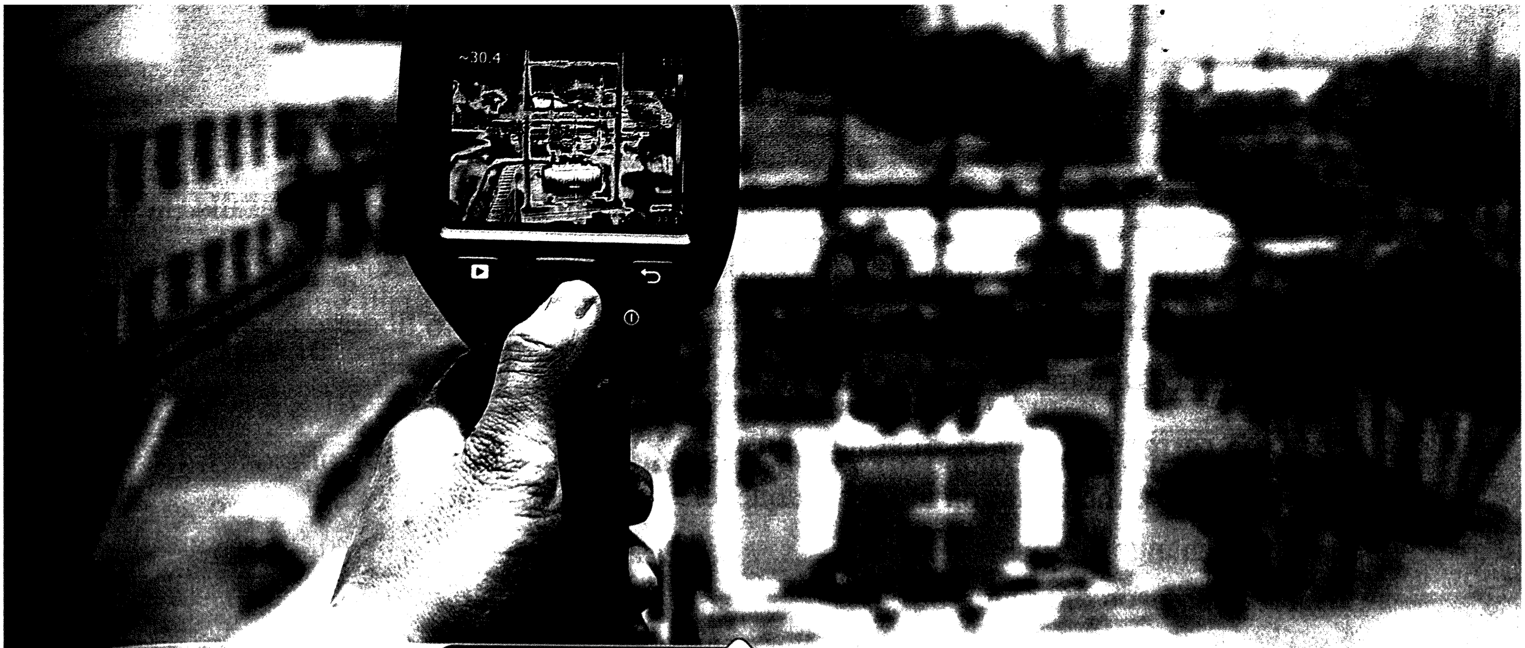
Questions on :

Lesson 1
- The Blackbody Radiation.
- Thermal Emission and the Photoelectric Effect.

Lesson 2
- Compton Effect.
- Wave Particle Duality.
- Electron Microscope.

Selected Questions on Chapter 5 from :

- Student Evaluation Guide (2017).
- Booklet Models of the Ministry of Education.



QUESTIONS ON **Chapter 5** LESSON 1

• The Blackbody Radiation.
• Thermal Emission and the Photoelectric Effect.

1 Write down the scientific term for each statement of the following :

1. It is the physics that allow us to interpret the daily observations and common experiences such as studying waves as sound , light , heat and electricity with their properties.
2. It is the physics that allow us to study and explain scientific phenomena which might not be directly observed in our daily life especially when we deal with atomic and subatomic systems.
3. A body that absorbs all the radiations falling on it with different wavelengths then emits them again in an ideal form.
4. A curve represents the graphical relation between the intensity of radiation and the wavelength of the emitted spectrum from a hot body.
5. The wavelength which is associating the maximum intensity of the radiation (λ_m) is inversely proportional to the temperature of a glowing source on Kelvin scale. *(1^{st} session 11 , 15 - Exp. 16)*
6. The ratio between the photon energy to its frequency. *(1^{st} session 12)*
7. A phenomenon used for criminology and night vision.
8. The attractive force which attracts the electrons to the inside and prevents them from escaping from the surface of the metal. *(Azhar 11 - Sudan 15)*
9. The emission of electrons from the surfaces of metals by heating.
10. The emission of the electrons phenomenon from metallic surfaces when a light of suitable frequency falls on it.

11. The emitted electrons from metallic surfaces when a light of suitable frequency falls on it.
12. The required energy to liberate an electron from a metallic surface. *(1st session 14)*
13. The minimum frequency of the incident light which is required to liberate an electron from a surface of a metal without gaining any kinetic energy.

2 Choose the correct answer of the given answers :

1. The intensity of the radiation at high frequencies in Planck's curve ....
   a. doesn't change. b. decreases.
   c. increases. d. approaches to zero.
2. In Planck's curve, the wavelength associating the maximum intensity of radiation emitted from the Sun lies in the region of ....
   a. the ultraviolet rays. b. the visible light.
   c. infrared rays. d. X-rays.
3. If the frequency of the photons which are emitted from a glowing body increases. Then, its number .... *(2nd session 09)*
   a. increases. b. decreases.
   c. remains constant. d. equals zero.
4. The kinetic energy of the electrons of cathode rays equals ....
   a. $h\upsilon$. b. $\frac{1}{2}mv^2$. c. mv. d. 2 mv.
5. When a light ray falls on a metallic surface, the electrons are emitted when ....
   a. the frequency of the incident light is less than the critical frequency.
   b. the potential difference between the cathode and anode is very small.
   c. the energy of the incident photon is greater than the work function of the metal.
   d. the energy of the incident photon is less than the work function of the metal.
6. The work function of a surface depends on ....
   a. the intensity of the light falling on a surface.
   b. time of exposure of light.
   c. material of the metallic surface.
   d. potential difference between the cathode and anode.
7. If the frequency of the incident light on a metallic surface doubles, the work function of this metal ....
   a. increases to double. b. decreases to half.
   c. remains constant. d. decreases to the quarter.
8. If the work function of a metallic surface is 3.3125×10^{-19} J, so the critical frequency of this metal equals .... ($h = 6.625 \times 10^{-34}$ J.s)
   a. 4.5×10^{14} Hz. b. 4.8×10^{14} Hz.
   c. 5×10^{14} Hz. d. 5.5×10^{14} Hz.

9. If the work function of a metallic surface is 2.5 eV. So, the maximum wavelength of incident light to liberate electrons from the surface equals ....
(Knowing that : $e = 1.6 \times 10^{-19}$ C, $c = 3 \times 10^{8}$ m/s, $h = 6.625 \times 10^{-34}$ J.s)

a. 4×10^{-7} m. b. 5×10^{-7} m.
c. 5.5×10^{-7} m. d. 6×10^{-7} m.

10. Liberation of electrons from a metallic surface (in photoelectric effect) depends on .... *(2nd session 06)*

a. the intensity of the incident light. b. the velocity of the incident light.
c. the frequency of the incident light. d. the time of exposure to the light.

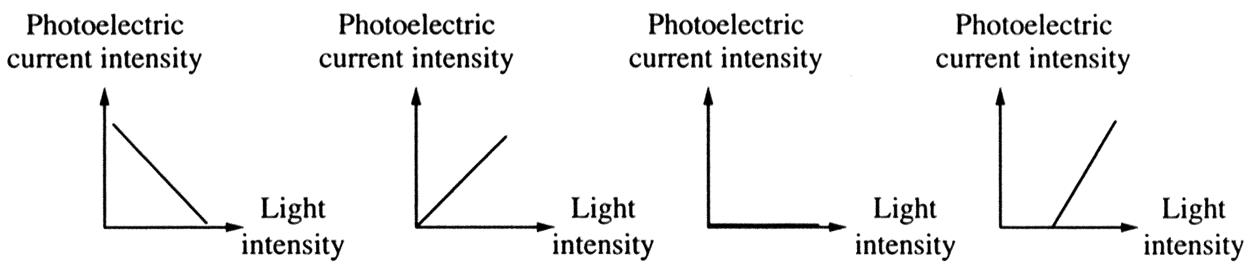
11. When a monochromatic light falls on a metallic surface , a number of electrons is liberated, if another monochromatic light of higher energy falls with the same intensity on the same metal, the number of liberated electrons .... *(1st session 14)*

a. increases. b. decreases.
c. doesn't change. c. no correct answer.

12. When a monochromatic light falls on a surface of metal, the electrons are liberated from its surface, if the intensity of incident light increased so, the number of liberated electrons .... *(2nd session 14)*

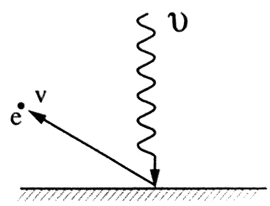
a. increases. b. decreases.
c. remains constant. d. no correct answer.

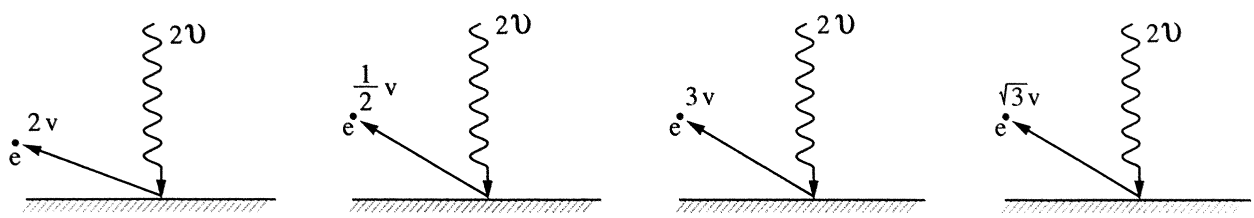
13. In the photoelectric effect phenomenon, if the frequency of the incident light is greater than the critical frequency, the graphical relation which represents the change in the intensity of the photoelectric current and the intensity of light is ....



(a) (b) (c) (d)

14. The opposite figure shows the occurrence of the photoelectric phenomenon at a certain surface of metal its work function is $\frac{1}{2}$ hυ, which of the following figures expresses this surface ? ....





(a) (b) (c) (d)

15. In two different experiments for studying the photoelectric phenomenon an electromagnetic radiation of frequency 4×10^{15} Hz , 6×10^{15} Hz has fallen on the surface of the same metal so that the ratio between the maximum kinetic energy for the emerged electrons in the first experiment to that emerged in the second experiment was 3 : 1, then the critical frequency for that surface is .... Hz.
a. 2×10^{15} b. 10^{15} c. 3×10^{15} d. 4×10^{15}

16. A light ray of wavelength 6000 Å has fallen on a metal surface where the incident light intensity was 39.6 W/m^2, if you know that only 1% of the incident photons liberate electrons, then the number of liberated electrons from the metal surface within one second for every 1 m^2 of the metal surface equals .... electrons.
(Where : $c = 3 \times 10^8$ m/s, $h = 6.625 \times 10^{-34}$ J.s)
a. 12×10^{16} b. 1.2×10^{18} c. 12×10^{18} d. 1.2×10^{15}

3 What is meant by ... ?

1. The work function (E_w) of zinc metal = 6.89×10^{-19} J *(1st session 06 - Sudan 11)*
2. The critical frequency of a metal surface = 3.35×10^{14} Hz *(2nd session 13)*
3. The critical wavelength of a metal surface = 5000 Å *(Exp. 16)*

4 Give reasons for :

1. The light which is emitted from radiating sources is variable.
2. • The maximum intensity of the emitted radiation from the Earth lies in infrared rays region.
   • Inability to see the emitted radiation from the Earth. *(1st session 13 - 2nd session 17)*
3. The color of radiation generated by heating a body is displaced until it becomes bright from red to yellow then finally to blue when the temperature increases.
4. The classical physics couldn't interpret Planck's curves (the relation between the intensity of radiation and the wavelength).
5. The anode in the photoelectric cell is a thin wire.
6. The classical physics could not explain the photoelectric effect.
7. Emission of the electrons in the photoelectric effect depends on the frequency of light not its intensity.
8. The photons fall on a metallic surface but it doesn't emit photoelectric electrons. *(1st session 12)*
9. Electrons are emitted from the surface of a sensitive metal when a dim blue light falls on it but they are not emitted when red light of high intensity falls on the surface of the metal.
10. The photoelectric electrons may be released acquiring kinetic energy.

5 Define :

1. The classical physics.
2. The quantum physics.
3. The blackbody.
4. Planck's curve. *(1st session 17)*
5. Wien's law. *(1st session 08 - 2nd session 14)*
6. The remote sensing.
7. A surface potential barrier.
8. The thermal emission.
9. The critical frequency of a metal. *(1st session 15)*
10. The work function of a metal. *(1st session 09, 11, 12 - 2nd session 10)*
11. The photoelectric effect phenomenon.
12. Photoelectric electrons. *(2nd session 15)*

6 What are the factors affecting each of the following :

1. The wavelength associating the maximum intensity of radiation. *(Sudan 14, 17)*
2. The work function of a metallic surface.
3. The liberation of the electrons from a metallic surface. *(Sudan 15)*
4. The generation of photoelectric current in the photoelectric cell.
5. Kinetic energy of the emitted electrons in the photoelectric effect.
6. The intensity of the photoelectric current.

7 Mention the scientific principle (scientific base) for each of the following :

1. The remote sensing instruments.
2. The cathode ray tube. *(1st session 14 - Sudan 14)*
3. The photoelectric cell. *(2nd session 11 - Sudan 11,12)*

8 What will happen in each of the following (mention the reason if possible) :

1. The intensity of the radiation at very short wavelengths and very long wavelengths.
2. The number of photons in radiation at very high frequencies in Planck's curve.
3. The intensity of the photoelectric current when a light of frequency greater than the critical frequency falls on a metallic surface with gradual increase in the intensity of the incident light. *(2nd session 07 - Azhar 11)*

9 What are the results for each of the following :

1. Increasing the temperature of the radiating source concerning the wavelength of the maximum intensity of radiation.
2. Transition of the atom from high energy level to low energy level.
3. Heating a metallic surface to very high temperature.
4. Falling of a light ray of high frequency on a surface of a metal with frequency less than the critical frequency. *(Sudan 07 , 11)*
5. • Falling of a light ray on a metallic surface with a frequency higher than the critical frequency.
   • Falling of a light ray of energy greater than the work function of the surface. *(Sudan 13)*

10 Mention one application for each of the following :

1. Infrared rays. *(2nd session 10)*
2. • The emission of the electrons from a metallic surface when heated. *(1st session 10)*
   • Thermoionic phenomenon. *(Sudan 15)*
3. The photoelectric effect phenomenon.

11 Mention one use for each of the following :

1. The microwaves. *(2nd session 06, 13 - 1st session 15)*
2. The photography by thermal emission. *(2nd session 08 - 1st session 15)*
3. The photoelectric cell. *(2nd session 11)*
4. Cathode ray tube. *(1st session 13)*
5. The grid in the cathode ray tube.
6. The electric and magnetic fields in the cathode ray tube. *(1st session 09)*

12 Compare between each of the following :

1. The emitted rays from the Sun (glowing body) and the emitted ray from the Earth (non-glowing body) (in terms of the region of the maximum intensity of radiation).
2. The emitted radiation from the Sun and the emitted radiation from electric lamp.
3. The effect of increasing the frequency of light and increasing the light intensity on the emitted electrons by the photoelectric effect. *(Exp. 15 , 16)*

13 Miscellaneous questions :

1. **How :**
   (a) 📖 Planck managed to explain the blackbody radiation phenomenon. *(Exp. 14)*
   (b) 📖 The blackbody radiation phenomenon proves the particle nature of light.
2. When does the intensity of radiation on Planck's curve reach zero? *(Azhar 11)*
3. 📖 Explain in details how the classical physics faced a problem to explain the graphs representing the radiation intensity versus wavelength for the glowing bodies at different temperatures.
4. Mention the condition of liberation (emission) of electrons from metallic surface when a light falls on it. *(1st session 07 , 11 - 2nd session 12)*
5. Mention three benefits for studying the emitted radiations from Earth and other bodies. *(2nd session 14)*
6. When a body is heated until it glows the color of radiations changes from red to yellow then to blue with increasing the temperature. Explain.

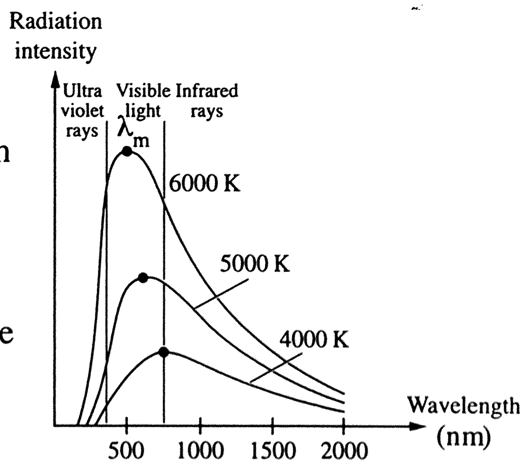
7. **From the opposite figure :**

(a) What are the names of these curves?

(b) Does the classical physics succeeded to explain these curves? And why?

(c) What is meant by (λ_m)?

(d) What will happen to (λ_m) when the temperature decreases?

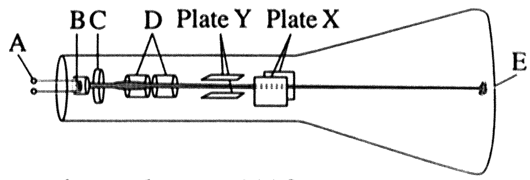


8. Explain by labelled diagram the structure of the cathode ray tube.

9. **The opposite figure :**

Represents a sketch for a cathode ray tube :

(a) Write the names of the following parts A, B, C, D, E.



(b) What will happen when an electric current passes through part (A)?

(c) Mention one application for the cathode ray tube in our daily life.

(d) What is the function of the plates (Y , X)?

10. Mention the hypotheses of Einstein to explain the photoelectric phenomenon.

(1st session 08 - Azhar 15)

11. Explain why the wave theory failed to interpret the photoelectric effect and how Einstein managed to interpret the experimental results of this phenomenon. *(Azhar 15)*

12. Write down the physical quantity which is determined by the following relation : $\frac{hc}{\lambda}$

13. **Mention the physical quantities that are measured by the following units :**

(a) $kg.m^2.s^{-1}$ *(Sudan 14)* (b) J.s *(Exp. 16)*

14. Although the source of red light has high intensity greater than the source of blue light but the red light source has no effect on the electron emission from a sensitive metallic surface unlike the source of blue light. Explain why.

15. From the study of the photoelectric effect phenomenon, draw a graphical relation between the intensity of the photoelectric current and the light intensity in the following cases :

(a) When the frequency of the incident photon is less than the critical frequency.

(b) When the frequency of the incident photon is greater than the critical frequency.

(Azhar 11)

16. In the experiment of the photoelectric emission from a metallic surface in an evacuated tube from air, the surface is exposed to a monochromatic light of frequency greater than the critical frequency of the metal, if the experiment repeated using a light of the same wavelength but its intensity is double that of the first.

What is the effect of that on each of the following : *(1st session 08)*

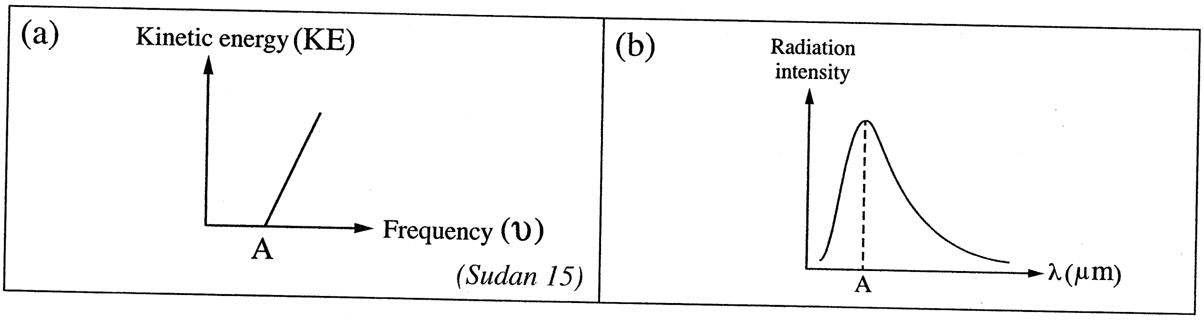
(a) The energy of the photons.

(b) The maximum kinetic energy of the emitted electrons due to falling of the light.

(c) The work function of the metal.

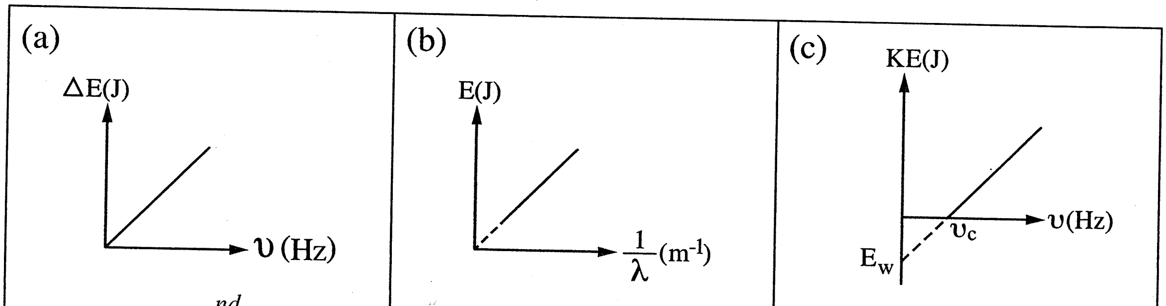
(d) The intensity of the photoelectric current.

17. **Write the quantity which is indicated by point (A) in the following two graphical figures :**



(Sudan 15)

18. **Write the mathematical relation and the equivalent to the slope for each of the following graphs :**



(2nd session 15)

(Where : (E) is photon energy, ($1/\lambda$) is the reciprocal of wavelength of photon, (KE) is the kinetic energy, (E_w) is the work function, (υ) is the frequency, (υ_c) is the critical frequency).

19. **Mention one of the factors to reduce the amount of each of the following :**

(a) The wavelength associating the maximum intensity of radiations which is emitted from a blackbody.

(b) The intensity of the photoelectric current which is emitted from a metallic surface.

14 Problems :

Guiding notes for solving problems

- Wien's law : $\frac{\lambda_1}{\lambda_2} = \frac{T_2}{T_1}$
- If the energy of the incident photon is greater than the work function :

  $E = E_w + KE$

  $E = h\upsilon = \frac{hc}{\lambda}$

  $E_w = h\upsilon_c = \frac{hc}{\lambda_c}$

  $KE = \frac{1}{2} m_e v^2$
- If the electron is placed in an electric field with a potential difference (V). So, it gains energy that changes into kinetic energy :

  $KE = \frac{1}{2} m_e v^2 = eV$
- The energy (in Joule) = The energy (in electron Volt) × Charge of the electron

Use the following constants if needed :

($c = 3 \times 10^8$ m/s , $h = 6.625 \times 10^{-34}$ J.s , $m_e = 9.1 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19}$ C)

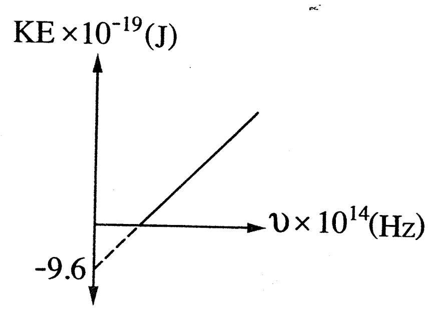
Wien's law

1. If the wavelength at the maximum radiation of the Sun is 500×10^{-9} m and the temperature of the envelope around the Sun is 6000°K, calculate the temperature of a radiating body when its wavelength associating the maximum radiation is 800×10^{-9} m. *(3750°K)*

The photoelectric effect phenomenon

2. If the critical wavelength of zinc is 3000 Å. Calculate its work function. *(6.625×10^{-19} J)*
3. Electrons are liberated from a metallic surface with velocity 4.6×10^5 m/s, if the wavelength of the incident light is 632 nm, **calculate :**
   (a) The critical frequency of the surface.
   (b) The work function of the surface. *(3.35×10^{14} Hz , 2.22×10^{-19} J)*
4. A light is incident on a metallic surface , the work function is 3 eV. **Calculate :**
   (a) The minimum frequency of a light to emit the photoelectric electrons.
   (b) The maximum wavelength of a light to emit the photoelectric electrons.
   (c) The frequency of a light to emit the photoelectric electrons of kinetic energy 2 eV.
   (7.25×10^{14} Hz, 4.14×10^{-7} m , 1.21×10^{15} Hz)

5. A photoelectric cell is used where different monochromatic light rays fall on the cathode and the opposite figure represents the relation between the kinetic energy of the emitted electrons and the frequency. **Calculate :**



(a) The critical wavelength of cathode's material.

(b) The frequency of the incident light until the electron liberate from the cathode's surface acquirs kinetic energy 9.6×10^{-19} J. *(2.07×10^{-7} m, 2.9×10^{15} Hz)*

6. If the energy required to liberate an electron from a metallic surface is 3.968×10^{-19} J when three monochromatic lights fall with wavelengths 7000 Å , 6200 Å , 5000 Å respectively :

(a) Which of these lights when falls on the surface of the metal liberates the electron ?

(b) **Calculate :**

1- The energy of the liberated electron.

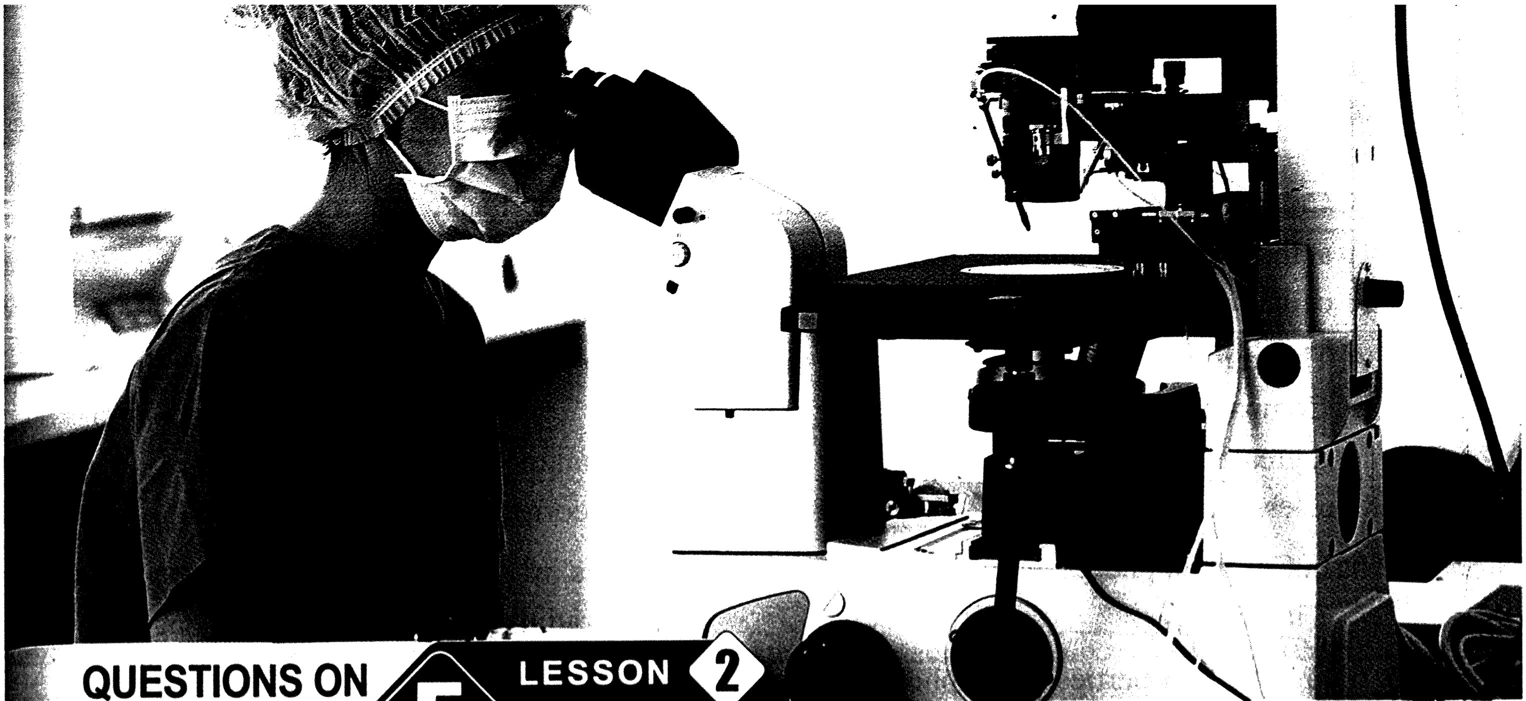
2- The velocity of this electron. *(7×10^{-22} J , 3.9×10^{4} m/s)*

7. When a monochromatic light of wavelength 4000 Å falls on a metallic surface , electrons are emitted with velocity equals 5.3×10^{5} m/s if another monochromatic light of wavelength 5500 Å fell on the same surface, do electrons emit from the metallic surface in this case? Explain mathematically. *(Doesn't emit) (2^{nd} session 08)*

8. A monochromatic light of wavelength (λ) is falling on a metallic surface, if the kinetic energy of the emitted electrons is 1.6×10^{-19} J and when another monochromatic light with wavelength $\frac{\lambda}{2}$ falls on the same surface the kinetic energy of the emitted electrons was 6.4×10^{-19} J. Calculate the work function of the surface. *(3.2×10^{-19} J)*

9. A red light of wavelength 670 nm and a green light of wavelength 520 nm have fallen on a metallic surface, thus electrons are emitted from the metallic surface in both cases, if the kinetic energy of the electrons in case of the green light equals 1.5 the kinetic energy emitted in case of the red light, calculate the work function of that surface. *(1.26×10^{-19} J)*

10. When the energy of the incident photons falling on a surface of photoelectric cell increases by 20%, then the kinetic energy of the electrons emitted from the metal surface increases from 0.5 eV to 0.8 eV, calculate the work function of that metal. *(1.6×10^{-19} J)*



QUESTIONS ON LESSON 2

Chapter 5

• Compton Effect. • Wave Particle Duality. • Electron Microscope.

1 Write down the scientific term for each statement of the following :

1. • Falling of a photon of very high energy on a free electron. So, the frequency of the photon decreases , changing its direction and the velocity of the electron increases and changing its direction. *(1st session 09)*

   • A photon of high frequency collides with a free electron where the frequency of the photon decreases and its direction changes. *(2nd session 13)*

2. A quantum of energy which is concentrated in a very small space and it has a mass and a linear momentum. *(Sudan 14 - Exp. 16)*

3. The wavelength of a wave associating a moving particle equals the ratio between Planck's constant and the linear momentum of the particle.

2 Choose the correct answer of the given answers :

1. According to Compton effect when a photon collides with a free electron. Then, ...
   a. the photon loses its energy.
   b. the electron gains a kinetic energy equals that of the photon energy.
   c. the frequency of the scattered photon is less than the frequency of the incident photon.
   d. the electron and the photon move together on the same line.

2. In Compton experiment , the sum of the photon energy and the electron energy before collision is .... the sum of their energies after collision.
   a. greater than b. less than
   c. equal to d. no correct answer

3. Compton effect proves ....

a. the wave nature of photons.
b. the particle nature of electron.
c. the particle nature of photons.
d. the wave nature of electron.

4. The ratio between the energy of photon after collision to its energy before collision in Compton effect is .... one. *(1st session 11)*

a. greater than
b. equal to
c. less than
d. no correct answer

5. In Compton phenomenon, the X-ray photon decreases in .... *(Exp. 15)*

a. its mass.
b. its velocity.
c. its radius.
d. its wavelength.

6. From the properties of the photon, ... *(Aug. 98)*

a. its velocity equals the velocity of light.
b. it can be accelerated.
c. it deflects by the electric field.
d. all the previous.

7. The law of conservation of mass can be combined with the law of conservation of energy in Einstein relation ....

a. $E = eV$
b. $E = \frac{1}{2} mv^2$
c. $E = mc^2$
d. $E = 2 mv^2$

8. The rest mass of the photon equals .... *(2nd session 99 , 03)*

a. hc/λ
b. $h/\lambda c$
c. h/λ
d. zero.

9. The mass of the photon during its motion equals .... *(2nd session 13)*

a. $h\upsilon/c$
b. zero.
c. $h\upsilon/c^2$
c. $h\upsilon /2 c$

10. The ratio between the photon energy and square the velocity of light is the .... of photon.

a. mass
b. frequency
c. kinetic energy
d. wavelength

11. The ratio between the photon energy and the velocity of light in air is the .... of photon. *(May 98 - 2nd session 05 , 07)*

a. mass
b. frequency
c. linear momentum
d. kinetic energy

12. A photon of wavelength (λ) and frequency (υ). So, its linear momentum is ....

a. h / λ
b. $h\upsilon / \lambda$
c. hc / λ
d. $h\upsilon / c^2$

(1st session 03 - Sudan 12)

13. A photon of wavelength (λ), frequency (υ) and velocity (c). So, its linear momentum equals .... *(2nd session 10)*

a. h / c
b. $h\lambda / c$
c. $h\upsilon / c$
d. no correct answer.

14. The ratio between the linear momentum of photon and its mass equals ....

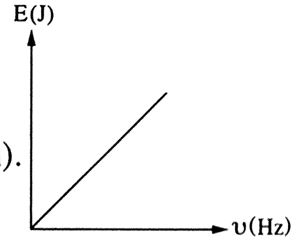
a. light velocity.
b. Planck's constant.
c. photon energy.
d. light frequency.

(1st session 09)

15. The ratio between the frequency of two photons is 1 : 2 so, the ratio between their energies is ....

a. 1 : 1 b. 1 : 2 c. 2 : 1 d. 4 : 1

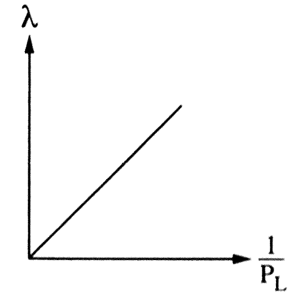
16. **The opposite graph :** Represents the relation between the energies of photons (E) and their frequencies (υ). So, the slope of the straight line equals .... *(1st session 07)*



a. the wavelength (λ). b. Planck's constant (h).

c. light velocity (c). d. the frequency (υ).

17. **The opposite graph :** Represents the relation between the wavelength (λ) of a beam of light rays and the reciprocal of the linear momentum ($1 / P_L$) of photons. So, the slope of the straight line equals .... *(1st session 10 - Azhar 15)*



a. light velocity. b. Planck's constant.

c. mass of the photon. d. no correct answer.

18. The wavelength (λ) associating a moving particle is determined from the relation : ....

a. c / P_L b. υ / P_L c. h / P_L d. P_L / h

19. All the following from the properties of the electron except ....

a. it has a wave nature during its motion.

b. it has a particle nature.

c. the wavelength associating the electron increases by increasing its velocity.

d. the wavelength associating the electron decreases by increasing its velocity.

20. If the number of the rebounded photons from a surface of metal in one second is (ϕ_L) and the frequency of the light (υ). So, the acting force on the surface equals ....

a. $2\, hc\phi_L / \lambda$ b. $2\, h\lambda\phi_L / c$ c. $2\, \lambda c\phi_L / h$ d. $2\, h\phi_L / \lambda$

21. If a light beam of power (P_w) fell on a certain surface, the acting force by which the beam of photons acts on this surface equals ....

a. $P_w / 2\,c$ b. $2\,P_w / c$ c. $2\,c / P_w$ d. $c / 2\,P_w$

22. The ratio between the dimensions of the viruses to be seen by electron microscope to the wavelength associating the used electrons beam .... one. *(2nd session 05)*

a. equals b. less than

c. greater than d. no correct answer

23. If the kinetic energy of an object is increased 16 times, then the change percentage in De-Broglie wavelength for that object is ....

a. 25 % b. 50 % c. 60 % d. 75 %

24. The sequence of the results which occur in the electron microscope when the potential difference between the cathode and anode increases is ....

	The kinetic energy of electrons	The wavelength associated the electron	The resolving power of microscope
a.	Increases	Increases	Increases
b.	Increases	Decreases	Decreases
c.	Increases	Decreases	Increases
d.	Decreases	Decreases	Decreases

(2nd session 17)

3 Give reasons for :

1. When a photon of X-ray falls on a free electron, its velocity increases and its direction changes.
2. The frequency of gamma ray photon decreases due to its collision with a free electron. *(2nd session 15)*
3. Compton phenomenon proves the particle nature of light.
4. The fission of the nucleus produces an enormous amount of energy.
5. The light has a wave particle duality.
6. • The wavelength associating the electron decreases by increasing its linear momentum. *(2nd session 01)*
   • The wavelength associating the electron decreases by increasing its velocity. *(1st session 15)*
7. The acting force due to a light ray, its effect appears on an electron, but doesn't appear on the surface of a wall, or a piece of metal coin.
8. The optical microscope can't be used to see the details of the viruses. *(Aug. 98)*
9. As the potential difference between the cathode and anode in the electron microscope increases, the wavelength associating the moving electron decreases. *(2nd session 14)*
10. The resolving power of the electron microscope is very high.

4 What is meant by ... ?

1. Compton effect.
2. Photon.
3. Wave particle duality.

5 What are the factors affecting each of the following :

1. The wavelength of a wave associating a moving particle.
2. The ability of viruses detection. *(Azhar 15)*

6 Mention the condition of occurrence for each of the following :

1. Observing the details of the structure of a tiny body by using the microscope. *(1st session 99 - Sudan 08 - Exp. 15)*
2. Examining the tiny body using the microscope. *(Exp. 15)*

7 What are the results for each of the following :

1. Falling of a photon of (γ) ray on a free electron. *(1st session 06 - 2nd session, Sudan 12)*
2. Falling of photons on a surface, the enteratomic spaces between its atoms are less than the wavelength of the photons.
3. Falling of photons on a surface, the enteratomic spaces between its atoms are greater than the wavelength of the photons.
4. • Increasing the linear momentum of a particle concerning the wavelength associating it.
   • Increasing the velocity of the electron concerning its wavelength. *(2nd session 12)*

8 Mention one application for each of the following :

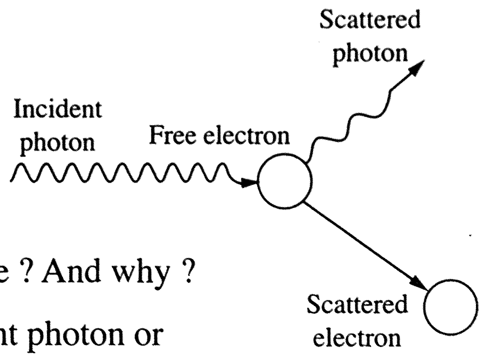
1. Einstein's relation to convert the mass into energy. *(2nd session 15)*
2. The wave particle duality property (De-Broglie concept for particles). *(1st session , Sudan 15)*

9 Compare between each of the following :

1. The electron and the photon. *(1st session 05, 07 - 2nd session 10)*
2. The electron microscope and the optical microscope (in terms of : the type of used rays - the type of used lenses - resolution (resolving power). *(1st session 00,03 - 2nd session 07 - Azhar 11)*

10 Miscellaneous questions :

1. How the macroscopic model and microscopic model are related to the photon ?
2. Explain Compton effect and show how it proves the particle nature of light ? *(Azhar 11)*
3. From studying Compton effect, mention what happens after collision for each value of the following, then mention the reason : *(1st session 10)*
   (a) The photon energy.
   (b) The photon velocity.
4. The opposite figure represents a certain phenomenon :
   (a) What is the name of this phenomenon ? and what does the property prove ?
   (b) Does the velocity of the scattered electron increase ? And why ?
   (c) Which one is bigger, the wavelength of the incident photon or the wavelength of the scattered photon ? And why ?



5. **Mention the mathematical relation which represents each of the following :**

(a) The relation between the mass and the energy according to Einstein proof. *(Sudan 14)*

(b) • The produced force due to collision of photons with a surface in the rate ϕ_L *(2nd session 14)*

• The force by which a beam of photons affects a surface. *(2nd session 15)*

6. **Prove that :**

The force by which a light beam whose power is P_w acts on a surface when it falls on it is determined from the relation : $F = 2 P_w / c$

Find mathematically the force by which a beam of photons acts on a certain surface. *(Azhar 15)*

7. A light ray of frequency (υ) falls on a surface, then it reflects if we considered that the number of falling photons is (ϕ_L) photon in one second then : *(Azhar 11)*

(a) The linear momentum of the incident photon = ...

(b) The linear momentum of the reflected photon = ...

(c) The change in the linear momentum of the photon = ...

(d) The rate of total change in the linear momentum of photons = ...

(e) The acting force of a light ray on a surface = ...

8. • Deduce the relation between the wavelength of the photon and its linear momentum. *(2nd session 11)*

• Prove mathematically that the wavelength associating the movement of the photon is inversely proportional to its linear momentum. *(1st session 14)*

9. If a proton and electron move with the same velocity, compare between the wavelength for each one according to De-Broglie equation.

10. Explain the scientific idea (scientific principle) of electron microscope. *(1st session 04 - 2nd session 06 , 10 , 11 , 12 - Sudan 16)*

11. Mention one use for the electron microscope. *(2nd session 15)*

12. The electron microscope is a practical example for the wave particle duality of the electrons. Explain the idea of this instrument and mention how it is distinguishable from the optical microscope and why?

13. Mention the name of the instrument which its idea of working depends on the wave particle duality of electrons and mention one use of it. *(Sudan 08, 10 - 2nd session 14)*

14. Mention one factor to reduce the wavelength which is associating the electronic ray. *(Exp. 15)*

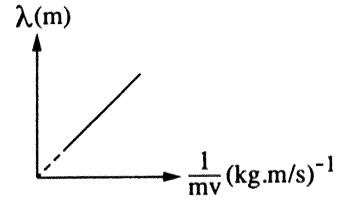
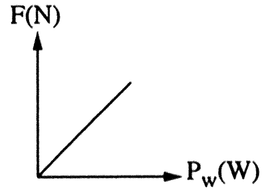
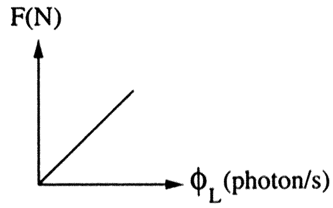
15. **Write the physical quantities which is determined by the following relations :**

(a) $\frac{h\upsilon}{c^2}$ (b) $\frac{h\upsilon}{c}$ (c) $\frac{h}{P_L}$

(d) $\frac{h}{\lambda c}$ (e) $\frac{h}{\lambda}$ (f) $\frac{P_w}{h\upsilon}$

(g) $\frac{2P_w}{c}$

16. **Write the mathematical relation and the equivalent to the slope for each of the following :**

(a)	(b)	(c)
		
(1st session 99)		*(1st session 14)*

(Where : (λ) the wavelength associating the moving particle, (m) particle's mass, (v) particle's velocity, (F) the acting force on a light ray, (P_w) the power of the light ray, (ϕ_L) the rate of falling photons).

11 Problems :

Guiding notes for solving problems

- To determine the mass of the moving photon (m) :

$$m = \frac{E}{c^2} = \frac{h\upsilon}{c^2} = \frac{h}{c\lambda} \text{ (kg)}$$

- To determine the linear momentum of the photon (P_L) :

$$P_L = mc = \frac{E}{c} = \frac{h\upsilon}{c} = \frac{h}{\lambda} \text{ (kg.m/s)}$$

- To determine the energy of the photon (E) :

$$E = h\upsilon = \frac{hc}{\lambda} \text{ (J)}$$

$$E = mc^2 = P_L c \text{ (Einstein equation)}$$

- To determine the wavelength associating the moving body (λ) :

$$\lambda = \frac{h}{P_L} = \frac{h}{mv} \text{ (De-Broglie equation)}$$

- To determine the force by which a beam of photons acts on a surface (F) :

$$F = 2\,mc\phi_L = \left(\frac{2\,h\upsilon}{c}\right)\phi_L = \left(\frac{2\,h}{\lambda}\right)\phi_L = \frac{2\,P_w}{c} \text{ (N)}$$

$$P_w = E\phi_L = h\upsilon\phi_L = \frac{hc}{\lambda}\phi_L \text{(W)}$$

(Where P_w is the power of the incident light)

- To determine the number of photons in one second (ϕ_L) :

$$\phi_L = \frac{P_w}{h\upsilon} \text{ (photon / sec)}$$

Use the following constants if needed :

($c = 3 \times 10^8$ m/s , $h = 6.625 \times 10^{-34}$ J.s , $m_e = 9.1 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19}$ C)

The force by which a beam of photons acting on a surface

1. Calculate the acting force of a beam whose power is 1000 kW on a surface. *(6.67×10^{-3} N)*
2. 📖 Calculate the force by which a beam whose power 100 kW affects an object whose mass is 10 kg, what happens if the object is an electron and why? *(0.67×10^{-3} N) (Sudan 12)*
3. A light ray of power 4000 W falls on a surface of a table, calculate the force of light beam, does the table move ? *(2.67×10^{-5} N)*

The wave particle duality

4. 📖 The wavelength of a photon is 770 nm, **calculate :**
   (a) The energy of the photon.
   (b) Its mass during moving.
   (c) Its linear momentum. *(2.58×10^{-19} J, 2.87×10^{-36} kg , 8.61×10^{-28} kg.m/s)*
5. **Calculate the wavelength of De-Broglie wave which is associating :**
   (a) A gold ball of mass 46 g moves with velocity 30 m/s.
   (b) Electron moves with velocity 10^7 m/s. *(4.8×10^{-34} m , 7.28×10^{-11} m)*
6. 📖 A ball of mass is 140 g and moves with a velocity 40 m/s. **Calculate :**
   (a) The wavelength associating its motion.
   (b) The wavelength of an electron if it moves with the same velocity. *(1.18×10^{-34} m , 1.82×10^{-5} m)*
7. 📄 Calculate the wavelength which is associating the movement of the proton when it moves with velocity 3.3×10^5 m/s if its mass is 1.7×10^{-27} kg. *(1.18×10^{-12} m)*
8. If the velocity of the electron of hydrogen atom is 2.2×10^6 m/s, calculate the wavelength which is associating it. *(3.31×10^{-10} m)*
9. 📄 An insect moves with velocity 12 m/s if the wavelength of the wave which is associating the movement of the insect is 5.5×10^{-30} m. What is the mass of this insect ? *(10^{-5} kg)*
10. 📖 Calculate the mass of X-ray photons and γ-ray photons if the wavelength of X-ray is 100 nm and that of γ-ray is 0.05 nm. *(2.21×10^{-35} kg , 4.42×10^{-32} kg)*
11. Calculate the velocity of an electron when a wave of wavelength 1 Å associates its motion. *(7.28×10^6 m/s)*

12. A body of mass 10 kg moves with velocity 5 m/s, calculate the wavelength which is associating it then compare between this wavelength and the wavelength which is associating the electron if it is moving with the same velocity.

(1.325×10^{-35} m , 9.1×10^{-32})

13. A light ray of wavelength 8×10^{-7} m and its power 200 W falls on a certain surface, **calculate :**

(a) The linear momentum of the photon.

(b) The force by which it acts on this surface.

(8.28×10^{-28} kg.m/s , 1.33×10^{-6} N) (2^{nd} session 09)

14. A radio station emits a wave whose frequency is 92.4 MHz. **Calculate :**

(a) The energy of each photon emitted from this station.

(b) The rate of the emitted photons ϕ_L if the power of the station is 100 kW.

(6.12×10^{-26} J , 1.63×10^{30} photon/s) (Azhar 11)

Cathode ray tube and electron microscope

15. If the least distance detected with an electron microscope is 1 nm, calculate the velocity of the electron and the potential of the anode. *(728×10^{3} m/s , 1.51 V)*

16. Find the least wavelength in the emitted radiation from a cathode ray tube which has a potential difference 5×10^3 V. *(1.74×10^{-11} m)*

17. If the potential difference between the anode and cathode of electron microscope is 500 V, calculate the De-Broglie wavelength which is associating the electrons beam.

(5.49×10^{-11} m)

18. An electron is under a potential difference 20 kV. Calculate its velocity upon collision with the anode , then calculate the wavelength associating its motion and its momentum. *(83.86×10^{6} m/s , 8.68×10^{-12} m , 7.63×10^{-23} kg.m/s)*

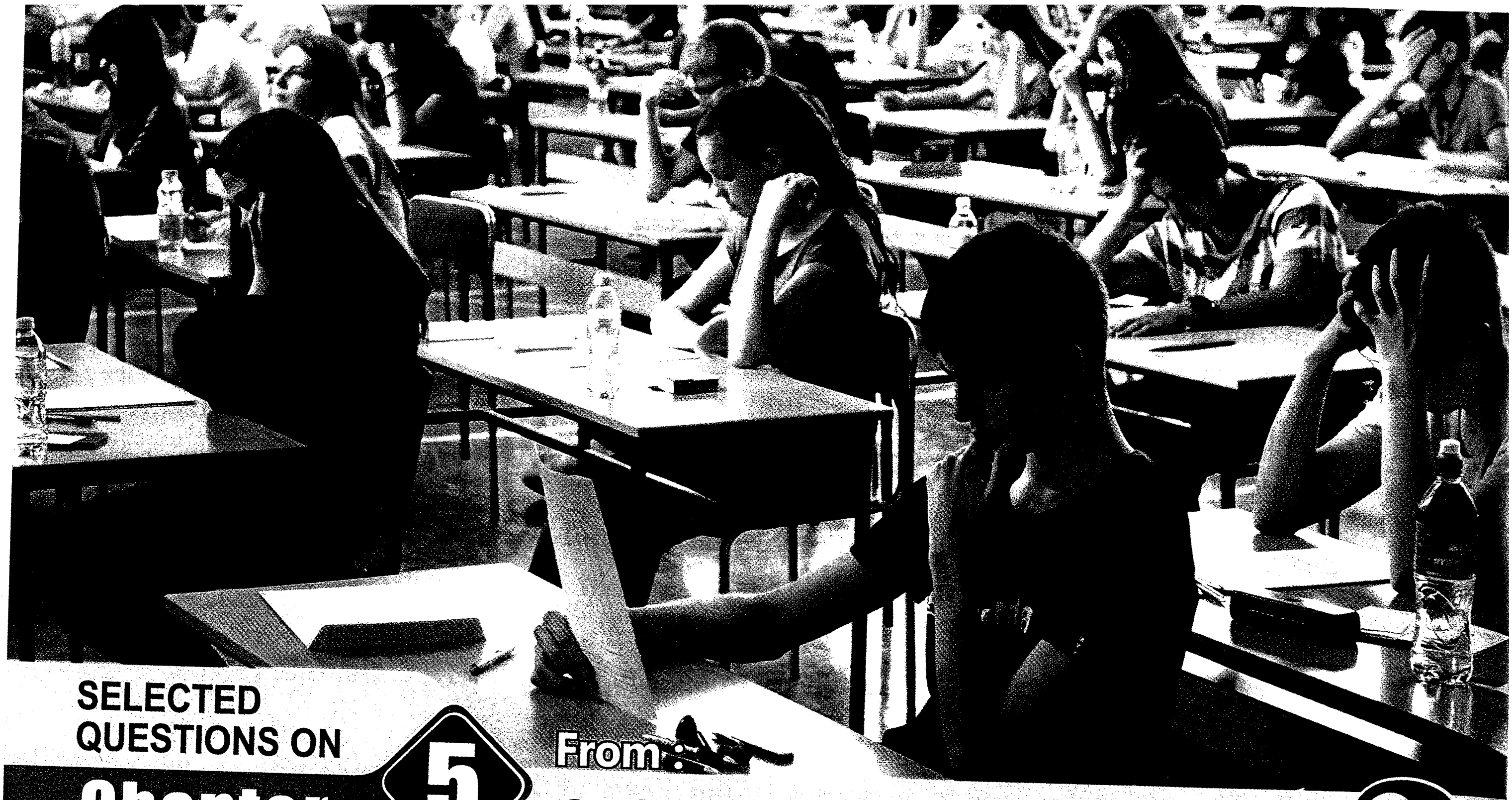
19. A photon of frequency υ collided a free electron so that the electron speed is increased by v and the photon frequency is decreased by $\frac{1}{2}\upsilon$, if the experiment is repeated using photons having the same frequency, find the change in the speed of electron if the frequency value is decreased after collision. *($\frac{1}{\sqrt{2}}$ v , $\sqrt{\frac{3}{2}}$ v)*

(a) By value $\frac{1}{4}\upsilon$ (b) To $\frac{1}{4}\upsilon$

20. X-ray photon with frequency 6×10^{18} Hz collides with a free electron each of them scattered and the scattered photon frequency became 2×10^{17}Hz given that the electron mass = 9.1×10^{-31}kg and Planck's constant = 6.625×10^{-34}J.s. **Calculate** the change in each of the following :

(a) The energy of X-ray photon.

(b) The electron velocity due to collision. *(3.48×10^{-15} J, 9.19×10^{7} m/s) (Sudan 17)*



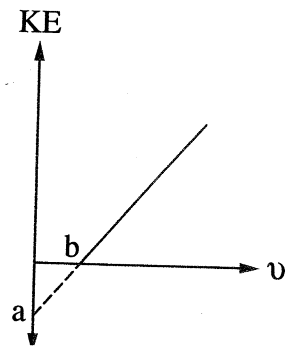
SELECTED QUESTIONS ON Chapter 5

From :

- **Student Evaluation Guide (2017).**
- **Booklet Models of the Ministry of Education.**

1 Choose the correct answer of the given answers :

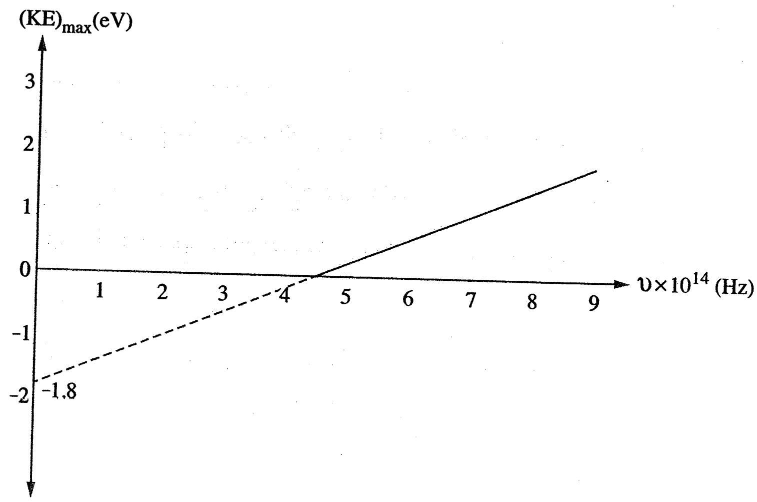
1. In the opposite graph, KE represents the maximum kinetic energy of the emitted electron in the photoelectric effect and (υ) represents the frequency of the falling light on a metal. The ratio between (a) to (b) represents .... *(Booklet 3)*



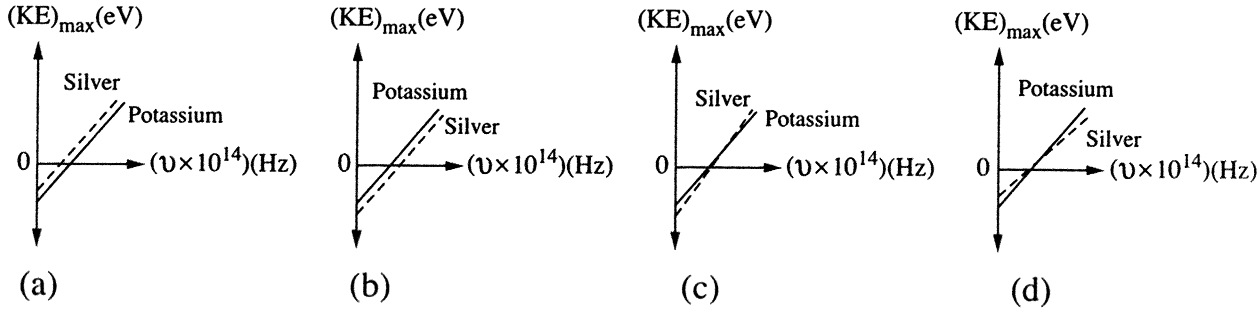
a. Planck's constant. b. critical frequency.

c. work function. d. photon energy.

2. The following graph represents the maximum kinetic energy for the emitted electrons from the potassium metal at different frequencies :



Which of the following graphs represents the correct comparison when replacing the potassium metal with silver metal which its work function equals (4.73 eV) ? ....



3. In Compton effect, gamma photon is scattered and its .... increases. *(Booklet 2)*

a. energy b. speed c. wavelength d. momentum

4. Laser source of power 300 mW at wavelength 6630 Å, so the number of photons are emitted from this source each minute is .... photon.

(Knowing that : $c = 3 \times 10^8$ m/s, $h = 6.625 \times 10^{-34}$ J.s)

a. 6×10^{16} b. 6×10^{17} c. 6×10^{18} d. 6×10^{19}

5. A static electron is accelerated under the effect of 2500 V, what is its final velocity ? ....(Knowing that : $m_e = 9.1 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19}$ C)

a. 3×10^7 m/s b. 2.5×10^8 m/s c. 2.5×10^6 m/s d. 1.5×10^8 m/s

6. If the momentum of a body increases by 25 %, so its kinetic energy increases approximately by ....

a. 65 % b. 56 % c. 38 % d. 25 %

7. If the kinetic energy of a particle is increased 16 times, then the ratio of change in the wavelength of De-Broglie is ....

a. 25 % b. 50 % c. 60 % d. 75 %

2 Give reasons for :

1. The emitted radiation from the human body is invisible.
2. The visible light can't penetrate through a lot of materials.

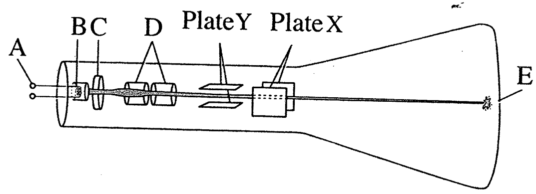
3 Mention one application for each of the following :

1. Wien's law.
2. The thermal radiation which is emitted from the human body.

4 Miscellaneous questions :

1. Mention two of the physical phenomena which the classical theory can't interpret them.
2. Compare between thermal imaging and photography imaging (in terms of the type of the used radiation).
3. Mention one use for the microwaves.
4. **What is meant by :** The surface potential barrier.

5. The opposite figure represents a sketch for the cathode ray tube.



(a) Write the names of the following parts A, B, C, D and E.

(b) What happens when an electric current passes through the part (A) ?

(c) Mention one of the applications of a cathode ray tube in our daily life.

6. **Mention the contribution of the following scientists in the theory of wave particle duality :**

(Booklet 3)

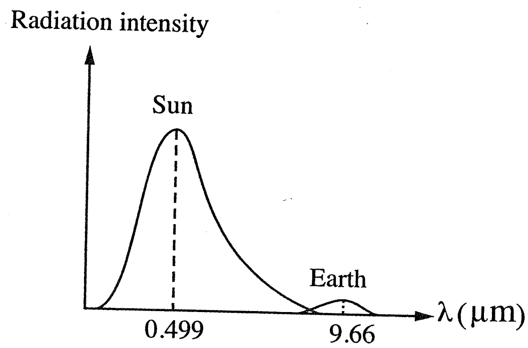
(a) Compton. (b) De-Broglie.

7. If a photon of gamma rays collides with a free electron what will happen to its properties :

(a) Its particle properties. (b) Its wave properties.

5 Problems :

1. The opposite figure represents the relation between the intensity of the emitted radiation from hot bodies and the wavelength. If you know that the temperature of the Sun surface is 6000° K, use the given data in the figure to calculate the average temperature of the Earth surface. *(309.94°K)*



2. If the potential difference in cathode ray tube 1000 Volt and the charge of electron 1.6×10^{-19} C and mass of electron 9.1×10^{-31} kg, calculate each of :

(a) Maximum kinetic energy of electrons.

(b) The maximum velocity of the emitted electrons from the cathode.

(1.6×10^{-16} J , 1.88×10^{7} m/s)

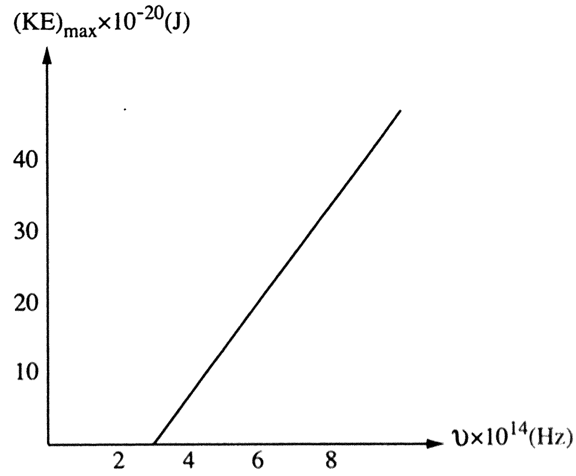
3. Some particles which have the same type and amount of charge are affected by the same potential difference, the following table represents the masses of these particles :

Particle	Mass (kg)
A	3×10^{-31}
B	27×10^{-31}
C	81×10^{-31}

(a) Find the ratio between the kinetic energy which gained by these particles.

(b) Determine the two particles which the ratio between their velocities (1 : 3), then find the ratio between the associating wavelength for each of them. *($1 : 1 : 1 , \frac{1}{3}$)*

4. The following graph represents the relation between the maximum kinetic energy of emitted electrons from a metallic surface (A) and the frequency of incident light, depending on the figure, **answer each of the following :**

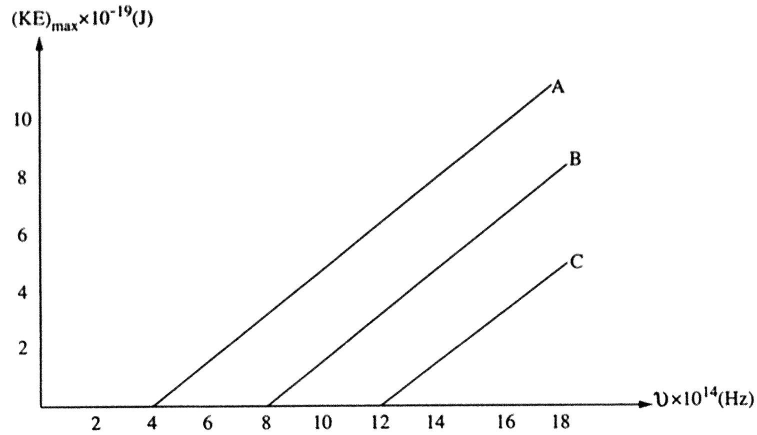


(a) What is the critical frequency of the metal ?

(b) Calculate the wavelength of light which causes the emission of electrons with a maximum kinetic energy equals 20×10^{-20} J.

(c) If the metal (A) is replaced by another metal (B) of critical frequency double the critical frequency of metal (A), draw on the same graph, the relation between the maximum kinetic energy of the emitted electrons from the metallic surface (B) and the frequency of light falling on it and show what happens for the slope of the resulted line. Explain your answer. *(3×10^{14} Hz , 5×10^{-7} m)*

5. The opposite graph represents the relation between the maximum kinetic energy of the emitted electrons from the surfaces of three metals and the frequency of the incident light on it, depending on the figure :



(a) Calculate the work function of the metal B.

(b) If a light with a certain frequency is incident such that it liberates electrons from the three metals, which of the liberated electrons has the highest kinetic energy ?

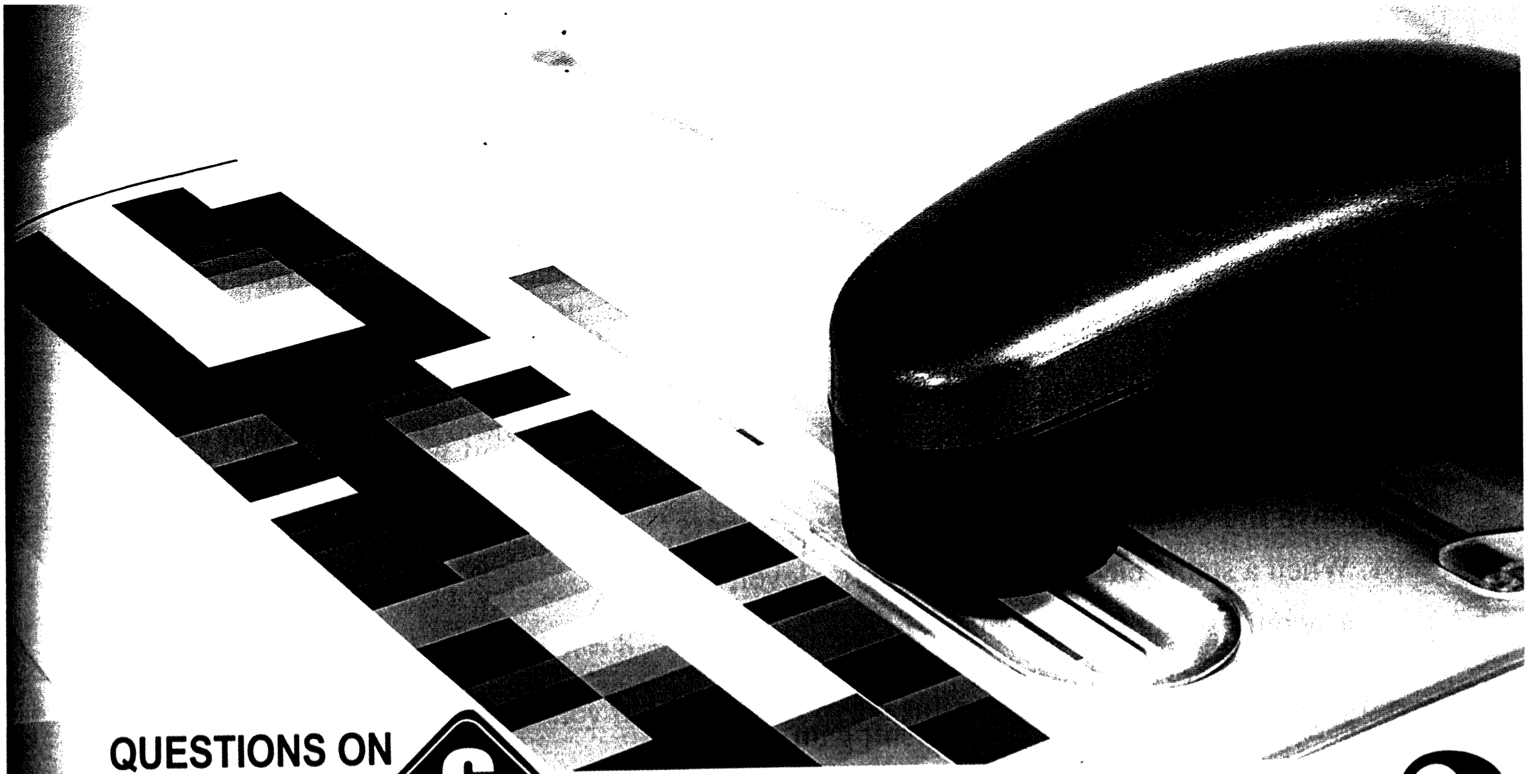
(c) If monochromatic light of frequency (7×10^{14} Hz) has fallen on the surface of each metal, what is the maximum kinetic energy of the liberated electrons from the metal ?

(d) What is the least suitable frequency required to liberate electron from any of these metals ? *(5.3×10^{-19} J , 1.99×10^{-19} J , 12×10^{14} Hz)*

Chapter 6

Atomic Spectra

- Questions on Chapter Six.
- Selected Questions on Chapter 6 from :
  - Student Evaluation Guide (2017).
  - Booklet Models of the Ministry of Education.



QUESTIONS ON

Chapter 6

Atomic Spectra

1 Write down the scientific term for each statement of the following statements :

1. • A series of spectrum lines lies in the infrared rays region due to returning an electron back from an external level to the third level (M) in the hydrogen atom spectrum.
   • A spectrum group is resulted due to returning of electrons back to the third level in the hydrogen atoms. *(2nd session 14)*
2. A series of spectrum lines lies in the infrared rays region due to returning an electron back from an external level to the fourth level (N) in the hydrogen atom spectrum.
3. A series of spectrum lines lies in the maximum region of the infrared rays due to returning an electron back from an external level to the fifth level (O) in the hydrogen atom spectrum.
4. A device used in obtaining a pure spectrum by analyzing the light into its visible and invisible components.
5. A spectrum of non overlapping colors and each color has a certain wavelength.
6. • A spectrum contains all the possible wavelengths. *(Aug. 98 - Sudan 17)*
   • A spectrum includes continuous distribution of frequencies and wavelengths.
7. • A spectrum includes certain wavelengths.
   • A spectrum includes non continuous distribution of wavelengths and frequencies. *(Azhar 06 - Sudan 14 - 2nd session 15)*
8. A spectrum resulted from the transition of an excited atom from high energy level to low energy level.

9. Dark lines of some wavelengths in the continuous spectrum of white light and these lines are due to absorption of the element vapor to the characteristics spectrum lines.
10. Line absorption spectra of the elements in the solar envelope.
11. Invisible electromagnetic rays their wavelengths lie between the wavelengths of ultraviolet rays and gamma rays and is characterized by a short wavelength.

2 Choose the correct answer of the given answers :

1. When a stable electron is in an energy level, it ....
   a. acquires energy and remains in this level.
   b. loses energy and remains in this level.
   c. remains in this level as it doesn't gain energy.
   d. no correct answer.
2. The atom emits a photon when ....
   a. it ionizes.
   b. the electron moves from the least energy level to higher energy level.
   c. it loses an electron.
   d. the electron moves from higher level in energy to the lower level.
3. When the electron moves from energy level (E_1) to the energy level (E_2) where $E_1 < E_2$, then ....
   a. the atom absorbs photon of energy equals ($E_2 - E_1$).
   b. the atom emits photon of energy equals ($E_1 - E_2$).
   c. the atom absorbs photon of energy equals ($E_1 + E_2$).
   d. the atom emits photon of energy equals ($E_1 + E_2$).
4. The line spectrum group of hydrogen atom which lies in the visible region is called .... group. *(2nd session 06)*
   a. Pfund b. Lyman c. Balmer d. Bracket
5. The spectrum of Paschen's series lies in the region of ....
   a. ultraviolet rays. b. visible light. c. infrared rays. d. X-rays.
6. The spectrum of Bracket's series of hydrogen atom lies in the region of ....
   a. ultraviolet rays. b. infrared rays.
   c. visible spectrum. d. no correct answer.
7. Lyman's series is produced when an electron moves from one of the external orbits of hydrogen atom to .... orbit , a spectrum lines are resulted and lie in the ultraviolet rays region.
   a. fourth b. third c. second d. first

8. In Balmer's series of hydrogen atom spectrum, the electron moves from the higher levels to the .... level. *(1^{st} session 12)*

a. first b. third c. second d. fourth

9. The largest wavelength in Balmer's series results from transition of an electron between the two orbits ....

a. 7 to 2 b. 7 to 1 c. 3 to 2 d. 2 to 1

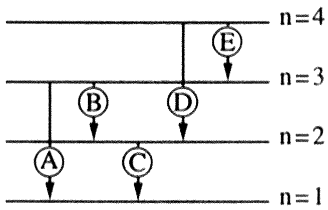
10. The longest wavelength in Lyman's series results from transition of an electron between the two levels ....

a. $n = 3 \longrightarrow n = 2$ b. $n = 8 \longrightarrow n = 2$ c. $n = \infty \longrightarrow n = 1$ d. $n = 2 \longrightarrow n = 1$

11. The maximum frequency in Balmer's series results from transition of the electrons between levels ....

a. $n = 4 \longrightarrow n = 1$ b. $n = \infty \longrightarrow n = 2$ c. $n = 6 \longrightarrow n = 2$ d. $n = 3 \longrightarrow n = 2$

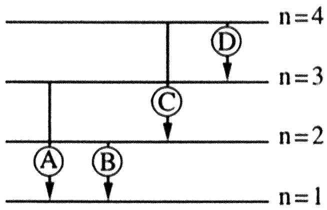
12. The opposite figure represents many transitions (A), (B),(C),(D),(E) of an electron for hydrogen atom between energy levels, which one of these transitions gives spectrum line lies in Balmer series ? ....



a. (A) and (B). b. (A) and (C).

c. (E) only. d. (B) and (D).

13. The opposite figure represents four transitions of an electron for hydrogen atom between energy levels, which one of the following statements is correct ? ....



a. The transition (D) gives a spectrum line has the least wavelength.

b. The transition (C) gives a spectrum line in the ultraviolet rays region.

c. The transition (B) gives a spectrum line in the infrared rays region.

d. The transition (A) gives the highest frequency between these transitions.

14. If the possible number of energy levels for the electron movement in an atom is four energy levels and the electron can move between any two levels of these levels. So, the number of spectrum lines which can be emitted is .... *(1^{st} session 07)*

a. 3 b. 6 c. 8 d. 4

15. The black lines which appear in the solar spectrum (Fraunhofer lines) are considered the spectra of .... *(2^{nd} session 99 - Sudan 07 - 1^{st} session 09)*

a. emission. b. line absorption.

c. line emission. d. continuous absorption.

16. The resulted spectrum from the transition of the excited atom from high level to low level is called .... spectrum. *(1st session 13)*
   a. absorption
   b. emission
   c. continuous
   d. no correct answer

17. The continuous spectrum of X-rays is called ....
   a. braking radiation.
   b. bremsstrahlung.
   c. soft X-rays.
   d. all the previous.

18. The wavelength of the characteristic radiation in X-rays depends on ....
   a. the voltage difference between target and filament.
   b. type of target's material.
   c. temperature of the filament.
   d. no correct answer.

19. X-rays are used in studying the crystalline structure of the material as they have the ability to .... *(Sudan 15)*
   a. penetrate.
   b. ionize the gases.
   c. diffract.
   d. all the previous.

20. In the hydrogen atom the ratio between the longest wavelength in Lyman's series to the longest wavelength in Balmer series is ....
   a. $\frac{5}{36}$
   b. $\frac{5}{27}$
   c. $\frac{27}{5}$
   d. $\frac{4}{36}$

21. Production of X-ray in coolidge tube can be considered a model for energy transformation .... *(2nd session 17)*
   a. Mechanical energy - electric energy - electromagnetic energy.
   b. electromagnetic energy - Mechanical energy - electric energy.
   c. electric energy - Mechanical energy - electromagnetic energy.
   5. electric energy - electromagnetic energy - Mechanical energy.

3 Give reasons for :

1. Several spectral serieses are formed when a group of hydrogen atoms is excited. *(1st session 14)*
2. • Lyman's series of hydrogen atom spectrum has the highest energy while Pfund's series has the least energy.
   • Lyman's series in hydrogen atom spectrum has the least wavelength while Pfund's series has the largest wavelength.
3. Balmer's series of hydrogen atom can be seen while Pfund's series can't be seen.
4. The line spectrum isn't emitted from the material unless it is in the form of separate atoms or in the gaseous state under low pressure.
5. The appearance of dark lines in the solar spectrum known as the Fraunhofer lines. *(May 97 - 2nd session 00, 04, 15)*

6. X-rays have a great penetrating power through the materials. (2nd session 14)
7. Using high potential difference in Coolidge tube to generate X-rays. (Azhar 11)
8. The X-rays generated from Coolidge tube have very high frequencies.
9. There is a continuous spectrum for X-rays.
10. • The wavelength of the characteristic spectrum of X-rays depends on the type of the target material and not the potential difference between the cathode and the target.
• There is a line spectrum for the X-rays characteristic for the target material. (Sudan 07)
11. X-rays are used in studying the crystalline structure of materials. (1st session 09, 17 - Azhar 11 - Sudan 11,13, 16)
12. X-rays are used in detecting the structural defects in the materials used in the metallurgical industry.
13. The X-rays are used to diagnose the fracture of bones.

4 Define :

1. Pure spectrum.
2. Continuous spectrum.
3. Line spectrum. (Sudan 16)
4. The emission spectrum. (Azhar 11)
5. Line absorption spectrum.
6. Fraunhofer lines. (1st session 12 , 14)
7. X-rays.
8. Braking radiation. (2nd session 15)
9. The intensive spectrum of X-rays.

5 What are the factors affecting each of the following :

1. The continuous spectrum of X-ray. (2nd session 14 - Sudan 15)
2. The wavelength of the line spectrum (characteristic) of X-rays. (1st session 14,16 - Exp.15)

6 What are the conditions of obtaining each of the following :

1. Pure spectrum by spectrometer. (2nd session 08)
2. The absorption spectrum of gas. (Exp. 15)
3. • The characteristic line spectrum of an element in Coolidge tube. (2nd session 06)
• Characteristic X-rays spectrum of a target material.

7 Mention the scientific base of each of the following :

1. Dividing the spectrum of hydrogen atom into five groups.
2. Using X-rays in studying the crystalline structure of materials. (2nd session 07 - Exp. 16)
3. Using X-rays in the bone fracture photography.

8 What happens in each of the following cases ... ?

1. Falling of the electron from higher energy level to lower energy level.
2. Exciting an electron from its energy level to higher energy level.
3. Exciting hydrogen atoms with different quantum energies.
4. Returning an electron of hydrogen atom from higher energy levels to level (M) (n = 3).
5. Passing a white light through gas (or vapor of element) and analyzing the resulted spectrum. *(Sudan 08 - 2nd session 10)*
6. Applying low potential difference between the filament and the target in Coolidge tube.
7. Replacing the target in Coolidge tube by another metal. *(1st session 08)*
8. Changing the type of the target material in Coolidge tube by another element with larger atomic number. *(1st session 13 - Sudan 15 , 16)*
9. Penetration of free electrons of very high kinetic energy to the target material in Coolidge tube. *(1st session 08)*
10. Passing X-rays through gas.
11. Passing X-rays through the atoms of crystalline material. *(1st session 08)*

9 Mention the function of each of the following :

1. Spectrometer. *(1st session 08 , 15 - 2nd session 06, 07, 12, 17 - Exp. 16)*
2. Objective lens in the spectrometer. *(2nd session 15 - Exp. 16)*
3. Coolidge tube. *(Sudan , 1st session 14)*
4. The filament in Coolidge tube to generate X-rays. *(2nd session 09 - Azhar 11)*
5. The electric field or the potential difference between the cathode and the target in Coolidge tube. *(2nd session 13)*

10 Compare between each of the following :

1. Pfund spectrum series and Lyman spectrum series (in terms of : the region which it lies in - the wavelength - the frequency). *(Sudan 07 , 11, 13 , 16 - 2nd session 07, 08)*
2. Paschen's series and Bracket's series in hydrogen atom spectrum of Bohr (in terms of : the reason of appearance - its position in the spectrum).
3. Balmer and Lyman serieses in the hydrogen atom spectrum (in terms of : the region which it lies in - the wavelength of the photon resulted from moving the electron from infinity). *(1st session 09 , 13 , 15)*
4. Pfund series and Balmer series (in terms of the wavelength of the emitted rays for each of them). *(1st session 14)*

5. 📖 The characteristic line spectrum and the continuous spectrum for X-rays (in terms of : definition - the relation between the wavelength and the potential difference between the filament and the target in Coolidge tube - the way of generating each of them). *(1st session 04, 07, 10, 17 - 2nd session 10 - Sudan 10, 14)*

6. Two target materials in Coolidge tube, one has low atomic number, while the other has high atomic number (in terms of the frequency of the line radiation for each of them). *(2nd session 14)*

11 Miscellaneous questions :

1. **Mention the used mathematical relation to calculate each of the following :**
   (a) The energy level in hydrogen atom.
   (b) • The wavelength of the characteristic X-rays. *(Azhar 11 - 2nd session 14 - 1st session 15)*
   • The wavelength of the characteristic line spectrum of X-rays. *(Sudan 15)*

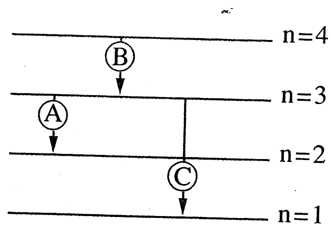
2. When does the line emission spectrum of hydrogen atom lie in the visible spectrum region ? *(2nd session 15)*

3. **Mention :**
   (a) Bohr hypotheses for explaining how the atom model benefited from Rutherford model.
   (b) The characteristics of Pfund's series of the hydrogen atom spectrum. *(2nd session 10 - 1st session 12)*
   (c) Three properties of Lyman's series in the hydrogen atom series. *(2nd session 12)*
   (d) The characteristics of X-rays. *(Sudan 10 - 1st session 12, 14 - 2nd session 13)*
   (e) Three applications of X-rays. *(2nd session 09, 10 - 1st session 15)*
   (f) The case of emission of line spectrum from the hydrogen atom that has the maximum wavelength in the visible region. *(Sudan 17)*

4. **How :**
   (a) 📖 Bohr was able to explain the spectrum of hydrogen atom.
   (b) • 📖 The spectrometer is used to obtain a pure spectrum. *(Azhar 11)*
   • Can we obtain a pure spectrum. Explain by drawing. *(Azhar 15 - Sudan 17)*
   (c) To differentiate between the Balmer spectrum series and Lyman spectrum series. *(1st session 07)*
   (d) Can you increase the value of the minimum wavelength of a continuous spectrum of X-rays.
   (e) Can you change the wavelength of the emitted characteristic spectrum of X-rays in Coolidge tube? *(2nd session 08)*
   (f) Can the characteristic line spectrum of X-rays be produced. *(2nd session 09)*
   (g) Can you identify each of the line absorption and the line emission spectra then classify the Fraunhofer lines for each of them. *(2nd session 02)*
   (h) Can you identify the gases forming the stars ?

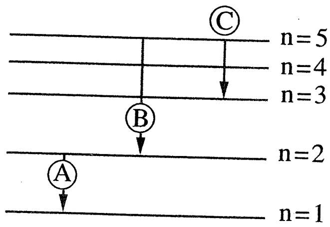
5. **Explain by schematic drawing and writing the labels :**
   (a) The spectrum lines serieses of the hydrogen atom.
   (b) The spectrometer. *(Azhar 11)*
   (c) The structure of Coolidge tube. *(Azhar 15)*

6. **The opposite figure :** Represents three transitions Ⓐ, Ⓑ and Ⓒ for an electron of hydrogen atom between the energy levels.
Which one of these transitions gives a spectrum line :
(a) Lies in Paschen's group.
(b) Lies in the visible spectrum region.
(c) Has the shortest wavelength.



(1^{st} session 10)

7. **The opposite figure :** Represents three transitions Ⓐ, Ⓑ and Ⓒ in hydrogen atom spectrum series.
(a) Which one of these transitions gives a line spectrum :
1- In infrared rays region.
2- Has higher energy.
(b) What is the name of the series in which the resulted photon from transition Ⓑ belongs to ?



(Sudan 15)

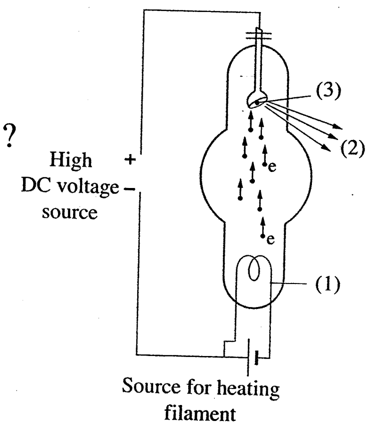
8. Calculate the possible emitted spectrum lines in the hydrogen spectrum supposing that the electron can move between any two levels from (N) to (K). (Showing your answer by drawing a schematic diagram of energy levels). *(6)*

9. Explain by drawing the way of obtaining X-rays by using Coolidge tube. *(Azhar 15)*
Then explain why these rays are used in studying the crystalline structure of the materials and explain the generation of the continuous spectrum or the connected spectrum. *(1^{st} session 06 - Exp. 16 - Sudan 08)*

10. Obtaining X-rays is considered as the inverted photoelectric theory. Discuss.

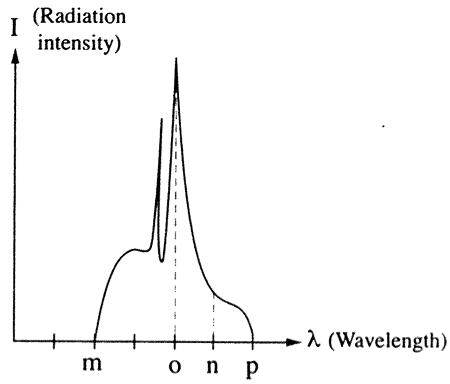
11. One of the steel companies suspect that one of the competitors adds a small fraction of the rare ground element to the products. How can you determine the type of that element in the shortest possible time ?

12. **In the opposite figure :**
(a) Mention the name of the device and its uses.
(b) What does the following numbers (1), (2) and (3) indicate ?
(c) What is the function of the used potential difference ?
(d) Why is the use of tungsten as a target in this tube ?
(e) Why is the positive pole (anode) made of copper and it is provided with cooling fins ?
(f) How can you change the strength of penetration of the resulted X-rays ?
(g) How can you change the strength of the resulted X-rays ?



(Exp. 14)

13. The following figure represents the X-ray spectrum produced from Coolidge tube. Which wavelength (m, o, n or p) is emitted from the target material due to the electron transition from higher energy level to energy level close to the nucleus. *(1st session 17)*



12 Problems :

Guiding notes for solving problems

- To determine the radius of the orbit of the electron in hydrogen atom :
  $2\pi r = n\lambda$ (Where n is the order of energy level)
- To determine the energy of any level (E_n) in hydrogen atom : $E_n = -\frac{13.6}{n^2}$ (eV)
- To determine the difference in energy between two levels (ΔE) : $\Delta E = E_{high} - E_{low}$
- The energy (in Joule) = The energy (in eV) × Charge of electron
- To determine the energy of the resulted radiation transition of the electron from high energy level to low energy level : $E = h\upsilon = \frac{hc}{\lambda}$
  (Where υ is the frequency of radiation)
- To determine the highest energy of the photon (shortest wavelength) : Emitted when the electron moves from energy level (E_∞) to level of energy (E_n) :
  $E_\infty - E_n = \frac{hc}{\lambda}$ $E_\infty = 0$
- To determine the least energy of photon (longest wavelength) : Emitted when the electron moves from level of energy (E_{n+1}) to level of energy (E_n) :
  $E_{(n+1)} - E_n = \frac{hc}{\lambda}$

⇒ **Coolidge tube:**

- The work done on the electron (eV) is converted into kinetic energy :
  $eV = \frac{1}{2} m_e v^2$
- The shortest wavelength (λ) of the produced X-rays is determined from the relation :
  $\lambda = \frac{hc}{eV}$

Use the following constants if needed :

($e = 1.6 \times 10^{-19}$ C , $m_e = 9.1 \times 10^{-31}$ kg , $h = 6.625 \times 10^{-34}$ J.s , $c = 3 \times 10^8$ m/s)

Serieses of hydrogen atom spectrum

1. According to Bohr's model of the atom if the wavelength of the wave associating the motion of the electron in the second energy level is 6.66×10^{-10}, **calculate :**
   (a) The radius of the second orbit of the electron.
   (b) The velocity of the electron in the second level. *(2.12×10^{-10} m , 1.09×10^{6} m/s)*
2. Calculate the radius of the third orbital of the electron when it moves with velocity 7.28×10^{5} m/s in hydrogen atom. *(4.77×10^{-10} m)*
3. Calculate the wavelength in Angstrom for a scattered spectrum of hydrogen atom when an electron moves from the fourth level to the first level. Knowing that the energy of the electron in the fourth and the first levels are – 0.85 eV and –13.6 eV respectively. *(974 Å)*
4. If the energy of the electron in each of the fourth and the third levels of hydrogen atom are respectively -1.36×10^{-19} J and -2.41×10^{-19} J. Calculate the wavelength of the emitted light when the electron transfers from the fourth level to the third level in Angstrom. *(18928.57 Å) (Sudan 08)*
5. If the energy of the electron in the first energy level of hydrogen atom is – 13.6 eV and the radius of the orbit in the first level is 0.53 Å, **calculate :**
   (a) The wavelength of the wave associating the electron in the first level.
   (b) The velocity of the electron in the first level.
   (c) The wavelength of the photon which is necessary to excite the electron to the third energy level. *(3.33×10^{-10} m , 2.19×10^{6} m/s, 1.03×10^{-7} m)*
6. Calculate the wavelength of the produced radiation in hydrogen atom when the electron moves from the fifth level to the second level. (Knowing that : $E_1 = -13.6$ eV) *(4349.4 Å)*
7. **Calculate the shortest and the largest wavelength in the groups of the following hydrogen atom spectrum :**
   (a) Balmer group. (b) Lyman group. (c) Pfund group.
   (3653 Å , 6576 Å, 913 Å , 1218 Å , 22834 Å , 74731 Å)
8. If you know that the shortest wavelength in one of the hydrogen atom spectrum serieses is 14610 Å, what is the name of this series ? Then calculate the largest wavelength of this spectrum. *(40594 Å)*
9. If the energy of hydrogen atom levels (first , fourth and fifth) are (-21.76×10^{-19} , -1.36×10^{-19} , -0.87×10^{-19}) J respectively knowing that the velocity of light is 3×10^{8} m/s), **calculate :**
   (a) The wavelength of the resulted radiation due to returning an electron back from the fifth energy level to the first energy level.
   (b) The minimum frequency in Bracket series. *(9.51×10^{-8} m , 7.4×10^{13} Hz) (2nd session 14)*
10. A photon of wavelength 486.1 nm is emitted from the hydrogen atom.
   (a) Calculate thc photon energy in eV.

(b) Using the opposite table which indicates the energy of some energy levels in hydrogen atom, determine the two energy levels between which is the electron transition. (Knowing that the spectrum range of visible light from 400 nm to 700 nm).

Energy level	Energy level (eV)
K	– 13.6
L	– 3.4
M	– 1.51
N	– 0.85

(2.55 eV , from N to L) (Exp. 15)

11. A free electron of kinetic energy equals 20 eV collides with a stable hydrogen atom then it was excited to a certain level and the electron scatters with velocity less than the collision velocity, if a photon of wavelength 1.216×10^{-7} m is emitted from the hydrogen atom when it returned back to stability. Calculate the velocity of the scattered electron. *(1.86×10^{6} m/s)*

Coolidge tube

12. If the potential difference between the anode and cathode of the tube of generating X-rays is 13255 V. What is the maximum frequency of the continuous spectrum for these rays ? *(3.2×10^{18} Hz)*

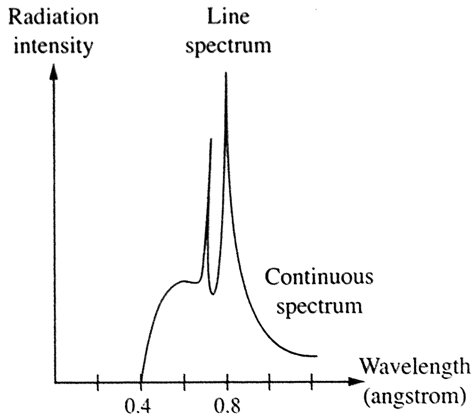
13. In Coolidge tube if the energy required to emit the characteristic spectrum of X-rays is 1.9875×10^{-15} J. Calculate the wavelength of this ray. *(1 Å)*

14. In a tube to generate X-rays if the energy of the accelerated electron is 5×10^{-18} J, calculate the shortest wavelength of the resulted rays. *(3.975×10^{-8} m)*

15. Calculate the shortest wavelength of the generated X-rays in Coolidge tube when the voltage difference equals :
(a) 10000 V. (b) 50000 V. *(1.24 Å , 0.248 Å)*

16. If you know that the shortest wavelength of the produced X-rays from Coolidge tube is 0.414 Å, **calculate :**
(a) The maximum energy of the photons of X-rays.
(b) The applied potential difference. *(4.8×10^{-15} J , 30×10^{3} V)*

17. The opposite figure represents the emitted X-rays spectrum from Coolidge tube, **calculate :**
(a) The potential difference between the filament and the target.
(b) The minimum voltage difference required to emit the characteristic line spectrum.
(c) The maximum frequency for the produced X-rays.



(31.05×10^{3} V , 1.55×10^{4} V , 7.5×10^{18} Hz)

18. If knowing that the electric current intensity passing through the filament of Coolidge tube is 7 mA when the potential difference between the filament and the target is 30 kV, **calculate :**

(a) The energy of the emitted electrons from the filament.

(b) The shortest wavelength of the produced X-rays.

(c) The number of electrons reaching the target each second.

(d) The velocity of the electron at the moment of arrival to the target.

(4.8×10^{-15} J , 0.414 Å , 4.375×10^{16} electrons , 10.27×10^{7} m/s)

19. The X-rays tube operates at potential difference equals 40 kV and electric current passes through the tube equals 5 mA , **calculate :**

(a) The minimum wavelength of the resulted X-rays.

(b) The number of electrons which collides the target in one second.

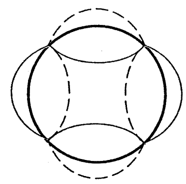
(c) The rate of the used electrical energy in the tube.

(d) The used electrical energy by the tube in one second.

(e) The energy rate of the resulted X-rays if the efficiency of the tube is 2%.

(3.1×10^{-11} m , 3.125×10^{16} electrons , 200 W , 200 J , 4 W)

20. The opposite figure shows the standing wave associating the electron motion of the hydrogen atom in one of the orbits, calculate the radius of the orbit if the speed of that electron in that orbit is 1.09×10^{6} m/s.

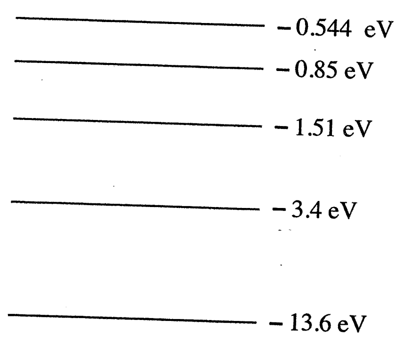


(2.13×10^{-10} m)

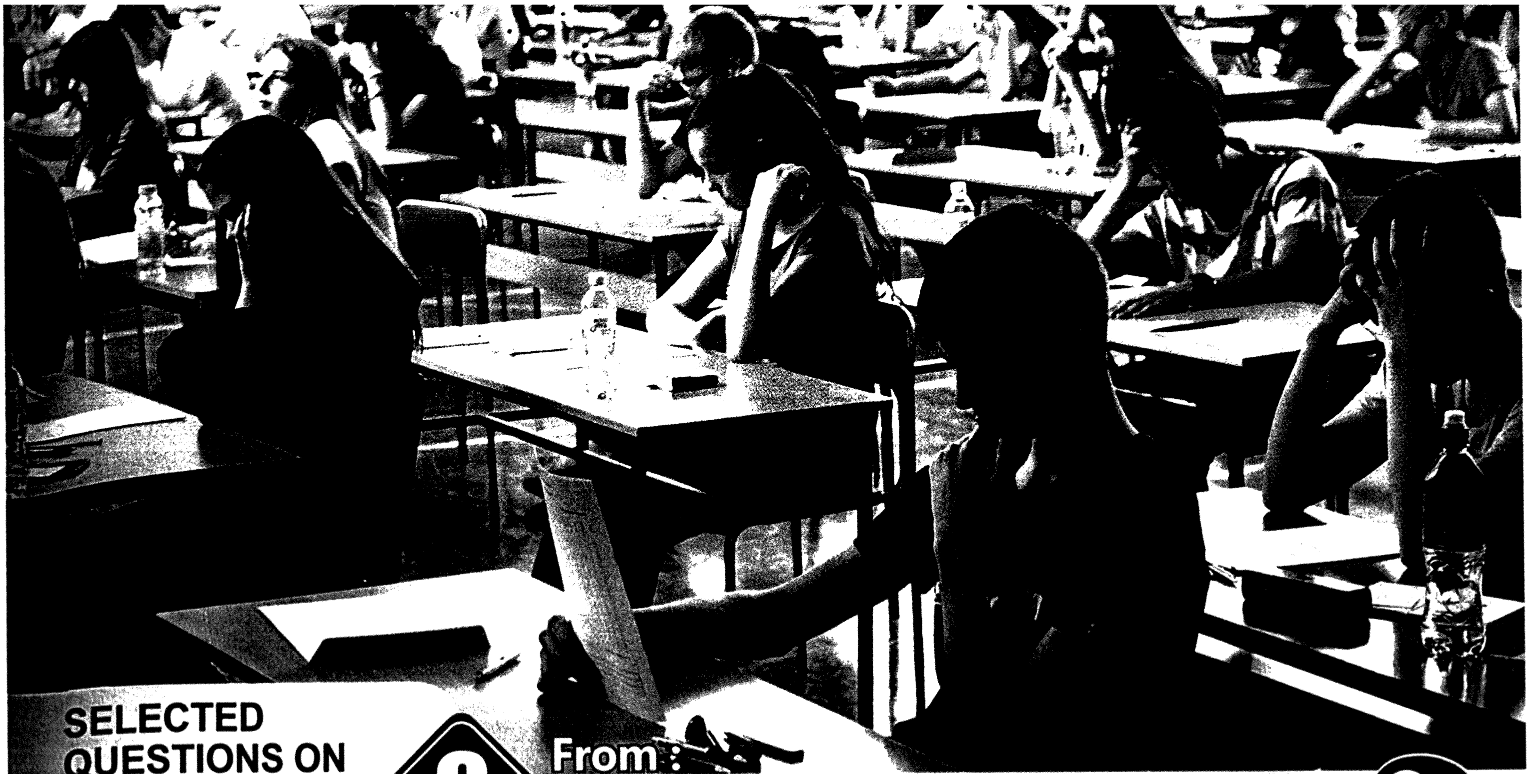
21. The opposite figure shows some of the levels in the hydrogen atom, draw arrows on the drawing to show the transition that produces a photon of wavelength :

(a) 656 nm.

(b) 487 nm.



(1.89 eV , 2.55 eV)



SELECTED QUESTIONS ON

Chapter 6

From :

- **Student Evaluation Guide (2017).**
- **Booklet Models of the Ministry of Education.**

1 Choose the correct answer of the given answers :

1. The ratio between the largest wavelength in Lyman and Balmer serieses in hydrogen atom spectrum is ·········

   a. $\frac{5}{27}$ b. $\frac{3}{23}$ c. $\frac{7}{27}$ d. $\frac{9}{31}$

2. The spectrum of a glowing body such as the Sun is ········· spectrum.

   a. continuous b. line absorption c. line emission d. no correct answer

2 Miscellaneous questions :

1. How would you explain presence of invisible spectrum serieses of hydrogen gas ? *(Booklet 2)*
2. **Which is maximum**, the velocity of the emitted photons from hydrogen atoms in Balmer's series or the velocity of emitted photons in Paschen's series ? And why ?
3. **Write the scientific term :**
   The type of X-rays that is given in Coolidge tube as a result of the transition of an electron in the target atom from a higher level to a level near the nucleus.
4. What are the results based on using molybdenum (atomic number 42) instead of tungsten (atomic number 74) as a target material in Coolidge tube with respect to the produced wavelengths of X-rays ? *(Booklet 2)*
5. Mention one factor affecting the kinetic energy of the emitted electrons from the filament of Coolidge tube.

3 Problems :

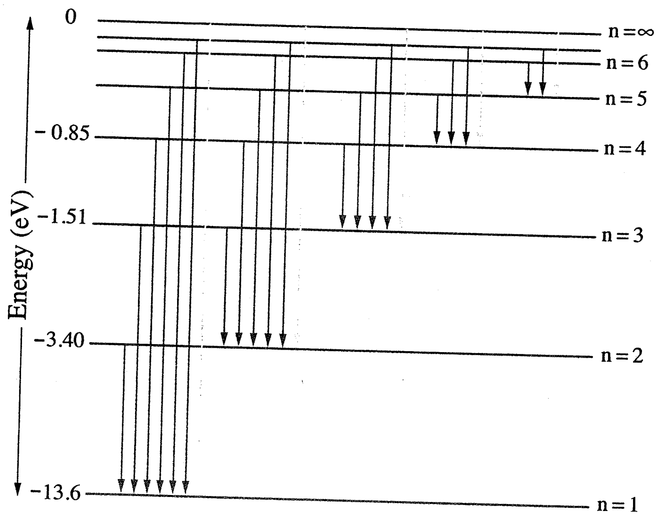
Use the following constants if needed :

($e = 1.6 \times 10^{-19}$ C , $m_e = 9.1 \times 10^{-31}$ kg, $h = 6.625 \times 10^{-34}$ J.s, $c = 3 \times 10^{8}$ m/s)

1. Calculate the longest wavelength of spectrum in the visible region emitted by the hydrogen atom.

(6.57×10^{-7} m) (Booklet 4)

2. From the following figure, when an electron of hydrogen atom in the fourth energy level, what is :



(a) The minimum frequency of photons which the atom emits in this case.

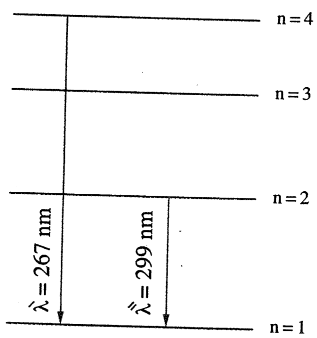
(b) The maximum frequency of photons which the atom emits in this case.

(c) The number of possible emission of photons of different frequency if the atom contains one electron which can move through the four energy levels only.

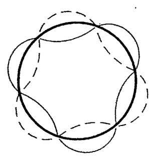
(1.59×10^{14} Hz , 3.08×10^{15} Hz, 6)

3. The opposite figure shows the wavelengths emitted from the atom of a certain element at the electron transition from high energy levels to the first energy level.

Calculate the energy of the emitted photons at electron transition from the fourth energy level to the second energy level. *(7.97×10^{-20} J)*



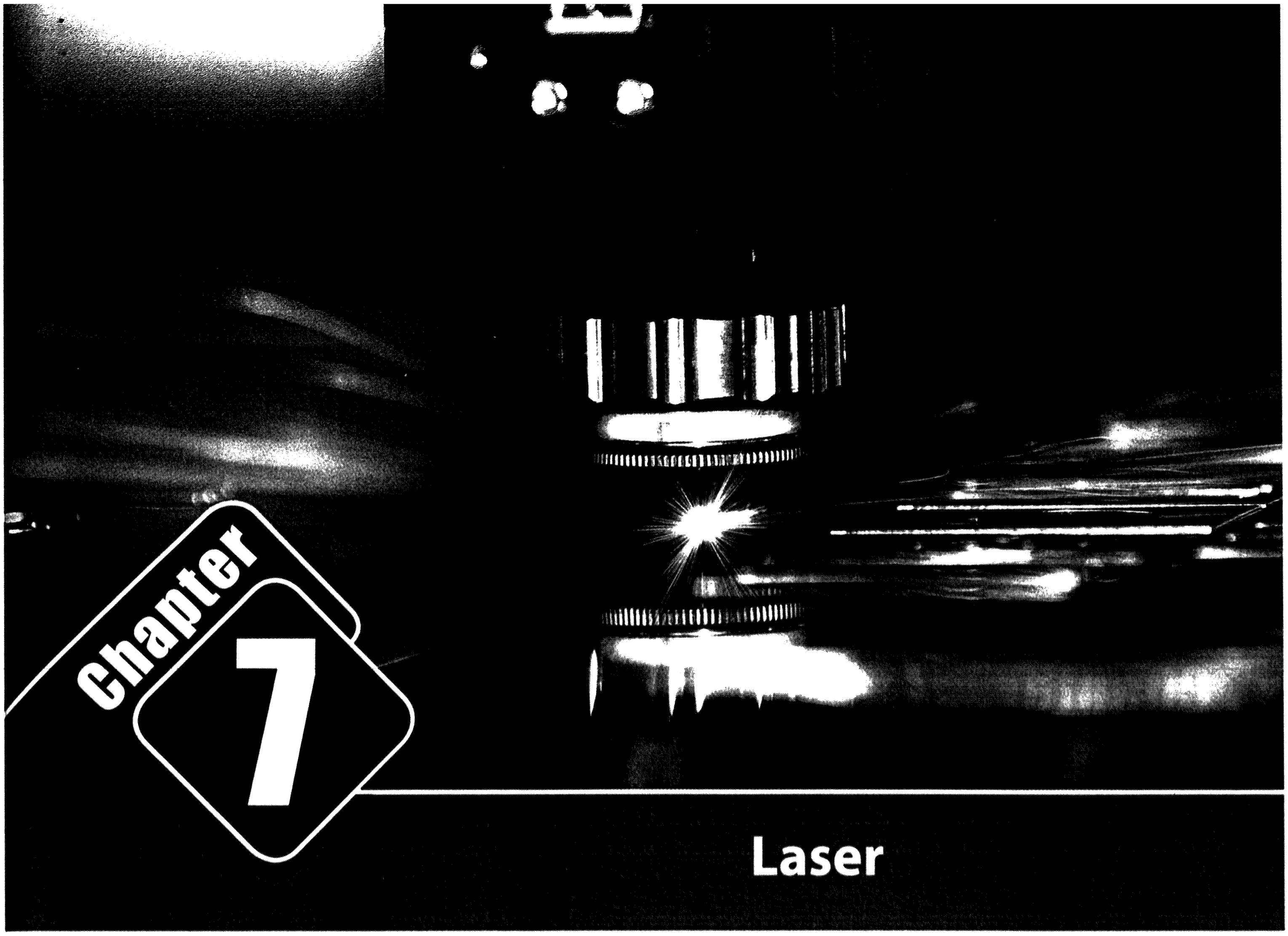
4. The opposite figure represents a standing wave associating an electron of hydrogen atom in one of the energy levels of hydrogen atom according to Bohr's model, study the figure, then answer the following questions :



(a) What is the order of the orbit (n) from the nucleus which this electron is found in it ?

(b) If knowing that the radius of the level which the electron is found in equals 4.761×10^{-10} m , what is the wavelength of the standing wave associating the electron ?

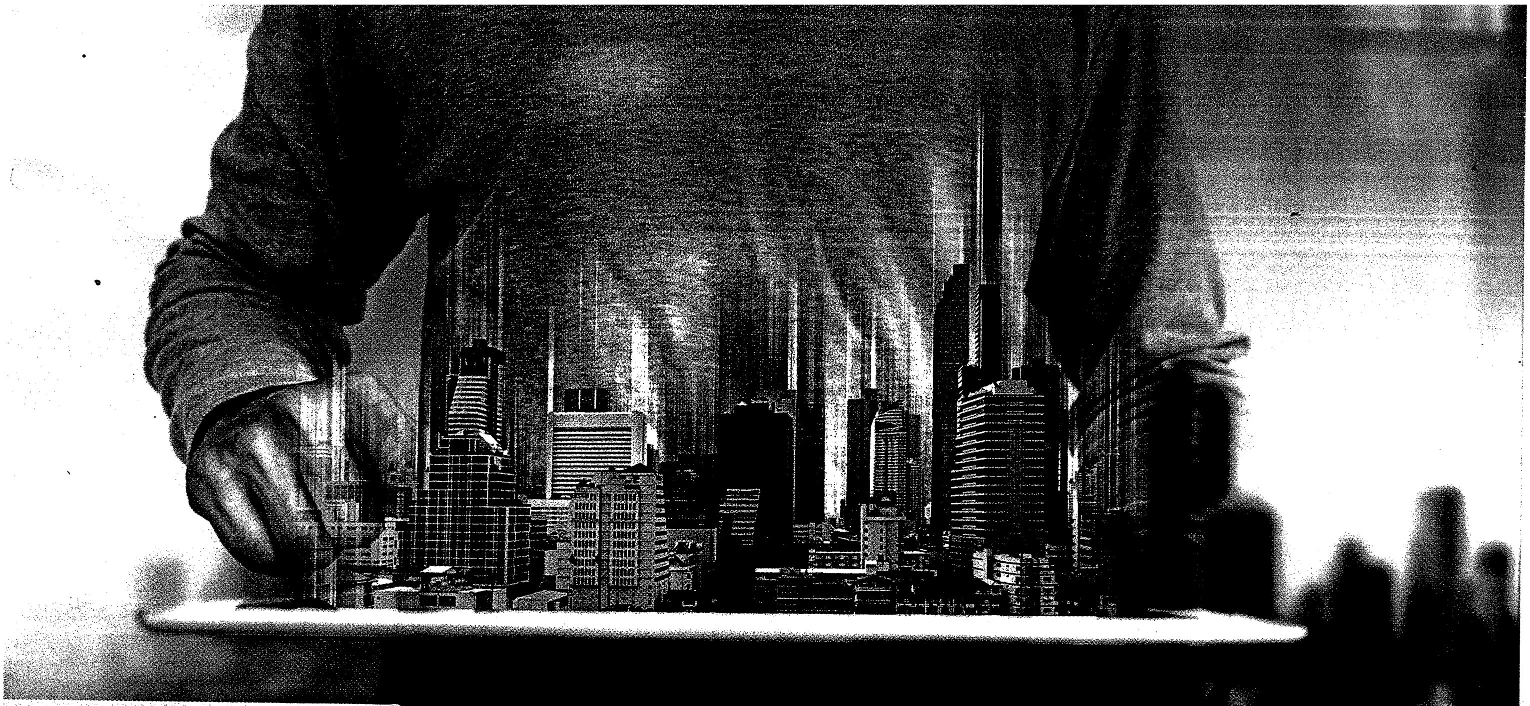
(3, 9.98×10^{-10} m)



Chapter 7

Laser

- Questions on Chapter Seven.
- Selected Questions on Chapter 7 from :
  - Student Evaluation Guide (2017).
  - Booklet Models of the Ministry of Education.



QUESTIONS ON

Chapter 7 Laser

1 Write down the scientific term for each statement of the following :

1. Amplification of light intensity by stimulated emission. *(1st session 16)*
2. The period of time at which the atom gets rid of the excitation energy and returns back to the ground state.
3. • The radiation emission when the excited atom moves from high energy level to low energy level when its lifetime is over spontaneously without any external factor. *(Exp. 14)*
   • The dominant emission in the ordinary light sources. *(Azhar 11)*
4. • The emission which occurs by the atom transition from high energy level (E_2) to low energy level (E_1) when a photon of energy ($h\upsilon = E_2 - E_1$) passes through an atom in the higher energy level (E_2). *(May 97)*
   • The radiation emission from the excited atom due to falling of another photon of the same energy before the end of its lifetime to emit at the end coherent photons (have the same phase, direction and frequency).
5. The light intensity falling on a surface is inversely proportional to square the distance between the surface and the light source.
6. The property in which the laser photons have the same frequency.
7. The property in which the laser photons have the same phase.
8. The active material to produce laser beam.

9. Excitation of the atoms of the active material to generate laser by light energy.

10. The container which contains the active material and responsible for amplification process. *(2nd session 15)*

11. A case in which the number of atoms in higher excitation levels is greater than the lower levels. *(Exp. 16)*

12. An energy level is characterized by long relatively lifetime equals 10^{-3} s. *(1st session 14 - 2nd session 17)*

13. • Parallel rays are used in holography have the same wavelength of the reflected rays on the body.
    • A bundle of parallel rays meets with the rays that leave the lighted body carrying information in holography. *(Sudan 14)*

14. Coded image is formed due to the interference of reference rays with the reflected rays on the body and it appears as bright fringe after developing the photographic plate.

2 Choose the correct answer of the given answers :

1. The resulted photon by the spontaneous emission and the exciting photon are having the same ········· when an atom is excited from the energy (E_1) to the energy (E_2).
   a. frequency only   b. direction only
   c. frequency and direction   d. frequency, direction and phase

2. In the spontaneous emission, the excited atom gets rid of its energy and returns back to its normal state after a short period of time called lifetime which equals ·········
   a. 10^8 s.   b. 10^{-8} s.   c. 10^5 s.   d. 10^3 s.

3. The dominant emission in neon lamp is ········· emission.
   a. spontaneous   b. stimulated
   c. absorption   d. no correct answer

4. The radiation photons resulted by the stimulated emission have the same ·········
   a. frequency.   b. direction.   c. phase.   d. all the previous.

5. The energy of photon resulting from the stimulated emission ········· the energy of the incident photon.
   a. equals   b. greater than
   c. less than   d. no correct answer

6. The velocity of laser ray ········· the velocity of light in the ordinary light sources.
   a. greater than   b. less than
   c. equals   d. no correct answer

7. From the properties of laser rays is ········· *(2nd session 06)*
   a. that the rays are not parallel.   b. monochromaticity.
   c. variety in wavelengths.   d. that the rays are parallel.

8. The monochromaticity of laser rays means that their photons ....
a. have one direction.
b. have one wavelength approximately.
c. are united in phase.
d. don't obey the inverse square law.
(1^{st} session 99 , 11 - 2^{nd} session 10)

9. Laser rays don't obey the inverse square law as in ordinary light because they ....
a. are coherent.
b. have high intensity. *(2^{nd} session 08)*
c. have one wavelength.
d. all the previous.

10. The laser rays keep their intensity constant. So, they ....
a. don't obey the inverse square law.
b. have only one wavelength.
c. have the same frequency.
d. (b) and (c).

11. The laser rays in the same beam are parallel. So, they have the same ....
a. direction.
b. frequency.
c. intensity.
d. phase.

12. The resonant cavity is responsible for the process of ....
a. excitation.
b. population inversion.
c. amplification.
d. stimulated emission.

13. In ruby laser, ...
a. the resonant cavity is outside.
b. the resonant cavity is inside.
c. there is no resonant cavity.
d. no correct answer.

14. In (helium - neon) laser, neon is mixed with helium in the ratio ....
a. 1 : 10
b. 1 : 9
c. 9 : 1
d. 10 : 1

15. The tube of (helium - neon) laser contains a mixture of neon and helium gases under pressure equals .... *(Azhar 11)*
a. 0.6 cm Hg.
b. 0.6 mm Hg.
c. 0.006 mm Hg.
d. 0.06 cm Hg.

16. In (helium - neon) laser, the atoms of active medium are excited by using ....
a. electric energy.
b. light energy.
c. thermal energy.
d. chemical energy.

17. Helium - neon laser lies in the region of ....
a. infrared rays.
b. ultraviolet rays.
c. visible light.
d. no correct answer.

18. The laser rays emitted in (helium - neon) laser are from the atoms of .... *(Azhar 11)*
a. helium.
b. neon.
c. both of them.
d. no correct answer.

19. The light intensity of the reflected rays from the body is directly proportional to ....
a. amplitude.
b. square of amplitude.
c. square root of amplitude.
d. no correct answer.

20. The difference in light phase equals ....

a. the path difference.

b. $\frac{2\pi}{\lambda}$

c. $\frac{\pi}{\lambda}$ × Path difference

d. $\frac{2\pi}{\lambda}$ × Path difference

21. .... is from the applications of laser rays.

a. Holography b. Optical shows c. Recording on CD d. All the previous

22. Each part of a hologram contains information about ....

a. entire object.

b. particular part of the object.

c. important part of the object.

d. front side of the object.

3 What is meant by ... ?

The lifetime of excited level in the atom = 10^{-8} s *(Sudan 15)*

4 Give reasons for :

1. The occurrence of stimulated emission. *(1st session 09)*
2. Although the photons are emitted by the effect of one photon in the stimulated emission process but it is not violation to the conservation of energy law.
3. The optical energy in laser is transmitted for long distances without significant loss.
4. Laser rays don't obey the inverse square law. *(Sudan 08 , 16 , 17 - 2nd session 09)*
5. The monochromaticity of laser ray. *(Sudan 13)*
6. • Using helium and neon gases as an active material in (He - Ne) laser. *(2nd session 07, 10 - Sudan 12 - Exp. 14 - 1st session 15)*
   • Helium and neon gases are suitable for producing gaseous laser. *(2nd session 12)*
7. During the operation of the laser sources it is a must that the active medium reaches population inversion which is not required in the ordinary light sources.
8. • The amplification of the photons of the stimulated emission occurs inside the resonant cavity.
   • There are two reflecting mirrors , one of them is semi-transparent at the two ends of (helium - neon) laser tube. *(1st session 09)*
9. The 3D image can only be formed by using laser rays.
10. Laser rays are used in the treatment of detachment of retina. *(2nd session 08)*
11. Laser rays play an important role in missile guidance in modern warfare applications.

5 Define :

1. Laser.
2. Lifetime of the excited atom.
3. Spontaneous emission.
4. Stimulated emission. *(1st session 05)*

5. Inverse square law.

6. The monochromaticity of laser rays. *(1st session 08 - Azhar 11)*

7. Active medium. 8. 📖 Optical pumping process. *(Sudan 14 - 2nd session 15)*

9. Resonant cavity. *(1st session 15)*

10. 📖 Population inversion state in active medium to generate laser. *(1st session 09 - Azhar 15)*

11. Lasing action. *(1st session 14)*

12. Metastable state. 13. Holography. *(1st session 11 - 2nd session 14)*

14. Reference rays in hologram. *(1st session 08 - Exp. 14)*

6 Mention one condition for the occurrence of each of the following :

1. Stimulated emission. *(2nd session 06 - 1st session 10 - Sudan 11 - Exp. 15 , 16)*
2. Lasing action. *(1st session 07 , 13 - Sudan 08 - 2nd session 12)*

7 What are the results of each of the following :

1. • Ending of the lifetime of an excited atom.
   • Transferring of the excited atoms from the excitation level to another level which has less energy after ending its lifetime. *(1st session 14)*
   • Transferring of the excited atom from the excitation level to another level which has less energy. *(2nd session 15 - Exp. 16)*
2. • A photon of energy ($h\upsilon = E_2 - E_1$) passes through an excited atom in the higher level (E_2). *(1st session 03)*
   • Transferring the excited atoms from the excitation level to another level which has less energy before ending its lifetime. *(Sudan, 2nd session 15)*
3. The laser tube contains helium gas only.
4. The atoms of the active medium reach population inversion state.
5. There are no parallel mirrors at the two ends of the active medium. *(1st session 14)*
6. The reference rays interfere with the reflected rays from the body in holography. *(2nd session 14)*
7. Lighting the hologram with laser rays have the same wavelength of the reference rays. *(2nd session 10)*

8 Mention the use (function) of each of the following :

1. The radio frequencies sources in laser. *(Azhar 11)*
2. • The DC high potential difference between the two ends of the discharge tube in (helium - neon) laser. *(2nd session 09 - Sudan 11)*
   • The electric field of high frequency in (helium - neon) laser. *(1st session 08 , 10)*
3. • 📖 The resonant cavity in gaseous laser. *(2nd session 07 , 12 - Exp. 16)*
   • The two reflecting mirrors in the laser generating device. *(2nd session 08 - Sudan 14 - Exp. 16)*

4. 📖 Helium atoms in (helium - neon) laser. *(1st session 07 - 2nd session 13)*

5. Neon atoms in (helium - neon) laser. *(Azhar , 2nd session 15)*

6. Reference rays in holography. *(1st session 13 , 14)*

7. Laser rays in 3D photography (holography). *(Azhar 15)*

8. Laser in medical field. *(Exp. , 2nd session 15)*

9. Laser rays in communications.

9 Compare between each of the following :

1. 📖 Spontaneous emission and stimulated emission.
(May 98 - Sudan 08 - 1st session 08 , 11 , 13 , 14 - 2nd session 07 , 10 , 12)

2. The ordinary light rays and laser rays.
(1st session 02, 05 - 2nd session 04 , 06 - Exp. 14 - Sudan 14)

3. X-rays and laser rays (in terms of the wavelength of each-coherency).
(2nd session 14 - 1st session 17- Sudan 15)

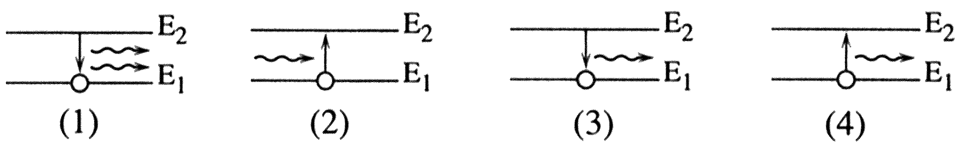
4. Laser ray (helium - neon) and ray of neon lamp when passing each of them through a spectrometer. *(Exp. 15)*

5. 📖 The normal photography and the holography (in terms of the recorded information of the image on the photographic plate). *(2nd session 08 , 09 - Sudan 17)*

10 Miscellaneous questions :

1. What is the scientific base of laser action ? *(1st session 10, 11 - Sudan 12 , 14)*

2. **The following figures represent energy levels of the atom :**



Which one is :

(a) Absorption case.

(b) Stimulated emission case.

(c) Spontaneous emission case.

3. Explain by drawing only the difference between the spontaneous emission and the stimulated emission. Which of them produce laser ray ? *(1st session 00)*

4. The stimulated emission process includes producing another coherent photon identical to the incident photon. Is getting these two photons considered a violation to the law of conservation of energy ?

5. Mention one factor that affects the emission of coherent photons from an excited atom. *(Azhar 15)*

6. How can you differentiate between the normal light ray and the laser ray? *(1st session 07)*

7. **Mention (without explanation) :**

   (a) The properties of stimulated emission. *(2nd session 02)*

   (b) The most important properties of laser rays.
   (1st session 00 , 09 , 12 , 15 - Sudan 10 , 15 - Azhar , 2nd session 11 , 15)

   (c) Three energy sources responsible for exciting the active medium to obtain laser ray. *(1st session 12)*

   (d) The main components of laser devices ? And why helium and neon have been chosen in (He - Ne) laser device? *(1st session 06 - Sudan 07, 10 - Azhar 11 - 2nd session 14)*

8. When the atoms of the active medium be in a state of population inversion ? *(1st session 15)*

9. Mention the name of a device that its working idea is based on the population inversion. *(2nd session 14)*

10. **Explain by labelled drawing the structure of (helium - neon) laser, then answer :** *(Exp. 15)*

    (a) Why have the two gases been chosen together ?

    (b) Compare between the resonant cavity of this device and the resonant cavity in ruby laser.

11. Mention one application of laser rays. *(1st session 10 - 2nd session 11)*

12. 🕮 Helium - neon laser is considered an example for converting electric energy into light and thermal energy. Clarify the mechanism of this conversion.

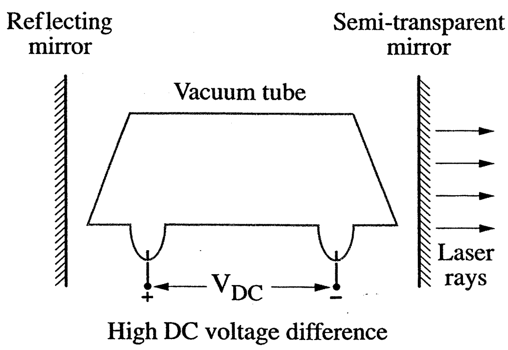
13. The opposite figure represents helium - neon laser.

    (a) What is the value of the pressure inside the tube ?

    (b) What is the medium responsible for producing laser in helium - neon laser ?

    (c) What is the function of the two mirrors in this device ?

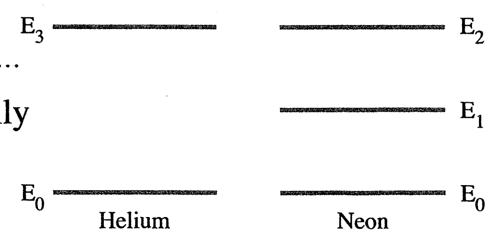
    (d) What is meant by metastable energy level ? What is the role of this level in the process of laser production ? *(1st session 17)*



14. The following figure represents the energy levels of helium and neon in (He - Ne) laser.
    Complete the following :

    (a) Helium atom transfers from E_0 into E_3 due to ....

    (b) Helium atom in the level .... collides inelastically with neon atom in the level .... so neon atom transfers from level .... to level ....



(c) Metastable level in helium is .... while metastable level in neon is ....

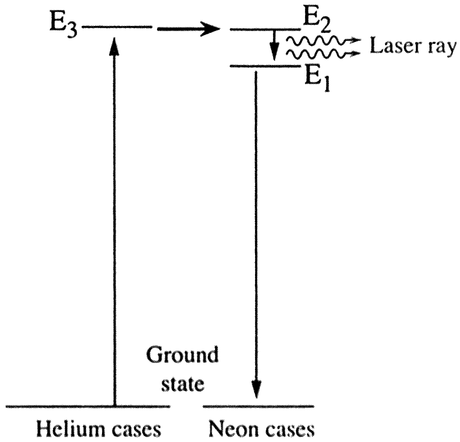
(d) Stimulated emission takes places when neon transfers from level .... to level .... *(Azhar15)*

15. The opposite figure shows the energy levels diagram for (He - Ne) laser.

(a) How the atoms of helium are transferred to the metastable energy level ?

(b) How the energy is transferred from helium atom to neon atom ?

(c) Mention how neon atoms accumulate in E_2 excited level . *(Exp. 16)*



16. How :

(a) Laser beam is generated in (helium - neon) laser device.

(b) The 3D photography is obtained by using laser.

17. What is the hologram ? What is the scientific base of it ?

18. A laser light of frequency 6×10^{14} Hz, if the emitted power from the source is 2×10^{-3} W , calculate the average number of photons per second emitted by the source.

(5.03×10^{15} photon)

SELECTED QUESTIONS ON

Chapter 7

From :

- **Student Evaluation Guide (2017).**
- **Booklet Models of the Ministry of Education.**

1 Choose the correct answer from the given answers :

1. The common feature of laser and X-rays photons is that they ....
   a. are coherent.
   b. are monochromatic.
   c. have the same speed.
   d. have the same energy. *(Booklet 2)*
2. If a laser ray falls on one of the sides of a triangular prism, so it emerges ....
   a. straight line without dispersion.
   b. deviating from its path by large dispersion angle.
   c. deviating from its path without dispersion.
   d. no correct answer. *(Booklet 1)*
3. A laser beam is used as an energy source to excite the atoms of the active medium in .... laser. *(Booklet 3)*
   a. gases
   b. solid crystals
   c. liquid dyes
   d. semiconductors

2 Write down the scientific term for each statement of the following statements :

1. The state in which the number of atoms of the active medium in the production of laser in the upper state is greater than that in the ground state. *(Booklet 1)*
2. Exciting the atoms of the active medium in the production of laser using light photons. *(Booklet 1)*
3. Light rays in phase used in holography and has the same wavelength as the reflected rays from the object and meet them on the photographic plate.
4. The property that laser photons are in phase.

3 What are the results of ... ?

1. Passing a photon of energy E through an atom in a level of energy higher by value E than the ground level. *(Booklet 1)*
2. Illuminating a hologram by a laser beam having the same wavelength as the reference beam. *(Booklet 3)*

4 What is the scientific idea for :

Forming a 3D image through the coded image on a hologram. *(Booklet 1)*

5 Compare between :

1. The spontaneous emission and stimulated emission (in terms of the condition of occurrence without drawing). *(Booklet 2)*
2. Ruby laser and (He - Ne) laser (in terms of the type of resonant cavity).

6 Give reason for :

Laser is used in holography (3D photography).

7 What happens when ...?

1. There are no mirrors at the ends of the active medium.
2. Ending the lifetime of an excited atom without external stimulus.

8 Miscellaneous questions :

1. Why is laser used in the treatment of retinal detachments ? *(Booklet 3)*
2. What is the function of the resonant cavity in the laser device ? *(Booklet 4)*
3. **What is meant by :** Laser photons are coherent. *(Booklet 4)*
4. Mention the three main parts of laser.
5. Mention three properties of laser.
6. **Mention one condition for :**
   (a) Stimulated emission.
   (b) Lasing.

Chapter 8

Modern Electronics

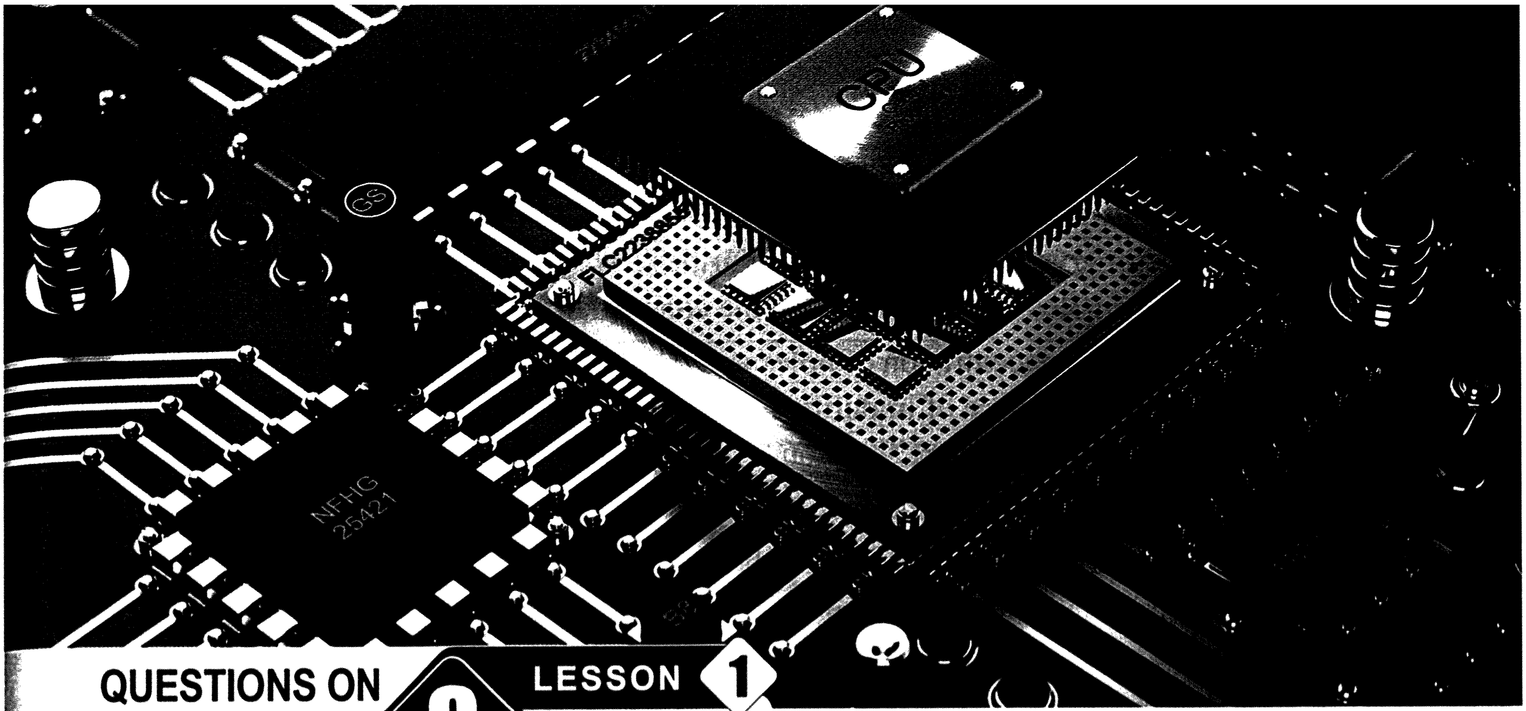
⊙ **Questions on :**

Lesson 1
- The Semiconductor Crystal.
- pn Junction.

Lesson 2
- The Transistor.
- The Digital and Analog Electronics.

⊙ **Selected Questions on Chapter 8 from :**

- Student Evaluation Guide (2017).
- Booklet Models of the Ministry of Education.



QUESTIONS ON Chapter 8 LESSON 1

- **The Semiconductor Crystal.**
- **pn Junction.**

1 Write down the scientific term for each statement of the following :

1. Materials conduct electricity and heat easily such as metals.
2. Materials don't conduct electricity and heat such as plastic and wood.
3. Materials, its electric conductivity is medium between the conductors and insulators and are characterized by increasing its electric conductivity as the temperature increases.
4. A regular geometric arrangement of atoms in solid state.
5. An empty place left by an electron (positive charge) in a broken bond in the semiconductor crystal.
6. • The case in which the number of broken bonds per second is equal to the number of formed bonds per second in the semiconductor crystal to keep the number of free electrons and holes constant for each certain temperature.
   • The number of formed bonds is equal to the number of broken bonds in the semiconductor crystal in one second. *(2nd session 15)*
7. A semiconductor in which the concentration of free electrons (n) = The concentration of holes (p) at any temperature.
8. Adding atoms of pentavalent element or trivalent element to a pure tetravalent element crystal to increase the concentration of free electrons or holes inside it.
9. An impurity atom gives free electron when found in a tetravalent element crystal.
10. A semiconductor crystal is doped with impurities from pentavalent element and the concentration of free electrons (n) is greater than the concentration of holes (p).

11. An impurity atom produces hole when found in tetravalent semiconductor crystal:
12. A semiconductor crystal is doped with impurities from a trivalent element and the concentration of holes (p) is greater than the concentration of free electrons (n).
13. The product of the concentration of holes and free electrons = Constant value and doesn't depend on the type of impurity and equals square the electrons concentration or holes concentration in the pure semiconductor crystal at constant temperature.
14. The building unit of all the electronic systems.
15. The produced current due to diffusion of holes from p-region to n-region and spreading of electrons from n-region to p-region.
16. Region of free charge carriers at the two sides of the contact position between n crystal and p-crystal in the pn junction.
17. The produced current due to the internal electric field between the positive ions towards n and the negative ions towards p on the two sides of the junction which is opposite to the diffusion current.
18. It is the least internal potential difference on the two sides of the pn junction that prevents the diffusion of more holes and free electrons to the less concentration region.

2 Choose the correct answer of the given answers :

1. In the pure semiconductors, the concentration of free electrons .... the concentration of holes.
   a. equal b. greater than c. less than d. is double
2. If the temperature of pure semiconductors is increased, its electric conductivity ....
   a. decreases by decreasing the free electrons.
   b. decreases by increasing free electrons.
   c. increases by increasing free electrons.
   d. increases by decreasing free electrons.
3. A pure silicon or germanium crystal becomes perfect insulator at .... *(Sudan 10)* *(Sudan 07)*
   a. 0°C b. 273°C c. – 273°C d. 273 K
4. The electric conductivity of a semiconductors at zero Kelvin ....
   a. decreases. b. increases. c. vanishes. d. doesn't change.
5. The acceptor atom is an impurity atom in tetravalent element crystal and it is introduced to produce ....
   a. free electron. b. hole.
   c. hole and electron. d. no correct answer.
6. To obtain a semiconductor of p-type, atoms of .... should be added.
   a. antimony b. boron c. phosphorous d. zinc
7. The element which doesn't give a p-type semiconductor when a silicon crystal is doped with it is .... *(1st session 02)*
   a. B^{3+} b. Sb^{5+} c. Ni^{2+} d. Al^{3+}

8. When adding antimony atoms to a pure silicon crystal they acts to ·········
   a. increase the concentration of free electrons.
   b. decrease the concentration of free electrons.
   c. increase the holes concentration.
   d. decrease the holes concentration.

9. The dominant charge carriers in p-type crystal are ········· *(Sudan 14)*
   a. electrons. b. holes.
   c. both electrons and holes. d. no correct answer.

10. In (p-type) crystal, the ratio of concentration of holes to the concentration of free electrons at a certain temperature ········· one. *(2nd session 15)*
   a. greater than b. equal to c. less than d. constant

11. The electric conductivity of an impure semiconductor crystal depends on ·········
   a. type of semiconductor. b. the concentration of impurities.
   c. the area of the crystal. d. no correct answer.

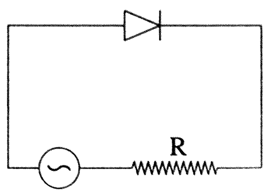
12. ········· are used as sensors to measure the intensity of light or the temperature or the pressure.
   a. Conductors b. Semiconductors
   c. Insulators d. No correct answer

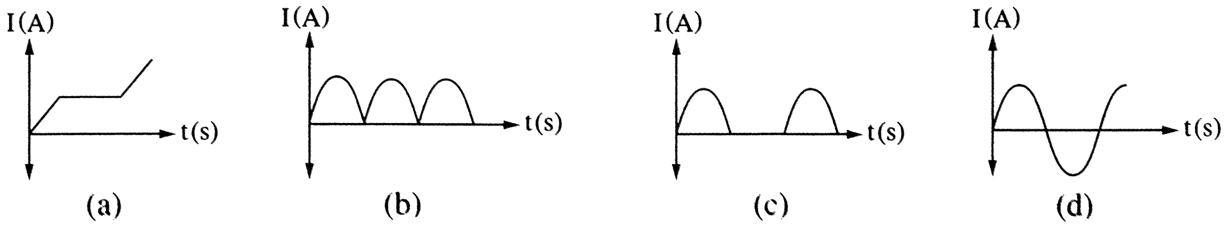
13. The induction coil is considered from the ········· devices. *(Sudan 15)*
   a. simple b. complex
   c. specialized d. no correct answer

14. When connecting pn junction in forward direction, the current is ·········
   a. zero. b. very weak.
   c. high. d. no correct answer.

15. When connecting the diode in reverse direction, ·········
   a. the potential barrier increases and the resistance increases.
   b. the potential barrier decreases and the resistance decreases.
   c. the potential barrier increases and the resistance decreases.
   d. neither the potential barrier nor the resistance changes.

16. From the opposite circuit :
   The figure ········· represents the electric current intensity (I) passing through resistance R with time (t).





3 What is meant by ... ?

The voltage barrier in the pn junction = 0.3 V *(2nd session 03)*

4 Give reasons for :

1. • The pure silicon crystal is perfect insulator at zero Kelvin.
   • The pure semiconductor crystal doesn't conduct electric current at very low temperatures. *(Sudan 15)*
2. When the temperature of the semiconductor increases, its electric conductivity increases.
3. The semiconductor atom which breaks down one of its bonds, can't be called ion.
4. At thermal equilibrium, the number of free electrons or holes doesn't increase.
5. It isn't preferable to heat the pure semiconductor to increase its conductivity for electric current.
6. The impure semiconductor conduct electric current more than the pure semiconductor at the same temperature.
7. Presence of impurity of antimony in silicon crystal increases its conductivity for electric current.
8. A semiconductor crystal of n-type or p-type is electrically neutral.
9. The semiconductors are used as sensors for the environmental factors surrounding them.
10. The electric current passes through the pn junction in case of forward connection.
11. In case of reverse connection, the electric current doesn't pass through pn junction.
12. The pn junction looks like a switch in the circuit.
13. The pn junction is used as half-wave rectifier for the AC current. *(Aug. 98 - 2nd session 99)*
14. Ohmmeter is used to ensure the validity of the diode. *(1st session 09)*
15. The pn junction is different from the electric resistance.

5 Define :

1. Semiconductors.
2. Hole.
3. The dynamic (thermal) equilibrium for a pure silicon crystal. *(2nd session 09, 10)*
4. Pure semiconductors. *(Sudan 12)*
5. The doping of a semiconductor crystal.
6. The impurity atom.
7. The donor atom.
8. The acceptor atom.
9. A semiconductor of n-type.
10. A semiconductor of p-type.
11. Law of mass action.
12. Electronic devices.
13. pn junction (diode).

14. 📖 Diffusion current in pn junction. *(Sudan 14)*
15. The depletion region in pn junction.
16. 📖 Drift current in pn junction.
17. 📖 The potential barrier of the pn junction.
18. The forward connection of the pn junction.
19. The reverse connection of the pn junction.

6 What are the results of each of the following :

1. Breaking down one of the covalent bonds of a semiconductor atom.
2. Increasing the number of broken bonds by thermal energy for a semiconductor crystal.
3. Doping a pure silicon crystal with one of the elements of the pentavalent group.
4. • Doping a pure silicon crystal with some of boron atoms. *(Sudan 12 - Exp. 15)*
   • There is a trivalent impurity atom in the semiconductor crystal.
5. Transferring the holes to region (n) and transferring the free electrons to region (p) in pn junction.
6. Forward connection of pn junction in an electric circuit. *(2nd session 03 - Sudan 16)*
7. Reverse connection of pn junction in an electric circuit. *(1st session 01 - 2nd session 05)*
8. Connecting pn junction to alternating current source.

7 Mention one use (or an application) for each of the following :

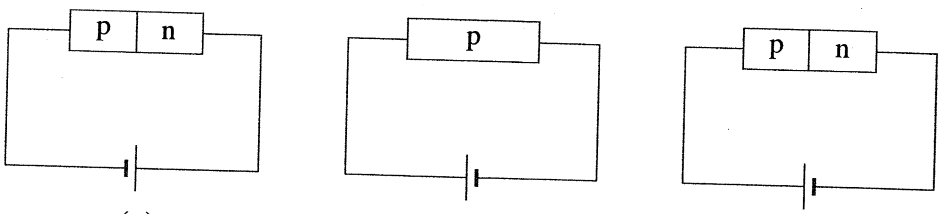
1. Doping in the pure semiconductors. *(2nd session 15)*
2. • Semiconductors with impurities.
   • Specialized electronic devices. *(Exp. 15)*
3. pn junction. *(2nd session 04 - 1st session 10 , 15 - Sudan 13 -Azhar 15 -Exp. 16)*

8 Compare between each of the following :

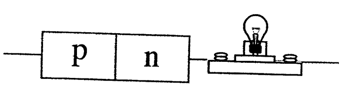
1. • Crystal of p-type and crystal of n-type from the semiconductors (in terms of : the concentration of charge carriers - the type of impurity atom - the dominant charge carriers). *(1st session 05 - 2nd session 12 , 13 , 15)*
   • Types of impure semiconductors (in terms of type of impurity). *(2nd session 00, 04 - Sudan 08)*
2. The donor impurities and the acceptor impurities.
3. Diffusion current and drift current in the diode.
4. The pn junction and the ohmic electric resistance (in terms of : the structure - charge carriers - the passing electric current intensity - the effect of heat).
5. The forward connection and the reverse connection in the pn junction (p – n). *(1st session 00 , 08 - Sudan 11 , 15)*

9 Miscellaneous questions :

1. Why is the pure silicon crystal considered bad conductor of electricity at low temperature, explain by drawing how this crystal convert into a semiconductor of n-type.
2. 📖 Mention the possible methods to raise the efficiency of the electric connection of the semiconductor material and mention the characteristic acquired by the material in each method.
3. **Mention one factor to :**
   (a) Decrease the electric conductivity of a pure silicon crystal. *(Exp. 15)*
   (b) Raising the electric conductivity for a semiconductor at the same temperature. *(Azhar 15)*
4. 📖 🗐 Discuss the concept of the dynamic thermal equilibrium for a semiconductor crystal.
5. Mention the scientific idea that the impure semiconductors depend on. *(1st session 99)*
6. When does a crystal of pure semiconductor material become in dynamic equilibrium state ? *(1st session 15)*
7. Mention the mathematical relation for the mass action law in semiconductors. *(Sudan 14 - 1st session 15)*
8. How can you differentiate between the ohmic resistance and pn junction by using ohmmeter device ? *(1st session 07 - Exp. 16)*
9. Show how can the polarity of pn junction be determined. *(Exp. 15)*
10. **Show by drawing only :**
    (a) Semiconductor crystal of p-type.
    (b) The diode symbol in the electric circuit.
    (c) The forward connection of pn junction.
    (d) The reverse connection of pn junction.
11. **Explain with drawing :**
    (a) The required electric circuit to use pn junction as a switch in on and off positions.
    (b) How is the potential barrier is formed in the pn junction (p - n). *(1st session 02)*
    (c) 📖 🗐 How does the pn junction rectify the alternating current.
12. 🗐 **Which one of the following circuits, has maximum resistance to the flow of electric current ? And why ?**



(a) (b) (c)

13. **The opposite figure :** Represents a diode connected in series to a small lamp works on DC potential difference.


    (a) Complete the drawing of the electric circuit to illuminate the lamp. *(1st session 04, 09)*
    (b) Explain the reason for illumination of the lamp. *(2nd session 01)*
    (c) What will happen if the connection is reversed with DC potential difference ?

10 Problems :

Guiding notes for solving problems

- When adding an impurity to a pure semiconductor crystal (silicon) then : $np = n_i^2$

If the impurity is pentavalent donor impurity (phosphorous - antimony)	If the impurity is trivalent acceptor impurity (boron - aluminum)
Then	
- Concentration of the free electrons : $n = N_D^+$	- Concentration of the holes : $p = N_A^-$
- Concentration of holes : $p = \frac{n_i^2}{N_D^+}$	- Concentration of the free electrons : $n = \frac{n_i^2}{N_A^-}$

1. If the concentration of the electrons or holes in the pure silicon is 10^8 cm^{-3} and aluminum is added to it with concentration 10^{10} cm^{-3}. Calculate the concentration of holes and electrons in this case at complete impurity ionization. *(10^{10} cm^{-3} , 10^6 cm^{-3})*

2. If the concentration of holes or electrons in the pure silicon crystal is 10^{14} cm^{-3} then antimony is added to the crystal with concentration 10^{16} cm^{-3}. Calculate the concentration of holes and electrons. *(10^{16} cm^{-3} , 10^{12} cm^{-3})*

3. If the concentration of electrons and holes in the pure silicon crystal is 10^{10} cm^{-3} and if phosphorous is added to it with concentration 10^{12} cm^{-3}. What is the type of the resulted silicon crystal ?

   Calculate :

   (a) The concentration of holes and electrons in this case.

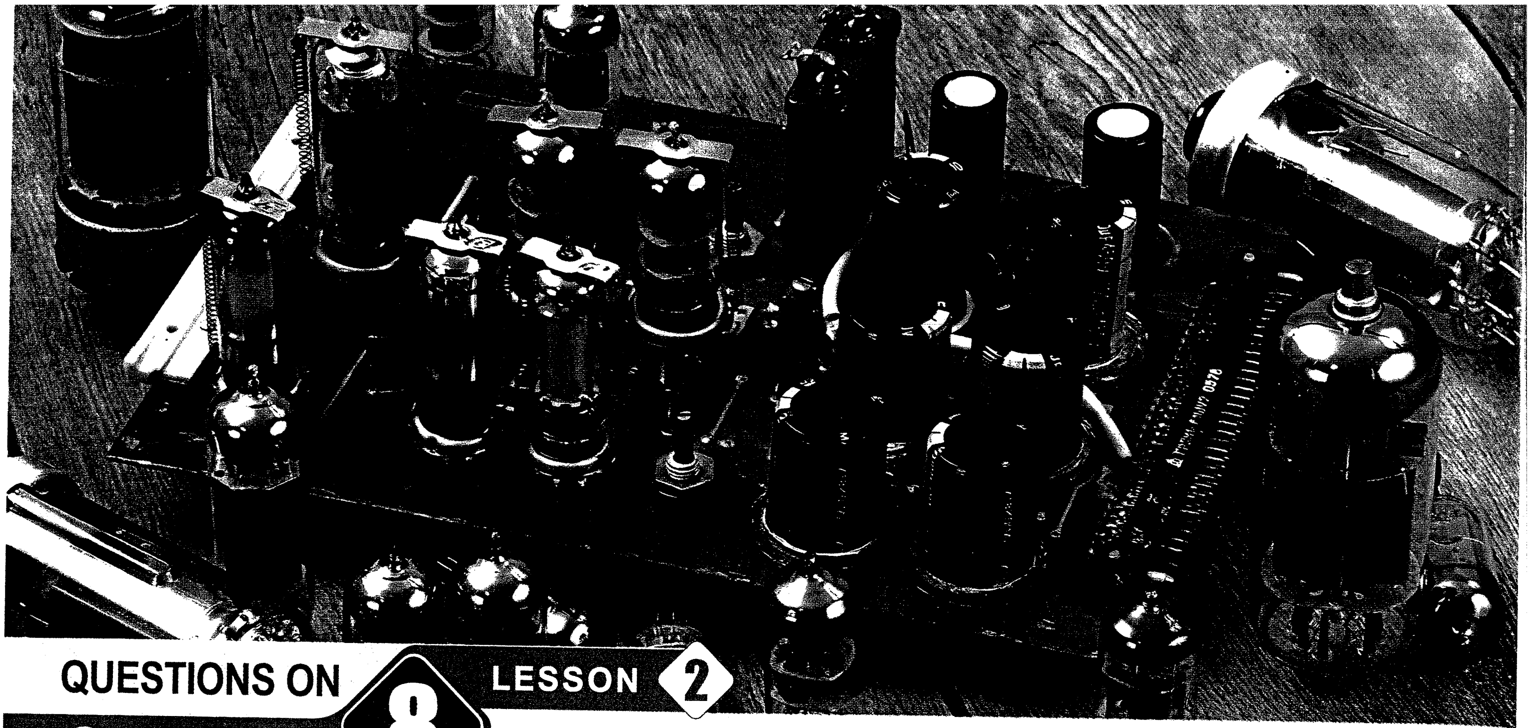
   (b) The aluminum concentration which is required to be added to the silicon to return to its original state again. *(10^{12} cm^{-3}, 10^8 cm^{-3}, 10^{12} cm^{-3})*

4. A diode can be represented by a resistance of 100 Ω in the forward connection and an infinite resistance in the reverse connections, if it is connected to a potential difference of +5V then reversed to –5 V. Calculate the current intensity in each case. *(0.05 A , 0)*

5. The following table represents the relation between the concentration of free electrons and the reciprocal of acceptor atoms :

N	10×10^6	5×10^6	2.5×10^6	2×10^6	1×10^6
$1/N_A$	0.1	0.05	0.025	0.02	0.01

Draw a graphical relation between the concentration of free electrons on the (Y-axis) and the reciprocal of acceptor atoms on the (X-axis), then find the number of free electrons in the pure crystal.



QUESTIONS ON **Chapter 8** LESSON 2

- **The Transistor.**
- **The Digital and Analog Electronics.**

1 Write down the scientific term for each statement of the following :

1. A triode junction consists of two similar crystals between them one of another type.
2. Ratio between the collector current to the emitter current at constant potential difference between the base and the collector.
3. Ratio between the collector current to the base current at constant potential difference between the emitter and the collector. *(Exp. 16)*
4. Electronics which deal with natural quantities as it is.
5. Electronics which deal with natural quantities and convert them into codes. *(Sudan 15)*
6. Parts from electronic circuits of the new devices which perform logic processes based on digital electronics.

2 Choose the correct answer of the given answers :

1. In the transistor , the impurities ratio in the emitter .... the impurities ratio in the collector.

   a. equal — b. greater than
   c. less than — d. double

2. In the transistor, the ratio I_C to I_E becomes ....

   a. very large. — b. very small.
   c. near to one. — d. no correct answer.

3. The current gain (β_e) in the transistor is determined from the relation : ....

a. $\beta_e = \frac{1-\alpha_e}{\alpha_e}$ b. $\beta_e = \frac{\alpha_e}{\alpha_e - 1}$ c. $\beta_e = \frac{\alpha_e}{1-\alpha_e}$ d. $\beta_e = \frac{\alpha_e - 1}{\alpha_e}$

4. In the transistor the current division (α_e) is determined from the relation : ....

a. $\alpha_e = \frac{\beta_e}{1+\beta_e}$ b. $\alpha_e = \frac{\beta_e}{1-\beta_e}$ c. $\alpha_e = \frac{1-\beta_e}{\beta_e}$ d. $\alpha_e = \frac{1+\beta_e}{\beta_e}$

5. Transistor (npn) is connected in the circuit where the emitter is common if the base has a positive voltage. So, the transistor acts as ....

a. a half wave rectifier. b. a closed switch.

c. an opened switch. d. no correct answer.

6. The decimal number which is equivalent to the binary number $(1010)_2$ is ....

a. 4 b. 8 c. 10 d. 14 *(1st session 15)*

7. The code for the analog number 20 according to the binary system is ....

a. $(10101)_2$ b. $(10100)_2$ c. $(11100)_2$ d. $(00111)_2$

8. The logic gate .... has one input and one output.

a. NOT b. AND

c. OR d. no correct answer

9. The .... gate works as two connected switches in series in the electric circuit.

a. AND b. OR

c. NOT d. no correct answer

3 What is meant by ... ?

1. The current division in the transistor = 0.98
2. The current gain of the transistor = 99

(May 97 - 1st session 00, 03, 13 - 2nd session 10 - Sudan 15 - Exp. 15, 16)

4 Give reasons for :

1. The thickness of the base must be very small in the transistor. *(1st session 99, 05)*
2. • The current division (α_e) is near to one while the current gain of the transistor (β_e) is very large.
   • Transistor is used as amplifier.
3. The transistor is used as a switch.
4. It is preferred to use the digital electronics to the analog electronics in the electronic devices. *(1st session 06 - 2nd session 10)*

5 What is meant by each of the following :

1. The transistor.
2. The current division (α_e). *(Sudan 14)*
3. The current gain (β_e).
4. The logic gates.

6 Mention the scientific idea for each of the following :

1. The transistor as an amplifier.
2. The transistor as a switch.
3. Digital electronics.
4. Logic gates. *(Sudan 16)*

7 Mention one use (one function) for each of the following :

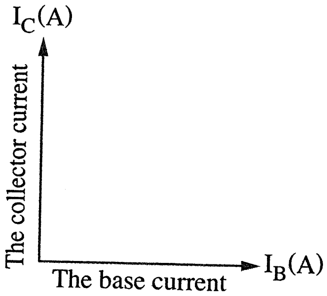
1. Transistor. *(1st session 08 - Sudan 11, 12 - 2nd session 15)*
2. The digital to analog converter.
3. The analog to digital converter.
4. The analog electronic devices.
5. The digital electronics.
6. Logic gates.

8 Compare between each of the following :

1. The emitter and the collector in the transistor (npn) (in terms of : type of the crystal - type of connection with the base in case of the connection in common base circuit - the voltage barrier with the base).
2. Transistor as a switch in case of opening (on) and closing (off).
3. The analog devices and digital devices (in terms of idea of working).
4. Inverter (NOT) gate , coincidence (AND) gate and optional (OR) gate (in terms of : the symbol - the number of inputs and outputs - the logic process - the truth table - the equivalent electric circuit). *(2nd session 12 , 15)*

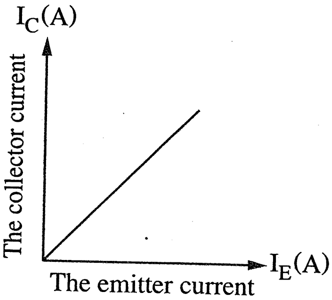
9 Miscellaneous questions :

1. Write down the mathematical relation to express the current gain in the transistor. *(Sudan 15)*
2. Prove that the current gain in the transistor is determined from the relation : $\beta_e = \dfrac{\alpha_e}{1 - \alpha_e}$
3. Explain the importance of the digital electronics and mention five applications for it.
4. **Mention the mathematical relation which joins each of the two variables in the following relations :**



(2nd session 08 , 15)

(a)



(b)

5. Explain briefly the operation of the (npn) transistor as a switch and draw the electric circuit in case of opening (off) only. *(2nd session 09 - Azhar 15)*

6. **Find the equivalent binary number for each of the following decimal numbers :**

(a) 59 (b) 120 (c) 18

7. **Find the corresponding decimal number for each of the following binary numbers :**

(a) $(11110)_2$ (b) $(100110)_2$ (c) $(10011011)_2$

8. **Show by drawing each of the following :**

(a) The transistor (npn) is used as amplifier in case of common emitter.

(b) The transistor is used as a switch in (on) position. *(1st session 09)*

(c) A simplified electric circuit is used as an inverter with one output then write the truth table for it.

(d) A simplified electric circuit is used as an AND gate with three inputs and one output then write the truth table for it. *(Sudan 08 , 10)*

(e) The equivalent electric circuit for AND gate then deduce the truth table. *(2nd session 06)*

(f) A simplified electric circuit is used as optional gate with four inputs and one output then write the truth table for it.

(g) A simplified electronic circuit is used as OR gate with three inputs and one output then write the truth table for it.

9. **Write the name of the logic gate in each of the following cases , then draw the equivalent electric circuit for each gate :**

(a) • Logic gate has one input. *(1st session 10)*

• Logic gate with low output if the input is high and vice versa.

(b) Logic gate has two inputs and gives high output if the voltage of one of them is high and the other is low. *(1st session 10)*

(c) • Logic gate has two inputs and its output is high only if all the inputs are high.

• Logic gate has low output if one of the inputs is low.

10. **Deduce the truth table :**

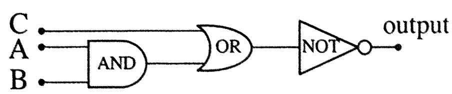
(a) For an AND gate of two inputs followed by an inverter.

(b) For an OR gate of two inputs followed by an inverter.

11. **Complete the truth table for the following electronic circuits and convert the output result into decimal number :** *(Sudan 11)*

(1)

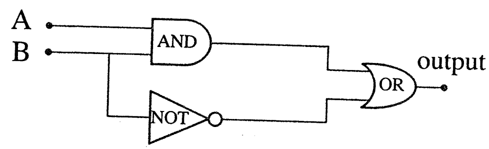
(A)	(B)	(C)	output
1	1	0	....
1	0	1	....
0	0	1	....



(2)

(1st session 07 - 2nd session 08)

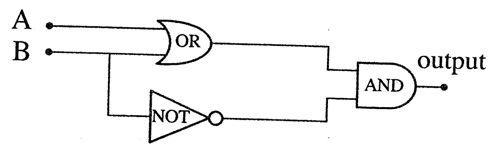
(A)	(B)	output
0	0	....
1	0	....
0	1	....
1	1	....



(3)

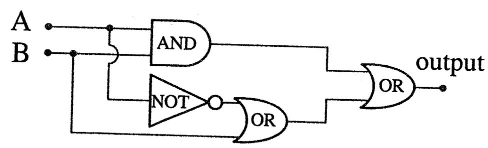
(Sudan 14)

(A)	(B)	output
0	0	....
1	0	....
1	1	....



(4)

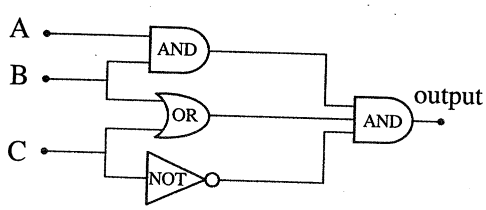
(A)	(B)	output
0	0	....
1	0	....
0	1	....
1	1	....



(5)

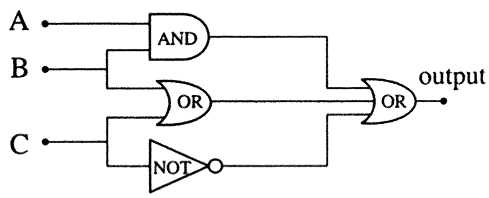
(Sudan 07)

(A)	(B)	(C)	output
0	0	0	....
1	1	0	....
1	0	1	....
0	1	1	....
0	0	1	....
1	1	1	....



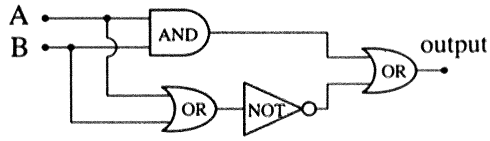
(6) *(2nd session 07)*

(A)	(B)	(C)	output
0	0	0	....
1	1	0	....
1	0	1	....
0	1	1	....
0	0	1	....
1	1	1	....



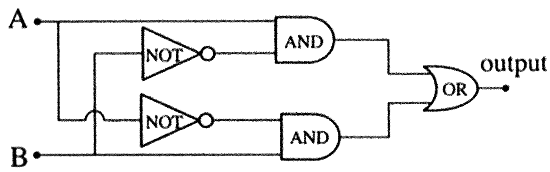
(7) *(Sudan 15)*

(A)	(B)	output
0	0	....
1	0	....
0	1	....
1	1	....



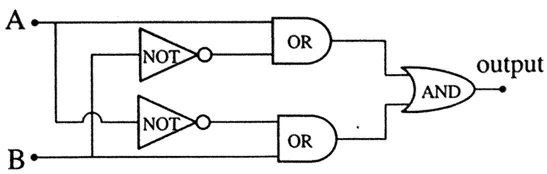
(8) *(1st session 09)*

(A)	(B)	output
0	0	....
1	0	....
0	1	....
1	1	....

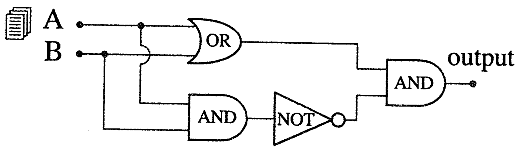


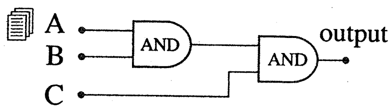
(9) *(Azhar 15)*

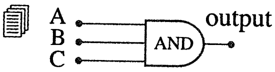
(A)	(B)	output
0	0	....
0	1	....
1	0	....
1	1	....

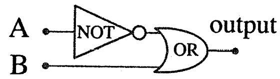


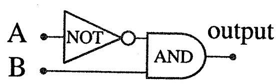
12. **Write the truth table of the following logic circuits :**

(1)


(2)


(3)


(4)


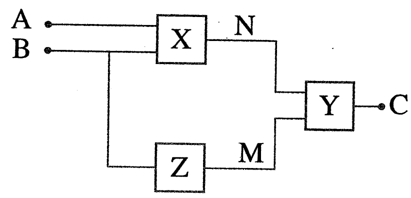
(5)


13. **From the following truth table :**

(a) Conclude the types of gates X, Y, Z.

(b) Complete the table :

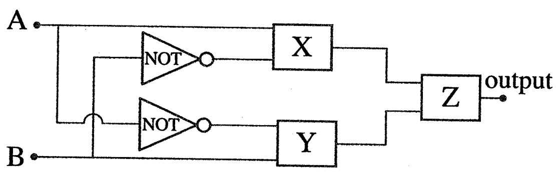
input		output		
A	B	N	M	C
0	1	1	0	0
1	1	....	0	....
1	0	1	....	1



(1st session 12)

14. **From the following truth table, conclude the types of gates (X,Y,Z) :** *(1st session 13)*

(A)	(B)	output
0	0	0
1	0	1
0	1	1
1	1	0

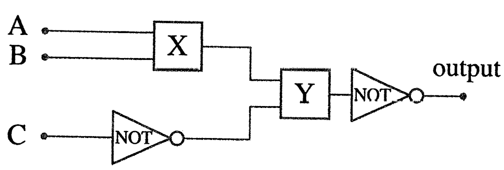


15. **The opposite truth table represents some of input and output values for the circuit of gates shown in the figure :** *(Exp. 15)*

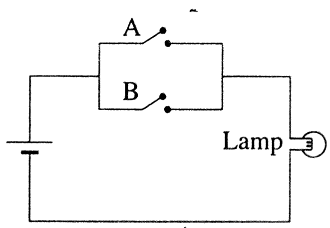
(a) Identify the type of gate (X) and gate (Y).

(b) Find the output (Z) in the table.

(A)	(B)	(C)	output
1	1	1	0
0	1	1	1
0	0	0	Z



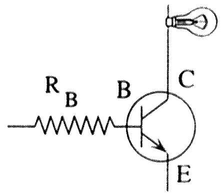
16. **The opposite figure represents the equivalent electric circuit for a logic gate :**



(a) Mention the type of the gate in the figure, then draw the symbol of the gate.

(b) Write down the truth table in case of the lamp lighting only. *(2nd session 13)*

17. The opposite figure shows a transistor connected in series with a small bulb works on DC potential difference :



(a) Complete the drawing of the electric circuit for the bulb to glow.

(b) What is the modification to do to the circuit of the previous case for the bulb to turn off.

10 Problems :

Guiding notes for solving problems

⇒ **Transistor as amplifier:**

- To determine (α_e) : $\alpha_e = \frac{I_C}{I_E} = \frac{\beta_e}{1+\beta_e}$
- To determine the emitter current (I_E) : $I_E = I_C + I_B$
- To determine the current gain (β_e) : $\beta_e = \frac{I_C}{I_B} = \frac{\alpha_e}{1-\alpha_e}$

⇒ **Transistor as switch :**

- To determine the battery voltage (V_{CC}) :

$V_{CC} = V_{CE} + I_C R_C$

1. A transistor has $\alpha_e = 0.99$ and base current is 100 μ A calculate β_e and the collector current I_C *($99, 9.9 \times 10^{-3}$A)*
2. If the base current of transistor is 24 μ A and the current gain is 24, calculate the collector current and α_e *(576×10^{-6}A, 0.96) (Sudan 11)*
3. The electrical signal in the base of the transistor is 200 μ A and it is required that the collector current becomes 10 mA. Calculate β_e and α_e *(50, 0.98)*
4. If β_e for a transistor is 120 when the emitter current was 90 mA, calculate α_e, emitter current and the base current. *(0.99, 89.1×10^{-3}A, 0.74×10^{-3}A)*
5. If the current gain in the transistor of type npn is 98 and the collector current is 10 mA, calculate the current division, emitter current and base current. *(0.99 , 10.1×10^{-3} A, 0.1×10^{-3} A)*

6. Transistor has current division of 0.94 and the collector current is 0.24 mA, calculate the current gain coefficient, base current and the emitter current.

($15.67,\ 15.3 \times 10^{-6}$ A, 0.255×10^{-3} A)

7. Draw an electric circuit for a transistor as a switch in case of turning on, then calculate the collector current (I_C) when $V_{CC} = 1.5$ V and the potential difference between the collector and the emitter $V_{CE} = 0.5$ V , $R_C = 500\ \Omega$ *(2×10^{-3} A) (1st session 06 - Exp. 16)*

8. If : $V_{CC} = 5$ V , $V_{CE} = 0.3$ V , $R_C = 5$ kΩ , $\beta_e = 30$

   Calculate :

   (a) The base current I_B

   (b) Value of α_e *(0.031×10^{-3} A , 0.97)*

9. If : $V_{CC} = 5$ V, $V_{CE} = 0.2$ V , $R_C = 1$ kΩ , $I_E = 4.848$ mA

   Find :

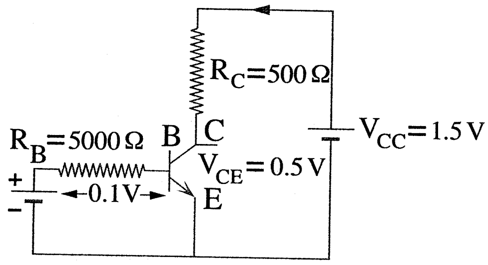
   (a) The value of α_e (b) The current gain β_e *(0.9901 , 100)*

10. **From the opposite figure, find :**

    (a) I_E

    (b) α_e

    (c) β_e



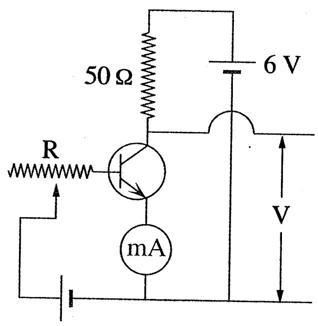
(2.02×10^{-3} A , 0.99 , 100)

11. The figure illustrates a transistor as a switch.

    (a) What is the type of the given transistor ?

    (b) If the milli-ammeter reads 100 mA and the current gain of the transistor = 49, find the voltage (V).

    (c) What happens to the voltage (V) when the resistor (R) is increased ? *(1.1 V)*



12. The following table illustrates the relation between the collector current I_C and the base current I_B of a transistor pnp :

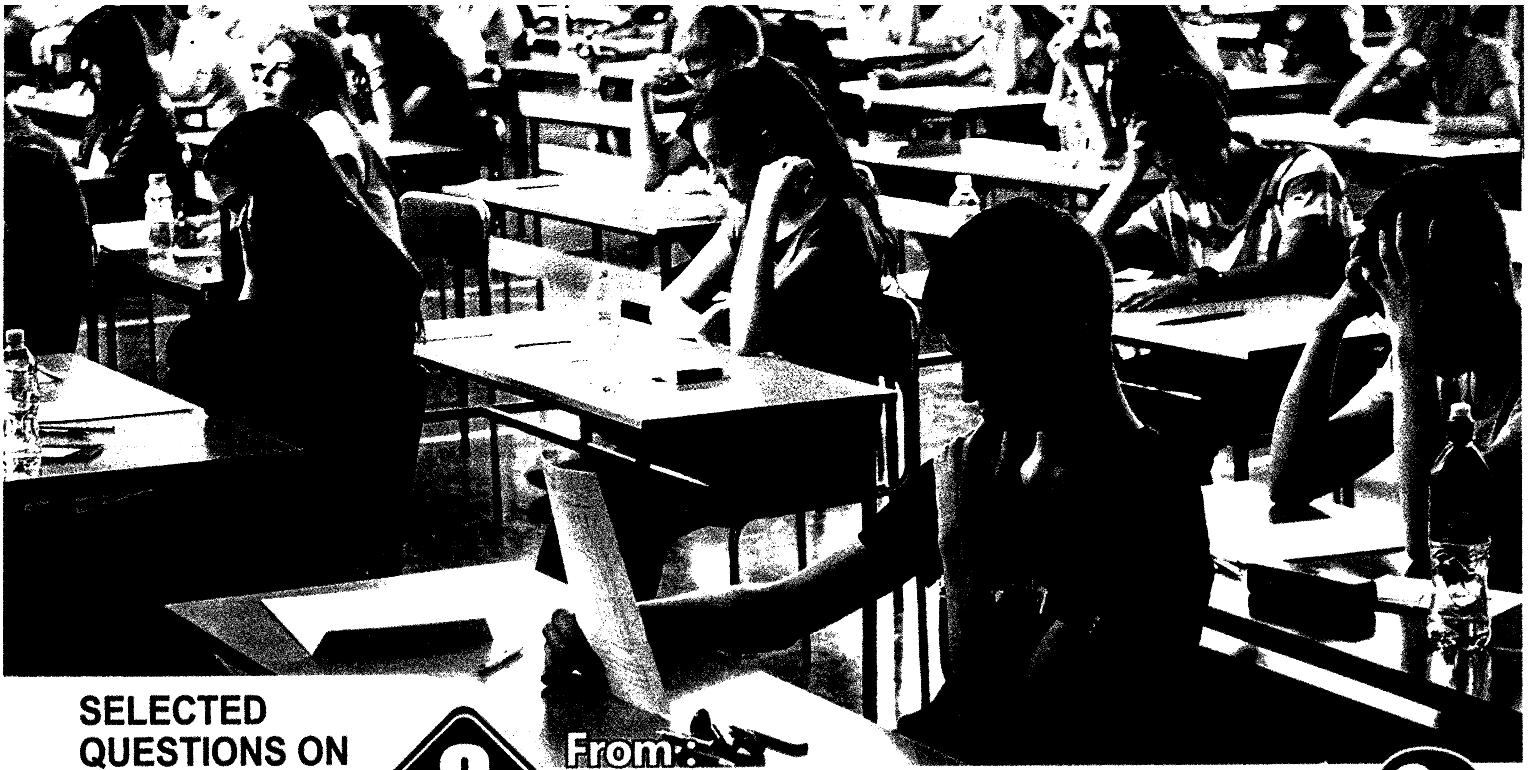
I_C (mA)	15	30	45	60	75
I_B (mA)	0.15	0.3	0.45	0.6	0.75

(a) Draw the graphical relation between I_C on the Y-axis and I_B on the X-axis.

(b) From the graph, find the current gain (β_e) of such transistor.

(c) **Find the value of each of the following :**

1. α_e 2. I_E when $I_C = 45$ mA *(100, 0.99 , 44.6 mA)*



SELECTED QUESTIONS ON

Chapter 8

From :

- Student Evaluation Guide (2017).
- Booklet Models of the Ministry of Education.

1 Choose the correct answer from the given answers :

1. The logic gate that is composed of two transistors connected in parallel is .... gate.

   a. NOT   b. AND   c. OR   *(Booklet 1)*

2. Doping a silicon crystal with impurities of aluminum atoms leads to an increase in ....   *(Booklet 2)*

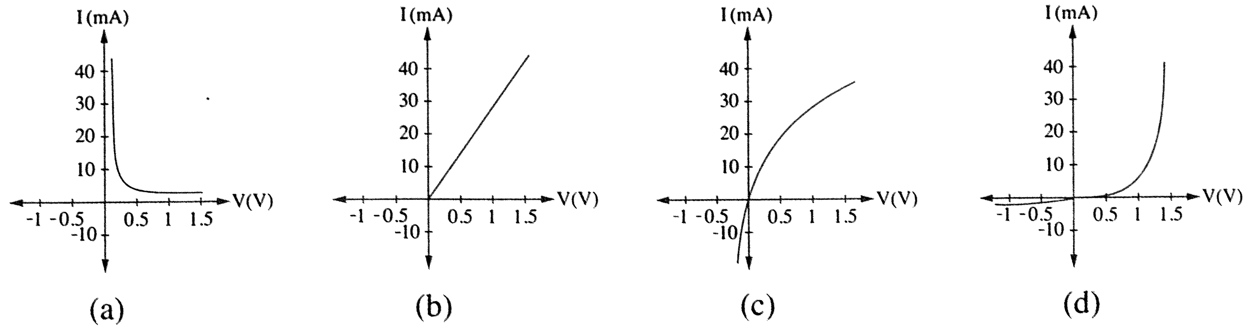
   a. its positive potential.   b. its negative potential.

   c. free electrons concentration.   d. holes concentration.   *(Booklet 3)*

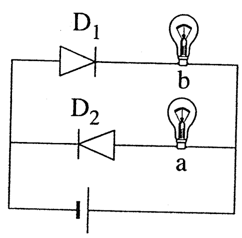
3. The dominant charge carriers in n-type crystal is ....

   a. free electrons.   b. negative ions.   c. holes.   d. positive ions.

4. Which of the following graphical figures represents the correct relation between the current intensity passing through pn junction and the potential difference between its ends ? ....

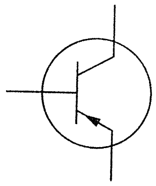


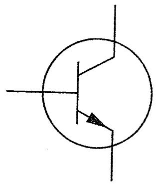
5. Which of the following cases can be applied in the opposite figure ? ....

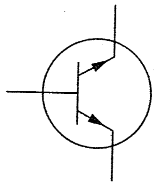


a. Both of the two lamps are illuminated.
b. Lamp (a) lights only.
c. Lamp (b) lights only.
d. No correct answer.

6. The symbol of pnp transistor in the electric circuits is ....


(a)


(b)


(c)

2 Write down the scientific term for :

The process of substituting some silicon atoms in its crystal by atoms of tri or pentavalent element.

3 What are the results of :

1. Connecting a pn junction to an alternating current supply having a suitable voltage. *(Booklet 2)*
2. Connecting the base of npn transistor to negative voltage where the emitter is common.

4 What is the scientific idea for :

Using the diode semiconductor as a switch. *(Booklet 2)*

5 Compare between :

OR gate and AND gate (in terms of : the probability of giving output (1) when having 2 inputs).

6 Give reasons for :

1. In the npn transistor circuit most of the emitter current goes to the collector while the base current is very small.
2. The silicon crystal which contains impurities from boron is called p-type crystal.
3. Passing a diffussion current in pn junction. *(Booklet 4)*
4. Presence of defects in sound and image in the analog transmitter device. *(Booklet 2)*
5. Purity of image when digital transmitter and receiver devices are used.

7 What is meant by :

The current gain of a transistor = 99 *(Booklet 2)*

8 Prove that :

$$\alpha_e = \frac{\beta_e}{1 + \beta_e}$$

9 What happens to :

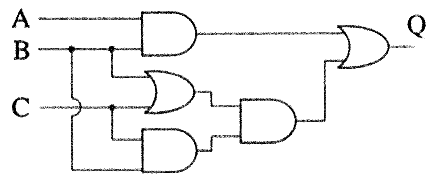
The AC current resulting from a full wave rectifier if its frequency resulting from half wave rectifier equals 50 Hz.

10 Miscellaneous questions :

1. Mention two factors that can increase the electric conductivity of a silicon crystal. *(Booklet 1)*

2. What is the idea or the method by which scientists could rectify the alternating current using semiconductor crystals ? *(Booklet 1)*

3. Record in a table the different probabilities of the output Q for the logic gate grouping shown in the diagram, when all input A, B and C is alike.



(Booklet 1)

4. Write down the mathematical expression for the law of mass action in the pure semiconductor crystal in case of the following : *(Booklet 1)*

   (a) n-type crystal. (b) p-type crystal.

5. Write down the mathematical relation that is used to calculate the concentration of the majority of charge carriers in n-type crystal. *(Booklet 2)*

6. Draw a labelled diagram for the circuit of npn transistor as a switch in (on) condition. *(Booklet 2)*

7. What is the effect of lowering temperature on the electric conductivity of a pure silicon crystal ? *(Booklet 3)*

8. Define dynamic equilibrium in semiconductors. *(Booklet 3)*

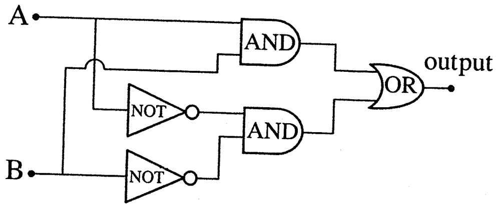
9. Mention one use of the transistor. *(Booklet 3)*

10. Show the reason of the increase in the electric conductivity of the silicon crystal when doped with aluminum atoms. *(Booklet 4)*

11. Write down the mathematical expression that is used to calculate the concentration of positive holes in n-type crystal. *(Booklet 4)*

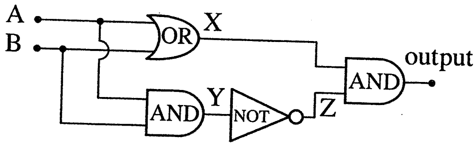
12. **Complete the truth table and record all the probabilities for the input of the following circuit :**

(A)	(B)	output
....	....	....
....	....	....
....	....	....
....	....	....

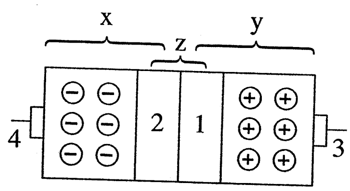


13. **Complete the truth table for the following circuit :**

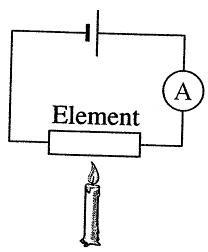
(A)	(B)	(X)	(Y)	(Z)	output
0	0	....	....	....	....
0	1	....	....	....	....
1	0	....	....	....	....
1	1	....	....	....	....



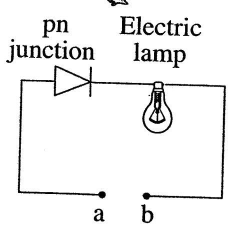
14. **The opposite figure shows pn junction :**
   (a) What is the name of the region (z) ?
   (b) What is the type of the semiconductor denoted by (x) and that denoted by (y) ?
   (c) In case of forward connection, which pole should be connected to terminal (4) ?
   (d) What is the element used in making the junction ?



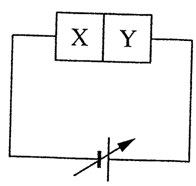
15. **Using the opposite figure, what will happen to the reading of ammeter in the following cases, with reason :**
   (a) If the element is copper.
   (b) If the element is silicon.



16. The figure represents pn junction connected in series to electric lamp.
   (a) Show on the drawing the method of connecting a battery between two points (a , b) to illuminate the lamp. Mention the reason.
   (b) If the battery is replaced by AC source, determine the type of the current passing through the lamp, mention the reason.

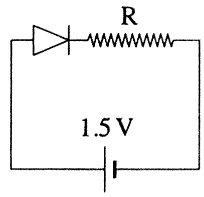


17. If you have two adjacent germanium crystals X, Y as shown in the figure , if the crystal (X) is doped with antimony and the crystal (Y) with boron to become pn junction and is connected to a battery as shown in the figure :
   (a) Is the connection forward or reverse ?
   (b) Draw the relation between V, I in this case.

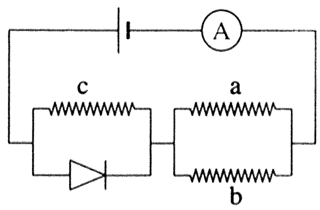


11 Problems :

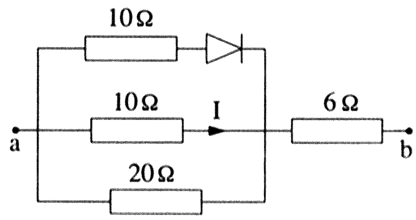
1. The diode shown in the figure works with constant potential difference equals 0.5 V when the maximum current passes through it and the maximum electric power is 100 mW , calculate the value of resistance (R) which allows the passage of maximum current. *(5 Ω)*



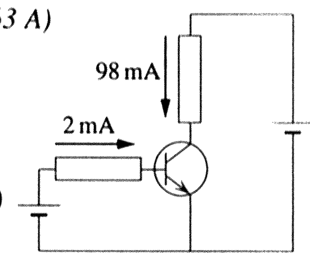
2. The electric circuit shown in the figure consists of a dry cell of emf V_B , neglecting its internal resistance, three identical ohmic resistance (a, b, c) and diode which its resistance in case of forward connection is the same value of one from the three ohmic resistance, find the ratio between the reading of ammeter before and after reversing the pn junction. $(\frac{3}{2})$



3. In the electric circuit shown in the opposite figure, a battery of emf equals 5 V of negligible internal resistance is placed between two points (a , b)
Calculate the value of electric current (I) in the following cases :
(a) $V_a > V_b$ (b) $V_a < V_b$ *(0.2 A, 0.263 A)*



4. The given diagram a transistor as a switch.
(a) Is the indicated transistor in (off) or (on) condition ?
(b) Use the given data to find the constants β_e and α_e *(49 , 0.98)*



5. Calculate the current passing in the resistor 40 Ω in both circuits, ignoring the internal resistance of the electric source and supposed that the resistance of the diode in forward is negligible and in reverse connection is infinity. *(0.1 A , 0.06 A)*

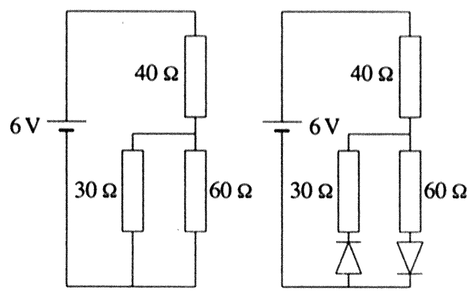


Figure (1) *Figure (2)*

6. If the concentration of the free electrons or holes in a pure silicon crystal is 10^{10} cm^{-3} and boron atoms are added in the concentration of 10^{12} cm^{-3}.

Calculate :
(a) Concentration of free electrons in the doped crystal.
(b) Concentration of holes in the doped crystal.
(c) What is the type of the produced silicon crystal p-type or n-type ?

(10^8 cm^{-3} , 10^{10} cm^{-3})