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**Newslands:** repetition of properties each 8 elements  
: created law of octaves

**Lothar Meyer:** arranged elements in order of atomic mass

**Mendeleev:** predicted the existence and properties of undiscovered elements

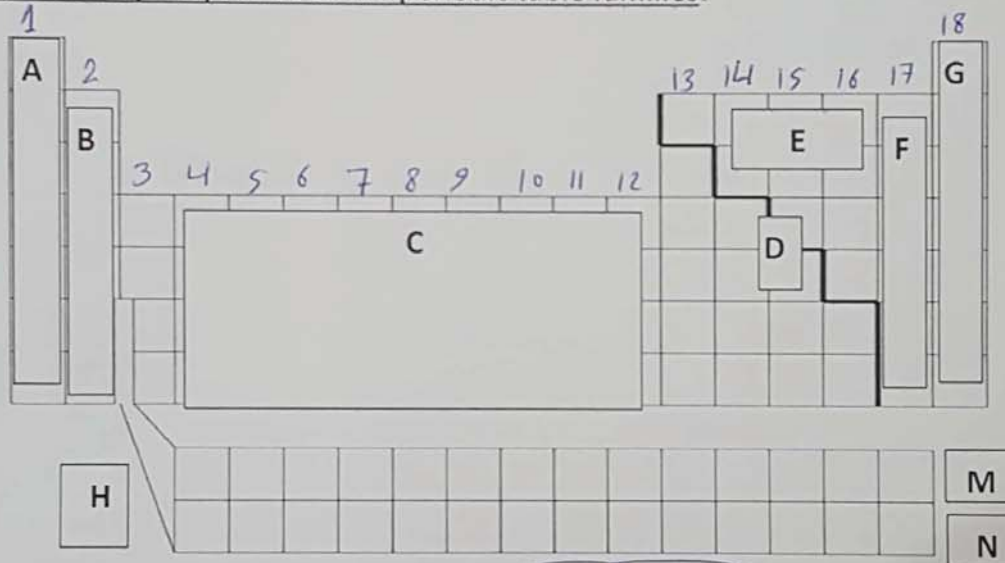
connection between  
atomic mass and  
properties

important

**Moseley:** atomic number

**Periodic law:** the periodic repetition of chemical and physical properties  
(increasing atomic number)

Questions (1-12) refers to the periodic table families:



1- Which letter(s) best represent transition elements?

- a) A and B  
b) C and D  
c) C → 3 → 12  
d) H

2- Which letter(s) best represent alkaline earth metals?

- a) A and B  
b) C and D  
c) C  
d) B → Group (2)

3- Which letter(s) best represent alkali metals?

- a) M and N  
b) C and D  
c) A → Group (1)  
d) B

4- Which letter(s) best represent halogens?

- a) A and N  
b) C and D  
c) F → Group (17)  
d) G

- 5- Which letter(s) best represent noble gases?  
 a) E and B  
 b) G and F  
 c) G → Group 18  
 d) F
- 6- Which letter(s) best represent metals? → left side (most of elements)  
 a) A and B  
 b) C and D  
 c) C  
 d) A, B, C and H
- 7- Which letter(s) best represent inner transition elements?  
 a) M and B  
 b) N and D  
 c) N  
 d) H
- 8- Which letter(s) best represent metalloids? → between metals and non-metals  
 a) D → zigzag  
 b) C and D  
 c) E  
 d) F
- 9- Which letter(s) best represent lanthanide series?  
 a) N and B  
 b) C and M  
 c) M → La  
 d) N
- 10- Which letter(s) best represent actinide series?  
 a) N and B  
 b) C and M  
 c) M  
 d) N → Ac
- 11- Which letter(s) best represent non-metals? → right side  
 a) D, E and B  
 b) E, F and G  
 c) C  
 d) D
- 12- Which letter(s) best represent representative elements? → 1, 2, 13 → 18  
 a) A, D, C and B  
 b) A, B, E, F and G  
 c) A, B, C and G  
 d) H, C

Complete the coming table?

element	Atomic number	Longhand configuration	Shorthand configuration	Valence electrons	group	period	block
C	6	$1s^2 2s^2 2p^2$	$[\text{He}] 2s^2 2p^2$	4	14	2	P
Na	11	$1s^2 2s^2 2p^6 3s^1$	$[\text{Ne}] 3s^1$	1	1	3	s
Al	13	$1s^2 2s^2 2p^6 3s^2 3p^1$	$[\text{Ne}] 3s^2 3p^1$	3	13	3	P
S	16	$1s^2 2s^2 2p^6 3s^2 3p^4$	$[\text{Ne}] 3s^2 3p^4$	6	16	3	P
Ca	20	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$	$[\text{Ar}] 4s^2$	2	2	4	s
Fe	26	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$	$[\text{Ar}] 4s^2 3d^6$		8	4	d

Fill the table

period ← (5) → group  
 block

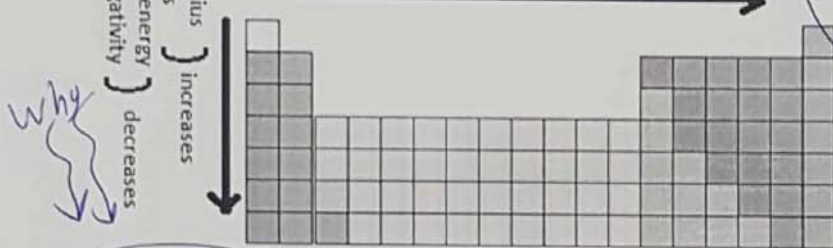
$s+0$   
 $p+12$   
 $d+2$  } → group

	group	period	block
[Kr] $5s^2$	2	5	s
[Ne] $3s^2 3p^4$	$4+2=$ 16	3	p
[Kr] $5s^2 4d^{10} 5p^5$	$5+2$ 17	5	p
[Ar] $4s^2 3d^5$	$5+2$ 7	4	d

Periodic trends:

why →

atomic radius } decreases  
 ionic radius }  
 ionization energy } increases  
 electronegativity }



more electrons in the same energy level, so more attraction to nucleus

more orbits, so electrons further from nucleus

Choose the correct answer

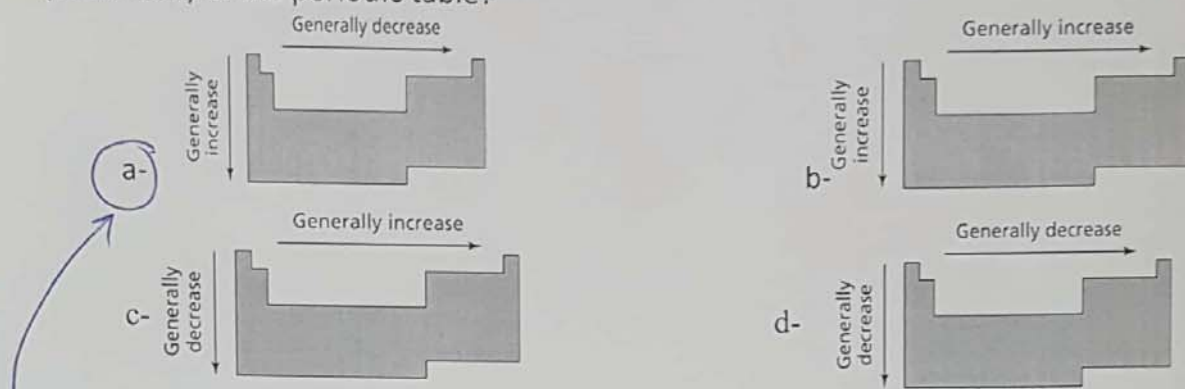
13. Why atomic radii decrease as you move from left to right across period?

- a. The decrease of the mass of the nucleus.
- b. The increase in the positive charge of the nucleus. ⇒ more attraction
- c. The fewer the number of filled orbitals.
- d. The increase of principal energy levels.

14. Why atomic radii increase as you move down a group?

- a. The decrease of the mass of the nucleus.
- b. The increase in the positive charge of the nucleus.
- c. The fewer the number of filled orbitals.
- d. The increase of principal energy levels.

15- Which diagram best represents the group and period trends in atomic radii (ionic radii) in the periodic table?



16- The general trend in the radius of an atom moving down a group is partially accounted for by the

- a- decrease in the mass of the nucleus.
- b- increase in the charge of the nucleus.
- c- fewer number of filled orbitals.
- d- shielding of the outer electrons by inner electrons.

17- A(n)..... is an atom, or bonded group of atoms, that has a positive or negative charge.

- a- halogen
- b- ion
- c- isotope
- d- molecule

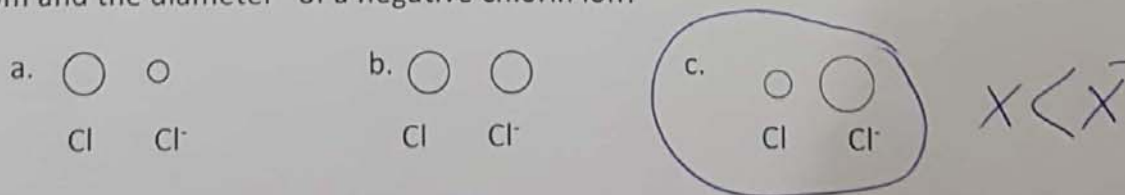
18- An atom becomes negatively charged by.....

- a- gaining an electron.
- b- gaining a proton.
- c- losing an electron.
- d- losing a neutron.

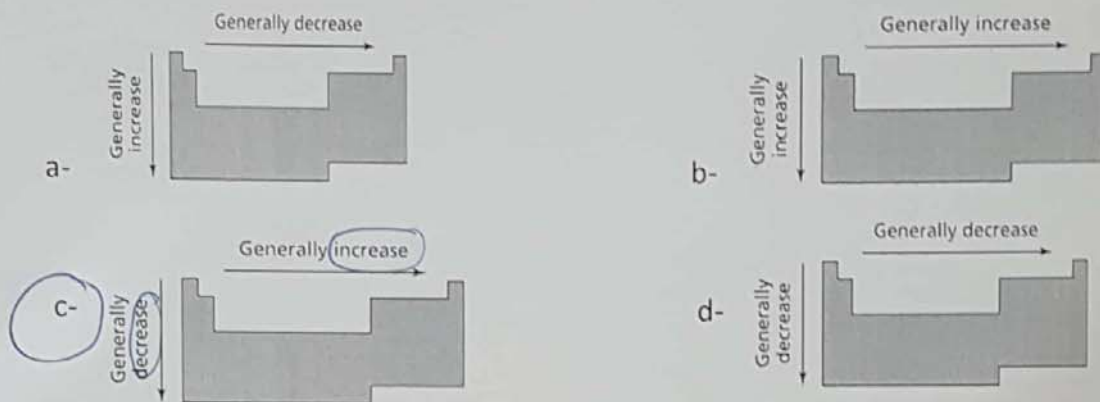
19- Which diagram best represents the relationship between the diameter of a sodium atom and the diameter of a positive sodium ion?  $X > X^+$



20 - Which diagram best represents the relationship between the diameter of a Chlorin atom and the diameter of a negative chlorin ion?  $X < X^-$



20- Which diagram best represents the group and period trends in ionization energy (electronegativity) in the periodic table?



23- Use this part of the periodic table to answer next questions.

3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn

24- Which element has greatest electronegativity value:

a- Li

b- C

c- Be

d- O

Handwritten notes: "decrease" with arrow pointing left, "increase" with arrow pointing right, and "right side" with arrow pointing right.

25- Which element has smallest atomic radius:

a. Se

b- K

c- Kr

d- Ga

Handwritten notes: "left side" with arrow pointing left, "decrease" with arrow pointing left, and "increase" with arrow pointing right.

26- Which element has greatest ionic radius:

a- Ca

b- Mg

c- Ba

d- Sr

Handwritten note: "down" with arrow pointing down.

27- Which element has smallest 1<sup>st</sup> ionization energy:

a- Rb

b- Li

c- K

d- Na

Handwritten note: "down" with arrow pointing down.

28- Which element has the greatest electronegativity value?

a. Fluorine

b. Chlorine

c. Bromine

d. Iodine

29- Which element has the least electronegativity values?

a. Cesium and Fluorine

b. Cesium and Francium

c. Bromine and Francium

d. Bromine and Fluorine

30-Who is the scientist that discovered electronegativity and its unit related to his name?

a. Moseley

b. Mayer

c. Newlands

d. Linus Pauling

31-Which group of the periodic table has no electronegativity value?

a. Alkali metals

b. Halogens

c. Noble gases

d. Alkaline earth metals

32-Choose the suitable definition from (A) for expression in group (B)

group (A)		group (B)	
A	Half the distance between nuclei of identical atoms that are chemically bonded together.	(...D...)	Ionization Energy
B	Atoms tend to gain, lose or share electrons in order to acquire a full set of eight valence electrons.	(...C...)	Ion
C	Atom or bonded group of atoms that has a positive or negative charge.	(...A...)	Atomic Radius
D	Energy required to remove an electron from a gaseous atom.	(...E...)	Electronegativity
E	Ability of atoms to attract electrons in a chemical bond.	(...B...)	Octet rule

33-Write number of valence electrons and the oxidation number of each group elements of the representative elements?

group	1	2	13	14	15	16	17	18
number of valence electrons	1	2	3	4	5	6	7	8
The oxidation number	+1	+2	+3	+4/-4	-3	-2	-1	0

## Chapter 2 Ionic compounds and metals

**chemical bond:** the force that holds two atoms together

**cation:** positively charged ion  
atom loses electrons  
metals

Na  $\xrightarrow{\text{loses } 1e^-}$  Na<sup>+</sup>

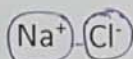
**anion:** negatively charged ion  
atom gains electrons  
non-metals

Cl  $\xrightarrow{\text{gains } 1e^-}$  Cl<sup>-</sup>

Why????? to get noble gas configuration (**octet rule**)

Ionic Compound

Na  $\xrightarrow{1e^-}$  Cl  
(metal) (non-metal)



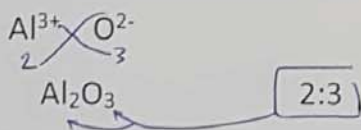
Ionic bond / ionic compound

**Ionic compounds properties:**

- Organized in crystal lattice (three dimensional arrangement)

What is the **ration** of ionic compound from

Aluminium and Oxygen?



Magnesium and Oxygen? How many magnesium atoms in the formula?



Form an ionic compound from these elements then **name it.**

<p>Calcium Ca<sup>2+</sup> and oxygen O<sup>2-</sup></p> <p>Ca<sub>2</sub>O<sub>2</sub></p> <p>CaO Calcium oxide</p>	<p>Aluminum Al<sup>3+</sup> and sulfur S<sup>2-</sup></p> <p>Al<sub>2</sub>S<sub>3</sub></p> <p>Aluminum sulfide</p>
<p>Sodium Na<sup>+</sup> and nitrogen N<sup>3-</sup></p> <p>Na<sub>3</sub>N</p> <p>Sodium nitride</p>	<p>Lithium Li<sup>+</sup> and oxygen O<sup>2-</sup></p> <p>Li<sub>2</sub>O</p> <p>Lithium oxide</p>



- **Electrolyte**: aqueous solution of ionic compound / conduct electricity
- **Solid ionic compound** doesn't conduct electricity (because no free-to-move ions)

**Dissolved/ melted** ionic compound conduct electricity (free-to-move ions)

- High melting and boiling points
  - Hard, brittle, rigid
- Why?? (because of strong attractions between ions)

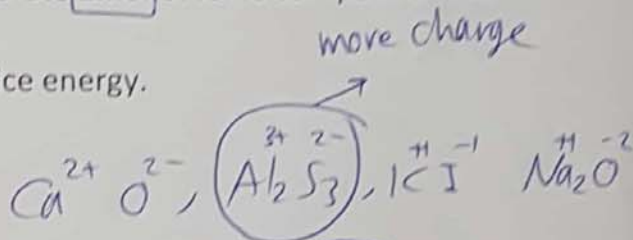
- **Easy to break if hammered**. Why?? (because of repulsion between same charge ions).

**Lattice energy**: the energy required to separate **1 mol** of ionic compound into ions.

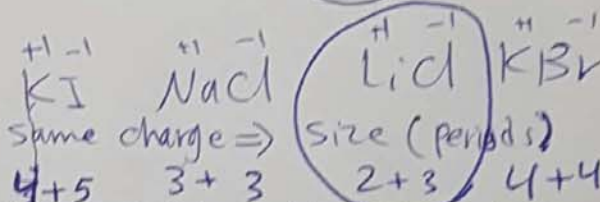
more charge/ smaller size >>> higher lattice energy.

Which has the highest lattice energy:

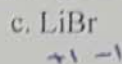
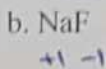
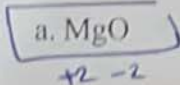
CaO, **Al<sub>2</sub>S<sub>3</sub>**, KI, Na<sub>2</sub>O



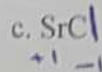
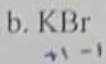
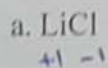
KI, NaCl, **LiCl**, KBr



Which of the ionic compounds has greatest lattice energy / Highest melting/ boiling point?



Which of the ionic compounds has greatest lattice energy?



### Names and formulas

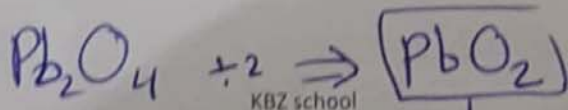
Net charge of ionic compound = zero

**Monatomic ion** (one atom) ion Na<sup>+</sup>, Ca<sup>2+</sup>, Cl<sup>-</sup> ....)

**Polyatomic ion** (more than one atom) ion SO<sub>4</sub><sup>2-</sup>, NO<sub>3</sub><sup>-</sup>, NH<sub>4</sub><sup>+</sup> ....)

**Formula unit** (the simplest ration)

oxyanion



formula unit

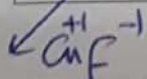
F <sup>-</sup>	Fluoride	O <sup>2-</sup>	Oxide
Cl <sup>-</sup>	Chloride	S <sup>2-</sup>	Sulphide
Br <sup>-</sup>	Bromide	P <sup>3-</sup>	Phosphide
I <sup>-</sup>	Iodide	N <sup>3-</sup>	Nitride
H <sup>-</sup>	Hydride		

Ion	Name	Ion	Name	Ion	Name
NO <sub>3</sub> <sup>-</sup>	nitrate	PO <sub>4</sub> <sup>3-</sup>	phosphate	C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> <sup>-</sup>	acetate
NO <sub>2</sub> <sup>-</sup>	nitrite	HPO <sub>4</sub> <sup>2-</sup>	Hydrogen phosphate	AsO <sub>4</sub> <sup>3-</sup>	arsenate
SO <sub>4</sub> <sup>2-</sup>	sulfate	H <sub>2</sub> PO <sub>4</sub> <sup>-</sup>	dihydrogen phosphate	MnO <sub>4</sub> <sup>-</sup>	permanganate
SO <sub>3</sub> <sup>2-</sup>	sulfite	CO <sub>3</sub> <sup>2-</sup>	carbonate		
S <sub>2</sub> O <sub>3</sub> <sup>2-</sup>	thiosulfate	HCO <sub>3</sub> <sup>-</sup>	hydrogen carbonate	OH <sup>-</sup>	hydroxide
		CrO <sub>4</sub> <sup>2-</sup>	chromate	CN <sup>-</sup>	cyanide
		Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup>	dichromate	NH <sub>4</sub> <sup>+</sup>	ammonium

Ion	Name	Ion	Name	Ion	Name
ClO <sub>4</sub> <sup>-</sup>	<b>perchlorate</b>			IO <sub>4</sub> <sup>-</sup>	<b>periodate</b>
ClO <sub>3</sub> <sup>-</sup>	chlorate	BrO <sub>3</sub> <sup>-</sup>	bromate	IO <sub>3</sub> <sup>-</sup>	iodate
ClO <sub>2</sub> <sup>-</sup>	chlorite				
ClO <sup>-</sup>	<b>hypochlorite</b>				

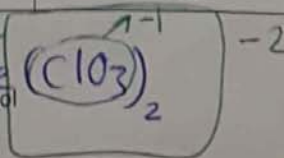
Name the following ionic compounds

Formula	Name	Formula	Name
NaCl	Sodium chloride	NaNO <sub>2</sub>	Sodium nitrite
MgF <sub>2</sub>	magnesium fluoride	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	Aluminium sulfate
Al <sub>2</sub> O <sub>3</sub>	Aluminium oxide	Li <sub>2</sub> CO <sub>3</sub>	Lithium carbonate
Li <sub>3</sub> N	Lithium nitride	Ca <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>	Calcium phosphate
CaS	Calcium sulfide	NaOH	Sodium hydroxide
CuF	Copper(I) fluoride	Fe(ClO <sub>3</sub> ) <sub>2</sub>	Iron(II) chlorate



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Write formulas of the following

<p>sodium phosphide</p> $\begin{array}{c} \text{Na}^+ \times \text{P}^{-3} \\ \text{Na}_3\text{P} \end{array}$	<p>lithium sulfide</p> $\begin{array}{c} \text{Li}^+ \times \text{S}^{-2} \\ \text{Li}_2\text{S} \end{array}$	<p>ammonium chloride</p> $\begin{array}{c} \text{NH}_4^+ \times \text{Cl}^{-1} \\ \text{NH}_4\text{Cl} \end{array}$	<p>Aluminum nitride</p> $\begin{array}{c} \text{Al}^{+3} \times \text{N}^{-3} \\ \text{AlN} \end{array}$
<p>Aluminum Hydroxide</p> $\begin{array}{c} \text{Al}^{+3} \times \text{OH}^{-1} \\ \text{Al}(\text{OH})_3 \end{array}$	<p>Iron (II) chloride</p> $\begin{array}{c} \text{Fe}^{2+} \times \text{Cl}^{-1} \\ \text{FeCl}_2 \end{array}$	<p>calcium chlorate</p> $\begin{array}{c} \text{Ca}^{2+} \times \text{ClO}_3^{-1} \\ \text{Ca}(\text{ClO}_3)_2 \end{array}$	<p>Ammonium Nitrate</p> $\begin{array}{c} \text{NH}_4^+ \times \text{NO}_3^{-1} \\ \text{NH}_4\text{NO}_3 \end{array}$
<p>Sodium cyanide</p> $\begin{array}{c} \text{Na}^+ \times \text{CN}^{-1} \\ \text{NaCN} \end{array}$	<p>aluminum chromate</p> $\begin{array}{c} \text{Al}^{+3} \times \text{CrO}_4^{-1} \\ \text{Al}(\text{CrO}_4)_3 \end{array}$	<p>magnesium perchlorate</p> $\begin{array}{c} \text{Mg}^{2+} \times \text{ClO}_4^{-1} \\ \text{Mg}(\text{ClO}_4)_2 \end{array}$	<p>Barium Nitrite</p> $\begin{array}{c} \text{Ba}^{2+} \times \text{NO}_2^{-1} \\ \text{Ba}(\text{NO}_2)_2 \end{array}$

Choose the correct answer:

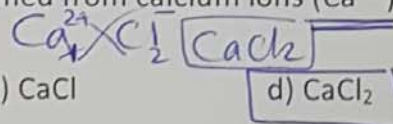
1. What is the chemical formula for a compound formed from calcium ions ( $\text{Ca}^{2+}$ ) and chloride ions ( $\text{Cl}^{-1}$ )?

a)  $\text{Ca}_2\text{Cl}$

b)  $\text{Ca}_2\text{Cl}_2$

c)  $\text{CaCl}$

d)  $\text{CaCl}_2$



2. Which pair of the following have the same number of electrons. (O=8, Ca=20, Fe=26, Cl=17, F=9)

a- F,  $\text{Cl}^-$   
9 10

b-  $\text{Ca}^{2+}$ ,  $\text{Fe}^{3+}$   
18 23  
(20-2) (26-3)

c-  $\text{O}^{2-}$ , F  
10 9  
(8+2)

d-  $\text{Ca}^{2+}$ ,  $\text{Cl}^-$   
18 18  
(20-2) (17+1)

3. Which of the following pairs can form an ionic compound?

a. C and F

b. Na and O

c. Na and Ba

d. Ar and F

metal

non-metal

metal/non-metal

4. What are the states of ionic compounds that conduct electricity?

a. solid and liquid

b. liquid and solution

c. solid and solution

d. answer is not given

melted

dissolved

## Metallic bond:

Only metals/ electrons-sea model/  
delocalized electrons/ metallic bond



### Properties:

- high melting and boiling points
- malleable, ductile and durable
- hardness and strength

why → because of  
strong attraction between cations and  
delocalized electrons

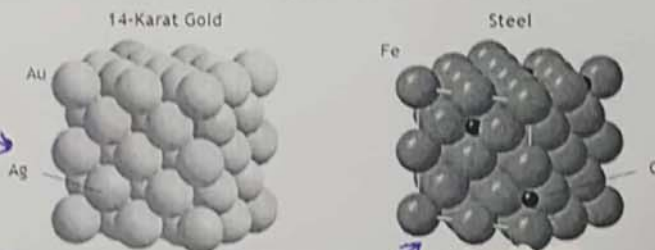
- conduct electricity (because of delocalized electron)

**Alloys:** mixture of elements.

Different properties from the properties of elements they contain.

**Substitutional:** replaced by similar-size atom (Silver and copper)

**Interstitial:** fill small holes with smaller atoms (Iron and carbon)



**Table 7.13 Commercial Alloys**

Common Name	Composition	Uses
Alnico	Fe 50%, Al 20%, Ni 20%, Co 10%	magnets
Brass	Cu 67–90%, Zn 10–33%	plumbing, hardware, lighting
Bronze	Cu 70–95%, Zn 1–25%, Sn 1–18%	bearings, bells, medals
Cast iron	Fe 96–97%, C 3–4%	casting
Gold, 10-carat	Au 42%, Ag 12–20%, Cu 37.46%	jewelry
Lead shot	Pb 99.8%, As 0.2%	shotgun shells
Pewter	Sn 70–95%, Sb 5–15%, Pb 0–15%	tableware
Stainless steel	Fe 73–79%, Cr 14–18%, Ni 7–9%	instruments, sinks
Sterling silver	Ag 92.5%, Cu 7.5%	tableware, jewelry

Which of the following pairs can form an interstitial alloy?

a. Fe, Mn  
26 25

b. Fe, C  
26 6

c. Ag, Au  
47 79

d. Ag, Cu  
47 29

(atomic number)  
small and big atoms

## Chapter-3 Covalent bond:

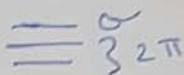
Non-metals/ sharing/ molecule/ Lewis structure

**Sigma bond is not formed when:**

- a. s orbital overlaps with another s orbital
- b. p parallel orbitals overlap and share electrons
- c. s orbital overlaps with another p orbital
- d. two p orbitals overlap end-to-end.

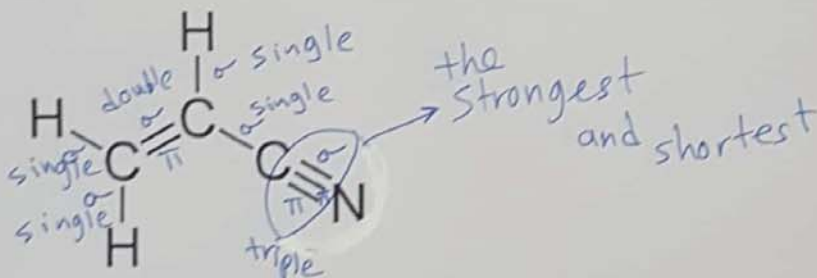
**What does a triple bond consist of?**

- A. three sigma bonds
- B. three pi bonds
- C. two sigma bonds and one pi bond
- D. two pi bonds and one sigma bond



Determine all: Single, double, triple, Sigma and pi bonds

The shortest and strongest bond



Which of the following has the shortest and strongest bond

- a.  $\text{F}_2$
- b.  $\text{O}_2$
- c.  $\text{N}_2$
- d.  $\text{HF}$

Endothermic reaction: absorbs energy / breaking bonds

Exothermic reaction: releases energy / forming bonds

Number of atoms	Prefix	Number of atoms	Prefix
1	mono-	6	hexa-
2	di-	7	hepta-
3	tri-	8	octa-
4	tetra-	9	nona-
5	Penta-	10	deca-

Name the following compounds:

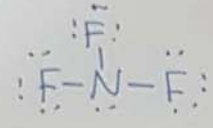
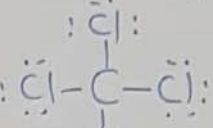
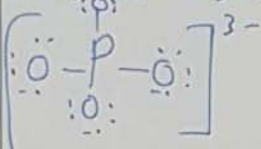
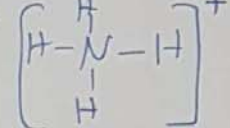
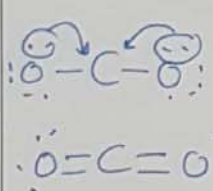
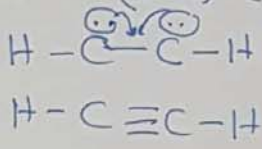
$\text{CCl}_4$ Carbon tetrachloride	$\text{P}_2\text{O}_5$ diphosphorous pentoxide	$\text{N}_2\text{O}$ dinitrogen monoxide
$\text{HCl}$ hydrochloric acid	$\text{HBr}$ hydrobromic acid	$\text{H}_2\text{S}$ hydro sulfuric acid
$\text{H}_2\text{SO}_4$ sulfuric acid	$\text{HNO}_2$ Nitrous acid	

Write the formula of the following compounds:

Chlorine trifluoride $\text{ClF}_3$	dihydrogen monoxide $\text{H}_2\text{O}$	carbon disulphide $\text{CS}_2$
Hydrofluoric acid $\text{HF}$	hydrobromic acid $\text{HBr}$	
Carbonic acid $\text{H}_2\text{CO}_3$	Nitric acid $\text{HNO}_3$	Sulfurous acid $\text{H}_2\text{SO}_3$

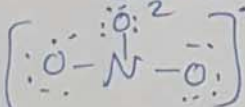
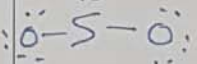
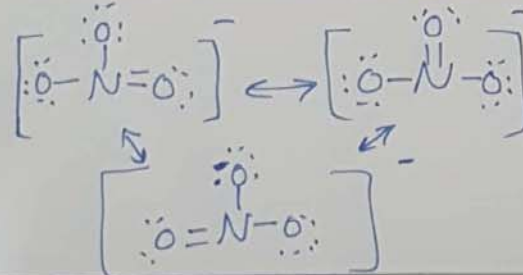
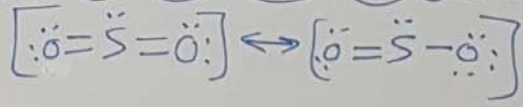
Table 8.5 Formulas and Names of Some Covalent Compounds		
Formula	Common Name	Molecular Compound Name
$\text{H}_2\text{O}$	water	dihydrogen monoxide
$\text{NH}_3$	ammonia	nitrogen trichloride
$\text{N}_2\text{H}_4$	hydrazine	dinitrogen tetrahydride
$\text{HCl}$	muratic acid	hydrochloric acid
$\text{C}_9\text{H}_8\text{O}_4$	aspirin	2-(acetyloxy)benzoic acid
$\text{NO}$	nitric oxide	nitrogen monoxide

Draw Lewis structure of the following

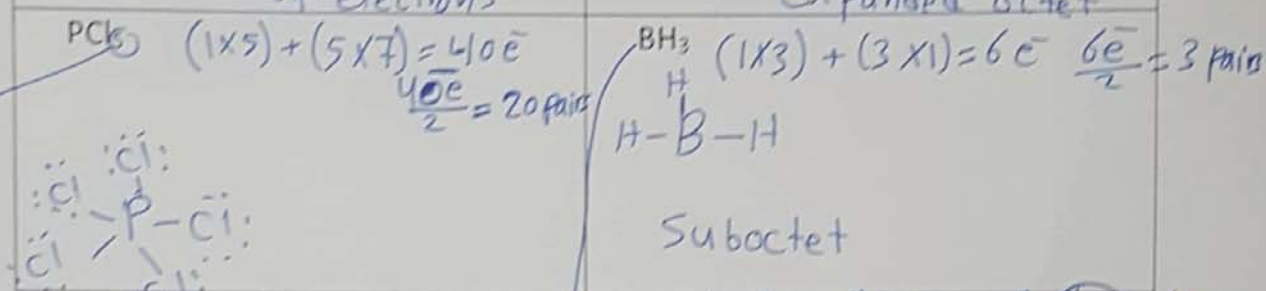
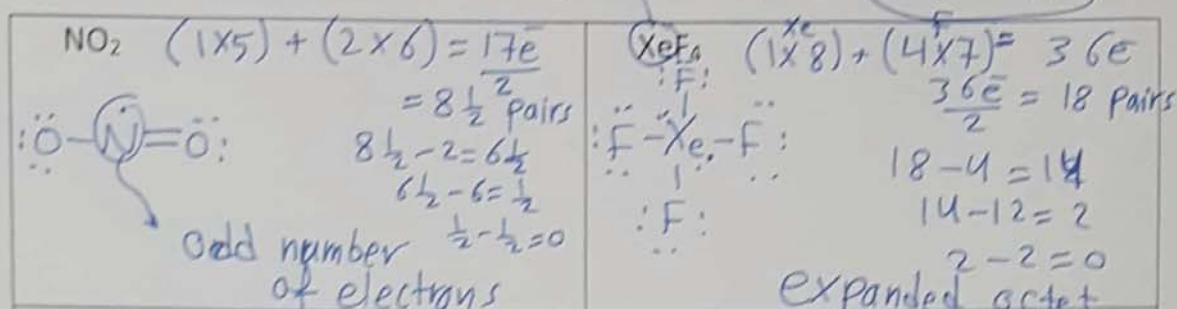
$\text{NF}_3$ $(1 \times 5) + (3 \times 7) = 26e^-$ $\frac{26e^-}{2} = 13 \text{ pairs}$  $13 - 3 = 10$ $10 - 9 = 1$ $1 - 1 = 0$	$\text{CCl}_4$ $(1 \times 4) + (4 \times 7) = 32e^-$ $\frac{32e^-}{2} = 16 \text{ pairs}$  $16 - 4 = 12$ $12 - 12 = 0$
$\text{PO}_4^{3-}$ $\rightarrow$ gained $3e^-$ $(1 \times 5) + (4 \times 6) + 3 = 32e^-$ $\frac{32e^-}{2} = 16 \text{ pairs}$  $16 - 4 = 12$ $12 - 12 = 0$	$\text{NH}_4^+$ $\rightarrow$ lost $1e^-$ $(1 \times 5) + (4 \times 1) - 1 = 8e^-$ $\left\{ \frac{8e^-}{2} = 4 \text{ pairs} \right.$  $4 - 4 = 0$
$\text{CO}_2$ $(1 \times 4) + (2 \times 6) = 16e^-$ $\frac{16e^-}{2} = 8 \text{ pairs}$  $8 - 2 = 6$ $6 - 6 = 0$	$\text{C}_2\text{H}_2$ $(2 \times 4) + (2 \times 1) = 10e^-$ $\frac{10e^-}{2} = 5 \text{ pairs}$  $5 - 3 = 2$ $2 - 2 = 0$

Draw resonance structures for:

more than one structure

$\text{NO}_3^-$ $(1 \times 5) + (3 \times 6) + 1 = 24e^-$ $\frac{24e^-}{2} = 12 \text{ pairs}$  $12 - 3 = 9$ $9 - 9 = 0$	$\text{SO}_2$ $(1 \times 6) + (2 \times 6) = 18e^-$ $\frac{18e^-}{2} = 9 \text{ pairs}$  $9 - 2 = 7$ $9 - 6 = 1$ $1 - 1 = 0$
	

Draw Lewis structure for the following and determine the exception type



Using the previous questions, determine hybrid orbitals, molecule shape (draw, name and angles) of the following:

