Chapter 5:

$\rightarrow \Sigma F_x = ma_x \longleftrightarrow \Sigma F_{\rightarrow} = \Sigma F_{\leftarrow}$

$\rightarrow \Sigma F_y = ma_y \longleftrightarrow \Sigma F_{\downarrow} = \Sigma F_{\uparrow}$

- جسم متزن .
- بوجود تسارع .

CH5

* خطوات حل أي سؤال على نيوتن :

١- نعين اتجاه الحركة (إن وجدت) ← (هل هو يتحرك متزن)

٢- نعين جميع القوى المؤثرة على الجسم

٣- نرسم محاور مناسبة ونحلل جميع القوى التي لا تنطبق على المحاور .

٤- نطبق في التوازن : [P] محور الاتزان

[L] محور الحركة (التسارع)

← القوة مع اتجاه الحركة (+)

← القوة عكس اتجاه الحركة (-) .

← أنواع القوة :

① قوة الوزن (Weight) ← W = (mg)

* الاتجاه (دائماً لأسفل) .

② قوة رد الفعل (Normal) ← N .

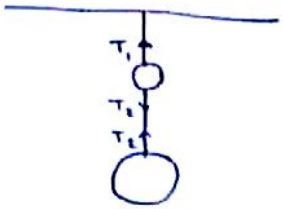
* القوة تنتج عن السطح فقط (ملامس)

* الاتجاه (دائماً عمودي على السطح)

2

الشد : (T)

- ينتج عن الحبال والخيوط .
- الاتجاه (دائماً من الجسم إلى الخيط)



- الشد في نفس الخيط متساوي فقط يختلف من خيط لخيط .

3 قوة الاحتكاك (F_s , F_k) :

Static Friction
(F_s)

$F_s \leq \mu_s N$

Kinatic Friction
(F_k)

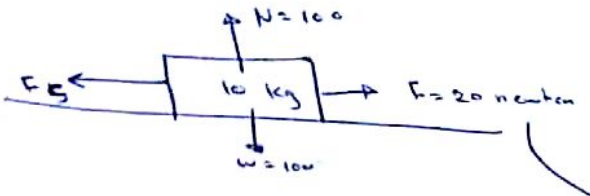
$F_k = \mu_k N$

* μ : Coefficent of Friction
- معامل الاحتكاك -

$0 \leq \mu_s \leq 1$

* $\mu_s \geq \mu_k$ *

- الاتجاه (عكس اتجاه الحركة)



$\mu_s = 0.4$

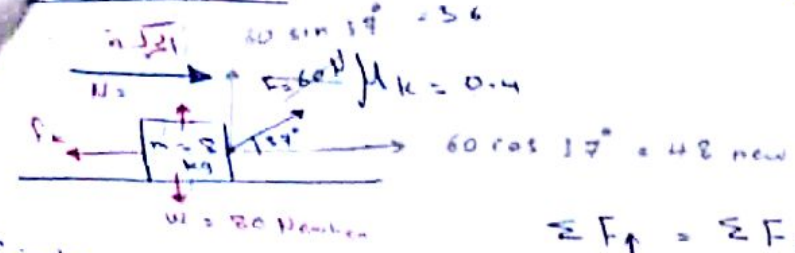
$F_s \leq \mu_s \cdot N$

$= 0.4 \cdot 100 = 40$ Newton

لو كانت 50
القوة > F_s الجسم
يتحرك الجسم

Examples:

② acceleration.



Find:

① Normal Force

$\Sigma F_\uparrow = \Sigma F_\downarrow$

$N + 56 = 80$

$N = 44$ New

$f_k = N \mu_k$

$= 0.4 \times 44 = 17.6$ New.

$\Sigma F_x = m a_x$

$48 - 17.6 = 8 \times a_x$

$\frac{31.6}{8} = a_x$

الحركة ←

$N = 80$

$= 80 \times 0.4 = 32$

F_k ← 8 → $F = 80$

80

$\mu_k = 0.4$

$N = W$

مساوية لبعضها وعكسيات

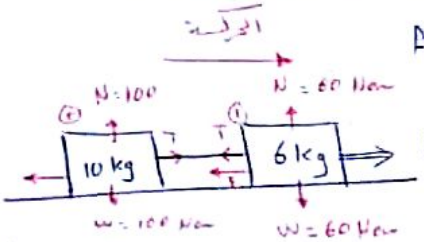
$\Sigma F_x = m a_x$

$80 - 32 = 8 \times a$

$\frac{48}{8} = a$

$\boxed{6 = a}$

Ex2



$f_k = \mu_k \times N$

$= 100 \times 0.3$

$= 30$ new

$f_k = \mu_k \times N$

$= 0.3 \times 60 = 18$ new

$F = 80$ N

① acceleration

② Tension.

$\mu_k = 0.3$

$\Sigma F_x = m_1 a_x$

$80 - T - 18 = 6 \times a$

$\boxed{62 - T = 6a}$ ①

$\Sigma F_x = m_2 a_x$

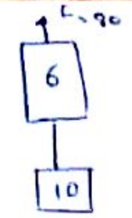
$\boxed{T - 30 = 10 a_x}$ ②

بالجمع

$32 = 16a$

$a = 2 \ m/s^2$

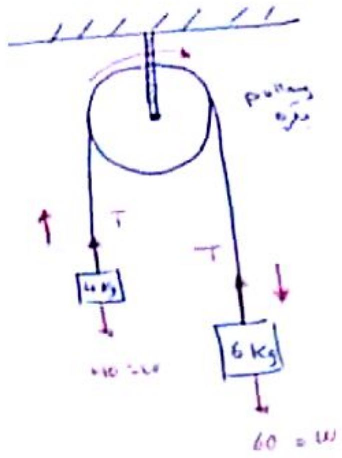
↳ $T = 20 + 30 = 50$ New



T , a

الحركة هنا

Ex 3



① a
② T

$\sum F_y = m \, a_y$

[1] $60 - T = 6 \, a_y$

[2] $T - 40 = 4 \, a_y$

$20 = 10 \, a$

$\boxed{a = 2}$

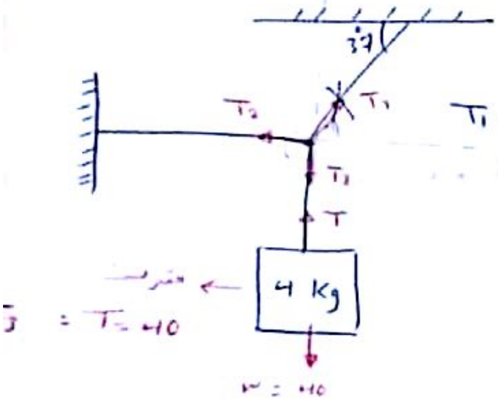
$T = 8 + 40 = 48$ N

لو الكتل متساوية
(إتزان) .
صفر = a
W = T

Ex 4

$T_1 \sin 37^\circ = 0.6 \, T_1$

⇒ find the (T) in each wire :-



$T_1 \cos 37^\circ = 0.8 \, T_1$

← إتزان $F_\uparrow = F_\downarrow$

$0.6 \, T_1 = 40$

$T_1 = \frac{40}{0.6}$

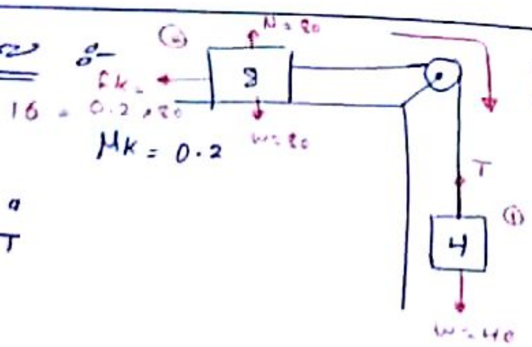
$F_\rightarrow = F_\leftarrow$

$0.8 \, T_1 = T_2$

$T_2 = 0.8 \, *$

ok

Ex 5 مهم :-



$\mu_k = 0.2$

find: ① a
② T

$\sum F_y = m \, a_y$

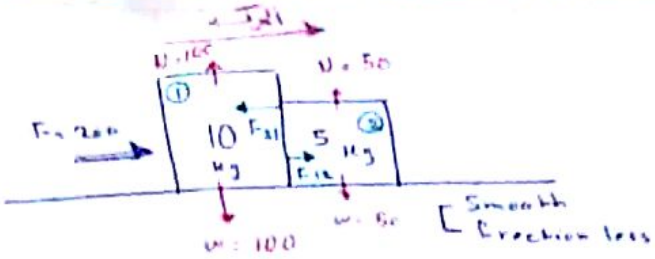
$40 - T = 4 \, a_y$ .. ①

$T - 16 = 8 \, a$ ②

$24 = 12 \, a$

$\boxed{a = 2}$

$T = 32$



(5)

① a

② Internal Forces

القوة الداخلية

(القوة المتبادلة بين جسمين)

($\vec{F}_{12} = -\vec{F}_{21}$)

($F_{12} = F_{21}$)

① $\sum F_x = m_1 a_1$

$200 - F_{21} = 10 * a$

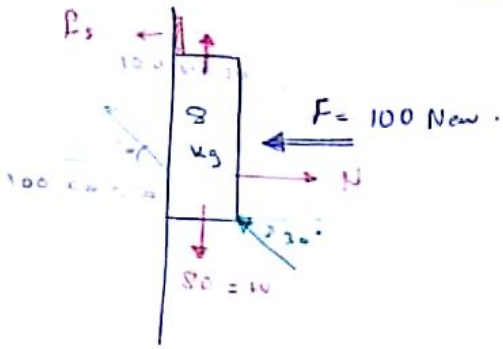
② $\sum F_x = m_2 a_2$

$F_{12} = 5 * a$

$200 = 15\,a$

$F_{21} = F_{12}$ ← لأن

E*



* what is coeff. of static friction that prevents the object from sliding down.

(Ms) ← معامل الاحتكاك الساكن ← يمنع الانزلاق

$f_s = 50 = 80$

$f_s = 80$

$N = 80$

$\sum F_{\rightarrow} = F_{\leftarrow}$

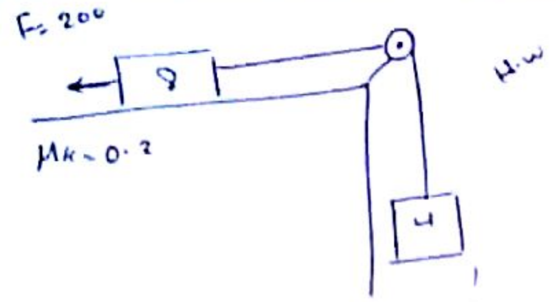
$N = 100$

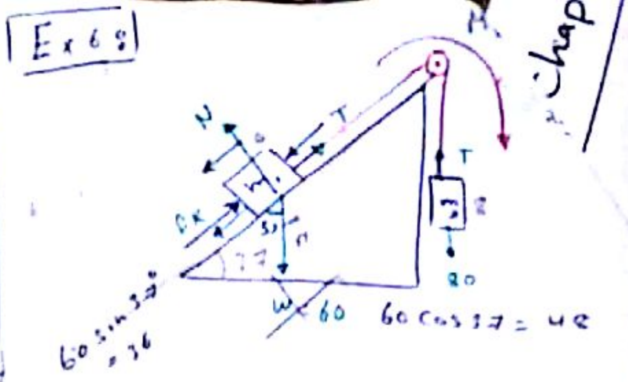
$F_{\uparrow} = F_{\downarrow}$

$80 = f_s$

$\frac{f_s}{N} = M_s$

$\frac{80}{100} = M_s = 0.8$.





$F_\uparrow = F_\downarrow$

N = 48

موجودة مباشرة

اذا كانت μ_k مجهول نعوضها بالقانون $\mu_k \cdot N$

$f_k = \mu_k \times 48$

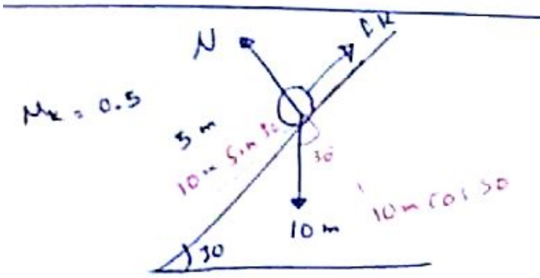
$= 9.6$

$\sum F_y = m_1 a_y$

$80 - T = 8a$

$T - 36 - 9.6 = 6a$

$T - 45.6 = 6a$



$N = \cancel{10m}\ 8.6\ m$

$f_k = \mu_k \times N$

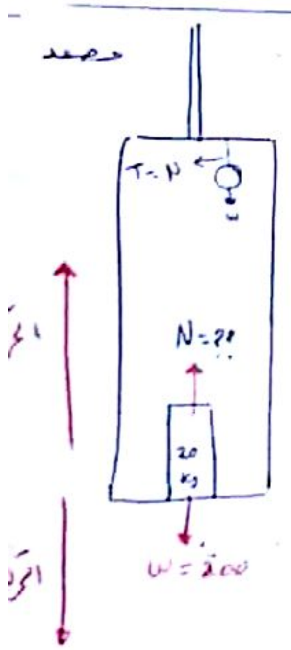
$= 0.5 \times 8.6\ m = 4.3\ m$

اذا كانت m مجهولة

$\sum F = m a$

$5m - 4.3m = m a$

$= 0.7$



المطلوب الأساسي ← الوزن الظاهري

app weight = N

← اذا واقف اتزان 200 = N

← يتحرك بسرعة ثابتة ، ساكن 200 = N

اذا كانت ديسليريشن (تباطؤ) = 5

→ moving upward with a = 5 m/s^2 :

$\sum F_y = m a_y$

$N - 200 = 20 \times 5$

$N = 100 + 200$

$= 300$

→ moving downward :

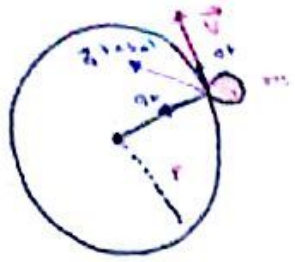
$200 - N = 20 \times 5$

$200 - 100 = N$

$N = 100$

Chapter 6 *

CH6

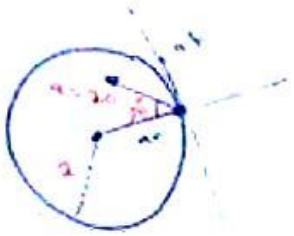


a_r تسارع مركزي $= \frac{v^2}{r}$

a_t تسارع مماسي $= \frac{dv}{dt}$ (rate)

$a_{total} = \sqrt{(a_r)^2 + (a_t)^2}$

Ex:



1) a_r
2) a_t
3) speed

$a_r = a_{total} * \cos 30$

$= 17.3$

$a_t = a_{total} * \sin 30$

$= 10.$

[V] $a_r = \frac{v^2}{r}$

$10 = \frac{v^2}{2}$

$20 = v^2$

$v = \sqrt{20}$

Ex 2

$v = 6t - 1 \Rightarrow 11$

$a_r = \frac{v^2}{r}$

1) a_r
2) a_t
3) a_{total}

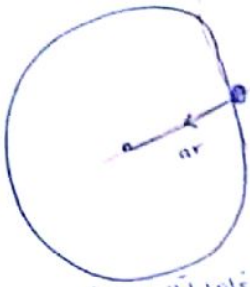
a_t $t = 2$ second

$r = 4$ m

1) $a_r = \frac{121}{4}$

2) $a_t = \frac{dv}{dt} = 6$

3) $a_{total} = \sqrt{(\frac{121}{4})^2 + (6)^2}$



$\Sigma F_r = m a_r$

$\Sigma F_r = \frac{m v^2}{r}$

F مع اتجاه المدار (+)

F عكس المدار (-)

عمودية على مستوى الدائرة

$\Sigma F_\uparrow = \Sigma F_\downarrow$

Uniform circular motion ←

$a_t = 0$

$a_{total} = a_r$

$V = \frac{2\pi r}{T_p}$ ← ثابتة

T_p ← periodic time

---

① نحدد القوى المؤثرة على الجسم

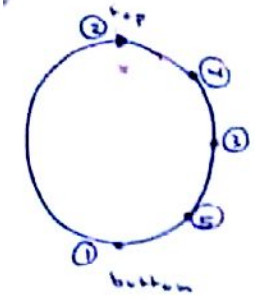
② عدد قادر بحيث تحور x منطبق على خط محور الدائرة ومحور y على المماس.

③ نطبق $\Sigma F_\uparrow = \Sigma F_\downarrow$ (إن وجد)

④ نطبق على قانون الدائرة $\Sigma F_r = \frac{m v^2}{r}$

---

① :



$m = 4$ kg

$r = 2$ m

$v = 10$ m/s

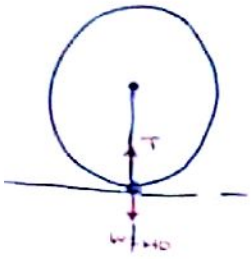
→ Find the (T) :.

- at each position -

$$\Sigma F_r = m \frac{v^2}{r}$$

$$T + 40 = \frac{4 \times 100}{2}$$

$$T = 200 - 40 = 160 \text{ Newton.}$$



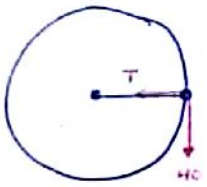
$$\Sigma F_r = m \frac{v^2}{r}$$

$$T - 40 = \frac{4 \times 100}{2}$$

$$T = 240 \text{ Newton}$$

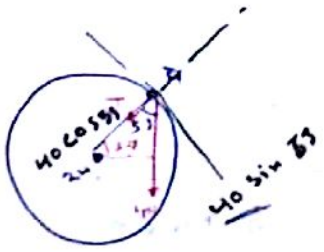
$a_t = 0$

عند القمة والقاع والوسط .



$$\Sigma F_r = m \frac{v^2}{r}$$

$$T = 200 \text{ Newton.}$$



$$\Sigma F_r = m \frac{v^2}{r}$$

$$T + 24 = 200$$

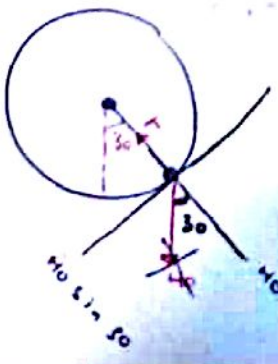
$$T = 176 \text{ Newton.}$$

اذا طلب a_t

$$\Sigma F_t = m a_t$$

$$32 = 4 a_t$$

$$a_t = 8$$



$$\Sigma F_r = m \frac{v^2}{r}$$

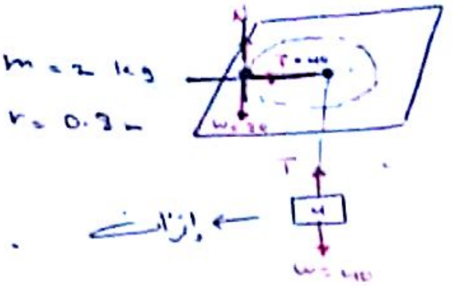
$$T - 35 = 200$$

$$T = 235 \text{ Newton}$$

Ex 2

$m = 2\ kg$

$r = 0.8\ m$



$N = 20$

→ Find the speed:

$\Sigma F_\uparrow = \Sigma F_\downarrow$

$T = 40$

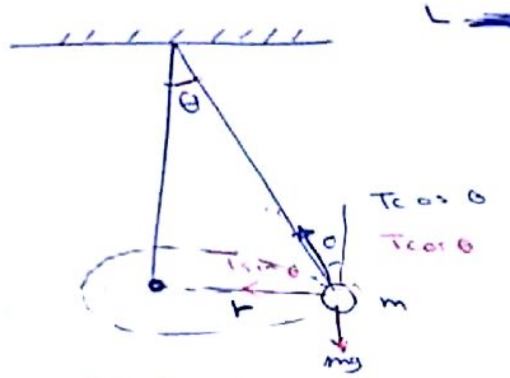
$\Sigma F_r = m \frac{v^2}{r}$

$40 = \frac{2}{0.8} v^2$

$\frac{32}{2} = v^2$

$16 = v^2$

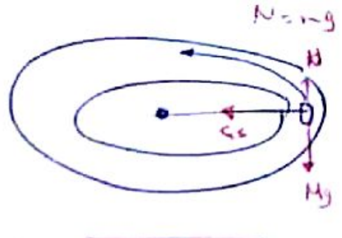
$v = 4\ m/s$



$v = \sqrt{r g \tan\theta}$

$T = \frac{mg}{\cos\theta}$

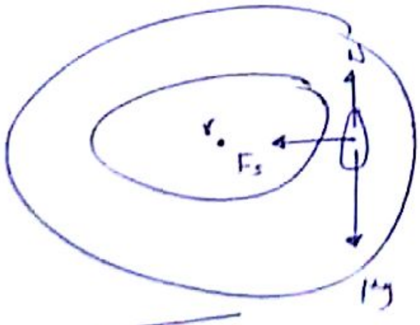
$\sin\theta = \frac{r}{L} \Rightarrow r = L \sin\theta$



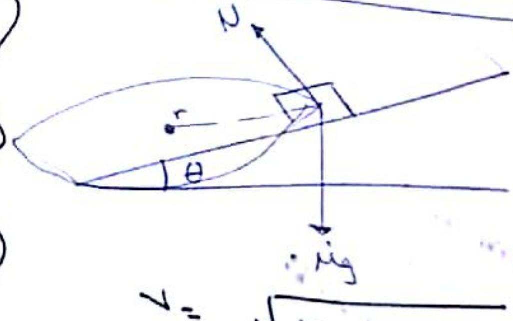
① μ_s

② ∃ v

$v = \sqrt{r g \mu_s}$



$v = \sqrt{r g \mu_s}$

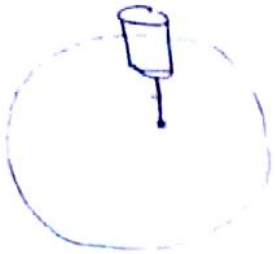


$v = \sqrt{r g \tan\theta}$

$N = \frac{mg}{\cos\theta}$

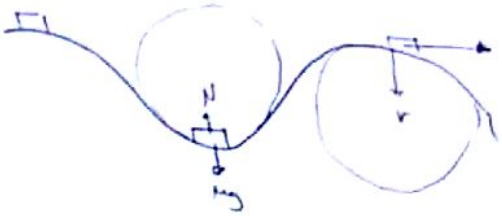
Scanned by CamScanner

What is the minimum or the maximum that prevent the object from falling down?



$$V_{min} = \sqrt{rg}$$

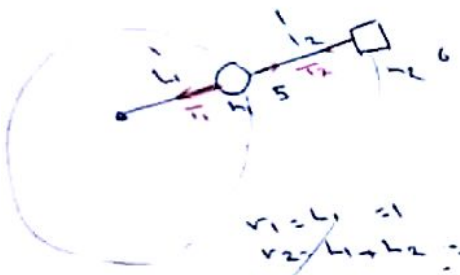
$$V_{min} = \sqrt{rg}$$



Ex:

اشترك البيرودك تايم .

$T_r = 5$ second



$r_1 = L_1 = 1$

$r_2 = L_1 + L_2 = 2$

$$v_1 = \frac{2\pi r}{T_p} = \frac{2\pi \cdot 1}{5} = 1.25$$

① $\Sigma F_r = \frac{m_1 v_1^2}{r}$

$T_1 - T_2 = \frac{5 v_1^2}{1}$

$T_1 - T_2 = 5 v_1^2$

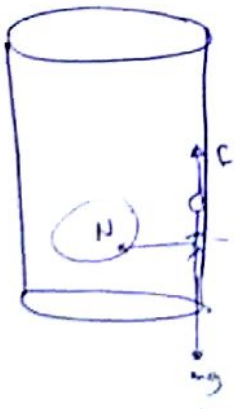
$T_1 - T_2 = 5 \cdot (1.25)^2$

② $\Sigma F_r = \frac{m_2 v_2^2}{r_2}$

$T_2 = \frac{6 \times v_2^2}{4} \rightarrow \frac{2\pi r_2}{5} = 2.5$

$T_2 = 6 \cdot \frac{(2.5)^2}{4}$

$T_2 = 18.75$



$\Sigma F_r = \frac{m v^2}{r}$

$N = \frac{m v^2}{r}$

$f_s = mg$

$\mu_s N = mg$

$\mu_s = \frac{mg}{N}$

$\frac{mg}{\mu_s} = \frac{m v^2}{r}$

$v^2 = \frac{rg}{\mu_s}$

$v = \sqrt{\frac{rg}{\mu_s}}$

Chapter 7 :- "Work and Energy" ←

CH7

① K.E ⟹ kinetic energy.

• $K.E = \frac{1}{2} m v^2$

$\Delta K = K_f - K_{e.}$ ← التغير

$= \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

② work : (w) →
كمية متجهة .

1

$W = \vec{F} \cdot \vec{d}$ ⟸ vectors

$= F d \cos\theta_{Fd}$ ← يرسم عليها ذيول متوازية ومعطاه زاوية .

⇒ E.x : If $\vec{F} = 3\hat{i} - 4\hat{j} + \hat{k}$, Find : ① work

$\vec{d} = 2\hat{i} + 2\hat{j} - 3\hat{k}$ ② angle between $\vec{F}$ and $\vec{d}$

① $W = \vec{F} \cdot \vec{d} = 6 - 8 - 3 = -5\ J$

② $W = F d \cos\theta$

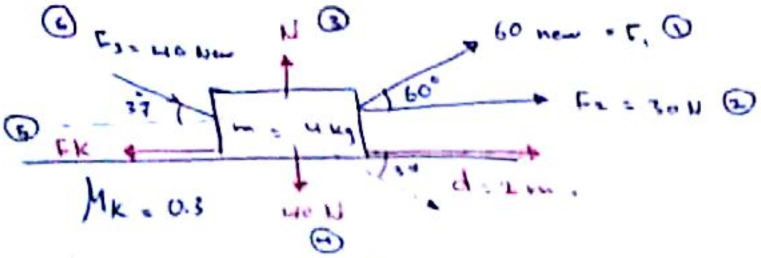
$-5 = \sqrt{26} \cdot \sqrt{17} \cos\theta$

$\cos\theta = \frac{-5}{\sqrt{26} \cdot \sqrt{17}}$

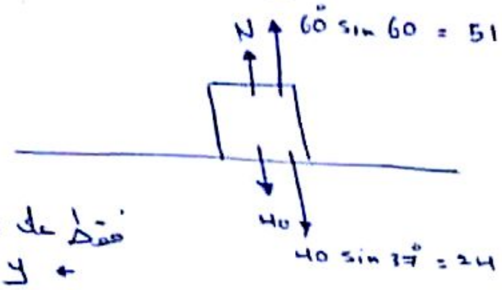
(Inverse)

$F = \sqrt{9 + 16 + 1} = \sqrt{26}$

$d = \sqrt{4 + 4 + 3} = \sqrt{17}$



* Find the:
① work due to each
② total work.
③ if $v_i = 0$ find final.



فقط على محور → y ←

- $\Sigma F\uparrow = \Sigma F\downarrow$

$N + 51 = 40 + 24$

$N = 40 + 24 - 51 = 13$ New

- $F_k = \mu_k \cdot N$

$= 0.3 \times 13 = 3.9$ Newton.

[1] $W_{F_1} = F_1 d \cos\theta_{F,d}$

$= 60 \times 2 \times \cos 60$

$= 60$ J

$W_{F_2} = 30 \times 2 \times \cos 0$

$= 60$ J.

$W_{F_3} = 40 \times 2 \times \cos 37$

$= 64$ J.

$W_{F_N} = 13 \times 2 \times \cos 90°$

$= 0$ ← دائماً

$W_{mg} = 40 \times 2 \times \cos 90°$

$= 0$ ← ليس دائماً.

$W_{F_k} = 3.9 \times 2 \times \cos 180°$

(Lost energy) $= -7.8$ J دائماً

[2] لأنه قياسي فقط
نجمع work مع بعض.

$W_{Total} = 60 + 60 + 64 + 0 + 0 - 7.8$

$= 166.2$

أو تحليل ونيوتن وقوانين الحركة.

[3]

$W_{total} = \Delta K$

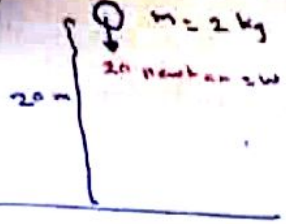
$166.2 = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$ (zero)

$166.2 = \frac{1}{2} \times 4 \times v_f^2$

$v_f = \sqrt{\frac{166.2}{2}}$

$v_f = \sqrt{83.1}$ m/s

← النوع الأول ←



$\rightarrow W_g = 20 \cdot 20 \cdot \cos\theta$

$= 400\ J$ ← مش دايما موجبة

$\rightarrow v_2^2 = v_1^2 + 2gy$

$= 2 \cdot 10 \cdot 20$

$= \pm 20 \longrightarrow +20$ السرعة

1)

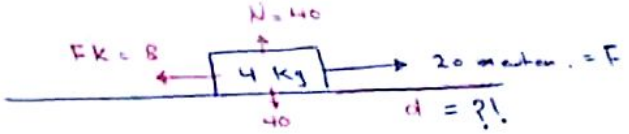
$W_{total} = \Delta K$

$20 = \frac{1}{2} \cdot 2 \cdot v_f^2 - 0$

$v_f^2 = \sqrt{400}$

$= \pm 20$

E.X 2 :



$\mu_K = 0.2$ $v_1 = 5$ m/s

$v_2 = 10$ m/s

$W_{Total} = \Delta K$

$W_F + W_N + W_{mg} + W_{Fk} = \frac{1}{2} \cdot 4 \cdot 100 - \frac{1}{2} \cdot 4 \cdot 25$

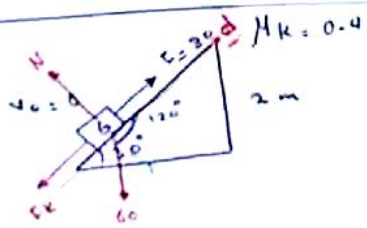
$(20 \cdot d \cdot \cos\theta) + (-8d) = 200 - 50$

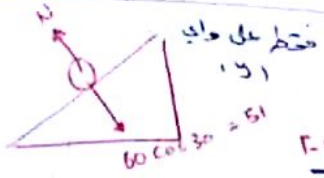
$20d - 8d = 150$

$12d = 150$

$d = \frac{150}{12}$ m.

E.X 3 :





$N = 51$ newton

$F_k = 0.4 \cdot 51$

$= 20.4$ newton

① Total work

② final speed

$\sin 30^\circ = \frac{2}{d}$

$\boxed{d = 4\ m}$

1) $W_F = 80 \cdot 4 \cdot \cos 0$

$= 320$ Joul

$W_N = 0$

$W_{mg} = 60 \cdot 4 \cdot \cos 120^\circ$

$= -120\ J$

$W_{Fk} = 20.4 \cdot 4 \cos 180$

$= -81.6$

Total (wl) $= 320 + 0 - 120 - 81.6$

$= 118.4\ J$

2) $W_{Total} = \Delta K$

$118.4 = \frac{1}{2} \cdot 6 \cdot v_f^2$

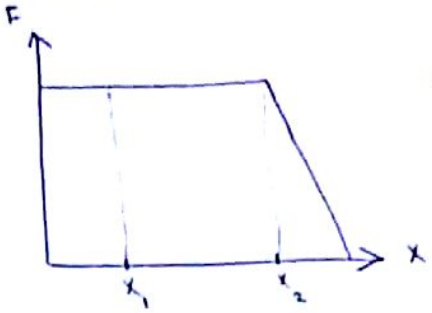
$\sqrt{\frac{118.4}{3}} = v_f$

(2)

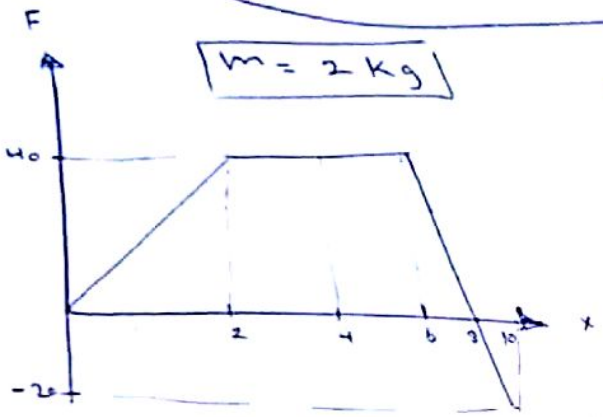
ارسم بياني بين F ، X ← موقع الجسم :

واذا طلب السرعة :

$W_{total} = \Delta K$



Work = Area



$m = 2\ kg$

→ Find work :

* From $x = 0 \Leftrightarrow x = 2$

$W = \frac{1}{2} * 2 * 40 = 40\ J$

* (2 - 6) :

$W = 40 * 4 = 160\ J$

* (6 - 8) :

$W = \frac{1}{2} * 2 * 40 = 40\ J$

Total work → مجموع ← * (8 - 10)

→ كلي

$W = \frac{1}{2} * 2 * -20 = -20\ J.$

→ I.P. $v_1 = 2\ m/s$ at $x = 2$

Find v_2 at $x = 8$.

* (6 - 10)

$W = 40 - 20 = 20\ J.$

$W_{total} = \Delta K$

$(2-6) + (6-8) = \Delta K$

$160 + 40 = \frac{1}{2} * 2 * v_2^2 - \frac{1}{2} * 2 * (2)^2$

$200 = v_2^2 - 4$

$\sqrt{204} = v_2$

rce is a function of position : أمثلة

$$W_{\vec{F}} = \int_{(i)} F_x\,dx + \int_{(j)} F_y\,dy + \int_{(k)} F_z\,dz + \int F_r\,dr$$

E.x1 : If $\vec{F} = 3r^2 - 2r + 1$, Calculate the work from $r = 0$ to $r = 10$ m.

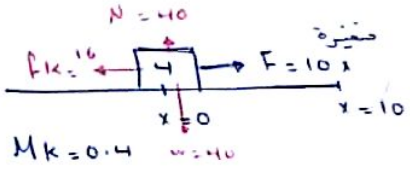
Sol. :

$$W = \int_0^{10} (3r^2 - 2r + 1)\,dr = r^3 - r^2 + r \Big|_0^{10}$$

$$= (1000 - 100 + 10) - (0)$$

$$= 910 \text{ J}$$

E.x2 :



$\rightarrow v_0 = 0$

$\rightarrow$ Find v_f

$W_N = 0$

$W_{mg} = 0$

$W_{Fk} = 16 * 10 * \cos 180$

$= -160 \text{ J}$

$W_F = 10x * 10 * \cos\theta$

$=$

$\Rightarrow W_F = \int_0^{10} (10x)\,dx$

$= 5x^2 \Big|_{10}^{10}$

$= 500 \text{ J}$

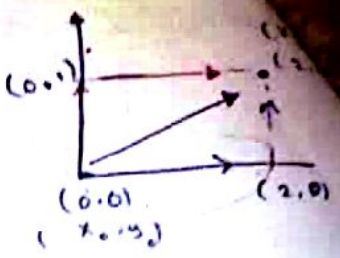
W_{Total} ----

E.x3 : $\vec{F} = 2xy\,\hat{i} - 3y^2zx\,\hat{j} + 5xyz\,\hat{k}$ Find work

$$W = \int (2xy)\,dx + \int (-3y^2zx)\,dy + \int (5xy)\,dz$$

$$x^2 y - zxy^3 + 5xyz$$

E.x4: $F = 4x^2y\,\hat{i} + 2yx\,\hat{j}$, find the work :



① $W = \int_{(y=0)}^{1} (4x^2y)\,dx + \int_{0}^{(x=2)} (2yx)\,dy$

$= 0 + x \times \frac{y^2}{x} \Big|_0^1 \quad (x=2)$

$= 2\,[1-0] = 2\ J$

← إذا كانوا الحوايش متساويين منتبج أن القوة محافظة

② $W = \int_{x=0}^{2} (2yx)\,dy + \int_{0}^{y=1} (4x^2y)\,dx$

$= 0 + 4\frac{x^3}{3}\,y \Big|_0^2 \quad [y=1]$

$= \frac{4}{3}(1)\,[2^3 - 0^3]$

$= \frac{16}{3}\ J$

③ $\frac{y-y_0}{x-x_0} = \frac{y_2-y_0}{x_2-x_0}$

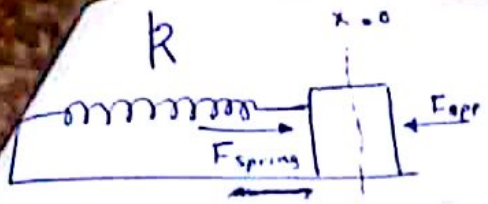
$\frac{y-0}{x-0} = \frac{1-0}{2-0}$

$2y = x \Rightarrow y = \frac{1}{2}x$

$W = \int_0^2 (4x^2y)\,dx + \int_0^1 (2xy)\,dy$

$= \int_0^2 \left(4x^2\left(\frac{x}{2}\right)\right) dx + \int_0^1 (2(2y)y)\,dy$

$\frac{x^4}{4} \Big|_0^2 + 4\frac{y^3}{3} \Big|_0^1$

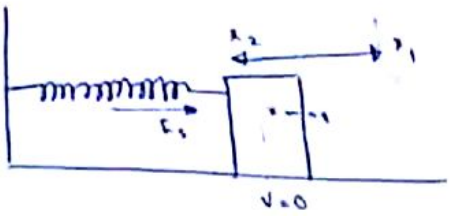


→ k. spring constant.

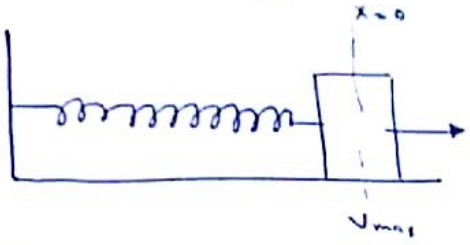
(Force).

$F_s = k x \rightarrow k = \frac{F_s}{x}$

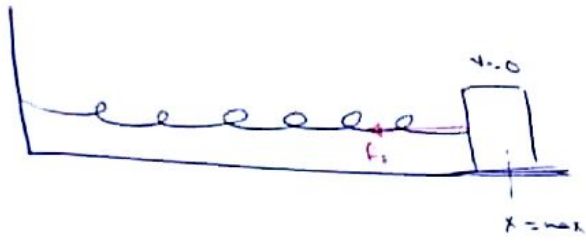
لما بعد الجسم عن موضع الاتزان



$\Rightarrow W_{F_{app}} = \frac{1}{2} k x_f^2 - \frac{1}{2} k x_i^2$

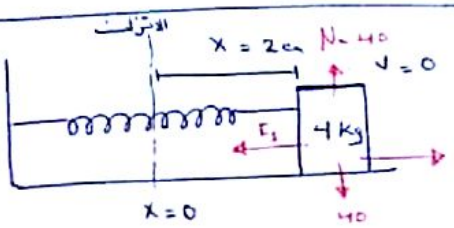


$\Rightarrow W_{F_s} = \frac{1}{2} k x_1^2 - \frac{1}{2} k x_2^2$



E.x₁ :-

$k = 10000 N/m$



what is at ... ضخية الاتزان

$\mu_K = 0.4$

$x = 0$

$V = max$

$W_{F_k} = 16 * (2 * 10^{-2}) * \cos 180$

$= -0.32$

$W_w = 40 * 2 * \cos 90 * 10^{-2}$

$= 0$

$W_N = 0$

$W_{total} = 2 - 0.32 = 1.68 J$

$W_{total} = \Delta k$

$1.68 = \frac{1}{2} * 4 * v_1^2$

$v_1 = \sqrt{\frac{1.68}{2}}$

$W_{F_s} = \frac{1}{2} * (2 * 10^{-2})^2 * 1000 - \frac{1}{2} * k * 0$

$= 0.2 J$

* Power : (P) ⇒ Watt - (القدرة)

→ $P_{av} = \frac{W}{t} = \frac{F(d)\cos\theta}{(t)}$ ⟶ متوسط

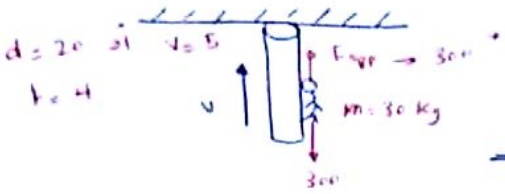
→ $P_{inst} = F\underline{v}\cos\theta = \vec{F}\cdot\vec{v}$ ⟶ (سرعة لحظية)

ثابتة ← $v = \frac{d}{t}$

→ متزن ←

$F\uparrow = F\downarrow$

$F\leftarrow = F\rightarrow$



⟶ $P = F \cdot v \cdot \cos\theta_{(v,F)}$

$= 300 * 5 * \cos 0$

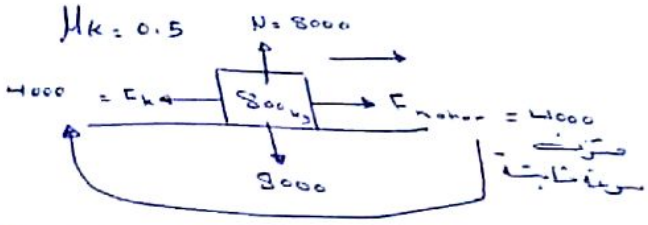
$= 1500$ Watt

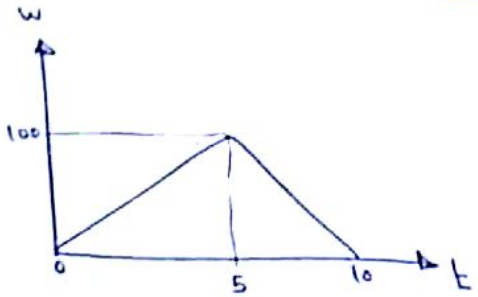
لو طلب P_w =

$P_w = 300 * 5 * \cos 180$

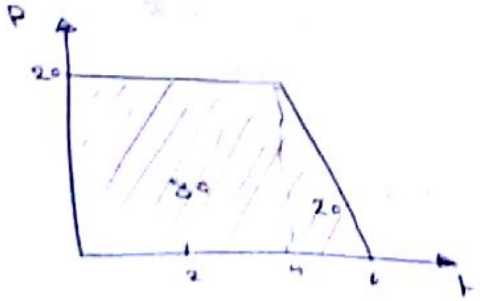
$= -1500$

$P = F\,v\cos\theta$





$P = \frac{\Delta W}{\Delta t}$



ΔW = Area

$w = w(t)$ *

* $P = p(t)$ *

$P_{av} = \frac{\Delta w}{\Delta t} = \frac{w_2 - w_1}{t_2 - t_1} = \frac{-2+5}{1} = 3$ $\quad w(t) = 3t^2 - 5$

$t \to (0-1)$ $\quad w_1 = -5$ $\quad w_2 = -2$

$P_{in} = \frac{dw}{dt} = 6t = \underline{12}$

$(t=2)$

$w = \int p(t)\, dt$ $\qquad p = 2t - 1$

Find w $(0-2) \Rightarrow t$.

$w = \int_0^2 (2t-1)\, dt$

$w = t^2 - t \Big|_0^2$

$= 2 - 0 = 2$ J

اختزام ⟵ w ⟵ $\frac{\Delta w}{\Delta t}$

اختزام ⟵ in ⟵ مشتق

(P) ⟵ w

Chapter 8 : → potential energy ← CH8

• $K = \frac{1}{2} m v^2$ لـ الطاقة الحركية

• $U = \frac{1}{2} k x^2 + mgh$ لـ طاقة الوضع

(Force)

→ K. spring Constant

→ X : displacement from the equilibrium position.

($X_{max} \Leftrightarrow v_0 = 0$)

→ h : hight

• Mechanical energy (E) :-

• $E \Rightarrow$ Constant.

* $E = K + U$

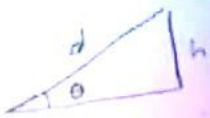
$W_{F_k} = d \cos\theta$ لـ شغل $\theta = 180°$

$\Rightarrow E_i = E_f$

ملاحظة: $K_i + U_i = K_f + U_f$

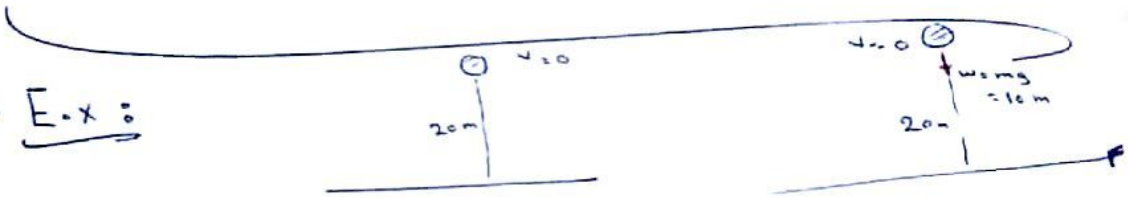
$\frac{1}{2} m v_i^2 + \frac{1}{2} k x_i^2 + mgh_i = \frac{1}{2} m v_f^2 + \frac{1}{2} k x_f^2 + mgh_f$

مثلثات :



$\sin\theta = \frac{h}{d}$

* E.x :



① $v_f^2 = v_i^2 + 2gy$

$= 0 + 20 + 20$

$v_f = 20$ m/s

② $W_w = 10\ m + 20 + \cos 0$

$= 200$ m

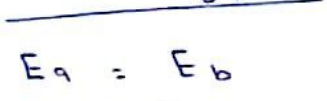
$W_{total} = \Delta K$

$200 = \frac{1}{2} v_f^2 -$ حذف

$400 = v_f^2$

$20 = v_f$

③ طاقة الحركة



$E_a = E_b$

مستوى مرجعية — شغل بدون — طاقة الارتفاع

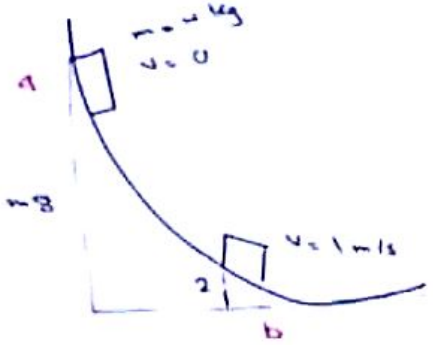
$\frac{1}{2} m v_a^2 + mgh_a + \frac{1}{2} k x_a^2 = \frac{1}{2} m v_b^2 + mgh_b + \frac{1}{2} k x_b^2$

$mgh_a = \frac{1}{2} m v_b^2$

$2 \times 10 \times 20 = \frac{1}{2} v_b^2$

$v_b = \sqrt{400} = 20$ m/s.

→ E.X 2 :



⇒ Find Lost energy

" W_{fk} "

$= d f \cos\theta$

$W_{fk} + E_a = E_b$ ← في حالة احتكاك →

$\frac{1}{2} m v_a^2 + mgh_a = \frac{1}{2} m v_b^2 + mgh_b$

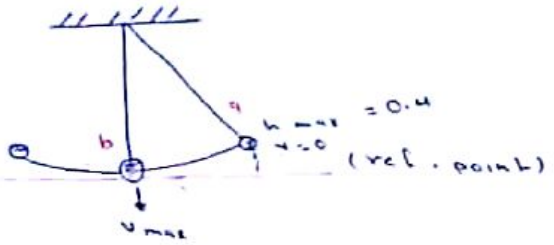
$W_{fk} + 4 * 10 * 8 = \frac{1}{2} * 4^2 * 1 + 4 * 10 * 2$

$W_{fk} + 320 = 2 + 80$

$W_{fk} = 82 - 320$

→ $W_{fk} = -238$ J ←

→ E.X 3 :



→ Find V max ←

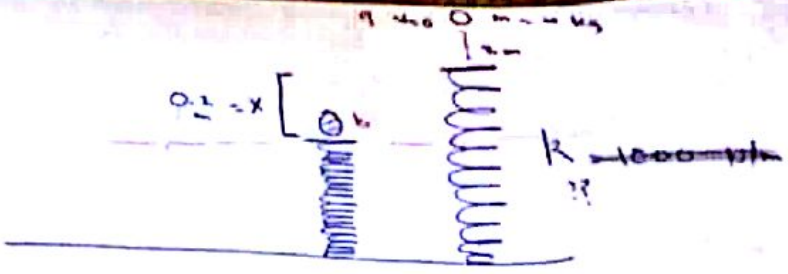
$E_a = E_b$

$\frac{1}{2} m v_a^2 + mgh_a = \frac{1}{2} m v_b^2 + mgh_b$

$gh_a = \frac{1}{2} v_b^2$

$10 * 0.4 = \frac{v^2}{2}$

$v_b = \sqrt{8}$ m/s



→ If a max compression 0.2 m find the string constant :

$$E_a = E_b$$

$$mgh_a + \frac{1}{2}mv_a^2 + \frac{1}{2}kx_a^2 = mgh_b + \frac{1}{2}mv_b^2 + \frac{1}{2}kx_b^2$$

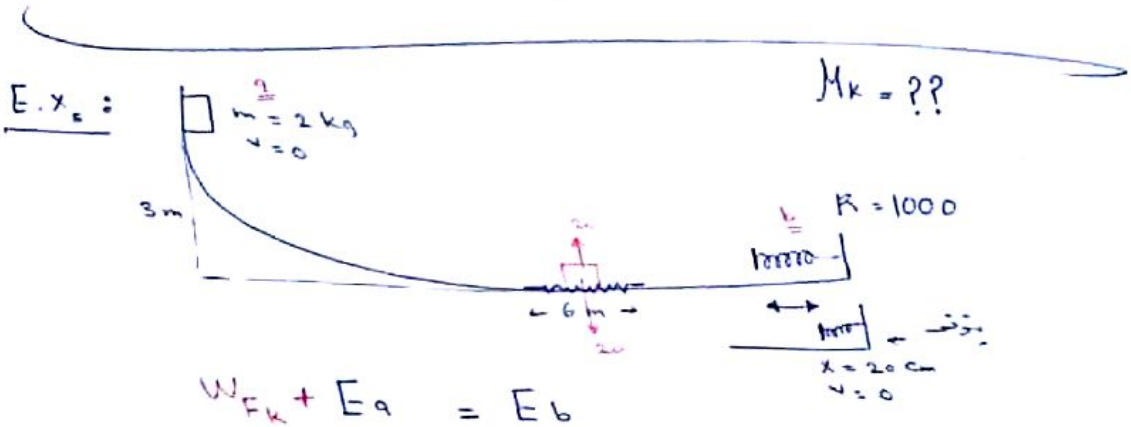
$$mgh_a = \frac{1}{2}kx_b^2$$

$$4 + 10 \cdot 0.2 + 2 = \frac{1}{2}k(0.2)^2$$

$$88 = \frac{1}{2}k\,0.04$$

$$k = \frac{88}{0.02} = 4400 \text{ N/m}$$

→ E.x :



$$W_{Fk} + E_a = E_b$$

$$mgh_a + \frac{1}{2}mv_a^2 + \frac{1}{2}kx_a^2 = mgh_b + \frac{1}{2}mv_b^2 + \frac{1}{2}kx_b^2$$

$$W_{Fk} + 2 + 10 \cdot 3 = \frac{1}{2} \cdot 1000 \cdot (0.2)^2$$

$$-f_k \cdot d + 60 = \frac{1}{2} \cdot 1000 \cdot (0.04)$$

$$d \cdot -\mu_k \cdot N + 60 = 20$$

$$-\mu_k \cdot 6 \cdot 20 + 60 = 20$$

$$-120\,\mu_k = -40 \Rightarrow \mu_k = \frac{40}{120} = \frac{1}{3}$$

→ **E.x₁:**

إذا أعطاك في السؤال U على شكل معادلة وطلب حساب F :

$$\vec{F} = -\hat{i}\,\frac{\partial U}{\partial x} - \hat{j}\,\frac{\partial U}{\partial y} - \hat{k}\,\frac{\partial U}{\partial z} - r\,\frac{\partial}{\partial}$$ ← مشتقة جزئية

→ If $U = \frac{-3}{r}$, find the force at $r = 4\,m$.

$$\vec{F} = -\hat{r}\,\frac{\partial U}{\partial r}$$

$$\vec{F} = -\hat{r}\left[\frac{3}{r^2}\right] = \frac{3\hat{r}}{r^2}$$

$$\vec{F}_{r=4} = -\frac{3}{16}\,\hat{r} \Rightarrow |\vec{F}| = +\frac{3}{16}$$

اتجاه   مقدار

→ **E.x₂:** $U = 6x^3yz^2 - 5xz$, find force at $(1,1,-1)$:

① $\frac{\partial U}{\partial x} = 18x^2yz^2 - 5z$

② $\frac{\partial U}{\partial y} = 6x^3z^2 -$

③ $\frac{\partial U}{\partial z} = 12zx^3y - 5x$

$$\vec{F} = -\hat{i}\,(18x^2yz^2 - 5z) - \hat{j}\,(6x^3z^2) - \hat{k}\,(12zx^3y - 5x)$$

$$\vec{F}_{(1,1,-1)} = -\hat{i}\,(18+5) - \hat{j}\,(6) - \hat{k}\,(-12-5)$$

(x, y, z)

$$\vec{F} = -23\,\hat{i} - 6\,\hat{j} + 17\,\hat{k}$$

إذا طلب (a) ⇐ $a = \frac{F}{m}$

$$|\vec{F}| = \sqrt{(-23)^2 + (6)^2 + (17)^2}$$

* اذا اعطى F_x وطلب حساب V :-

$$W = \int f_1 \, dx + \int f_2 \, dy + \int f_3 \, dz + \int f_4 \, d$$

$$V = -W$$

good luck