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Chapter 7
Kinetic Energy work.

* Kinetic energy (K) → mass, → speed

$$\boxed{K = \frac{1}{2} m v^2}$$

K ≡ scalar quantity (قياسية)

P5

$$\begin{bmatrix} K_F = \frac{1}{2} K_s \\ m_s = \frac{1}{2} m_F \end{bmatrix}$$ initial

f : father
s : son

$(K_f)_i = \frac{1}{2} (K_f)_f$

$\frac{1}{2} \cancel{m} (V_f)_i^2 = \frac{1}{2} \left[\frac{1}{2} \cancel{m} (V_{if} + 1)^2 \right]$

$V_{if} = ??$ ⟶ $(V_f)_f = V_{if} + 1 \cdot m/s$

$K_f = K_s$?

سبب العمل هو القوة المؤثرة

* work
  - ① force ≡ constant (ثابتة) [graviti onal force] (قوة الجاذبية الارضية)
  - ② force [variable] (متغيرة) [spring]

$\vec{f}$ ≡ constant ⟹ $\boxed{W = \vec{f} \cdot \Delta \vec{x}}$ ⟹ $\vec{f}$ = force, ΔX = displacement (الازاحة), W = work. work scalar quantity

$[W] = N \cdot m$: Joule

$W = |\vec{f}| \, |\Delta x| \cos \theta$

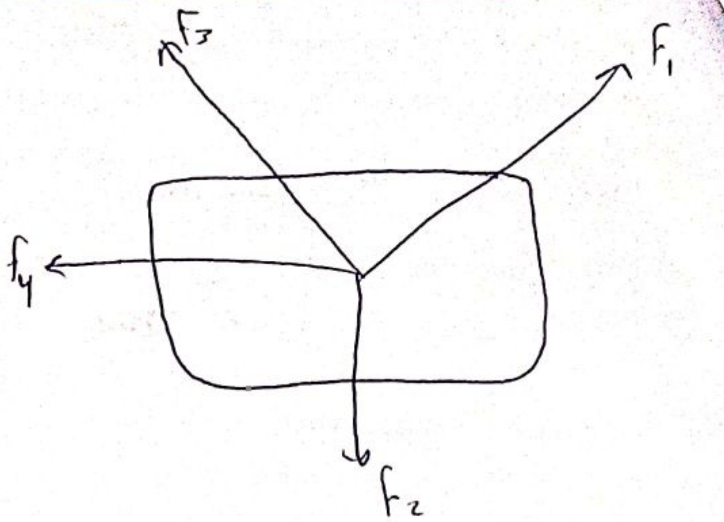
θ بين Δx و f

$$W = 0 \begin{cases} \vec{f} = 0 \\ \Delta \vec{x} = 0 \\ \vec{f} \perp \Delta \vec{x} \end{cases}$$

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

① $W_{net} = \vec{f}_{net} \cdot \Delta\vec{r}$

② $W_{net} = W_1 + W_2 + W_3 + \dots$

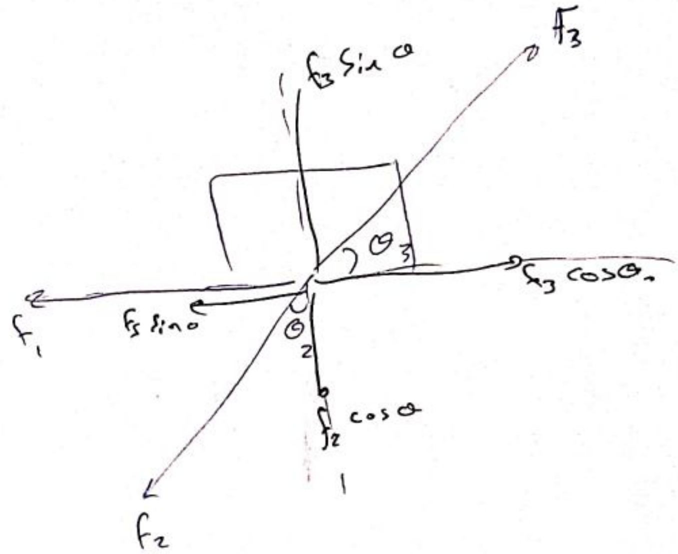


P [14] $f_1 = 3N$ $\theta_2 = 50°$

$f_2 = 4$ $\theta_3 = 35$

$f_3 = 9N$

$W = ??$



$W_{net} = \vec{f}_{net} \cdot \overline{\Delta X}$

$\sum f_x = f_3 \cos\theta_3 - f_2 \sin\theta_2 - f_1$

$= 9\cos 35 - 4 \sin 50 - 3$

$= \boxed{1,24\,N}$

$f_{net} = \sqrt{(1,24)^2 + (2,6)^2} = \boxed{2,88}$

$\sum f_y = f_3 \sin\theta_3 - f_2 \cos\theta_2$

$= 9 \sin 35 - 4 \cos 50$

$= \boxed{2,6\,N}$

$W = f \cdot \Delta r$

$= 2,88 \cdot 4 = \boxed{11,5}$ Joul

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Exp: gravitional force

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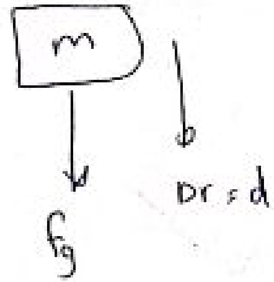
(1) $\vec{f_g} = mg$

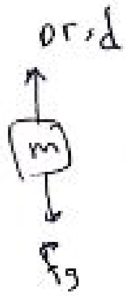
(1) $W_{f_g} = \vec{f_g} \cdot \vec{\Delta r}$

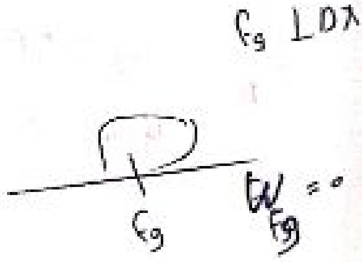
$= f_g \, d \cos \theta$

$\boxed{W_{f_g} = f_g \, d}$

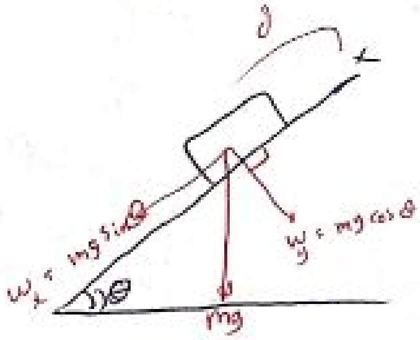


(2) $\boxed{W_{f_g} = - f_g \, d}$





Case 3



(1) downword

$W_{w_y} = 0$

$W_{w_x} = w_x \cdot d$

constant speed (up) (+)

" —— (~~..~~ nyzero)

تارع نزول (-)

(2) upword $W_{w_x} = -w_x \cdot d$

Kientic energy - work theorem :-

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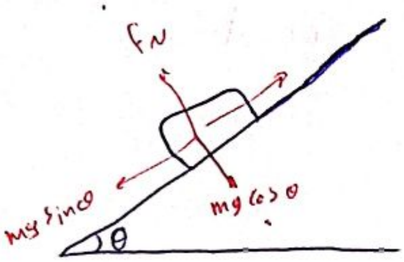
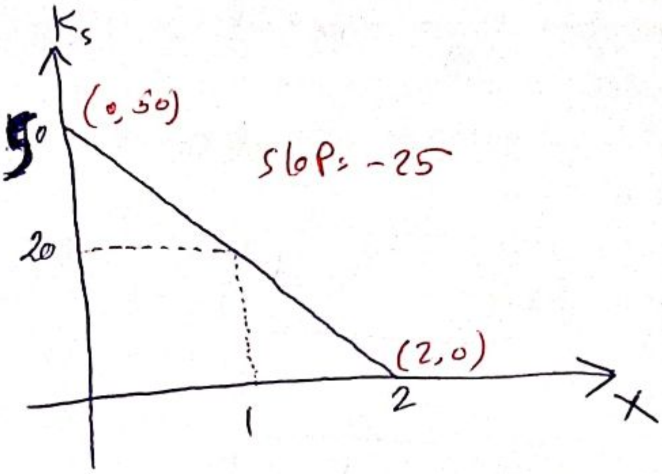
$$W_{net} = \Delta K$$

P_{20}





$V_i = 5\ m/s$

$f_N = ??$

$f_N = mg \cos\theta$

$= 4(9,8) \cos 39,6°$

$W_{net} = f_{net} \cdot \Delta X = \Delta K$

$slope = \frac{\Delta K}{\Delta X} = f_{net\ x} = -mg\sin\theta$

$25 = 4(9,8)\sin\theta$

$\boxed{\theta = 39,6}$

$K_i = 50\ J$

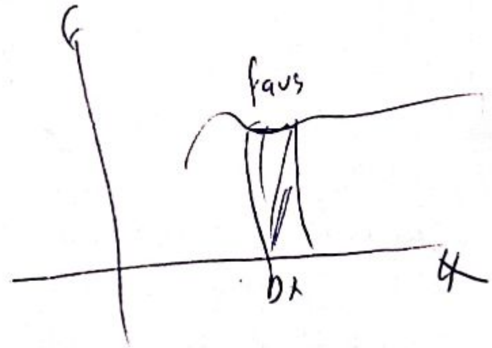
$50 = \frac{1}{2} m (5)^2$

$\boxed{m = 4\ kg}$

Part ②

work done by Variable

$\Delta X \longrightarrow f_{avg}$



$W_i = f_{avg} \cdot \Delta X$

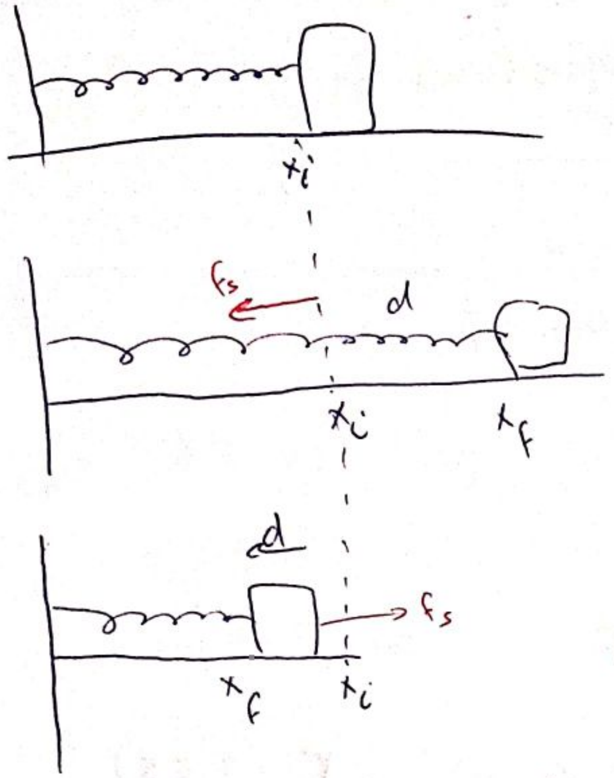
$W = \sum_i f_{avg} \cdot \Delta X$

$W = \lim_{\Delta X \to 0} \sum f_{avg}\, \Delta X$

$$\boxed{W = \int_{x_i}^{x_f} F\, dx}$$

* Spring force قوة النابض

f_s عكس الازاحة



Hook's law.

$\vec{f} \propto \vec{d}$

$$\boxed{f_s = -K\vec{d}}$$

$K \equiv$ spring constant ثابت المرونة

$$W_{spring} = \int_{x_i}^{x_f} f_s \cdot dx$$

$$= \int_{x_i}^{x_f} -Kx \, dx$$

$$= \frac{1}{2}Kx \Big|_{x_f}^{x_i}$$

$$= \frac{1}{2}Kx_i^2 - \frac{1}{2}Kx_f^2$$

$$= \frac{1}{2}K(x_i^2 - x_f^2)$$

$$W_{applied} = -W_{sprin}$$

$$= \frac{1}{2}K(x_f^2 - x_i^2)$$

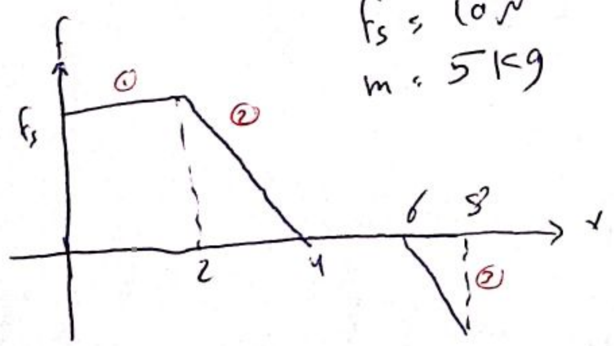
$$f \xrightarrow{\int} W$$
$$f \xleftarrow{\frac{dw}{dt}} W$$

$$x_f = \sqrt{\frac{mv_i^2}{K}}$$

P36

$f_s = 10N$

$m = 5kg$



$$W = \int_{x_i}^{x_f} f \, dx = \text{Area}(f\text{-}x)$$

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تابع-

force
- Constant → $W = F \cdot d$ (gravitational force)
- Variable → $W = \int_{x_i}^{x_f} F\,dx$ (Spring force)
- → $W_{net} = \Delta K$

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* $\vec{F}$ in 2D, 3D

$$\vec{F} = F_x \hat{i} + F_y \hat{j} + F_z \hat{k}$$

$$W = \int_{x_i}^{x_f} F_x\,dx + \int_{y_i}^{y_f} F_y\,dy + \int_{z_i}^{z_f} F_z\,dz$$

Exp 1 $\vec{F} = 2x\,\hat{i} - 3y\,\hat{j} + \hat{k}$ $\vec{r}_1 = (0,2,4) \longrightarrow \vec{r}_2 = (2,3,5)$

$$W = \int_0^2 2x\,dx - \int_2^3 3y\,dy + \int_4^5 dz$$

$$= x^2\Big|_0^2 - \frac{3y^2}{2}\Big|_2^3 + z\Big|_4^5$$

* work - Kinetic theorem

$W_{net} = \int F_{net}\,dx$, $F_{net} = ma$, $a = \frac{dv}{dt}$

$= \int ma\,dx = \int m \frac{dv}{dt}\,dx$

$\frac{dv}{dt} = \frac{dv}{dx} \cdot \frac{dx}{dt} = v\frac{dv}{dx}$

$\int mv \frac{dv}{dx}\,dx$

$m \int_{v_i}^{v_f} v\,dv$

$W_{net} = m\left[\frac{v^2}{2}\Big|_{v_i}^{v_f}\right]$

$= \frac{1}{2}m\left(v_f^2 - v_i^2\right) = \Delta K$ #

* Power (P)

$P_{avg} = \frac{\Delta W}{\Delta t} = \frac{J}{s}$ | $\Rightarrow P_{inst} = \frac{dW}{dt}$

$[P] = \frac{J}{s} =$ watt

$\boxed{P_{avg} = \vec{F} \cdot \vec{V}}$

$P = F \cdot V$ magnitude $\left(\frac{J}{s}\right)$

$W = mgh$

Discussion :

P_1 : $m_p = 1,67 \times 10^{-27}$ kg

$a = 3,6 \times 10^{15}$ m/s²

$V_i = 2,4 \times 10^{7}$ m/s

$\Delta X = 3,5$ cm

ⓐ final speed ⓑ ΔK

ⓐ $V_f^2 = V_i^2 + 2a\Delta X$

$V_f = \sqrt{(2,4 \times 10^7)^2 + 2(3,6 \times 10^{15})(3,5 \times 10^{-2})}$

$= 2,9 \times 10^{7}$ m/s

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ⓑ $\Delta K = K_f - K_i$

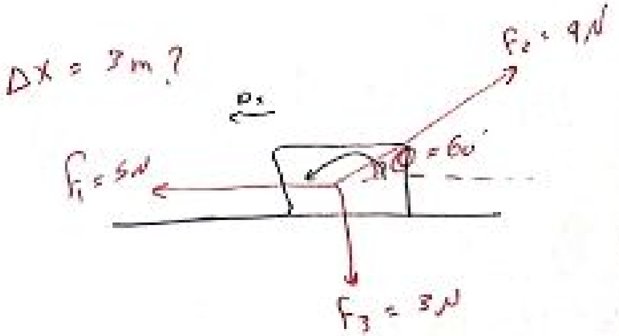
$= \frac{1}{2} m (V_f^2 - V_i^2) = \frac{1}{2}[1,67 \times 10^{-27}]\left[(2,9 \times 10^7)^2 - (2,4 \times 10^7)^2\right]$

$= \boxed{2,1 \times 10^{-13} \text{ J}}$

P_{15}

ⓐ $W_{net} = ??$ → $W_1 + W_2 + W_3$; $W_{net} = F_{net} \cdot \Delta X$

$\Delta X = 3$ m ?



$W_1 = \vec{F} \cdot \Delta X = |F||\Delta X| \cos\theta$

$= 5(3) \cos 0 = 15$ J

$W_2 = Fd\cos\theta = 9(3)\cos 120 = -13,5$ J

$W_3 = Fd\cos\theta = 3(3)\cos 90 = 0$ J

$W_{net} = 1,5$

ⓑ $\Delta K = W_{net}$

$= 1.5\ J$

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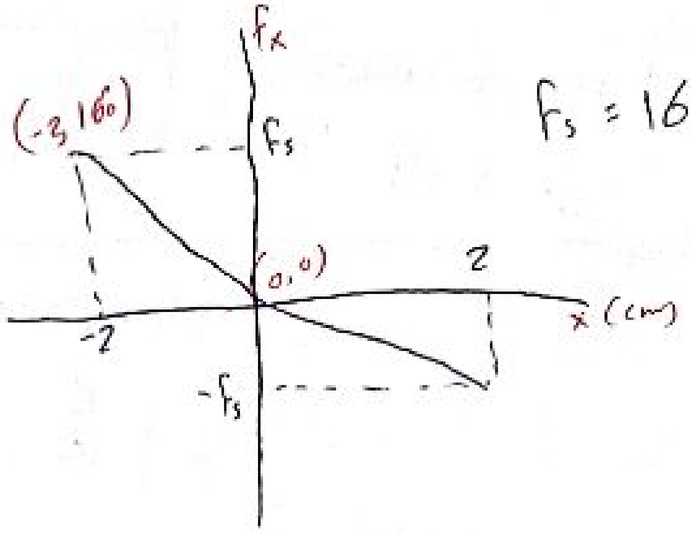
P32

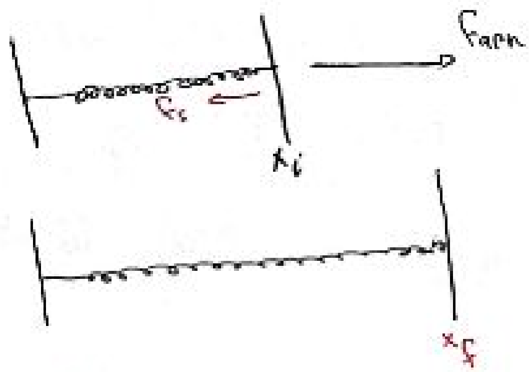
how much work does the spring do on the block moves from $x_i = 8$ cm to

ⓐ $x_f = 5$ cm ⓑ $x_f = -5$ cm

ⓒ $x_f = -8$ cm



$f_s = 160 N$



$W_s = \frac{1}{2}K(x_i^2 - x_f^2)$

$f_s = -K\ x$

$y \quad , \quad$ slope $\quad x$

slope $= -K = \frac{160 - 0}{-2 - 0} = -80$

$K = \boxed{80}\ N/cm \quad \times 10^{-2}$

$\boxed{K = 8000\ \frac{N}{m}}$

ⓐ $W_s = \frac{1}{2}(8000)\left[(8\times10^{-2})^2 - (5\times10^{-2})^2\right] = \boxed{15.6\ J}$

ⓑ $W_s = 15.6$

ⓒ $W_s = 0$

$f_s = -K\ X$

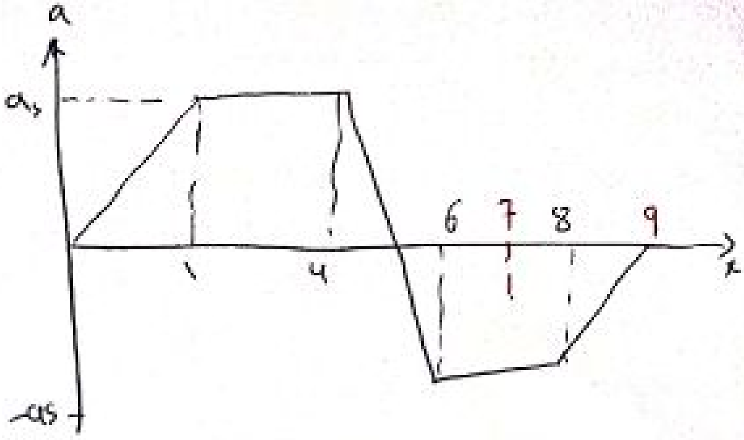
$f_a = -F_s$

$\Rightarrow W_s = \int_{x_i}^{x_f} f\,dx$

$W_s = -W_a$

P 37

$m = 2\,kg$



$W_{net} = \Delta K$

$W = \int f_{net}(x)\,dx$

$= \int m\,a(x)\,dx$

$W_{net} = m \int a(x)\,dx \rightarrow$ area

(a) $W_{net(4)} = 2\left[\frac{1}{2}(1)(6) + (3)(6)\right] = 42\,J$

(b) $W_{net(7)} = 30\,J$

(c) $W_{net(9)} = 12\,J$

(d) v at $x = 4$

$W_{net} = \Delta K$

$= K_f - \cancel{K_i}^{\,0}$

$42 = \frac{1}{2} m v_f^2 \Rightarrow v_f = \boxed{6.5\ m/s}$

v at $x = 7$

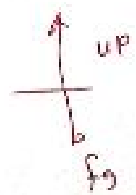
$30 = K_f - \cancel{K_i}^{\,0} \Rightarrow 30 = \frac{1}{2}(2)v_f^2 \Rightarrow v_f = \boxed{5.5}$

v at $x = 9$

$12 = \frac{1}{2}(2)v_f^2 \Rightarrow v_f = \boxed{3.5\ m/s}$

$P_{avg} = \frac{\Delta W}{\Delta t}$, $P_{int} = \frac{dw}{dt}$, $P = \vec{F} \cdot \vec{v}$

P 45 $m = 3\times10^3\,kg$, $\Delta y = 210\,m$ ↑up, $\Delta t = 23\,sec$



$P = f \cdot v = f v \cos\theta$

$= mg\,v$

$|P| = mg \frac{\Delta y}{\Delta t}$

$= 3\times10^3 (9.8)\left(\frac{210}{23}\right) = 2.68\times10^3$

Good Luck

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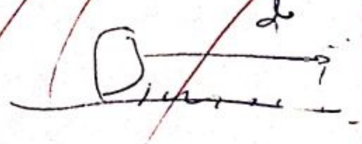
~~$E_{tot} = E_m + E_{int}$~~

~~$m = 2kg$~~

~~$v = 3m/s$~~

~~$\mu_k = 0.5$~~



Chapter 8

Potential energy (U)

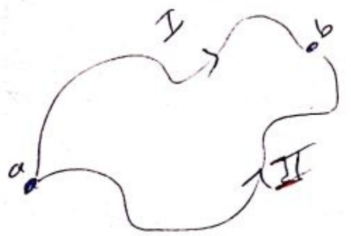
$\Delta U = U_2 - U_1$ $\boxed{U_1 = 0}$

$\boxed{\Delta U = -W}$

① Isolated system ② Conservetev force

forces
- → conservative القوة المحافظة
- → Non-conservative القوة الغير محافظة

* الشغل لا يعتمد على المسار يعني الشغل ثابت Conservative force : ① work dosenot depend on the path.



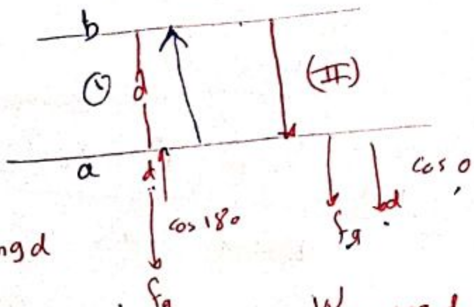
$-W_{I} = -W_{II}$ نفس المقدار وعكس الاشارة

② W_{net} [~~clsed~~ closd path] $= 0$

- Non-conservative forces : work depends on the path الشغل يعتمد على المسار
  - K. friction
  - Drag force

انواع Conservavative forces

① gravitational force قوة الجاذبية الارضية



$W_{(I)} = -mgd$

$W_{II} = mgd$

لانها قوة محافظة conservative $\boxed{W_{net} = 0}$

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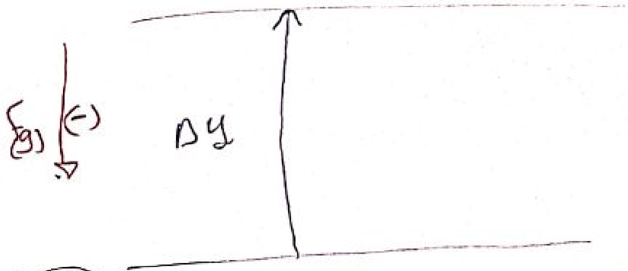
$$W = \int_{x_i}^{x_f} f(x)\,dx$$

$$\Delta U = -W = -\int_{x_i}^{x_f} f(x)\,dx$$

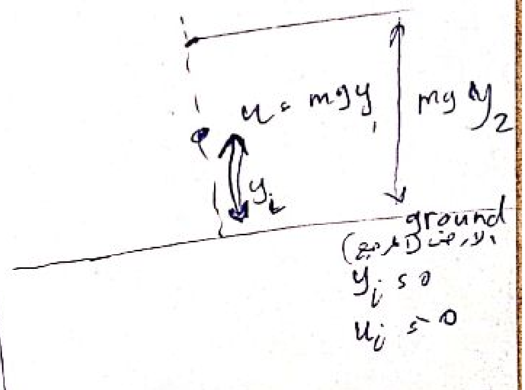
$$\boxed{U_2 - U_1 = -\int_{x_0}^{x_f} f(x)\,dx}$$

Case (I) : gravitational force



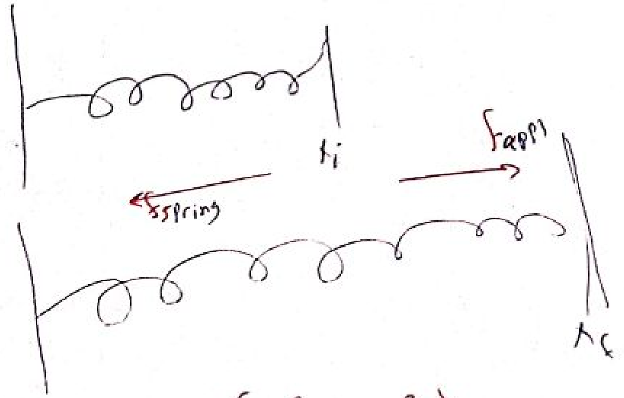
$$\Delta U = -\int_{y_i}^{y_f} f(y)\,dy$$

$$= \int_{y_i}^{y_f} mg\,dy \Rightarrow \boxed{\Delta U = mg\,(y_f - y_i)}$$



Case (II) spring force

x [illegible] $f_{spring} = -KX$ "Hook's law"



$$W_s = \frac{1}{2}K\left(x_i^2 - x_f^2\right)$$

$$\boxed{W_{app} = -W_s}$$

$$\Delta U = -\int_{x_i}^{x_f} f(x)\,dx$$

$$= \int_{x_i}^{x_f} Kx\,dx$$

$$\boxed{\Delta U = \frac{1}{2}K\left(x_f^2 - x_i^2\right)}$$

$$\Delta U = -W_s$$

* Mechanical Energy (E)

$$\boxed{E_{mec} = K + U}$$

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- Isolated [no external forces]
- Conservative forces

E_{mec} = Conserved 'محفوظة'

$W = \Delta K \Rightarrow \Delta K = -\Delta U$

$W = -\Delta U$

$K_f - K_i = -(U_f - U_i)$

$K_i + U_i = K_f + U_f$

حفظ الطاقة الميكانيكية $\boxed{E_i = E_f}$ $\Delta E_{mec} = 0$

$E = \frac{1}{2} m w^2 a^2$

$w = \sqrt{\frac{K}{m}}$

$E = \frac{1}{2} K a^2$

$a = \sqrt{\frac{2E}{K}}$

$v = w a$

$h = \frac{u^2 \sin^2\theta}{2g}$

$v = \sqrt{2gh}$, $\frac{\Delta v^2}{2}$, 5f

P(29)

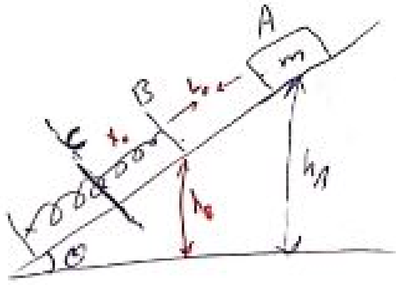
$m = 12 kg$

$v_i = 0$

$\theta = 30$, $x_o = 5,5$ cm

$x = 2$ cm , $f = 270 N$

$l_o + x_o = ??$



$f = -Kx \Rightarrow K = \frac{f}{x}$

$= \frac{270}{2\times10^{-2}}$

$= \boxed{1,35 \times 10^4}$

نعوض

$\sin\theta = \frac{h_a}{l_o + x_o}$

$\sin 30 = \frac{0,174}{l_o + 5,5\times10^{-2}}$

$l = 0,292$ m

$E_A = E_c$

$\cancel{K_A} + U_A = \cancel{K_c} + U_c$

$0 + mgh_{(a)} = 0 + \frac{1}{2}Kx^2$

$mgh_{(a)} = \frac{1}{2}Kx_o^2$

$12(9.8)h_a = \frac{1}{2}(1,35\times10^4)(5,5)$

$\boxed{h_{(a)} = 0,174 \text{ m}}$

انحفاظ $E_A = E_B$

$\cancel{K_A} + U_A = K_B + U_B$
0

$mgh_{(a)} = \frac{1}{2} m v_B^2 + mgh_{(B)}$

$Dy = h_A - h_B$

$L_0 \sin\theta = Dy$

$L_0 \sin\theta = h_A - h_B$

$\boxed{h_B =}$

(ونعوض فوق وشرحه (تم

$\boxed{v_B = 1.7\ m/s}$

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Chapter 8,2

Reading a potential energy curve :-

$\Delta U(x)$

$$\underbrace{\Delta U(x)}_{} = -W = -\underbrace{f(x)\cdot\Delta X}_{}$$

$$\# \; f(x) = \frac{-\Delta U}{\Delta x}$$

$$f(x) = \frac{-dU(x)}{dx}$$

فرضًا

$E_{mec} = 5 \, J$

$E = K(x) + U(x)$

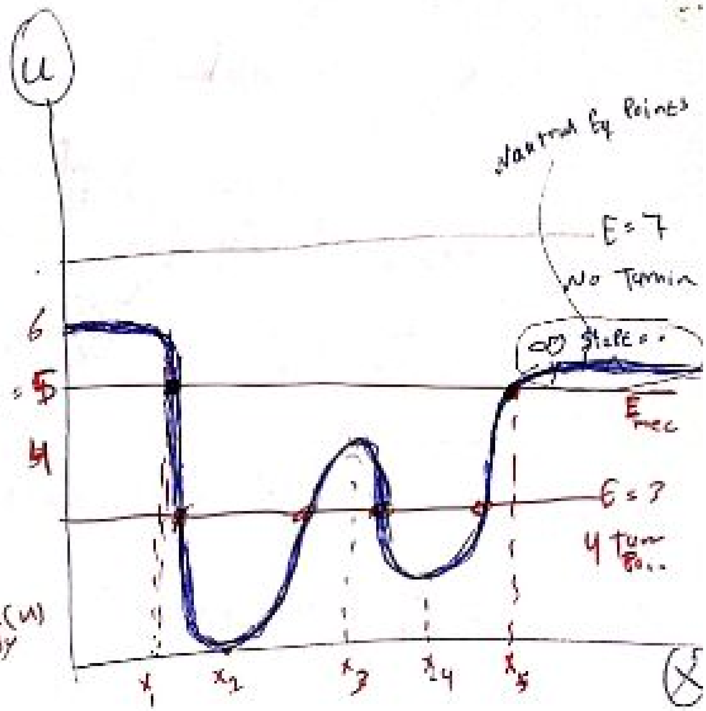
* turning point

$E = U$

$K(x) = 0$

النقطة التي عندها كل E_{mec} تتحول الى Potential (U) energy

$K = 0$



X_5, X_1 = turning Points

$U = E$

$K(x) = 0$

$V(x) = 0$

$\boxed{V = 0}$

النقطتين عندهم $E = U$

---

* Equilibrium Points :-

نقطة التعادل/الاتزان محصلة القوة صفر

من تعريفها max وال min للـ U

$$\boxed{\vec{F}_{net} = 0} \;,\quad F = \frac{-dU}{dx}$$

slope (U - x)

$$\frac{-dU}{dx} = 0 \Rightarrow \left[\text{local min, local max}\right]$$

if $F = 0$, slope = 0

يعني مزمن x يكون صفر

$x_2, x_3, x_4 \Rightarrow E_q$ points

* E_q, Points

① Stable E_q Points — min

X_2, X_4 (stable)

② غير ثابت un-stable E_q Points, — max

X_3 (un-stable)

Exp $F(x) = x^2 - 2x$

$\left.\frac{df}{dx}\right|_{x_0} > 0$ max

$\left.\frac{df}{dx}\right|_{x_0} < 0$ min

$u(x)$

① Eq. Points $\left(F = 0 \Rightarrow \frac{du}{dx} = 0\right)$

stable — unstable

② Turning Points

$(K = 0)$ $(v = 0)$

$E = u(x)$; $X \in$ turning Points

Exp: if $u(x) = X^2 - 2X$, and $E_{mec} = 4$ J find

① Turning Points, ② Eq. Points.

① $E_{mec} = u(x)$

$4 = X^2 - 2X$

$X^2 - 2X - 4 = 0$

$X = \frac{b \mp \sqrt{b^2 - 4ac}}{2a}$

$= \frac{2 \mp \sqrt{4 - 4(1)(-4)}}{2}$

$\frac{2 \mp \sqrt{20}}{2} \Rightarrow X_1 = \frac{2 + \sqrt{20}}{2} = \boxed{3.2}$ m

$X_2 = \frac{2 - \sqrt{20}}{2} = \boxed{-1.2}$ m

② Eq. Points

$F = 0 \Rightarrow \frac{du}{dx} = 0$

$2X - 2 = 0 \rightarrow \boxed{X = 1\text{m}}$

u': $- - - - - -$ | $+ + + +$

local min [Stable Points]

لو بعوض 4 ما بتوجد

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$f(x) = -\frac{du}{dx}$

$\Delta U = \int F\,dx = -W$

$\boxed{\Delta U = -W}$ - Isolated
- Conservative forces.

Exp $u(x,y) = x^2y + 2x$

$f(x) = \frac{-du}{dx} = -(2xy + 2)$ $\quad \vec{F} = (-2xy+2)\hat{i} - x^2\hat{j}$

$f(y) = \frac{-dy}{\partial y} = -(x^2 + 0)$ $\quad$ في $\left(\begin{matrix} x=1 \\ y=2 \end{matrix}\right.$

$\vec{F} = -4\hat{i} - \hat{j}$

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9 **Anan Elayan** Chapter 8 , 3

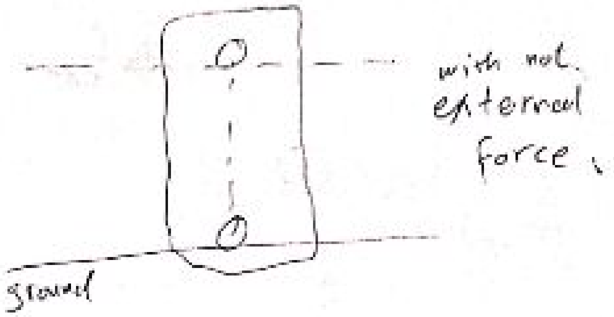
review :

نظام معزول

* Isolated system :

قوة محافظة

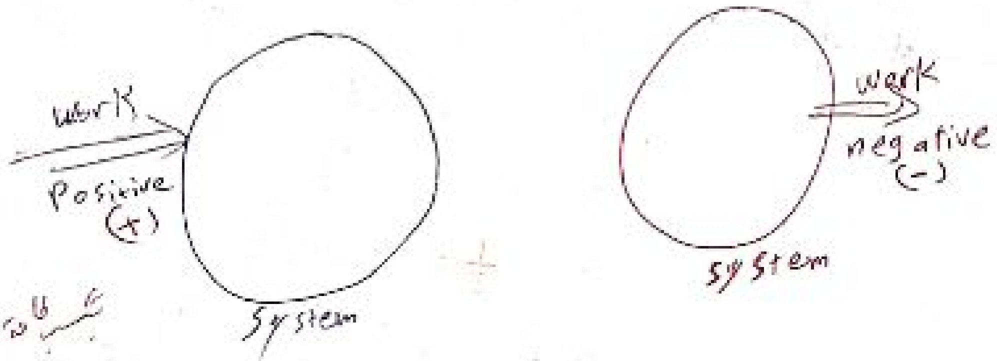
[conservative force]



$$E_{mec} = K + U \qquad W = 0$$

$$\Delta E_{mec} = \Delta K + \Delta U = 0$$

* work : is energy transfered to or from the system when external force acts on that system :



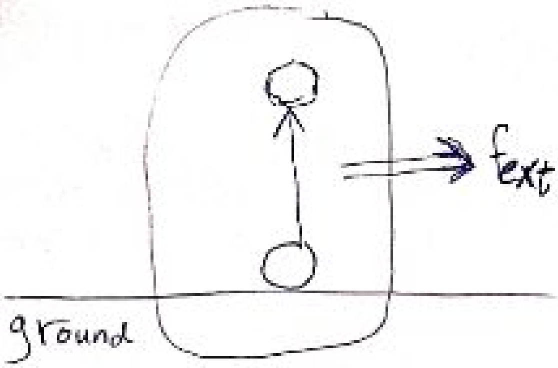
$K \leftarrow U$

* non - Isolated system
($f_{external}$)

Case I → No. fraction [conservative force]

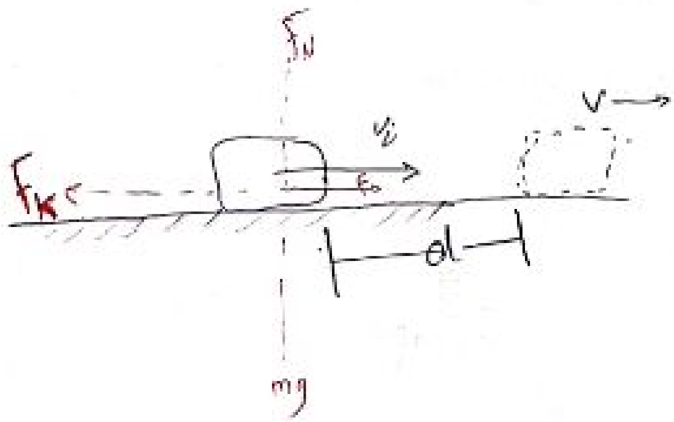
Case II → friction [non - conservative force]

⇒ Non-Isolated system (without friction):
غير معزول   بدون احتكاك



$$W = \Delta E_{mec} \neq 0$$
$$= \Delta K + \Delta U$$

⇒ Non-Isolated system with friction:



$$f_{net} = ma$$
$$\boxed{f - f_k = ma}$$

to find (a) →

$$v^2 = v_0^2 + 2ad$$
$$2ad = v^2 - v_0^2$$
$$\boxed{a = \frac{1}{2}\frac{(v_f^2 - v_0^2)}{d}}$$
$$\boxed{fd = \underbrace{\tfrac{1}{2}mv^2 - mv_0^2}_{\Delta K} + f_k d}$$
$$fd = \Delta K + f_k d$$
$$fd = \Delta E_{mec} + f_k d$$
$$\boxed{\Delta E_{mec} = \Delta K}$$
$$\boxed{W = \Delta E_{mec} + f_k d}$$

$-W_{friction}$

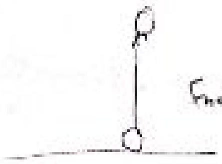
ΔE_{th} thermal energy

تلخيص

$\boxed{\text{Isolated system}}$ ($W = 0$)

No friction

$\Delta E_{mec} = 0$



$F_{net} = 0$

friction

$\Delta E_{mec} + \Delta E_{th} = 0$

$\boxed{\text{NoN-Isolated system}}$

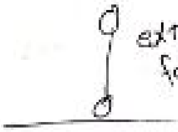
$W \neq 0$

$\Delta E_{int} = 0$

No friction

$W = \Delta E_{mec}$

$= \Delta K + \Delta U$



external force

friction

$W = \Delta E_{mec} + \Delta E_{th}$

---

* Conservastion of energy

$W = \Delta E_{mec} + \Delta E_{th} + \Delta E_{int}$

* Isolated system (friction)

$W = 0$

$\Delta E_{mec} + \Delta E_{th} = 0$

$\Delta U + \Delta K + f_k d = 0$

$U_f - U_i + K_f - K_i + f_k d = 0$

$\boxed{U_f + K_f = U_i + K_i} - f_k d \rightarrow W_{friction}$

$Power = P\,[watt]$

$P_{int} = \frac{dE}{dt}$ $\quad P = \frac{\Delta W}{\Delta t}$

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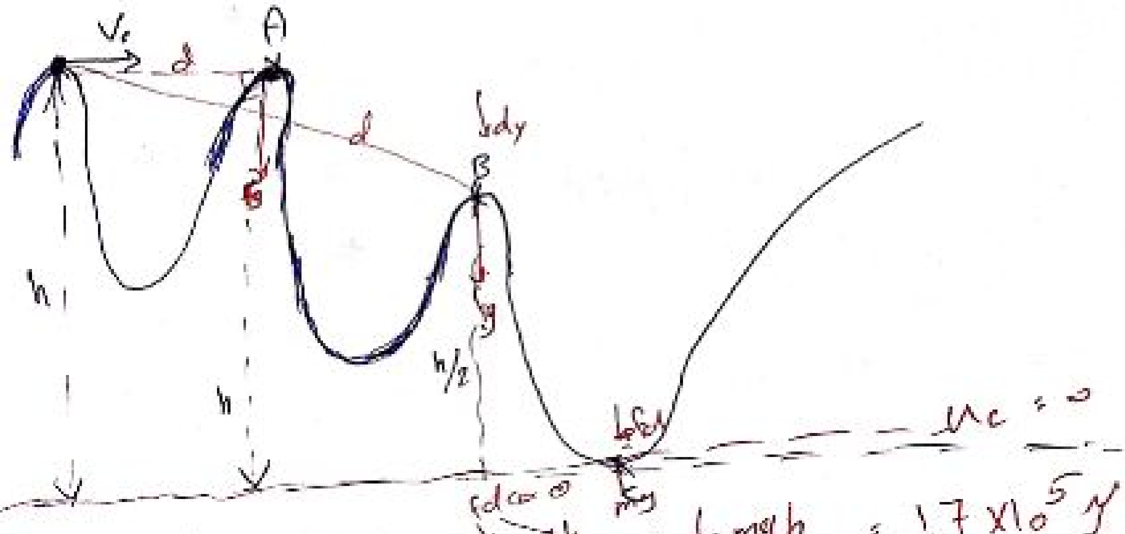
$P_{avg} = \frac{\Delta E}{\Delta t}$

Dissipation

P2)



$V_0 = 17\,m/s$

$m = 825\,kg$

$h = 42\,m$

a) W_A, W_B, W_C $\quad W_B = mg\frac{h}{2} = \frac{1}{2}mgh = 1.7\times10^5\,J$

$\Downarrow$

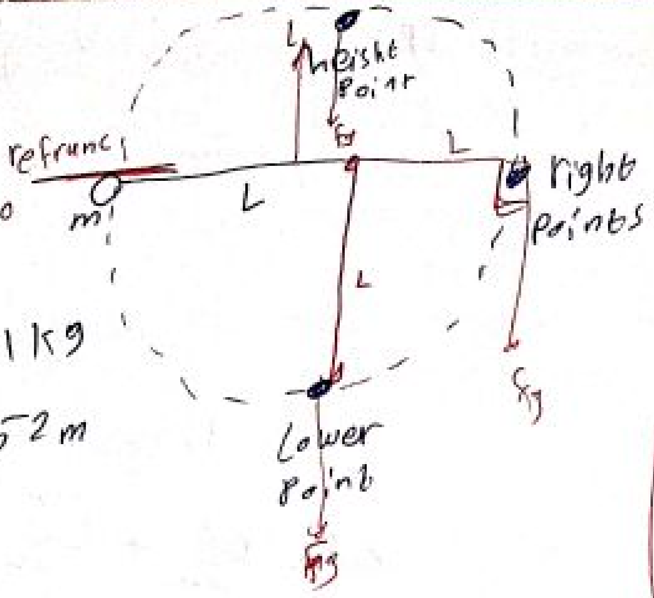
$W = F d \cos 90 = \boxed{0\,J}$ $\quad W_C = F d \cos\theta = mgh = 3.4\times10^5\,J$

b) U_B, U_A والنقطة عبارة ع

$U_c = 0$ $\quad \Delta U_{BC} = -W$ $\quad$ OR $\quad U = mg\Delta y$

$U_B = mg\frac{h}{2} = 1.7\times10^5\,J$

$U_A = mgh = 3.4\times10^5\,J$



$m = 0.341 \, kg$

$L = 0.452 \, m$

(a)

$W_{lower} = f_g \cdot d = mgL = 1.51 \, J$

$W_h = -mgh = -1.51 \, J$

$W_R = 0$

(b) $\Delta U = -W$

$\Delta U_L = -1.51 \, J$

$\Delta U_R = 0$

$\Delta U_H = 1.51 \, J$

$K_i + U_i = K_f + U_f$

$K_i = \frac{1}{2}(0.9)(7)^2 = \boxed{22.1 \, J}$

$22.1 + 15 = \frac{1}{2}(0.9)(v_f^2) + 35$

$v_f^2 = \frac{(37.1 - 35) \times 2}{0.9}$

$\boxed{v_f = 2.1 \, m/s}$

(b) $f_x = -\frac{\Delta U}{\Delta x} = -\text{slope}$

from $x = 0$ to $x = 2$ $\boxed{F = 0}$

$f_x = -\left(\frac{15 - 35}{4 - 2}\right) = \boxed{10 \, N}$

(c) $K_i + U_i = K_f + U_f$

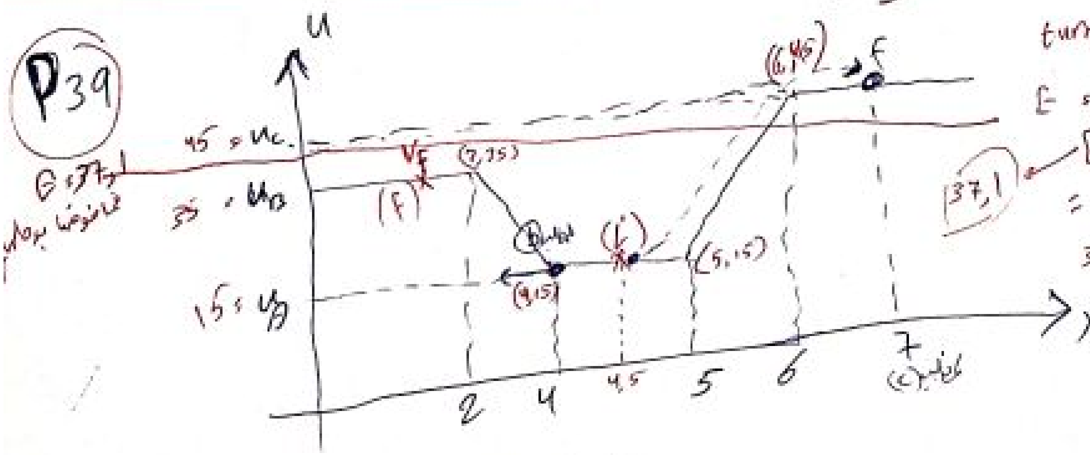
$37.1 = \frac{1}{2}(0.9)(v_f^2) + 45$

$v_c^2 = \frac{(37.1 - 45) \times 2}{0.9} < 0$

$\cancel{v_f}$

مش رح يوصل

الحل



turning points $(v = 0, K = 0)$

$E = \cancel{K}^{0} + U$

37.1 — $E = U(x)$

$= 15 + 30(x - 5)$

$y - y_1 = m(x - x_1)$

$37.1 = 15 + 30(x - 5)$

$\Rightarrow \boxed{x = 5.7 \, m}$

$U_A = 15 \, J$

$U_B = 35 \, J$

$U_C = 45 \, J$

$m = 0.9 \, kg$

at $x = 4.5 \Rightarrow \boxed{v_i = 7 \, m/s}$

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Isolated system ($f_{ext} = 0$)

$W_{ext} = 0$

no-friction

$W = \Delta E_{mec} = 0$

$K_i + U_i = K_f + U_f$

friction

$f_k \cdot d$

$W = \Delta E_{mec} + \Delta E_{th} = 0$

[illegible]

$K_i + U_i = K_f + U_f + f_k d$

Non Isolated ($f_{ext} \neq 0$, $W_{ext} \neq 0$)

No friction

$W = \Delta E_{mec}$

$= \Delta K + \Delta U$

friction

$W = \Delta E_{mec} + \Delta E_{th}$

$= \Delta K + \Delta U + f_k d$

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P19

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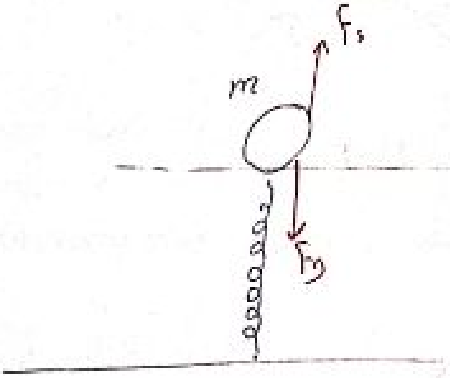
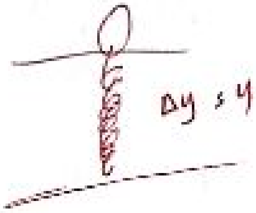


$m = 8\,Kg$,
$v_i = 0$ (at rest $a = 0$)
$\Delta y = 10\,cm$

(a) $K = ??$
$F_s - F_g = 0$
$K\Delta y = mg$
$K = \frac{mg}{\Delta y} = 7{,}84\ N/m$

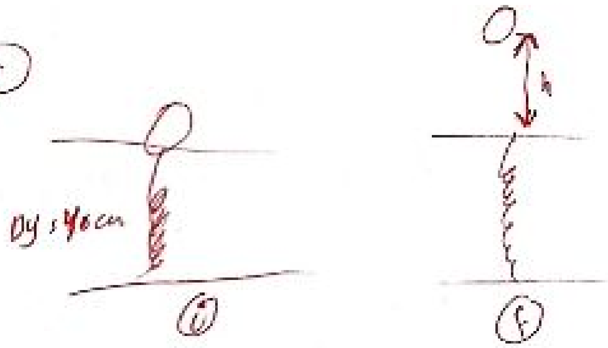
(b)



$\Delta y = 40$ $(10+30)$

$U_s = \frac{1}{2}Ky^2 = \boxed{62{,}7\ J}$

(c)

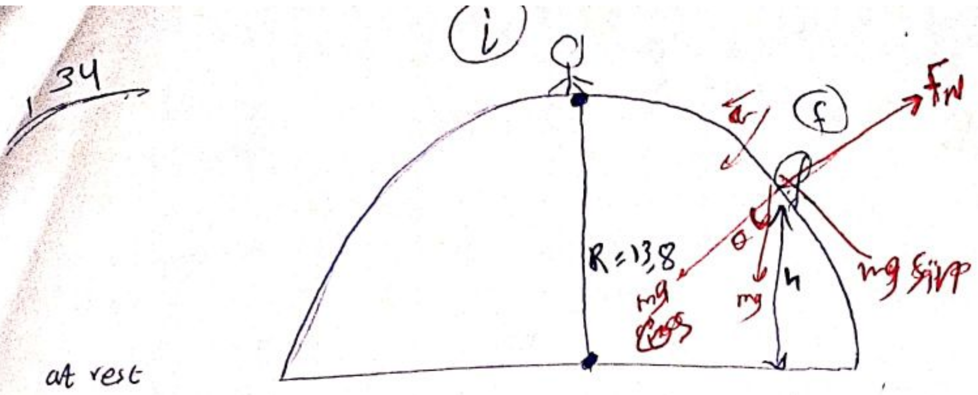


$\boxed{\cancel{K_i} + U_i = \cancel{K_f} + U_f}$ محفوظ بدون احتكاك
0 0

$62{,}7 = mgh$

$h = \frac{62{,}7}{mg} = \boxed{0{,}8\,m}$

134



$\cancel{K_i} + U_i = K_f + U_f$

0

$\cancel{m}gR = \frac{1}{2}\cancel{m}v_f^2 + \cancel{m}gh$??

$\cancel{g}R = \frac{1}{2}\cancel{m}R\cancel{g}\cos\theta + \cancel{mg}h$

$R = \frac{1}{2}R\cos\theta + h$

(f=0) بعد منفلت

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

$mg\cos\theta - F_N = \frac{mv^2}{R}$

$\cancel{m}g\cos\theta = \frac{\cancel{m}v^2}{R}$

$v^2 = Rg\cos\theta$

عوض

$\cos\theta = \frac{h}{R}$

$\boxed{h = 9,2\,m}$

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Chapter 8

Potential Energy & Conseration of Energy

Forces in Nature :

قوى المحافظة

① Gravitational force = mg
② Spring force = $-Kx$

→ Conservative forces

U Potential Energy
طاقة الوضع

$U_s = \frac{1}{2}Kx^2$ Joul
الزمبرك

$U_g = mgy$

③ Normal force = $f_n = N$
④ Friction force $f_s \le f_{sm} = \mu_s N$
$f_k = \mu_k N$
⑤ Air Drag force $= \frac{1}{2}c\rho A v^2$

→ Non conservative force

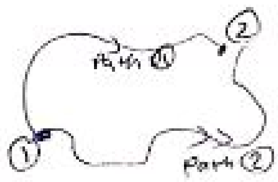
خصائص

* Properties of conservative forces :-

① Work done by $f_{conservation}$ is Path independent :

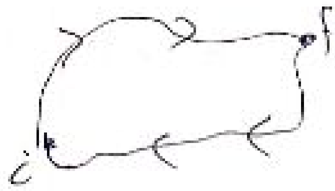
شغل القوة المحافظة لا يعتمد على المسار

$W_{con\,1} = W_{con\,2}$



② Work done by $F_{con} = 0$
$i \to i$

$W_{cons} = 0$ around a closed path



③ Work done against $F_{conserva}$ do not Lost But it Stored as
لا يضيع
Energy called Potential Energy.

الشغل المبذول ضد القوى المحافظة لا يضيع وإنما يخزن على شكل طاقة وضع

$$W_{app\; i \to f} = \Delta U = U_f - U_i$$

① W done by $f_{cons} = -\Delta U$

شغل القوة المحافظة

$$W_{f_{cons},\, i \to f} = -\Delta U = -[U_f - U_i]$$

Gravitational Potential Energy.

$$W_{f_{cons},\, i \to f} = -\Delta U = -[U_f - U_i] ;$$

$$\boxed{\int_{r_i}^{r_f} \vec{F}_{cons} \cdot d\vec{r} = -\Delta U}$$

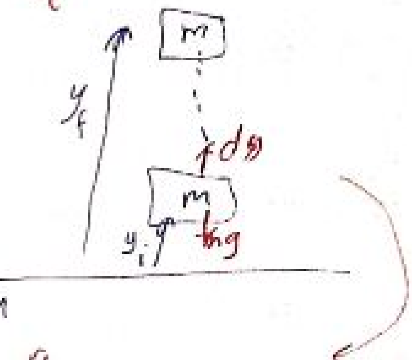
شغل القوة المحافظة — طاقة الوضع (التغير)

$$\Delta U = -\int_{r_i}^{r_f} \vec{F}_{cons} \cdot d\vec{r}$$

$$\boxed{U_f - U_i = -\int_{r_i}^{r_f} \vec{F}_{cons} \cdot d\vec{r}}$$

(B)

$$\int_{r_i}^{r_f} \vec{F} \cdot d\vec{r} = \int_{x_i}^{x_f} F_x\, dx + \int_{y_i}^{y_f} F_y\, dy + \int_{z_i}^{z_f} F_z\, dz$$



$$U_f - U_i = -\int_{r_i}^{r_f} \vec{F}_g \cdot d\vec{r}$$

$$= -\int_{y_i}^{y_f} (-mg\, dy)$$

$$= mg \int_{y_i}^{y_f} dy$$

$$U_f - U_i = mg y_f - mg y_i$$

let $y_i = 0$, $U_0 = 0$

$$\boxed{U_g = mgy} \text{ Joul}$$

y is above zero level

Ⓒ Spring Potential Energy ;

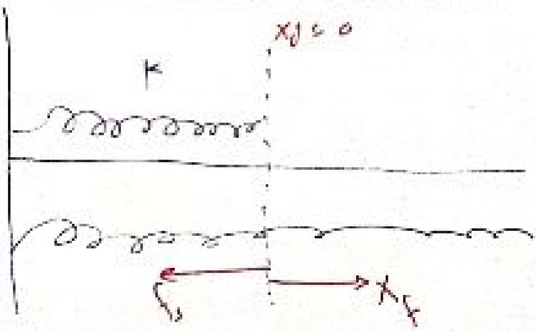
$$U_f - U_i = -\int_{r_i}^{r_f} \vec{F}_s \cdot d\vec{r}$$

$$U_f - U_i = -\int_{x_i}^{x_f} (-Kx)\, dx = K \int_{x_i}^{x_f} x\, dx$$

$$U_f - U_i = \tfrac{1}{2} K x_f^2 - \tfrac{1}{2} K x_i^2$$

let $x_i = 0 \Rightarrow U_0 = 0$

$$U_s = \tfrac{1}{2} K x^2 \quad x_i = 0$$



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$E_{mechanical}$ = Kinetic Energy + Potential Energy

$E_m = \frac{1}{2}mv^2 + U$

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✱ Conservation of Mechanical Energy :-

قانون حفظ الطاقة الميكانيكية

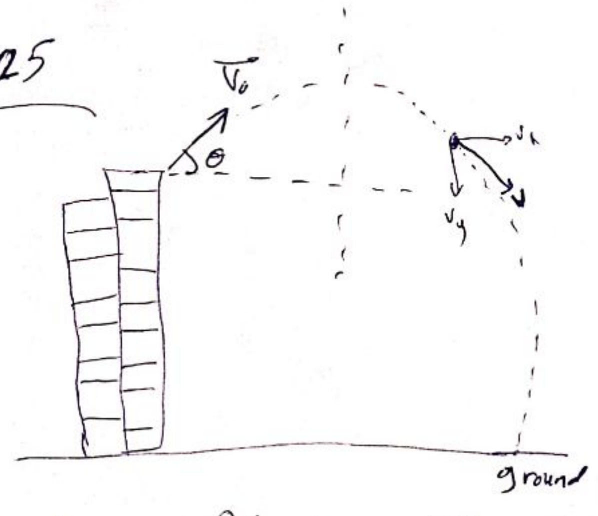
IF the only force Acting on the System is Conservative force.

$$\boxed{\begin{aligned} W_{cons} &= -\Delta U \\ W_{net} &= \Delta K \end{aligned}} \Longrightarrow \begin{aligned} \Delta K &= -\Delta U \\ \Delta K + \Delta U &= 0 \end{aligned}$$

قانون حفظ الطاقة الميكانيكية

$$\boxed{\begin{aligned} \Delta(K+U) &= 0 \\ K+U &= \text{constant} \\ (K+U)_i &= (K+U)_f \end{aligned}}$$

Q25



الي at 6s $\rightarrow v_x = 18\,m/s$

$\rightarrow v_y = v_{0y} + a_y t$

$= 24 + (-10)(6)$

$= 24 - 60$

$= -36\,m/s$

$\vec{V}_6 = 18\hat{i} - 36\hat{j}\ m/s$

$m = 1\,kg$ At $t=0$, $\vec{V}_0 = 18\hat{i} + 24\hat{j}\ m/s$

After 6s find ΔU?

$(K+U)_i = (K+U)_f = K_0 + U_0 = K_6 + U_6$

$= K_0 - K_6 = U_6 - U_0 \Longrightarrow U_6 - U_0 = 450 - 768 = -318\,J$

$K_0 = \frac{1}{2}mv_0^2$

$= \frac{1}{2}(1)(18^2+24^2)$

$= \boxed{450\,J}$

$K_6 = \frac{1}{2}mv_6^2$

$= \frac{1}{2}(1)(18^2+(-36)^2)$

$\boxed{768\,J}$

$w_g = -\Delta U$

$= 318\,J$

Chapter (8)
Lecture (2)

$F_{conservation}$ → $mg = U_g = mgy$ (J)

$F_{conservation}$ → $-kx \Rightarrow U_s = \frac{1}{2}kx^2$ (J)

$E_{initial} = E_{Final}$

$$\boxed{\frac{1}{2}mv_i^2 + U_i = \frac{1}{2}mv_f^2 + U_f}$$

F is conservative

$$\boxed{W_{conservative} = -\Delta U}$$ مهم

* Finding F_{cons} from U :-

$W_{con} = -\Delta U$

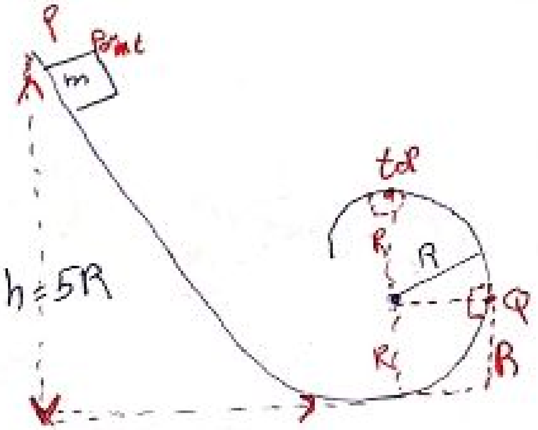
$du = -F_x\,dx$

u بعطيني
f بطلب

$$\boxed{F_{x\,cons} = -\frac{du}{dx}}$$ مهم

Problem 8, 6

$m = 0.32$ kg
$R = 12$ cm



ⓐ W_g (P→Q)

$W_g(P\to Q) = -\Delta U$

$= -[U_Q - U_P]$

$= -[mgR - mg(5R)]$

$= +4mgR = \boxed{0.150\ J}$

ⓑ W_g (P→top) $= -\Delta U$

$= -[U_{top} - U_P]$

$= -[mg(2R) - mg(5R)]$

$= +3mgR = \boxed{0.113\ J}$

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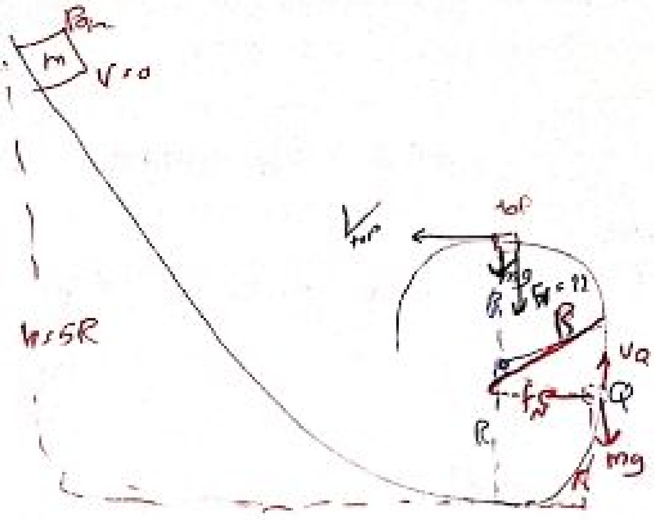
Problem 8 - 17

[illegible]



ⓐ At Q find $\vec{F_N}$? $\vec{F_V}$?

$$\boxed{F_y = -mg}$$

$$\cancel{K} = \frac{1}{2} m v_p^2 + U_p = \frac{1}{2} m v_Q^2 + U_Q$$

$$0 + 5mgR = \frac{1}{2} m v_Q^2 + mgR$$

$$\frac{1}{2} V_Q^2 = 4Rg \Rightarrow V_Q = \sqrt{8Rg}$$

$$F_N = \frac{m V_Q^2}{R} = \frac{m(8Rg)}{R} = 8mg = (\ )(-\hat{i})$$

$$\vec{F_Q} = -8mg\,\hat{i} - mg\,\hat{j}$$

ⓑ find the Normal force acting on ⓜ at the top Point

at the top

$$\boxed{F_N + mg = \frac{m V_t^2}{R}}$$

$$(K + U)_p = (K + U)_t$$

$$(0 + 5mgR) = \frac{1}{2} m v_t^2 + mg(2R) \Rightarrow \boxed{V_t = \sqrt{6Rg}}$$

at the top

$$F_N = \frac{m V_t^2}{R} - mg$$

$$F_N = \frac{m}{R} 6Rg - mg \Rightarrow F_N = 5mg \text{ at the top}$$

$$\boxed{\vec{F_N} = -5mg\,\hat{j}}$$

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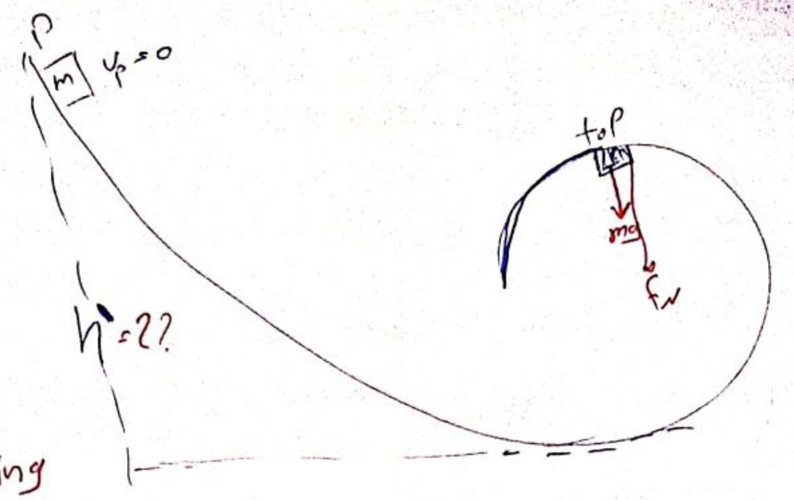
(c) find h ??



At the top

$$\frac{mv^2}{R} = mg + f_N$$

on the verge of losing contact at the top means $\boxed{f_N \longrightarrow 0}$

$$\frac{mv_t^2}{R} = mg \Rightarrow v_t = \sqrt{Rg}$$

$$K_p + U_p = K_t + U_t$$

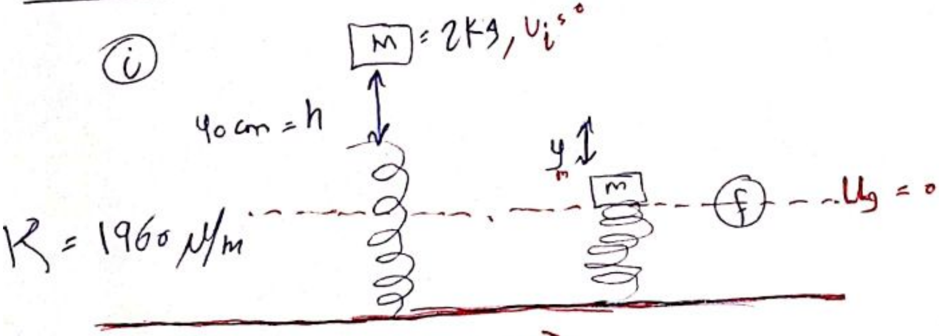
$$0 + mgh' = \tfrac{1}{2}mv_t^2 + 2mgR$$

$$mgh' = \tfrac{1}{2}m(Rg) + 2mgR$$

$$\cancel{mg}h' = 2.5\cancel{mg}R \Rightarrow \boxed{h' = 2.5R}$$

Problem 8-24

(i)



$$(K+U)_i = (K+U)_f$$

$$\left(0 + mg(h + y_m)\right) = \left(0 + \tfrac{1}{2}Ky_m^2\right)$$

$$2(9.8)[0.4 + y_m] = \tfrac{1}{2}(19600)y_m^2 = \square$$

problem 8 - 104

$m = 20kg$, $f_{con} = -3X - 5X^2$

at $X = 0$, $U_0 = 0$

ⓐ find U at $X = 2m$?

$W_{con} = -\Delta U \longrightarrow \Delta U = -\int_i^f f_{con} \, d_x$

$U_f - U_i = -\int(-3x - 5x^2) \, dx$

$U = \frac{3}{2}x^2 + \frac{5}{3}x^3 + C$

$0 = 0 + 0 + C$

$\boxed{C = 0}$

$U = \frac{3}{2}x^2 + \frac{5}{3}x^3$

$U(2) = \frac{-3}{2}(2)^2 + \frac{5}{3}(2)^3 = 19,6 J$

ⓑ At $X = 5m$, $U_x = -4 m/s$

find V_x at $X = 0$??

$(K + U)_{X=0} = (K + U)_{X=5}$

$\frac{1}{2}mV_0^2 + 0 = \frac{1}{2}m(-4)^2 + \left[\frac{3}{2}(5)^2 + \frac{5}{3}(5)^3\right]$

$V_0 = \sqrt{\quad}$

$V_0 = -6,37 m/s$

ⓒ Repeat a & b for $U = -8J$ at $X = 0$

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Problem $m = 0.2\,kg$, $U(x) = 8x^2 + 2x^4$ Joule

at $x = 1m$, $v = 5\ m/s$

find v at the origin ?

$$(K+U)_1 = (K+U)_0$$

$$\frac{1}{2}(0.2)(5)^2 + (8(1) + 2(1)) = \left(\frac{1}{2}(0.2)v_0^2 + 0\right)$$

(b) find F_{cons} ?

$$F_{cons} = -\frac{dU}{dx} = -\left[6x + 8x^3\right]$$

$$F_{cons} = -16x - 8x^3$$

End ch8

Good Luck

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Chapter 9

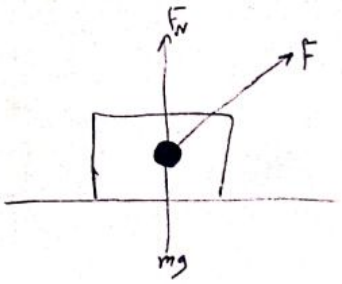
Center of mass, linear momentum:

مركز الكتلة ، كمية التحرك الخطي (الزخم)

* center of mass: is the Point that moves as though, all of the system's mass concentrated there, and all external force applied there.

كتلة النظام — مركزة — القوى بتأثر عنده النقطة

- محصلة القوة على النقطة
- كتلة الجسم مركزة في تلك النقطة



* Two cases
  - → system of Partical (مجموعة من الاجسام)
  - → Rigid (solid) bodies. (اجسام صلبة)

Case I: system of Particles

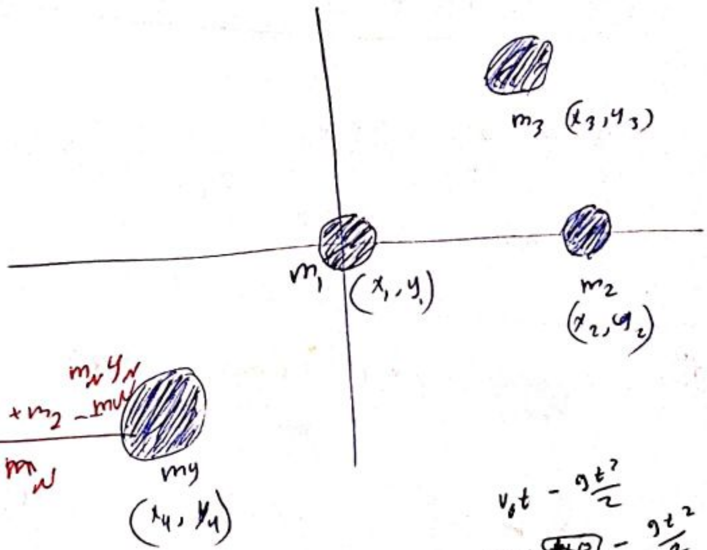
$$X_{com} = \frac{m_1x_1 + m_2x_2 + m_3x_3 + m_4x_4}{m_1 + m_2 + m_3 + m_4}$$

$$\Rightarrow X_{com} = \frac{1}{M}\sum_{i=1}^{N} m_i x_i$$

M: total mass

$$\Rightarrow Y_{com} = \frac{1}{M}\sum_{i=1}^{N} m_i y_i = \frac{m_1y_1 + m_2y_2 + m_2 \ldots m_Ny_N}{m_1 + m_2 \cdots m_N}$$

$$\Rightarrow Z_{com} = \frac{1}{M}\sum_{i=1}^{N} m_i Z_i$$



$v_0t - \frac{gt^2}{2}$

$25 + \boxed{\cancel{x}0} - \frac{gt^2}{2}$

$v = gt$

$$\vec{r}_{com} = x_{com}\hat{i} + y_{com}\hat{j} + Z_{com}\hat{k}$$

$$r_{com} = \frac{1}{M}\sum_{i=1}^{N} m_i \vec{r}_i$$

P_1 $m_1 = 2\,kg \longrightarrow (-1, 5) \longrightarrow r_1 = -\hat{i} + 5\hat{j}$

$m_2 = 4\,kg \longrightarrow (6, -7{,}5)$

$m_3 = 3\,kg \longrightarrow ??\ (x_3, y_3)$

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$r_{com} = (-0{,}5, -0{,}7)$

$\downarrow x_{com}$ $\quad\downarrow y_{com}$

$$X_{com} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3^{??}}{m_1 + m_2 + m_3}$$

$$\frac{-0{,}5}{1} = \frac{-2 + 24 + 3x_3}{2+4+3} \Longrightarrow \boxed{x_3 = -1{,}5\,m}$$

$-4{,}5 = 22 + 3x_3$
$-22 \quad -22$

$$Y_{com} = \frac{m_1 y_1 + m_2 y_2 + m_3 y_3}{9}$$

$$-0{,}7 = \frac{10 + 30 + 3y_3}{9} \Longrightarrow \boxed{y_3 = -1{,}43\,m}$$

$-6{,}3 = 40 + 3y_3$
$-40 \quad -40$

$\frac{-46{,}3}{3} = \frac{3y_3}{3}$

$y_3 =$

OR

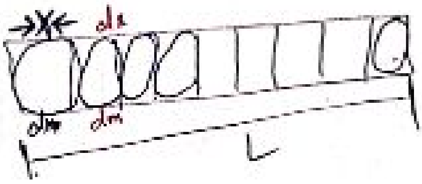
$$r_{com} = \frac{m_1 r_1 + m_2 r_2 + m_3 r_3}{M}$$

$$-0{,}5\hat{i} + 0{,}7\hat{j} = \frac{2(-\hat{i} + 5\hat{j}) + 4(6\hat{i} - 7{,}5\hat{j}) + 3(x_3\hat{i} + y_3\hat{j})}{M \quad 9}$$

Case II: Solid bodies (Rigid)

الاجسام الصلبة

$$\boxed{X_{com} = \frac{1}{M}\int x\, dm}, \quad \boxed{Y_{com} = \frac{1}{M}\int y\, dm}, \quad \boxed{Z_{com} = \frac{1}{M}\int z\, dm}$$



$$\frac{dm}{dx} = \frac{M}{L} \Rightarrow \boxed{dm = \frac{m\,dx}{L}}$$

$$\boxed{dm = \lambda\, dx}$$

uniform منتظم $\Longrightarrow$ $\boxed{\lambda = \text{constant}}$ ثابت

اذا كان $\frac{dm}{dx}$ = مقدار ثابت ...

$$\boxed{\frac{dm}{dx} = \frac{M}{L} = \lambda}$$

uniform linear dincity

كثافة خطية

يعني: كتلة في وحدة طول

1-D

$$\left.\begin{aligned} X_{com} &= \frac{1}{m}\int x\, dm \\ Y_{com} &= \frac{1}{m}\int y\, dm \\ Z_{com} &= \frac{1}{m}\int z\, dm \end{aligned}\right] \Longrightarrow r_{com} = \frac{1}{m}\int \vec{r}\, dm$$

$\boxed{dm = \lambda\, dx}$, λ = uniform, $\boxed{\lambda = \frac{M}{L}}$ $\quad \lambda$ = linear dincity

2-D ابعاد

$\boxed{dm = \sigma\, dA}$, σ = surface densitndy

$\boxed{\sigma = \frac{M}{A}}$ مساحة

3-D

$\boxed{dm = \rho\, dV}$, ρ = volume dincity $= \boxed{\frac{M}{V_{vol}}}$

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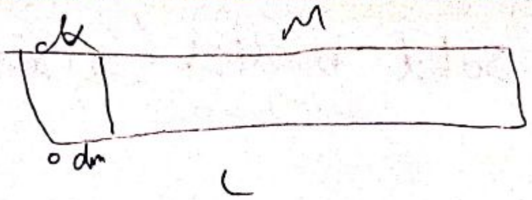
Q5

$$\boxed{X_{com} = \frac{1}{M}\int x\,dm}$$



$$dm = \lambda\, dx = \frac{M}{L}dx$$

$$\Rightarrow X_{com} = \frac{1}{\cancel{M}}\int_0^L x\left(\frac{\cancel{M}}{L}\right)dx = \frac{1}{L}\int_0^L x\,dx$$

$$= \frac{1}{L}\left[\frac{x^2}{2}\Big|_0^L\right] = \frac{1}{\cancel{L}}\cdot\frac{L^{\cancel{2}}}{2} = \boxed{\frac{L}{2}}$$

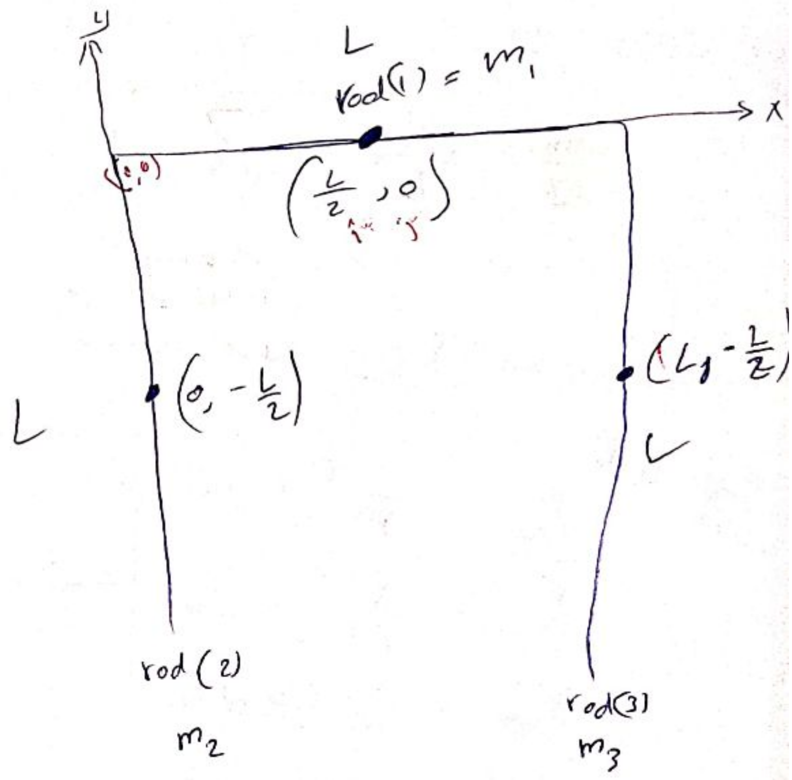
جسم منتظم (uniform rod)

بمنتصف النص

$L = 10\,cm$

$$X_{com} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$$

$$Y_{com} = \frac{m_1y_1 + m_2y_2 + m_3y_3}{m_1 + m_2 + m_3}$$



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Q6

A جسم
ومساحته

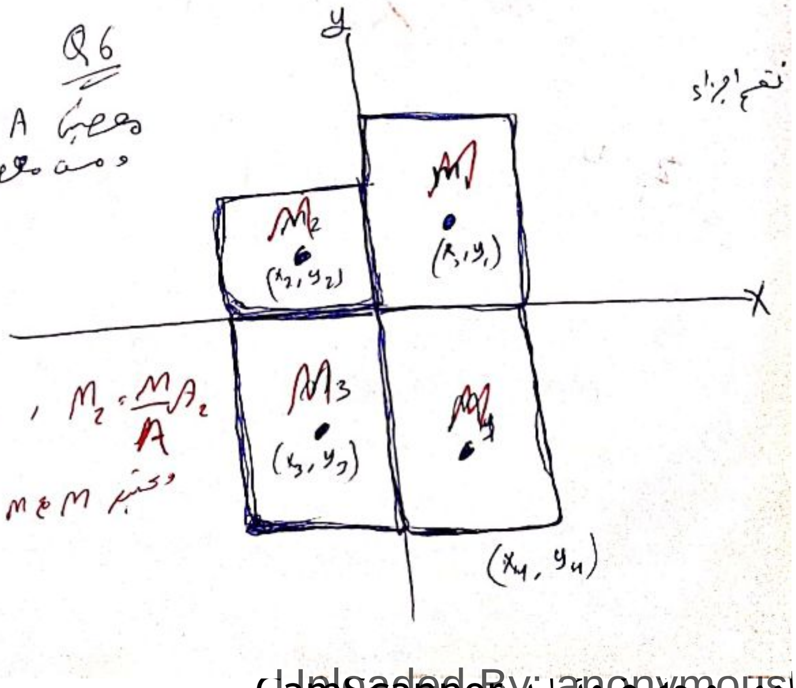
m_1
m_2
m_3
m_4

$$\frac{M_1}{A_1} = \frac{M}{A}$$

$$M_1 = \frac{M}{A}A_1 \quad , \quad M_2 = \frac{M}{A}A_2$$

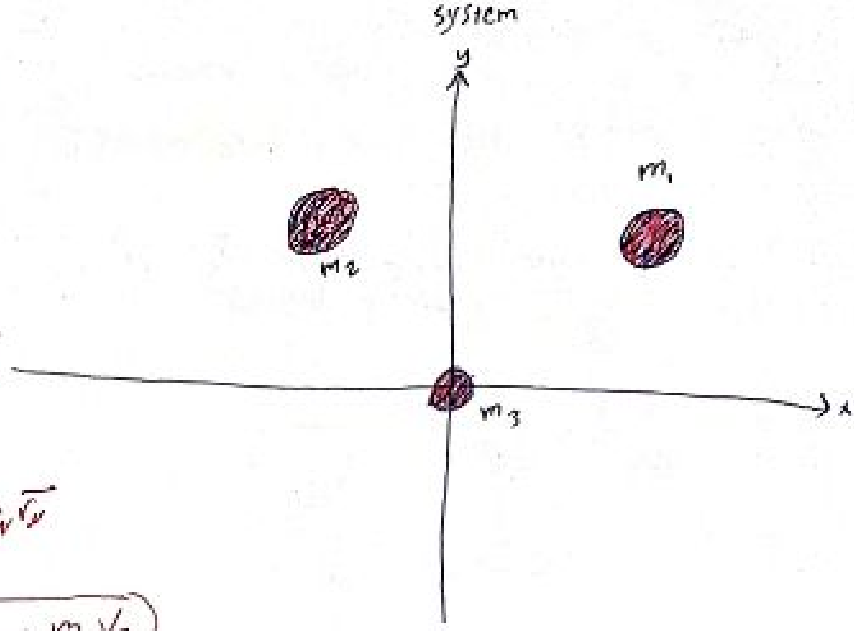
M و M وحتبر

نقسم لأجزاء



Newton's 2^{nd} Law for System of Partical.

$$\boxed{\vec{F}_{net} = \underset{\text{الكتلة الكلية}}{M}\,\vec{a}_{com}}$$



$$\vec{r}_{com} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2 \cdots\cdots + m_N\vec{r}_N}{M}$$

[illegible] $M r_{com} = m_2 r_2 + m_2 r_2 + \cdots m_N \vec{r}_N$

[illegible] $M V_{com} = m_1 V_1 + m_2 V_2 \;---\; + m_N V_2$

$$M a_{com} = \frac{\overset{F_1}{m a_1} + \overset{F_2}{m_2 a_2} \;---\; m_N a_N}{M}$$

$$\boxed{M a_{com} = F_{net}}$$ [illegible]

Chapter 9, 2

center of mass

system of Partical

$X_{com} = \frac{1}{M}\sum_{i=1}^{N} m_i x_i$

$y_{com} = \frac{1}{M}\sum_{i=1}^{N} m_i y_i$

$Z_{com} = \frac{1}{M}\sum_{i=1}^{N} m_i z_i$

$\vec{r}_{com} = \frac{1}{M}\sum_{i=1}^{N} m_i \vec{r}_i$

rigid bodies

$\left(X_{com} = \frac{1}{M}\sum_{i=1}^{N}\int x\,dm\right)$

$dm = \lambda dx$

$\lambda = \frac{M}{L}$

$\sigma = \frac{M}{A}$

$\rho = \frac{M}{V}$

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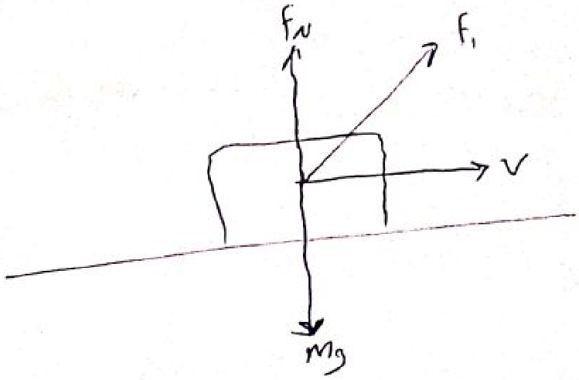
* linear momentum كمية التحرك $(\vec{P})$

* $\vec{P} = m\vec{V}$, m = mass

V = Velocity

* P in the same direction of $\vec{V}$.

بنفس اتجاه (V) تكون P



$$\boxed{\frac{dP}{dt} = F_{net}}$$

محصلة القوة

* Newton's 2nd law

$$\boxed{\begin{array}{l} F_{net} = m\bar{a} \\ m = \text{constant} \end{array}}$$

ثابت

$F_{net} = \frac{dP}{dt}$, $\vec{P} = m\vec{v}$

$= \frac{d}{dt}[mv] = \frac{m\,dv}{dt} + \frac{v\,dm}{dt}$

لما يبقى

if m = constant $\Rightarrow \frac{dm}{dt} = 0$

$F_{net} = \frac{m\,dv}{dt} = \boxed{m\bar{a}}$

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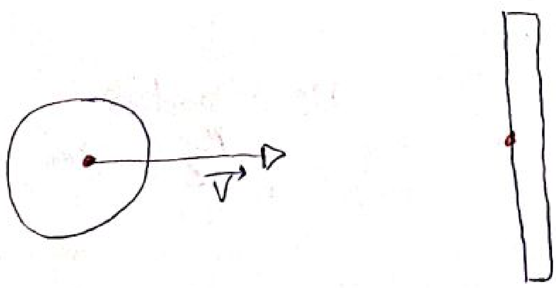
* Collision and Implus e ~~الدفع~~

التصادم — الدفع



* Impulse $(\vec{J})$

$$\boxed{J = F_{Avg} \cdot \Delta t}$$

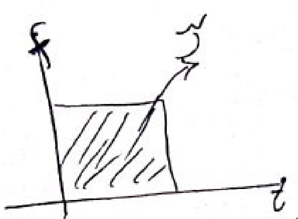
, $\vec{F}$ constant الشرط

الثاني

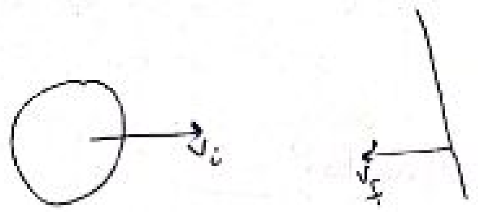
* $\vec{J} = \int_{t_1}^{t_2} f(t)\,dt$ (f varable) متغيرة

derend on time

يعتمد على الزمن



area under the curve



$J = \Delta P$

$J = m \Delta V$

$= m(\vec{v}_f - \vec{v}_i)$

اشارته

$F_{net} = \frac{dP}{dt}$

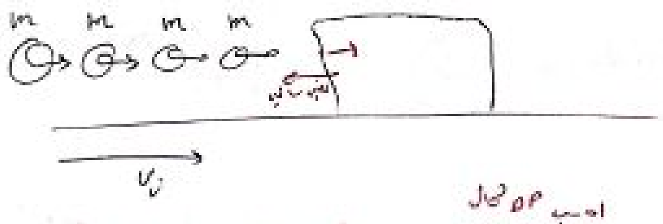
$F_{avg} = \frac{\Delta P}{\Delta t}$

$\vec{J} = F_{avg} \cdot \Delta t = \Delta P = m(v_f - v_i)$, F Constant

$J = \int F\,dt = \Delta \vec{P}$, not Constant.

---

special case



$\vec{J} = -n \Delta \vec{P}$

n = # of Partical

ΔP = change in linear momentum of 1 - Partical.

احسب ΔP لجسم واضربه بالعدد

* $J = -n \Delta P = n\, m \Delta V$

$F_{avg}\, \Delta t = -n\, m \Delta V$

$F_{avg} = \frac{-n\, m \Delta V}{\Delta t}$

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حفظ كمية الحركة

Conservation of linear momentum

* From Newton's 2^{nd} law

$F_{net} = \frac{dP}{dt}$, P is conserved if $\boxed{\Delta P = 0}$

(بشرط ان النظام معزول)

* $\vec{P}$ is conserved (محفوظة) $(\Delta \vec{P} = 0)$, if the system is Isolated and closed (ومغلق)

$\vec{\Delta P} = 0$

$\vec{P_f} - \vec{P_i} = 0$

$\boxed{\vec{P_f} = \vec{P_i}}$

Isolated system

$\Delta P = 0 \Rightarrow \boxed{\vec{P_f} = \vec{P_i}}$

$\boxed{P_{ix} = P_{fx}}$ $\boxed{\vec{P_{iy}} = \vec{P_{fy}}}$

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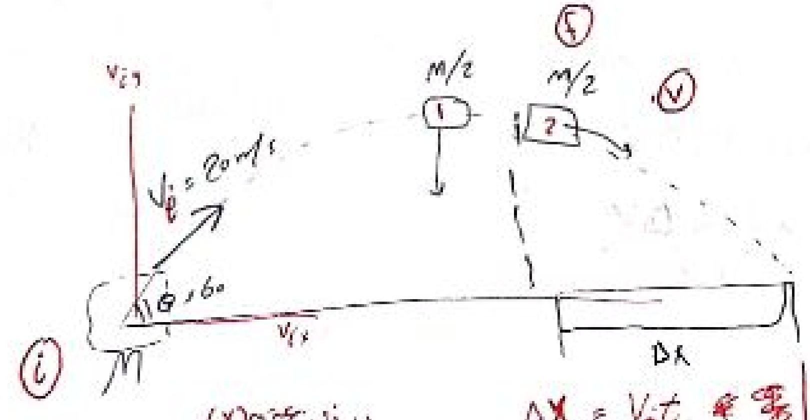
P13



(x)ناخذ محور

$P_{ix} = P_{f,x(2)} + \cancel{P_{f,x(1)}}$

$M_i v_i \cos\theta = \frac{M}{2} V$

$V = 2 v_i \cos\theta$

السرعة V

$= 2(20)\cos 60 = \boxed{20\,m/s}$

$\Delta x = V_0 t$

$V_f^2 = V_{0y}^2 + 2a\Delta y$

$0 = V_0^2 \sin^2\theta + 2g\Delta y$

$\Delta y = \frac{-V_0^2 \sin\theta^2}{2g} = \boxed{15.3}$

$\Delta y = \cancel{V_{0y}} t + \frac{1}{2} g t^2$

نعوض

$15.3 = \frac{1}{2} g t^2 \Rightarrow t = \boxed{}$

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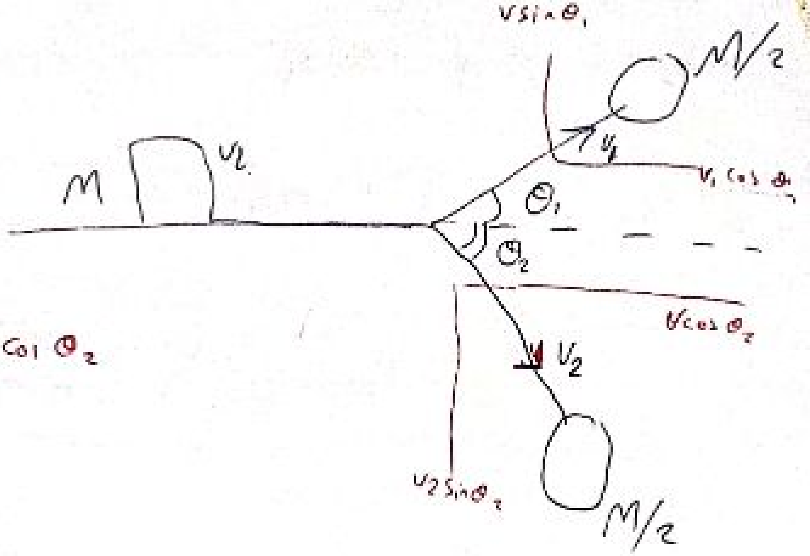


$\vec{P}_{ix}, \vec{P}_{fx}$

$$MV_i = \frac{M}{2} V_1 \cos\theta_1 + \frac{M}{2} V_2 \cos\theta_2$$

$$\vec{P}_{iy} = \vec{P}_{fy}$$

$$0 = \frac{M}{2} V\sin\theta_1 - \frac{M}{2} V_2 \sin\theta_2$$

---

chapter 9, 3

momentum and Kinetic energy in collision

انواع التصادمات

* Type of collisions.

في جميع الانواع

تصادم مرن

① elastic collision • $\vec{P}_i = \vec{P}_f$ $(\Delta\vec{P}) = 0$ $(\Delta K = 0)$ محفوظة

غير مرن

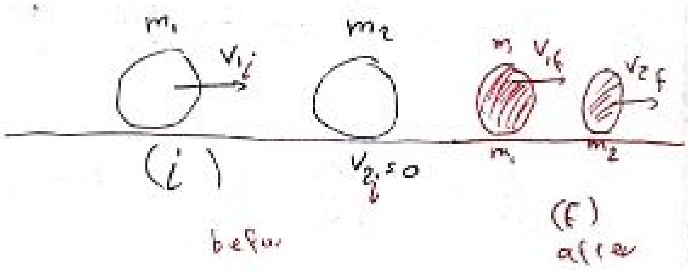
② inelastic collision $(\Delta K \neq 0)$

عديم المرونة

③ completely inelastic collision. $(\Delta K \neq 0)$

---

1 Elastic collision:



$$\vec{P}_i = \vec{P}_f$$

$$K_i = K_f$$

$$m_1 v_{1i} + \cancel{m_2 v_{2i}} = m_1 v_{1f} + m_2 v_{2f}$$

$$m_1 v_{1i} = m_1 v_{1f} + m_2 v_{2f} \longrightarrow ①$$

$$\frac{1}{2} m v_{1i}^2 + 0 = \frac{1}{2} m v_{1f}^2 + \frac{1}{2} m v_{2f}^2 \longrightarrow ②$$

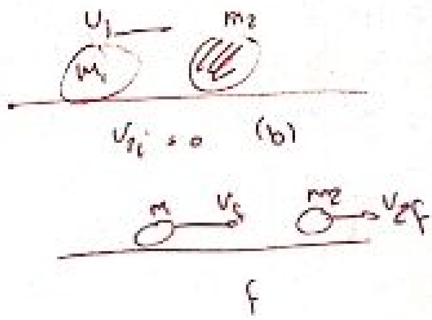
$$m_1 v_{1i} = m_1 v_{1f} + m_2 v_{2f} \quad \text{——} (1)$$

find v_{2f} from equ (1)
subsitute in equ (2)

$$\tfrac{1}{2} m v_{1i}^2 = \tfrac{1}{2} m v_{1f}^2 + \tfrac{1}{2} m v_{2f}^2 \quad \text{——} (2)$$

مع شرط m_2 ثابتة

$$\boxed{v_{1f} = \frac{m_1 - m_2}{m_1 + m_2} v_{1i}} \qquad \boxed{v_{2f} = \frac{2m_1}{m_1 + m_2} v_{1i}}$$



اذا تغير m_2 تتحرك ⟸

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

$$\tfrac{1}{2} m v_{1i}^2 + \tfrac{1}{2} m_2 v_{2i}^2 = \tfrac{1}{2} m_1 v_{1f}^2 + \tfrac{1}{2} m_2 v_{2f}^2$$

thrust(F) = mass rate of fuel exhaust velocity
$F = (\dot{m}) \cdot (v_e)$

if $m_1 = m_2 \xRightarrow{(1)} \boxed{v_{1f} = 0}$

$$\xRightarrow{(2)} v_{2f} = \frac{2m}{m_1 + m_2} v_{1i}$$

$$\boxed{v_{2f} = v_{1i}}$$

بيرجع الثاني بعد التصادم [illegible]
بيرجع الاول قبل التصادم

(2) if massive target ($m_2 >> m_1$) neglect m_1

الكتلة الاكبر الهدف

نهمل

$$v_{1f} = \frac{-m_2}{m_2} v_{1i} = \boxed{-v_{1i}}$$

$$\boxed{v_{2f} = \frac{2m_1}{m_2} v_{1i}}$$

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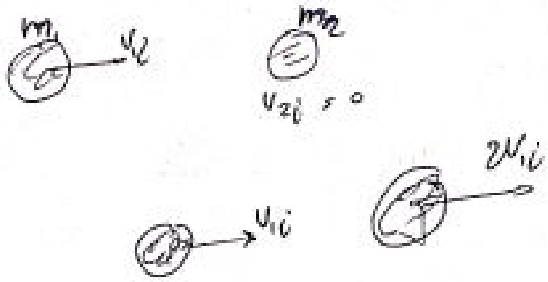
③ massive Projectile $(m_1 \gg m_2)$

$$V_{1f} = V_{1i}$$

$$V_{2f} = \frac{2m_1}{m_1} V_{1i} = 2V_{1i}$$



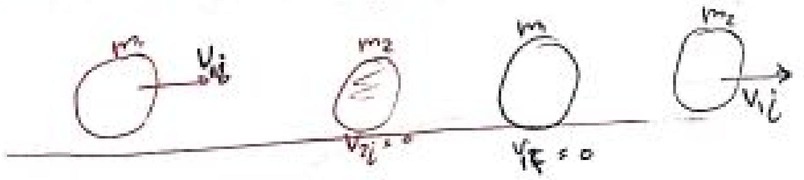
ـ تلخيص

[illegible]

* target at rest $(V_{2i} = 0)$

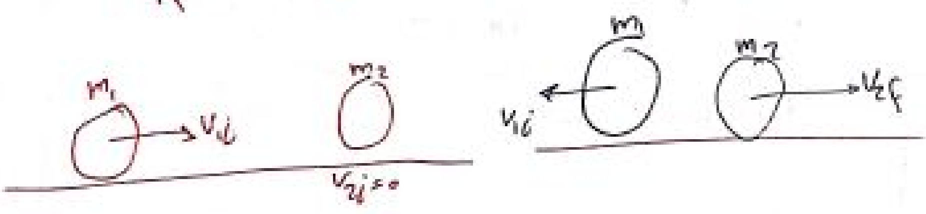
$$V_{1f} = \frac{m_1 - m_2}{m_1 + m_2} V_{1i} \qquad V_{2f} = \frac{2m_1}{m_1 + m_2} V_{1i}$$

Case ① $m_1 = m_2$ $(V_{1f} = 0 \;,\; V_{2f} = V_{1i})$



Case ② massive target $(m_2 \gg m_1)$

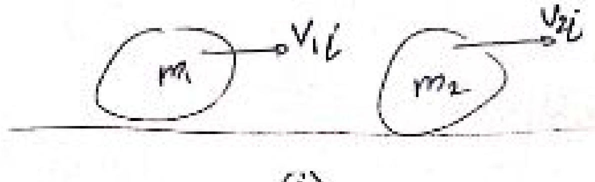
$$V_{1f} \simeq -V_{1i} \;,\; V_{2f} \simeq \frac{2m_1}{m_2} V_{1i}$$



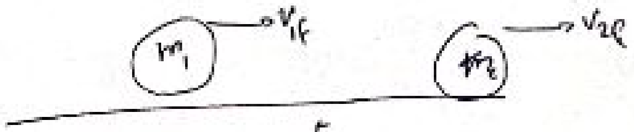
Case ③ massive Projectile $(m_1 \gg m_2)$

$$V_{1f} \simeq V_{1i} \;,\; V_{2f} \simeq 2V_{1i}$$

الهدف متحرك
* moving targer



(i)



f

* $\vec{p_i} = \vec{p_f}$

$m_1 v_i + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$

* $k_i = \vec{k_f}$

$\frac{1}{2} m v_{1i}^2 + \frac{1}{2} m v_{2i}^2 = \frac{1}{2} m v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2$

moving targit

$$V_{1f} = \frac{m_1 - m_2}{m_1 + m_2} V_{1i} + \frac{2m_2}{m_1 + m_2} V_{2i}$$

$$V_{2f} = \frac{2m_1}{m_1 + m_2} V_{1i} + \frac{m_2 - m_1}{m_1 + m_2} V_{2i}$$

* Elastic collision
  - target at rest
  - moving target

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② Inelastic collision:

$\vec{P_i} = \vec{P_f}$, $K_i \neq K_f \Rightarrow K_i = K_f + \underset{\text{dispt.}}{E}$ $\xleftarrow{} \Delta E$

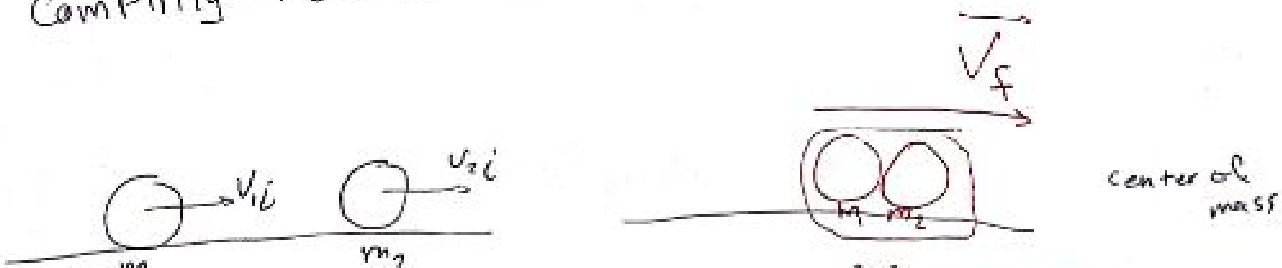
$\boxed{\Delta K = K_i - K_f}$

$P_i = P_f$

$m_1 v_{1i} + m_2 v_{2i} = m v_{1f} + m v_{2f}$ —— ①

$\Delta E = \left(\frac{1}{2} m_1 v_{1i}^2 + \frac{1}{2} m v_{2i}^2\right) - \left(\frac{1}{2} m v_{1f}^2 + \frac{1}{2} m v_{2f}^2\right)$ —— ②

③ Complitly Inelactic Collision



$M = m_1 + m_2$

$\vec{P_i} = \vec{P_f} \Rightarrow m_1 v_{1i} + m_2 v_{2i} = M v_f$

$\Delta E = K_i - K_f \Rightarrow \Delta E = \left(\frac{1}{2} m_1 v_{1i}^2 + \frac{1}{2} m_2 v_{2i}^2\right) - \frac{1}{2} M v_f^2$

$P = M \vec{v}_{com}$

$v_{com} = \frac{\vec{P}}{M} = \frac{m_1 v_{1i} + m_2 v_{2i}}{M}$

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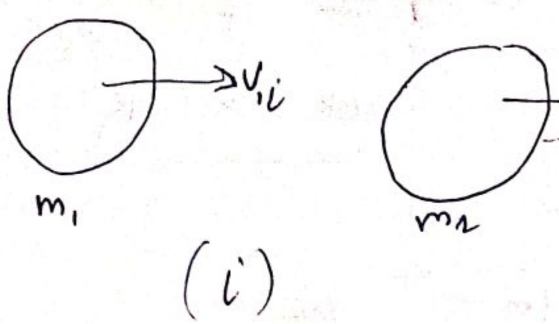
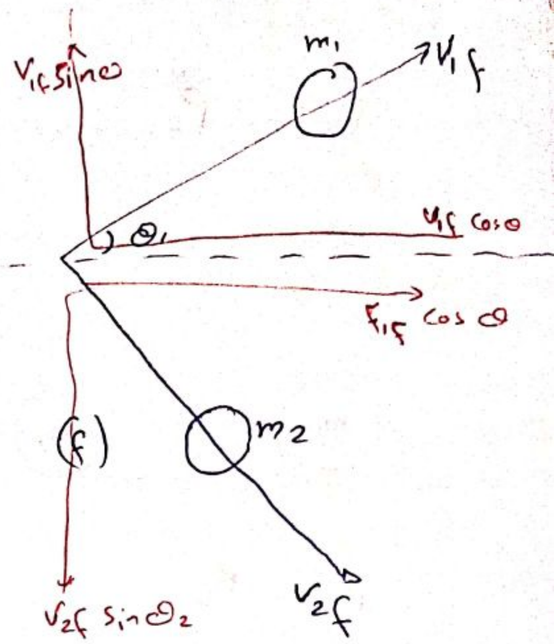
* Collision in 2D :





$\overline{P_i} = \overline{P_f}$ → $P_{ix} = P_{fx}$, $P_{iy} = P_{fy}$

لأي نوع تصادم

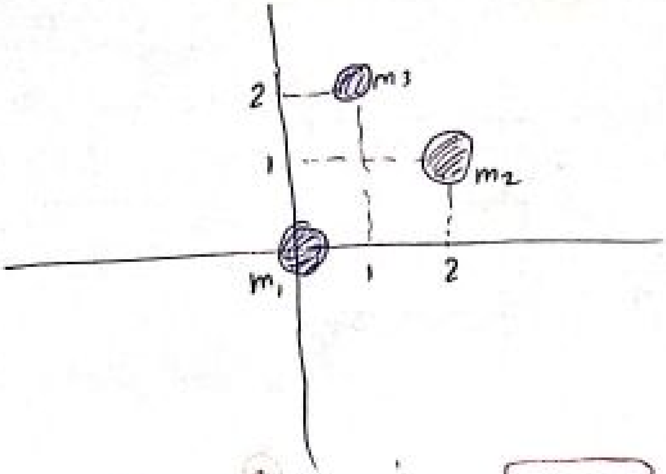
$$P_{ix} = P_{fx}$$

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f}\cos\theta_1 + m_2 v_{2f}\cos\theta_2 \quad \text{--- (1)}$$

$$P_{iy} = P_{fy}$$

$$0 = m_1 v_{1f}\sin\theta_1 - m_2 v_{2f}\sin\theta_2 \quad \text{--- (2)}$$

P(2)



$m_1 = 3Kg$

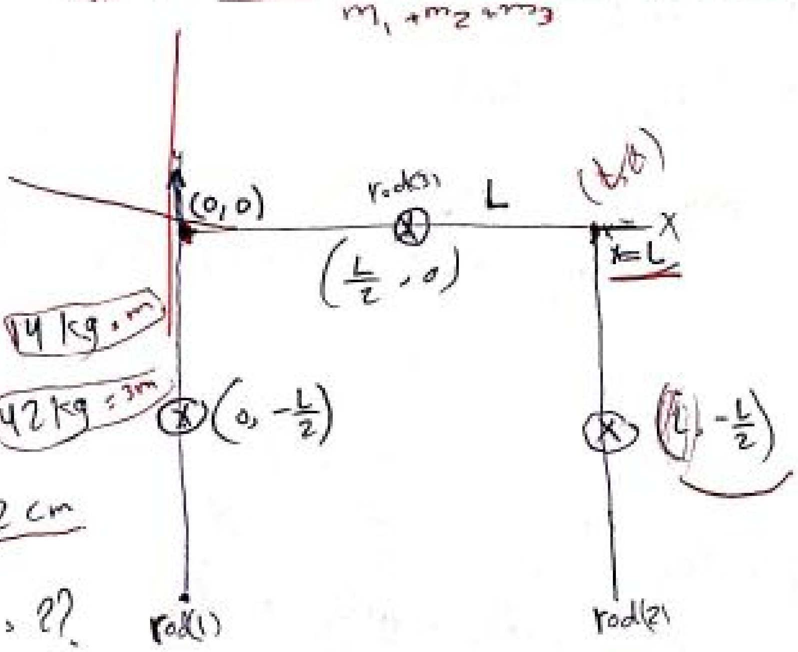
$m_2 = 4Kg$

$m_3 = 8Kg$

$$X_{com} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3}{m_1 + m_2 + m_3} = \boxed{1,1m}$$

$$Y_{com} = \frac{m_1 y_1 + m_2 y_2 + m_3 y_3}{m_1 + m_2 + m_3} = \boxed{1,3\ m}$$

P(4)



$m_1 = m_2 = \boxed{14\ kg = m}$

$m_3 = \boxed{42\ kg = 3m}$

$L = \underline{22\ cm}$

$y_{com}, x_{com} = ??$

$$X_{com} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3}{M} = \frac{\cancel{m}(0) + \cancel{m}L + 3\cancel{m}\frac{L}{2}}{5\cancel{m}}$$

$$= \frac{L}{2} = \frac{22}{2} = \boxed{11}$$

$$Y_{com} = \frac{\cancel{m}(\frac{-L}{2}) + \cancel{m}(\frac{-L}{2}) + 3\cancel{m}(0)}{5\cancel{m}} = -\frac{\cancel{m}L}{5\cancel{m}} = \frac{-L}{5} = \boxed{-4,4\ cm}$$

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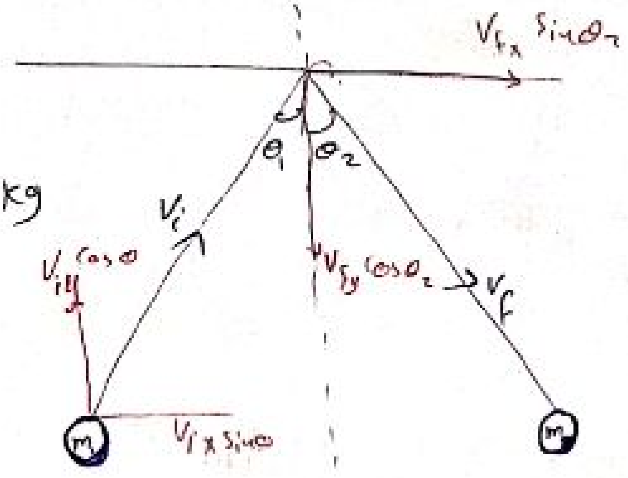
P 22



$\theta_1 = 30°$

$m = 0.165$ kg

$V_i = 2$ m/s

$\boxed{V_{xi} = V_{xf}}$

y = variable

(a) angle $\theta_2 = ??$

(b) $\Delta \vec{P} = ??$

(a) $\vec{P}_x = m \vec{V}_x$

$\vec{P}_{x(i)} = \vec{P}_{x(f)}$

$\cancel{m}\cancel{V_i} \sin\theta_1 = \cancel{m}\cancel{V_f} \sin\theta_2$

$\sin\theta_1 = \sin\theta_2 \Longrightarrow \theta_2 = \theta_1 = \boxed{30°}$

(b) ΔP — $\Delta P_x = 0$, $\Delta P_y = ??$

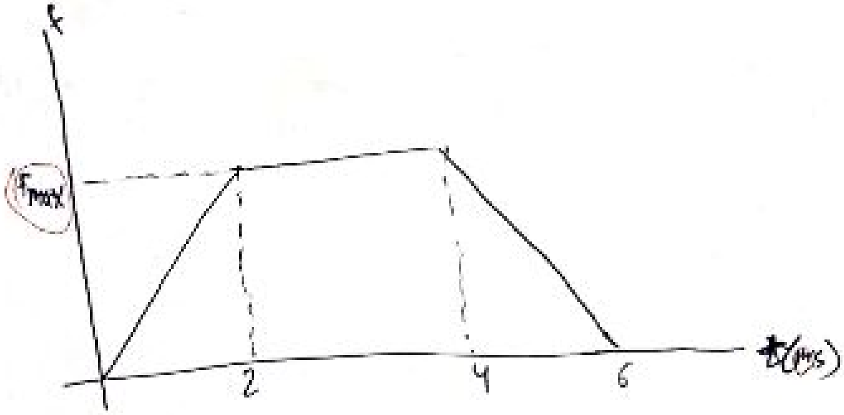
$\Delta P_y = P_{fy} - P_{iy}$

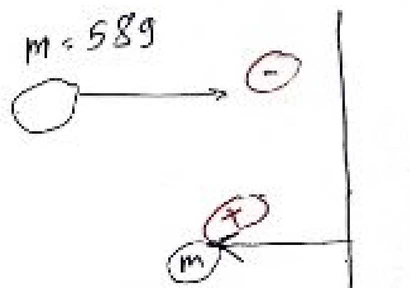
$= -m V_f \cos\theta_2 - m V_i \cos\theta_1$

$= -2 m V_i \cos\theta$

$\Delta P = -0.572$ kg m/s

P 35





$V_i = 34$ m/s

$V_f = 34$ m/s

[illegible] → $\vec{J} = \Delta P = \int F\,dt$

المساحة تحت المنحنى

نحسب المساحة $t(ms)$

$\Delta P = \vec{P_f} - \vec{P_i}$

$= mv_f + mv_i$

$\Delta P = 2mv_i$

$\int F dt = \frac{1}{2}(0{,}002)F_{max} + 0{,}002\, F_{max}$

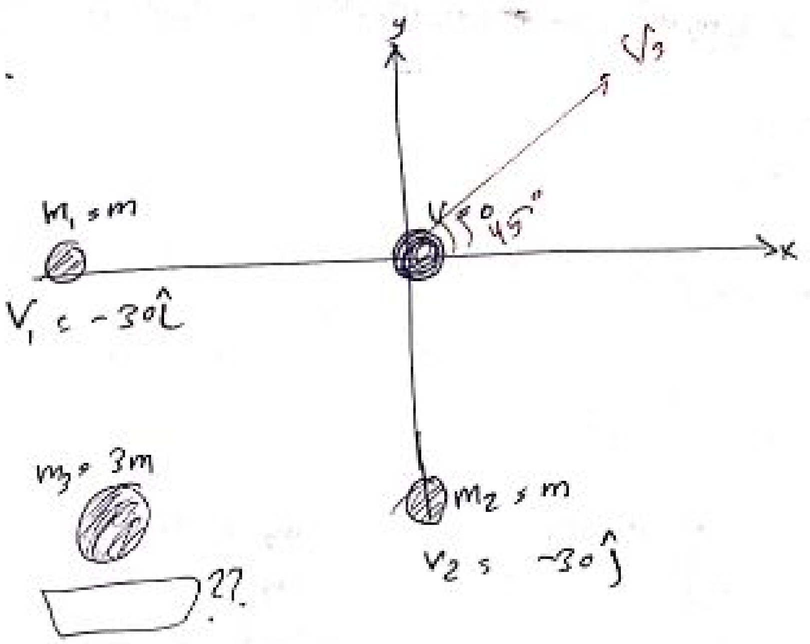
$+ \frac{1}{2}(0{,}002)F_{max}$

$= 0{,}004\, F_{s\,max}$

$2mv_i = 0{,}004\, F_{s\,max}$

$F_{s\,max} = 9{,}9 \times 10^2\ N$

P(47)



$\vec{P_i} = \vec{P_f}$

$0 = m_1\vec{V_1} + m_2\vec{V_2} + m_3\vec{V_3}$

$V_3 = \dfrac{-m_1\vec{V_1} - m_2\vec{V_2}}{m_3} = \dfrac{30m\hat{i} + 30m\hat{j}}{3m} = \boxed{10\hat{i} + 10\hat{j} = V_3}$

$\tan\theta = \frac{10}{10} = 1 = 45$

$\times\ 225$

$\theta = 45$

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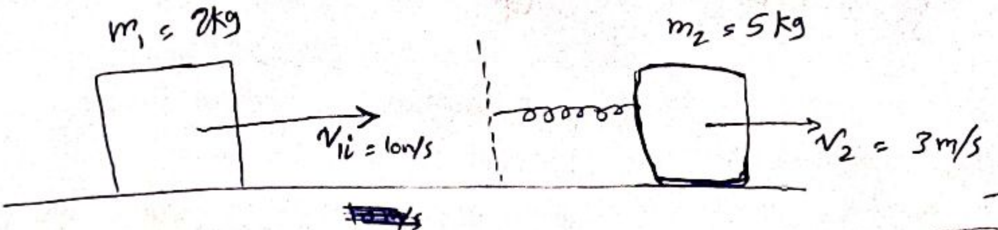
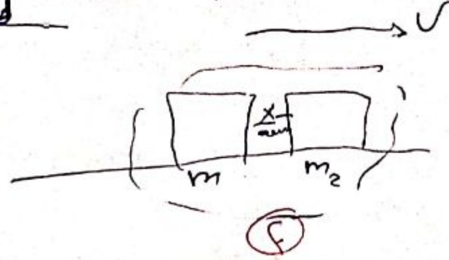
P(59)

$k = 1120\ N/m$





$x_{s\,max} = ??$

" completely inelastic collision "
عدم مرونة

$K_i + U_i = K_f + U_{f\,spring} \qquad U_s = \frac{1}{2}kx^2$??

$K_i - K_f = U_s$

$\left(\frac{1}{2}m_1 v_{1i}^2 + \frac{1}{2}m_2 v_{2i}^2\right) - \frac{1}{2}(m_1 + m_2)v^2 = \frac{1}{2}kX^2 \Rightarrow \boxed{X = 0.25\ m}$

لإيجاد v $\quad P_i = P_f$

$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2)v_f$

$v_f = \boxed{}$

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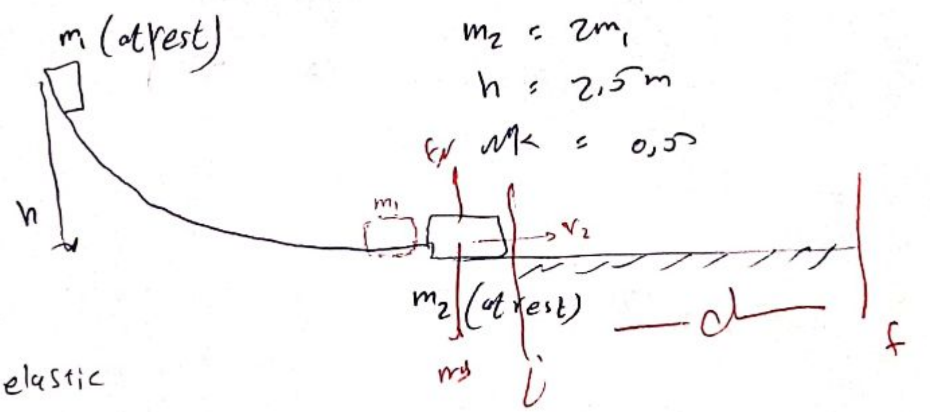
P(68)



$m_2 = 2m_1$

$h = 2.5\ m$

$\mu_k = 0.5$

@ elastic

(b) Completely inelastic

$v_{1i} = \sqrt{2gh} = \sqrt{2(9.8)(2.5)} = 7\ m/s$

بعد التصادم $V_2 = \frac{2m_1}{m_1 + m_2} V_{1i}$ قبل التصادم

$= \frac{2m_1}{m_1 + 2m_1}(7) = \frac{2}{3}(7) = \boxed{4.67\ m/s}$

$$K_i + \cancel{U_i} = \cancel{K_f} + \cancel{U_f} + \underbrace{\Delta E_{th}}_{W_{friction}}$$

$$\frac{1}{2} m v_2^2 = \Delta E_{th}$$

$$\frac{1}{2} m v_2^2 = f_K \cdot d$$

$$\frac{1}{2} \cancel{m} v_2^2 = \mu_K (\cancel{m} g) d$$

$$\boxed{d = 3{,}22 \text{ m}}$$

(2) $V_2 = \frac{m_1}{m_1 + m_2} V_{1i} \Rightarrow d = 0{,}556$ m

$$m_1 v_1 = (m_1 + m_2) V_2$$

$$F_{net} = \frac{dP}{dt} \Rightarrow F_{net} = m\vec{a}$$

$$P = mv$$

$$F_{net} = \frac{d}{dt}[mv] = m\frac{dv}{dt} + v\frac{dm}{dt}$$

$$= ma + v\cancel{\frac{dm}{dt}}$$ → 0 at m constant

$$\boxed{F_{net} = m\vec{a}}$$

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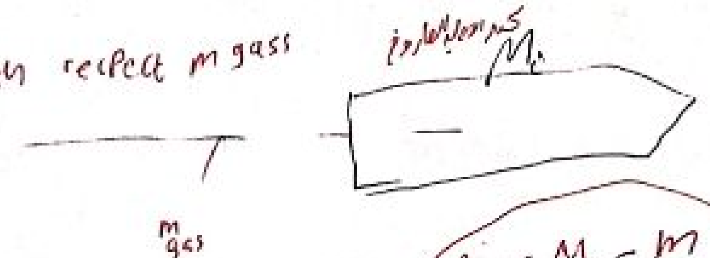
* $Ma = R V_{rel}$ "is equation of rocket"

* $V_f - V_i = U_{rel} \ln \frac{M_i}{M_f}$ "2nd rocket equation"

[illegible]/ بالنسبة للصاروخ

V_{rel} = velocity of gas with respect the rocket.



$M_f = M_i - m$

$R = \frac{dm}{dt}$ يقصد بها
كتلة بالنسبة
للزمن

P(76) $M_i = 6090$ kg

$V_i = 105$ m/s

$m_{gass} = 80$ kg

$V_{rel} = 253$

$V_f = ??$

$V_f - V_i = V_{rel} \ln \frac{M_i}{M_f}$

$M_f = M_i - m_{gass}$

$6090 - 80 = \square$

$V_f - 105 = 253 \ln \frac{6090}{\square}$

$V_f = \square$

End ch9

Good Luck

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Chapter 10

Rotation الحركة الدورانية

motion الحركة
- → translation انتقالية (x position , $\Delta x = \vec{x}_2 - \vec{x}_1$, $v_{avg} = \frac{\Delta \vec{x}}{\Delta t}$, $a_{avg} = \frac{\Delta v}{\Delta t}$, speed
- → Rotation دائرية (θ , $\Delta\vec{\theta} = \vec{\theta}_2 - \vec{\theta}_1$, ω_{Avg} , α_{Avg}

* Rotational Variables : متغيرات الحركة الدورانية

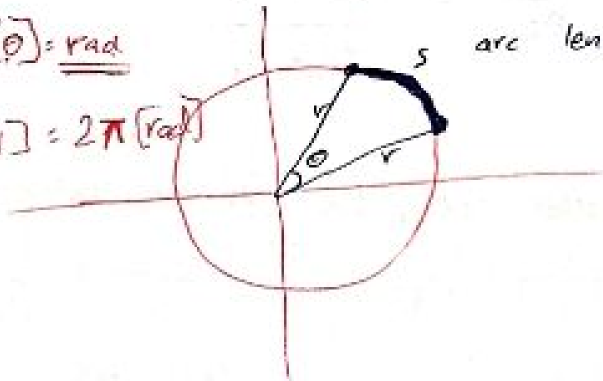
① angular position : الموقع الزاوي / الزاوي (θ)

$$\boxed{\theta = \frac{s}{r}}$$

$[\theta] = rad$

$1\,[rv] = 2\pi\,[rad]$

s arc length طول القوس

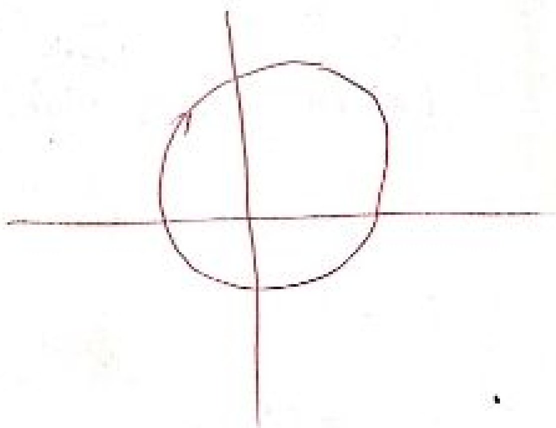


② angular displacement ($\Delta\vec{\theta}$) الإزاحة الزاوية

$\Delta\vec{\theta} = \vec{\theta}_2 - \vec{\theta}_1$

تقسم لم الزاوية ... دائما

$[\Delta\theta = rad]$



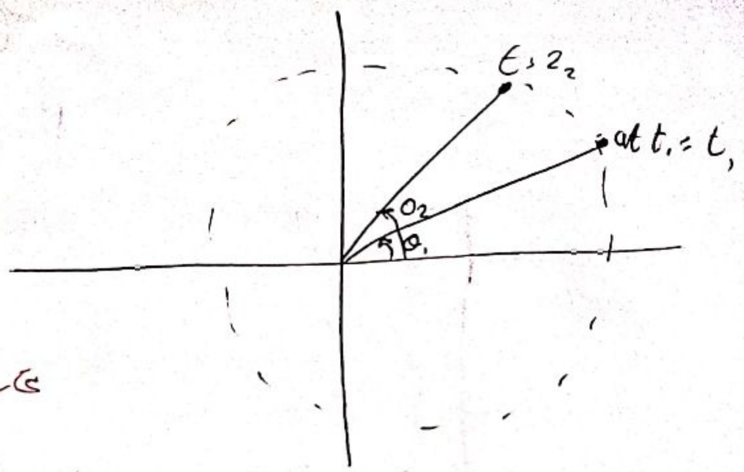
تحدد الاشارة حسب اتجاه الجسم

* clock wise ⇒ $\Delta\theta$ is negative (−)
* Counter clockwise ⇒ $\Delta\theta$ is Positive (+)

السرعة الزاوية

$\boxed{3}$ angular Velocity (ω_{avg})

$$\omega_{Avg} = \frac{\Delta\theta}{\Delta t} = \frac{\theta_2 - \theta_1}{t_2 - t_1}$$



$\omega_{avg} \xrightarrow{+}$ Counter clockwise عكس عقارب

$\omega_{Avg} \xrightarrow{-}$ clockwise مع عقارب

التسارع الزاوي

$\boxed{4}$ angular acceleration (α_{Avg})

$$\alpha_{Avg} = \frac{\Delta\omega}{\Delta t} = \frac{\omega_2 - \omega_1}{t_2 - t_1}$$

* angular speed = | angular velocity (ω) |

عند لحظة معينة

Translation $\longrightarrow x(t) \xrightarrow{\frac{dx}{dt}} v(t) \xrightarrow{\frac{dv}{dt}} a(t)$ بالعكس تكامل

Rotation $\longrightarrow \theta(t) \xrightarrow{\frac{d\theta}{dt}} \omega(t) \xrightarrow{\frac{d\omega}{dt}} \alpha(t)$ بالعكس تكامل

(rad) rad/sec (بالجمع الزاوي) rad/sec^2

$\theta(t)$: Instantaneous angular Possition

$\omega(t)$: Instantaneous angular velocity

$\alpha(t)$: Instantaneous angular acceleration.

$\cancel{\int \omega\,dt}\ \theta(t) \xleftarrow{\int \omega\,dt} \omega(t) \xleftarrow{\int \alpha(t)} \alpha(t)$

اتجاه

(ω) direction (right hand rule).

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$P(4)_2$ $\theta(t) = 2 + 4t + 2t^3$

at $t = 0$ $\Longrightarrow$ (a) angular Position

(b) angular velocity (c) ω at $t = 4$ sec (d) α at $t = 2$sec ?

a $\theta\big|_{t=0} = 2$ rad (b) $\omega(t) = \frac{d\theta}{dt} = 4 + 6t^2 = \omega(0) = \boxed{4}$ rad/sec

(c) $\omega\big|_{t=4} = 4 + \cancel{96} = \boxed{100 \text{ rad/s}}$

(d) $\alpha = \frac{d\omega}{dt} = \boxed{12\,t} = \alpha\big|_{t=2} = \boxed{24 \text{ rad/sec}^2}$

غايب (ω_{avg} = $t = 1$, $t = 4$ $\omega_{Avg} = \frac{\theta_2 - \theta_1}{t_2 - t_1}$

---

* Rotation motion at constant α :- (w) Hoof mosk

translation ($a \equiv$ cons)	Rotation ($\alpha \equiv$ cons)
$V = V_0 + at$	$\omega = \omega_0 + \alpha t$
$V^2 = V_0^2 + 2a\Delta X$	$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$
$\Delta X = V_0 t + \frac{1}{2} a t^2$	$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$
ΔX, V, a	$\Delta\theta$, ω, α $\quad$ $V = \frac{2\pi R}{T}$ $\quad$ $a = \frac{v^2}{r}$

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P(9)₂ $\omega_0 = 12,6$ rad/sec , $\alpha = -4,2$ rad/sec²

(a) t until t stop ??

$\overset{0}{\cancel{\omega}} = \omega_0 + \alpha t$

$t = \frac{-\omega_0}{\alpha} = \frac{-12,6}{-4,2} = \boxed{3 \text{ sec}}$

(b) $\overset{0}{\cancel{\omega^2}} = \omega_0^2 + 2\alpha \Delta\theta$

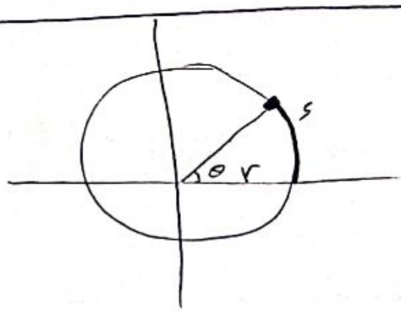
$\Delta\theta = \frac{-\omega_0^2}{2\alpha} = \frac{-(12,6)^2}{-(2)(4,2)} = \boxed{18,9 \text{ rad}}$

1rev → 2π rad

x ← 18,9 rad

---

translation | Rotation



x , v, a ⟷ θ, ω, α (r·)

s

$\boxed{s = r\theta}$ → angular Position.

linear Position $\frac{ds}{dt} = r \frac{d\theta}{dt} \Rightarrow \boxed{v = r\omega}$

$\frac{ds^2}{dt^2} = r \frac{d\theta^2}{dt^2}$

$\boxed{a = r\alpha}$

$\alpha = \frac{v^2}{r}$
a

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P28

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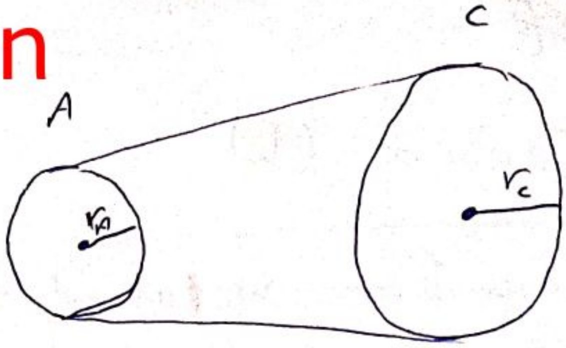


$r_A = 10\,cm$, $r_c = 25\,cm$

$\omega_{A(i)} = 0$, $\alpha_A = 1.6\ rad/sec^2$

$V_a = V_c$

(a) $t \longrightarrow \omega_c = 100\ rev/min$?? $\Longrightarrow 100 \times \frac{2\pi}{60} = 10.47\ rad/s$

حل :

$V_A = V_C$

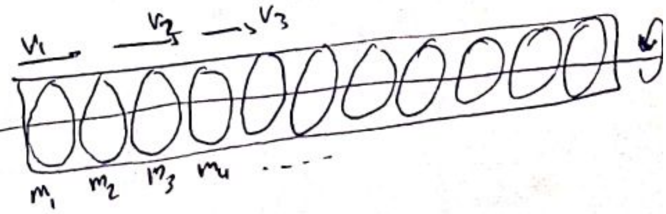
$\omega_a r_a = \omega_c r_c$

$\omega_A = \frac{\omega_c r_c}{r_A} = (10.47)\left(\frac{25}{10}\right) = \boxed{26.16\ rad/sec}$

$\omega_A = \omega_{0A} + \alpha t$

$26.16 = 0 + 1.6(t) \Rightarrow \boxed{t = 16\ sec}$

Kientic energy (K.E) in Rotation :-



$K.E = \sum_{i=1}^{N} \frac{1}{2} m v_i^2$

$v_i = r_i \omega_i \Longrightarrow K.E = \sum_{i=1}^{N} \frac{1}{2} m_i (r\omega_i)^2$

$= \frac{1}{2} \underbrace{\sum_{i=1}^{N} (m_i r_i^2)}_{\text{Inetria } (I)} \omega_i^2 = \boxed{\frac{1}{2} I \omega_i^2}$ $(m \propto I)$

انرشيا

Inetria (I)

* Inetria (I)

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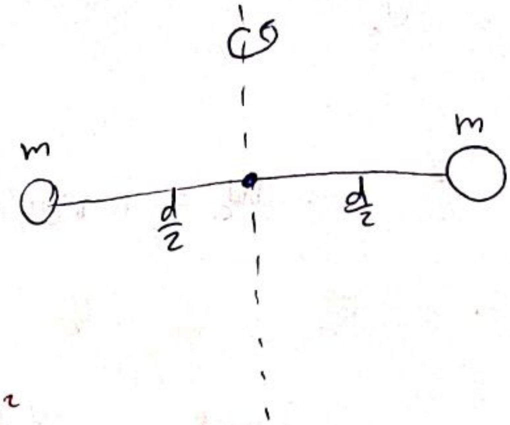
محور الدوران يمر من المركز

Case I → Rotational axis through the center of mass

$$I_{com} = \sum_i m_i r_i^2$$



$$= m\left(\frac{d}{2}\right)^2 + m\left(\frac{d}{2}\right)^2$$

$$= \frac{md^2}{2}$$

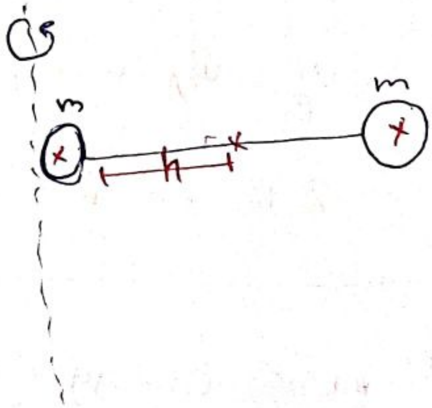
$6ma^2$

→ Rotational axis through apart from the com

$$\boxed{I = I_{com} + Mh^2}$$

M: total mass

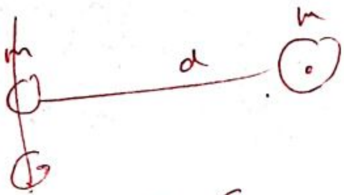
h: distanse of Center of mass Rotationall axis. محور الدوران



$$= \frac{md^2}{2} + 2m\left(\frac{d}{2}\right)^2$$

$$= md^2$$ للسستم كله

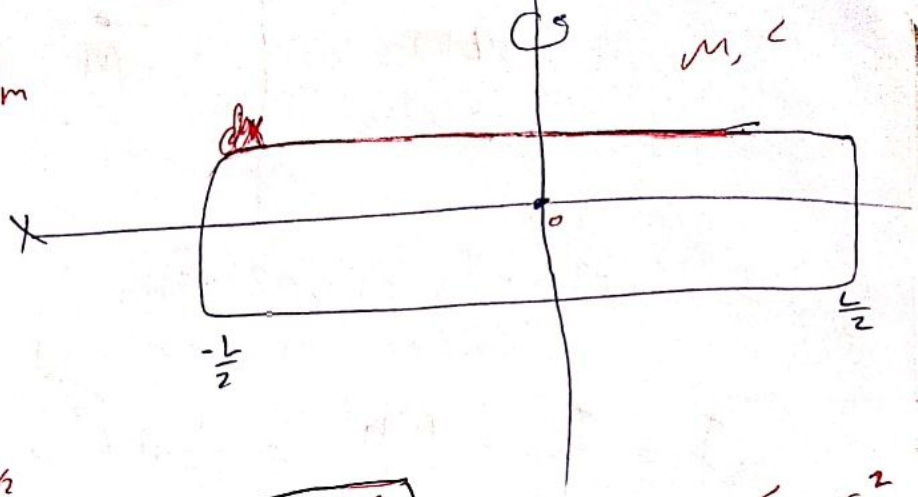
OR



$$I = I_1 + I_2$$

$$= 0 + md^2 = md^2$$

Case II : rigid body (solid)



$$I = \int r^2\, dm = \int x^2\, dm$$

$$\lambda = \frac{dm}{dx} = \frac{M}{L}$$

$$\Rightarrow dm = \frac{M}{L}\, dx$$

$$I = \int_{-L/2}^{L/2} x^2 \frac{M}{L}\, dx = \frac{M}{L} \int_{-L/2}^{L/2} x^2\, dx = \boxed{\frac{1}{12} M L^2}$$

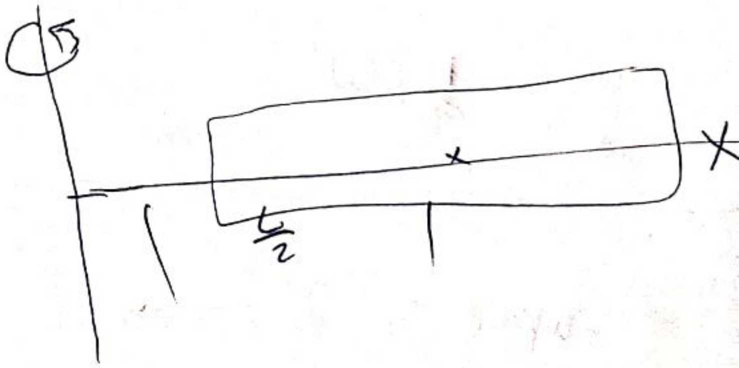
$I = \sum m_i r_i^2$

$$\boxed{I_{rod} = \frac{1}{12} m L^2}$$

شرط محور الدوران
يمر بـ com

<u>OR</u>

Parrallel - axis theorem



$$I = I_{com} + M h^2$$

$$= \frac{1}{12} m L^2 + m\left(\frac{L}{2}\right)^2$$

$$= \frac{1}{12} m L^2 + \frac{M L^2}{4} = \frac{4 m L^2 + 12 M L^2}{12 \times 4} = \frac{16 M L^2}{48}$$

$$= \boxed{\frac{M L^2}{3}}$$

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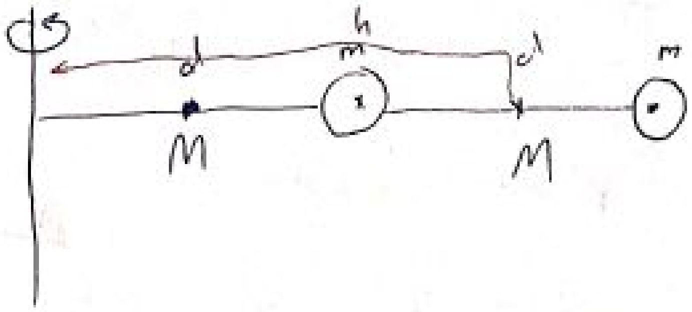
P41

$m = 0{,}85\,kg$

$M = 1{,}2\,kg$

$w = 0{,}3\ rad/sec$



$I = I_1 + I_2 + I_3 + I_4 = \boxed{0{,}023\ kg/m^2}$

$I_1 = I_{cm} + Mh^2 = \frac{1}{12} M \overset{\to d}{L^2} + M\left(\frac{d}{2}\right)^2 =$

$I_2 = \frac{1}{12} M \overset{\to d}{L^2} + M\left(\frac{3d}{2}\right)^2 =$

$I_3 = m d^2 =$

$I_4 = m(2d)^2 =$

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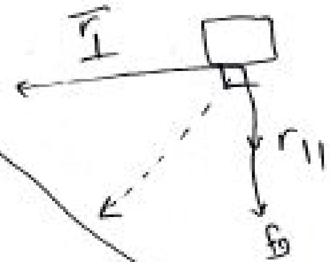
$K_{tot} = \frac{1}{2} I W^2 =$

Torque : $(\tau) \Longrightarrow \vec{\tau} = \vec{r} \times \vec{F} = |\vec{r}||\vec{F}| \sin\theta$

$[\tau] = N \cdot m$

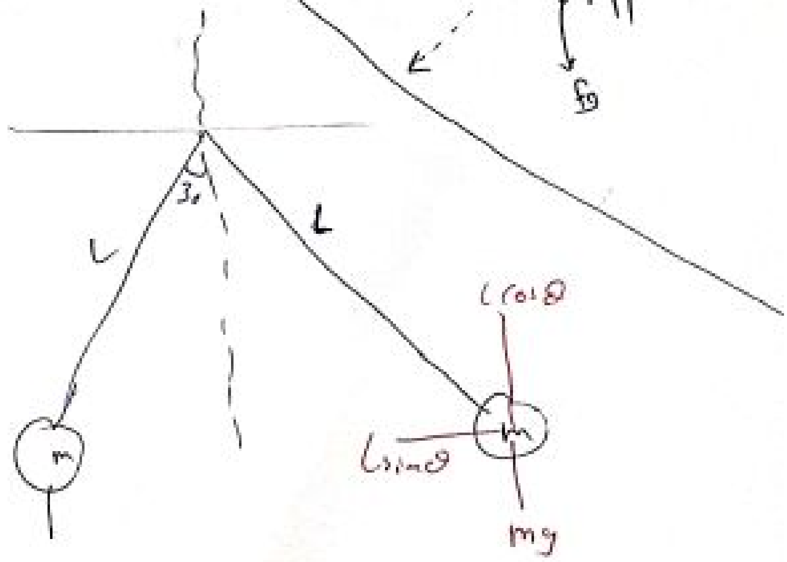


P47 $m = 0.75\,kg$

$L = 1.25\,m$

$\tau,\ f_g = ??$

$\tau = mg\, d \sin\theta = 4.6\ N \cdot m$



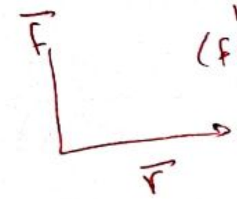
* Newtun's second law: $f_{net} = m\vec{a}$

$$\boxed{\tau_{net} = I\alpha}$$, $\vec{\tau}_{net} \equiv$ net tourqe

$I \equiv$ Intertia

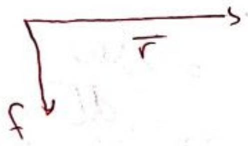
$\alpha \equiv$ angular acceleration.

$\vec{\tau} = \vec{r} \times \vec{F}$



بدي من r وبتحرك نحو (f)

$t = \boxed{+Z}$ داخل

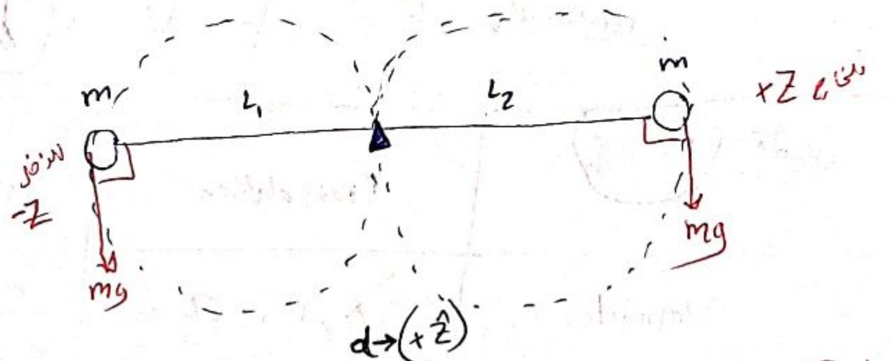


$t = \boxed{-Z}$

$\tau = \hat{i} \times -\hat{j}$
$= (-Z)$

P56) $l_1 = 20$ cm , $l_2 = 80$ cm

a_1 , a_2 ??



$a = r\alpha$

$a_1 = l_1 \alpha$

$a_2 = l_2 \alpha$

$\tau_{net} = I\alpha$

$\tau_{net} = \vec{\tau}_1 + \vec{\tau}_2 \Rightarrow t_1 = mg\,l_1$

$t_2 = mg\,l_2$

$\Rightarrow \tau_{net} = mg\,(l_2 - l_1)$

$I = m l_1^2 + m l_2^2$

$mg\,(l_2 - l_1) = (m l_1^2 + m l_2^2)\,\alpha \Rightarrow \boxed{\alpha = 8.65 \text{ rad/sec}^2}$

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$W_{net} = \Delta K \Rightarrow K = \frac{1}{2} I w^2$ →

④ Transulution motion : $w = \int_{x_0}^{x_f} f\,dx$

Rotutional $\Rightarrow w = \int_{\theta_i}^{\theta_f} \tau \, d\theta$

$\tau(\theta), \theta^2$

$w = \tau_{avg} \cdot \Delta\theta$

⑤ Power $\xRightarrow{\text{translation}} \vec{P} = \frac{dw}{dt}$

rotational → $\vec{P} = \vec{F} \cdot \vec{v} = \boxed{\vec{\tau} \cdot \vec{w}}$

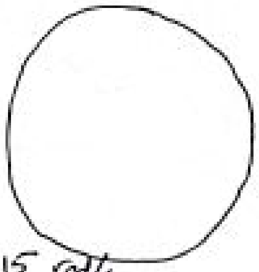
ملخص Part I :	translation	rotation
Varables	x, v, a	θ, w, α
Constant acceleration	$v = v_0 + at$ $v^2 = v_0^2 + 2a\Delta x$ $\Delta x = v_0 t + \frac{1}{2}at^2$	$w = w_0 + \alpha t$ $w^2 = w_0^2 + 2\alpha\Delta\theta$ $\Delta\theta = w_0 t + \frac{1}{2}\alpha t^2$
Part 2 K	$K = \frac{1}{2}mv^2$	$K = \frac{1}{2} I w^2$ → Part 3
Part 4	$w = \int f\,dx$ $W_{net} = \Delta K$ $P = \vec{F} \cdot \vec{v}$ $F_{net} = ma$	$w = \int \tau \, d\theta$ $W_{net} = \Delta K$ $P = \tau \cdot w$ $\tau_{net} = I\alpha$

$w_f^2 = w_i^2 + 2\alpha\theta$

Discussion chapter 10

2
13
23
34

P2



$\omega = \frac{\Delta\theta}{\Delta t}$

$\Delta\theta = \frac{1}{2}(\omega_0 - \omega_f)t$
$\omega = \omega_0 + \alpha t$
$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$
$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$
$\Delta\theta = \omega t - \frac{1}{2}\alpha t^2$

W – anguler velocity

$\omega_{\text{second hand}} = \frac{2\pi}{60} = 0,15$ rad/s

$\omega_{\text{min-hand}} = \frac{2\pi}{60 \times 60} = 1,75 \times 10^{-3}$ rad/s

$\omega_{\text{hour hand}} = \frac{2\pi}{60 \times 60 \times 60} = 1,45 \times 10^{-4}$ rad/sec

P13 : $\theta_0 = 0$, $\omega_0 = 1,5$ rad/sec $\theta = 40$ rev , $\omega_f = 0$

1 rev → 2π rad
40 rev → x

(a) t (b) α

(a) $\omega_{avg} = \frac{\Delta\theta}{\Delta t} \Rightarrow \Delta t = \frac{\Delta\theta}{\omega_{avg}} = \frac{2\Delta\theta}{\omega_0} = \boxed{3,4 \times 10^2 \text{ sec}}$

$\omega_{avg} = \frac{1}{2}(\omega_0 + \cancel{\omega}) = \frac{\omega_0}{2}$

(b) $\cancel{\omega} = \omega_0 + \alpha t$

$\alpha = \frac{-\omega_0}{t} = \boxed{-7,12 \times 10^{-4}}$ rad/s²

1 rev → 2π rad
20 rev → x

(c) t for first 20 rev

$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

t = 98 sec ✓

t = 572 sec ✗

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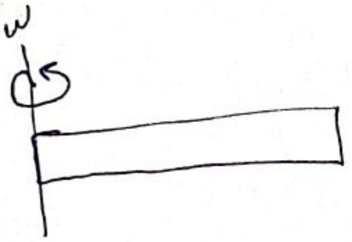
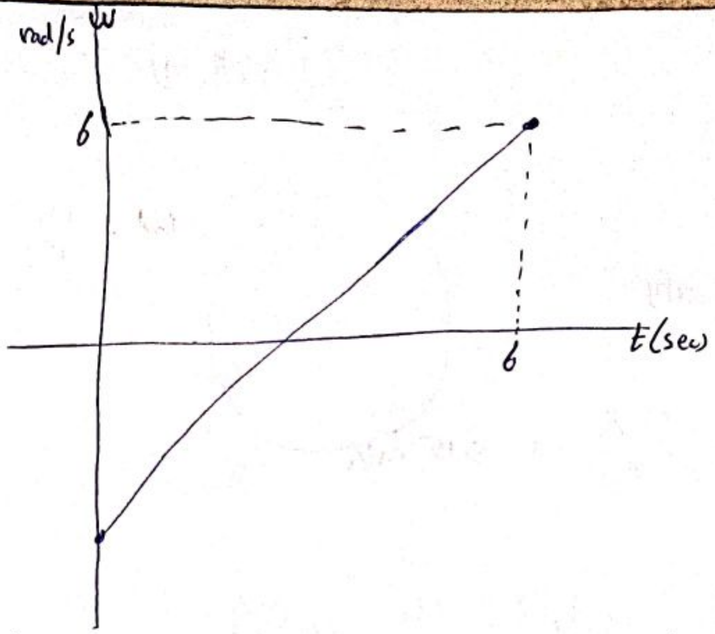
P 34





(a) α rod

$\frac{4-1}{4-2} = 1,5$

$\theta \xrightarrow{\frac{d\theta}{dt}} \omega \xrightarrow{\frac{d\omega}{dt}} \alpha$

$\alpha_{rod} = \frac{d\omega}{dt} = \text{slope} = 1,5 \text{ rad/s}^2$

(b) $t = 4 \text{ sec} \longrightarrow K_{(4)} = 1,6 \text{ J}$ $\quad \omega_4^2$

$K_0 \longrightarrow (t=0) = ??$

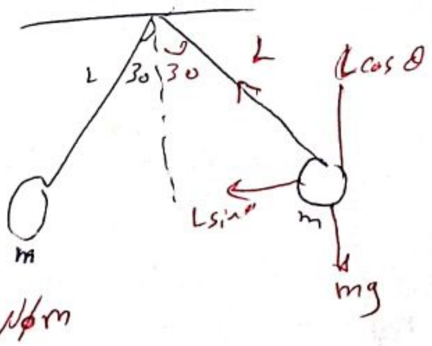
$K = \frac{1}{2} I \omega^2$

$\frac{K_0}{K_4} = \frac{\cancel{\frac{1}{2} I}\, \omega_0^2}{\cancel{\frac{1}{2} I}\, \omega_{(4)}^2} =$

$K_0 = \frac{\omega_0^2}{\omega_4^2} K_{(4)} = \boxed{0,4 \text{ J}}$

P 47 $\quad m = 0.75 \text{ kg}$

$L = 1.25 \text{ m}$



العمودي

$\tau = r \times F$

$= r F \sin\theta$

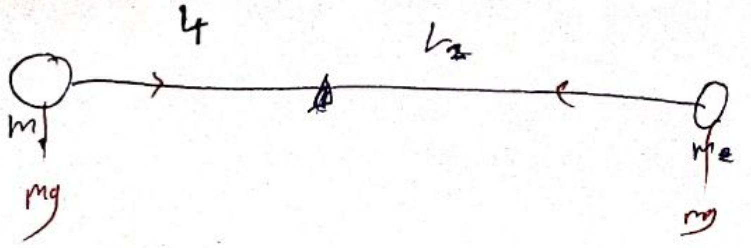
when $\theta = 0$, $180 \rightarrow \tau = 0$

τ (Taarqe gravitintional force)

$\tau = mgL\sin\theta = 4.6 \text{ N·m}$

P 34

P 56



$L_1 = 20$ cm

$L_2 = 80$ cm

$a_1 , a_2 = ??$

$a = \alpha r$
$V = r\omega$
$S = r\theta$

$a_1 = \alpha L_1$

$a_2 = \alpha L_2$

$\tau_{net} = I\alpha = (m_1 L_1^2 + m_2 L_2^2)\alpha$

$mgL_1 - mgL_2 = (m_1 L_1^2 + m_2 L_2^2)\alpha$

$\alpha = \boxed{}$

عوضي

P 23 $D = 1.2$ $r = 0.6$ $\omega_0 = 200$ rev/min

(A) $\omega_0 = \frac{200 \text{ rev} \times 2\pi}{60} = \boxed{20.9 \text{ rad/sec}}$

(B) $V = \omega_0 r = 20.9(.6) = \boxed{12.5 \text{ m/s}}$

(C) $\omega = 1000$ rev/min , $t = 1$ min

مشابهة مع 12

$\omega = \omega_0 + \alpha t$

$1000 = 200 + \alpha(1) \longrightarrow \boxed{\alpha = 800 \text{ rev/min}^2}$

(D) $\theta_0 = .5(\omega_0 + \omega)t$

$\Delta\theta = .5(200 + 1000)(1) \longrightarrow \boxed{\Delta\theta = 600 \text{ rev}}$

End ch10

Good Luck

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