Chapter 8 : (Potential energy and conservation of energy).

→ In chapter 7 :-

F const → $W = \vec{F} \cdot \vec{d}$

F non-const → $W = \int_{x_i}^{x_f} F(x)\, dx$.

$W_{net} = \Delta k$.

8.1 → Potential energy (u).

$\Delta u = u_2 - u_1$.

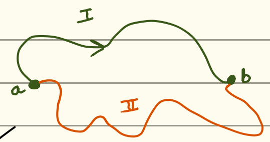
$\Delta u = -W$ ⇒ 1. Isolated system
2. Conservative forces. } شروط.

* force → conservative.
→ non-conservative.

* Conservative force :-

– work does not depend on the path.

– work net on close path = zero.



$W_I = -W_{II}$.

* non - Conservative force :-

– work depend on the path. → k. friction. , Drag force.

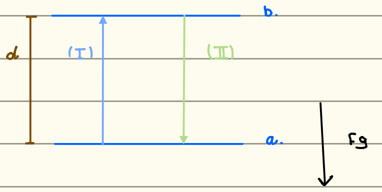
* Gravitational force :-

$W_I = -mgd$

$W_{II} = mgd$.

$W_{net} = 0$.

∴ conservative force.



→ $W = \int_{x_i}^{x_f} F(x)\, dx$

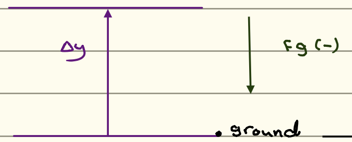
$\Delta u = -W = \int_{x_f}^{x_i} F(x)\, dx$ → $u_2 - u_1 = -\int_{x_i}^{x_f} F(x)\, dx$.

Case I :- Gravitational force.

$\Delta u = -\int_{y_i}^{y_f} F(y)\, dy$.

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

$= mg \int_{y_i}^{y_f} dy$ → $\Delta u = mg(y_f - y_i)$.



→ $y_i = 0$

نقطة الرجوع.

$u = 0$

Case II : spring force.

$F_s = -kx$ (Hook's law).

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

$W_a = -W_s$ } → From chapter 7

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

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

$\Delta u = \frac{1}{2}k(x_f^2 - x_i^2)$ → $\Delta u = -W_s$

8.2 → conservation of mechanical energy. (E)

$E = k + u$

- Isolated [no external force]
- conservative forces.

→ E_{mec} = conserved

$W = \Delta k$

$W = -\Delta u$

$\Rightarrow \Delta k = -\Delta u$

$\therefore k_f - k_i = -(u_f - u_i)$

$k_f + u_f = k_i + u_i$

$E_f = E_i \longrightarrow \Delta E = 0.$

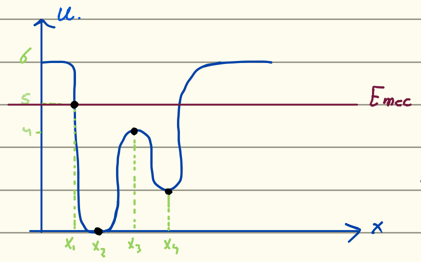
8.3 → Reading a potential energy curve.

$\Delta u(x) = -W \quad , \quad W = F(x) \cdot \Delta x$

$\therefore \Delta u(x) = -F(x) \cdot \Delta x$

$F(x) = \dfrac{-\Delta u}{\Delta x} \longrightarrow$

$= \dfrac{-d\,u(x)}{dx} \longrightarrow$ لو كان التغير صغير



$* \; E = k(x) + u(x) \longrightarrow \underline{\underline{const}}$

ثابتة دائما.

$E_{mec} = 5J.$

*** turning Point :-** النقطة الي عندها كل ال Potential energy

ل mec. energy

$\hookrightarrow E_{mec} = u(x) \quad , \quad k(x) = 0.$

* بالنسبة للمنحنى الي موجود عند x_1 بكونه في عندي turning Point

لانو ال $u(x) = E_{mec} \Leftarrow \underline{\underline{V = 0}}$

← يعني لحابدي أطلع ال turning بتكونه عبارة عن نقاط التقاطع مفتي u

وخط ال Emec. ⇐ والسرعة راح تساوي صفر.

*** Equilibrium Points :-** → نقطة الاتزان.

$\vec{F}_{net} = 0 \quad , \quad F = \dfrac{-du}{dx}$

↳ slope (u-x).

$\boxed{\Delta u = 0}$

if $\vec{F} = 0$, slope $= 0$

* بالنسبة للمنحنى الي موجود عند x_2, x_3, x_4 بكونه في عندي

equilibrium Point لانو ال slope بكونه بساوي صفر.

*** 1. Stable Eq. Point :-**

↳ النقطة الي بحب الجسم يتحرك حوليها، يعني بفضل

الجسم يمشي بهاد الموقع. زي (x_2, x_4) ⋁

↳ local min

2. un-Stable Eq. Point :-

↳ النقطة الي جسم بفضل يتجاوزها بسرعة

زي x_3 ⋀ ← local Mas

Ex :- $u(x,y) = x^2 y + 2x$

$F_x = \frac{-du}{dx} \longrightarrow -(2xy + 2)$, y ثابت

$F_y = \frac{-du}{dy} \longrightarrow -(x^2 + 0)$, x ثابت

$\Rightarrow \vec{F} = -(2xy+2)\hat{i} - (x^2)\hat{j}$.

8.4 → work done on a system by an external force .

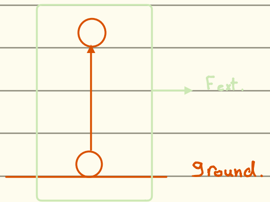
work :- is energy transferred to or from the system when external force acts on that system.

* non - Isolated system. (F external).

→ No Fricition. (conservative force).

→ Fricition. (non - conservative force).

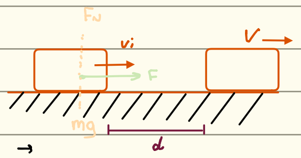
Case I :- Non - Isolated system / without fricition force .



$W = \Delta E_{mec}$, $\Delta E \neq 0$.

$= \Delta K + \Delta U$

Case II :- Non - Isolated system / with fricition force.



* $\vec{F}_{net} = ma$

$F - f_k = m\vec{a}$ 1

* $v_f^2 = v_i^2 + 2ad$

$a = \frac{v_f^2 - v_i^2}{2d}$ 2

$\therefore Fd = \underbrace{\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2}_{\Delta K} + f_k d.$

$\therefore Fd = \Delta K = f_k d$, $U = 0$

$Fd = \Delta E_{mec} + f_k d$ → ΔE_{th} → thermal energy

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

8.5 → conservation of energy.

$W = \Delta E_{mec} + \Delta E_{th} + \cancel{\Delta E_{int}}^{\,0}$

→ Isolated system :- / Fricition.

$W = 0$

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

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

* Power = [watt]

$P_{inst} = \frac{dE}{dt}$

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

Chapter 9 :- (center mass , linear momentum).

الزخم . بيا لمركز الكتلة .

9.1 → center of mass

→ ١. عبارة عن نقطة بتتركز عندها الكتلة للجسم أو النظام .

٢. محصلة القوى للسستيم بتكون بهاي النقطة .

is the point that moves as though , all of the system's mass concentrated there , and all external forces applied there . (Physical meaning .)

two cases
- → System of Particles . (مجموعة من الأجسام)
- → Rigid (solid bodies . (أجسام صلبة .)

Case I : system of particles :-

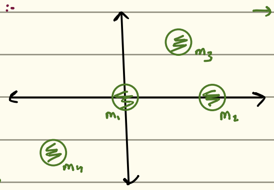
كيف بطلع المركز للكتلة ؟

١. بطلع الـ x_{com} لحال .

2. بطلع الـ y_{com} لحال .

3. بطلع الـ z_{com} لحال . (إذا في)

4. بكتب الجواب اللي طلع معي على شكل vectors



→ كلا جسم إلى كتلة وإحداثي سيني وصادي .

$$x_{com} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3 + \dots + m_n x_n}{m_1 + m_2 + m_3 + \dots + m_n}$$

$$= \frac{1}{M} \sum_{i=1}^{n} m_i x_i$$

total Max ← M

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

$$z_{com} = \frac{1}{M} \sum_{i=1}^{n} m_i z_i$$

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

$$= \frac{1}{M} \sum_{i=1}^{n} m_i \vec{r}_i .$$

Case II : Solid bodies (Rigid) .

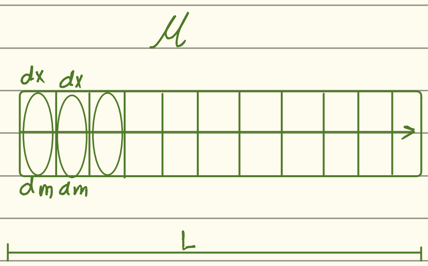
$$x_{com} = \frac{1}{M} \int x\, dm$$

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

لم بجوها عشان أقدر أكامل .

$$y_{com} = \frac{1}{M} \int y\, dm$$

$$z_{com} = \frac{1}{M} \int z\, dm$$



uniform . $\Rightarrow \lambda$ (constant) .

← قيمتها بالشكل المنتظم بتكون ثابته ،

لم الجسم بكون منتظم اذا لما أقسم الـ $\frac{dm}{dx}$ ← أو dz , dy .
للقطعة الأولى تساوي نفس قيمه باقي
القطع ، وكمان أقسم $\frac{M}{L}$ ← بيعطي
نفس الجواب

$$\frac{dm}{dx} = \frac{M}{L} = \lambda \text{ (linear dencitey .)}$$

كثافة خطية .

لم قديه عندي كتله في وحدة طول .

* مهم جداً :-

١. اذا كانه الجسم في بعد واحد (1D) :- $dm = \lambda\, dx$ ⇐ غالباً بس هاي راح استخدم .

$\frac{M}{L.}$ = uniform

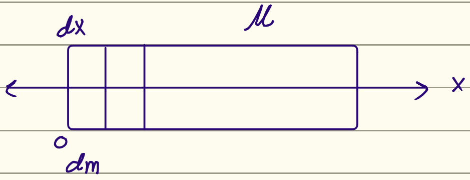
2. اذا كانه الجسم في بعدين (2D) :- $dm = \sigma\, dA$

$\frac{M}{A}$ = surface density

3. اذا كانه الجسم في ٣ أبعاد (3D) :- $dm = \rho\, dV$

$\frac{M}{V}$ = Volume density (كثافة حجمية)

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



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

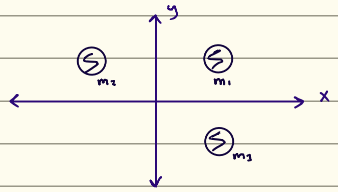
$\Rightarrow X_{com} = \frac{1}{M}\int_0^L x\left(\frac{M}{L}\right)dx$

$= \frac{1}{L}\int_0^L x\,dx \longrightarrow \left.\frac{x^2}{2L}\right|_0^L = \frac{L}{2} \rightarrow$ uniform rod $\Rightarrow$ دائماً مركز الكتلة بكونه بالوسط.

9.2 → Newton's 2nd law for system of Particles :-

$F_{net} = M\vec{a}_{com}$

الكتلة الكلية.



$\vec{r}_{com} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2 + \dots + m_n\vec{r}_n}{M}$

$M\vec{r}_{com} = m_1\vec{r}_1 + m_2\vec{r}_2 + \dots + m_n\vec{r}_n$ / أشتقه بالنسبة للزمن.

$M\vec{V}_{com} = m_1\vec{V}_1 + m_2\vec{V}_2 + \dots + m_n\vec{V}_n$ / وأشتقه

$M\vec{a}_{com} = \underbrace{m_1\vec{a}_1}_{F_1} + \underbrace{m_2\vec{a}_2}_{F_2} + \dots + \underbrace{m_n\vec{a}_n}_{F_n}$

$\vec{F}_{net} = M\vec{a}_{com}$. $\Rightarrow$ بستعملو لما تكون الكتلة ثابتة.

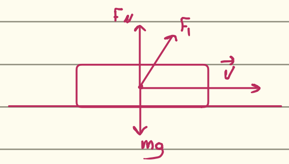
9.3 → linear momentum ($\vec{P}$) "زخم خطي"

$\vec{P} = m\vec{v}$

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

$\frac{d\vec{P}}{dt} = F_{net}$.

newton's 2nd law



$\vec{F}_{net} = \frac{d\vec{P}}{dt}$, $\vec{P} = m\vec{v}$ → صار القانون الأصلي لنيوتن بزبط سواء كتلة ثابتة أو متغيرة

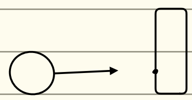
$= \frac{d(mv)}{dt} = m\frac{dv}{dt} + v\frac{dm}{dt}$

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

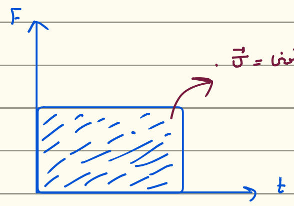
$\therefore \vec{F}_{net} = m\frac{dv}{dt} = m\vec{a}$

9.4 → Collsion and impluse :-

التصادم الدفع



* Impluse ($\vec{J}$) = $F_{avg} \cdot \Delta t$
  $\vec{F} \Rightarrow$ constant "شرط".
* $\vec{J} = \int_{t_i}^{t_f} F(t)\,dt \rightarrow \vec{F} \rightarrow$ not constant. "depends on time".



التكامل = المساحة تحت المنحنى = $\vec{J}$.

$* \ \vec{J} = \Delta\vec{P}$

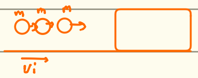
$= m\Delta\vec{V}$

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

$\therefore \ \vec{J} = F_{avg} \cdot \Delta t = \Delta\vec{P} = m(\vec{V}_f - \vec{V}_i).$ constant

$\vec{J} = \int F dt = \Delta\vec{P}$ not constant

* special case :-



لما يكون في مجموعة أجسام ⇐

بدها تصدم بجسم :-

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

n: # of particles.

ΔP : change in linear momentum of 1- particle.

$* \ J = -n\Delta P = -nm\Delta V$

$F_{avg}\Delta t = -nm\Delta V$

$$F_{avg} = \frac{-nm\Delta V}{\Delta t}$$

9.5 → Conservation of linear momentum.

* From Newton's 2nd law.

$\vec{F}_{net} = \frac{d\vec{P}}{dt}$, $\vec{P}$ is conserved.

if $\Delta\vec{P} = 0$

معزول.

$\therefore \ \vec{P}$ is conserved $(\Delta\vec{P} = 0)$, if the system is Isolated and close

$\Delta\vec{P} = 0$

$\vec{P}_f - \vec{P}_i = 0$

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

* Isolated system

$\Delta\vec{P} = 0 \Rightarrow \vec{P}_f = \vec{P}_i$

$\vec{P}_{ix} = \vec{P}_{fx}$ $\quad$ $\vec{P}_{iy} = \vec{P}_{fy}$

9.6 → momentum and kientic energy in collsions :-

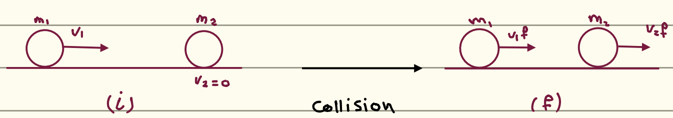
* types of collisions :-

1. elastic collision . مرنة → $\Delta\vec{P} = 0$, $\Delta K = 0$
2. inelastic collision . غير مرنة → $\Delta\vec{P} = 0$, $\Delta K \neq 0$
3. compeletly inelastic collision . عديم المرونة → $\Delta\vec{P} = 0$, $\Delta K \neq 0$

1. elastic collision :-

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

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



→ if $m_1 = m_2 \Rightarrow v_{1f} = 0$

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

$\therefore \ V_{2f} = v_{1i}$

لـ يعني الساكنة تتحرك بسرعة الأولى

والمتحرك يسكن.

$* \ m_1 v_{1i} + m_2 \cancel{v_{2i}}^{\,0} = m_1 v_{1f} + m_2 v_{2f}$

$m_1 v_{1i} = m_1 v_{1f} + m_2 v_{2f} \quad \dots \underline{1}$

$* \ \frac{1}{2} m v_{1i}^2 = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2 \quad \dots \underline{2}$

↳ find v_{2f} from equ $\underline{1}$, subsitute in equ $\underline{2}$

$v_{1f} = \frac{m_1 - m_2}{m_1+m_2} v_{1i}$, $\quad v_{2f} = \frac{2m_1}{m_1+m_2} v_{1i}$ ⇒ شرط حدوث المعادلتين انو يكون في جسم بيتحرك قبل التصادم والجسم الأخر ساكن.

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

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

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

→ أساسيات.

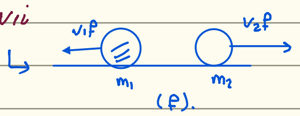
case I :- $(m_1 = m_2)$

$v_{1f} = 0$

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

Cas II :- massive target $(m_2 >> m_1)$. , neglect m_1

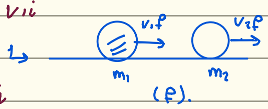
$v_{1f} \simeq \frac{-m_2}{m_2} v_{1i} = -v_{1i}$



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

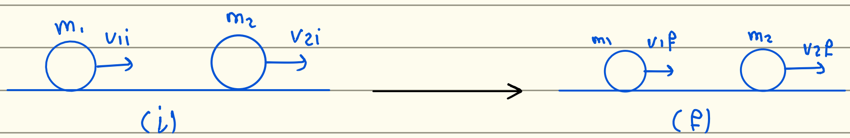
case III :- massive Projectile $(m_1 >> m_2)$.

$v_{1f} \simeq \frac{m_1}{m_1} v_{1i} = v_{1i}$



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

* moving target



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

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

* $k_i = k_f$

$\frac{1}{2} m_1 v_{1i}^2 + \frac{1}{2} m_2 v_{2i}^2 = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2$.

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

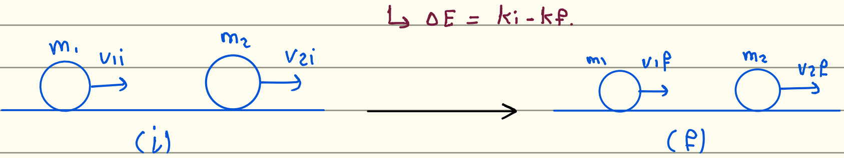
$$v_{2f} = \frac{2m_1 v_{1i}}{m_1 + m_2} + \frac{m_2 - m_1}{m_1 + m_2} v_{2i}.$$

2. Inelastic collision :-

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

$k_i \neq k_f$ → بسبب وجود ضياع للطاقة

↳ $\Delta E = k_i - k_f$.



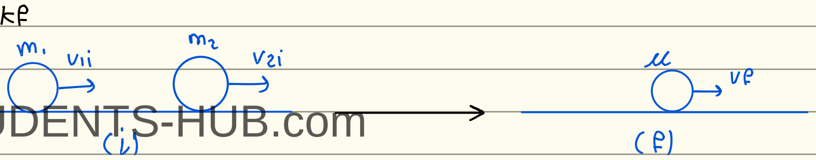
* $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$. 1

$\Delta E = (\frac{1}{2} m_1 v_{1i}^2 + \frac{1}{2} m_2 v_{2i}^2) - (\frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2)$.

3. Compeletly inelastic collision :-

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

$k_i \neq k_f$

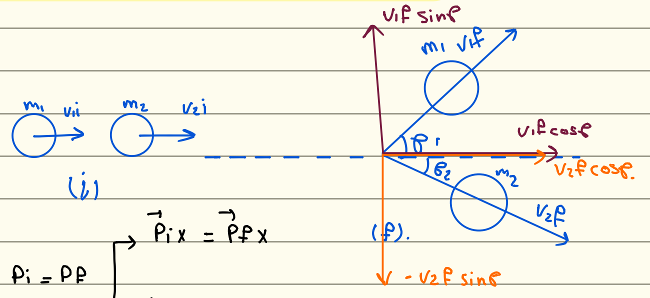


, $M (m_1 + m_2)$

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

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

9.8 → Collisions in two dimensions.



$P_i = P_f$
- $\vec{P}_{ix} = \vec{P}_{fx}$
- $\vec{P}_{iy} = \vec{P}_{fy}$

$P_x \rightarrow \quad m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} \cos\theta + m_2 v_{2f} \sin\theta.$

$P_y \rightarrow \quad 0 = m_1 v_{1f} \sin\theta + m_2 v_{2f} \cos\theta.$

$\vec{P}_{net} = \sqrt{(P_x)^2 + (P_y)^2}.$

$\tan\theta = \frac{P_y}{P_x}.$

9.9 → Systems with varying mass : A Rocket.

- The first rocket equation :- . معادلة الصاروخ الأولى

$R v_{rel} = Ma$ → Force. = Thrust (قوة دفع)

R is the mass rate of fuel consumption. $= \frac{dm}{dt}$. // "قديه بزيد أو بنقص كتلة للجسم"

$v_{rel} \rightarrow$ سرعة نسبية.

- The second rocket equation :-

$v_f - v_i = v_{rel} \ln \frac{M_i}{M_f}.$

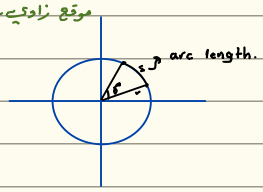
سرعة الغاز بالنسبة للصاروخ

Chapter 10 :- (Rotational variables).

1. Angular position (θ) :- موقع زاوي.

$\theta = \frac{s}{r}$ $[\theta] = rad.$

2π rad = 1 rev.



2. Angular displacement ($\Delta\vec{\theta}$) .إزاحة زاوية

$\Delta\vec{\theta} = \vec{\theta}_2 - \vec{\theta}_1$, $[\Delta\theta] = rad.$

Clock wise $\Rightarrow$ $\Delta\theta$ is negative. (-) .

Counter clock wise $\Rightarrow$ $\Delta\theta$ is Positive. (+).

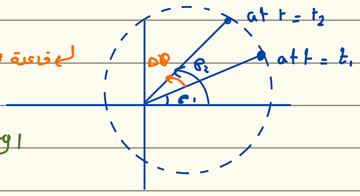
3. Angular velocity (ω_{avg}) .سرعة زاوية

$\vec{\omega}_{avg} = \frac{\Delta\vec{\theta}}{\Delta t} \rightarrow \frac{\vec{\theta}_2 - \vec{\theta}_1}{t_2 - t_1}$, $[\omega] = rad/sec$

لقاعدة اليد اليمنى ← بلف ايدي مع حركة الجسم

اتجاه الابهام بكون اتجاه «ω»

$\Rightarrow$ angular speed = |angular velocity|



4. Angular acceleration (α_{avg}) .تسارع زاوي

$\alpha_{avg} = \frac{\Delta\omega}{\Delta t} \rightarrow \frac{\omega_2 - \omega_1}{t_2 - t_1}$, $[\alpha] = rad/sec^2$

* $\theta(t) \xrightarrow{\frac{d\theta}{dt}} \omega(t) \xrightarrow{\frac{d\omega}{dt}} \alpha(t)$ $\Rightarrow$ اذا بدي عند زمن معين وقتها بشتق.

$\theta(t) \rightarrow$ Instantaneous angular Position.

$\omega(t) \rightarrow$ Instantaneous angular Velocity.

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

* Rotation motion at constant α :-

$\omega_f = \omega_i + \alpha t.$

$\omega_f^2 = \omega_i^2 + 2\alpha\,\Delta\theta.$

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

translation Rotation

$x, v, a \xleftrightarrow{?} \theta, \omega, \alpha$

$s = r\theta$ / اشتق

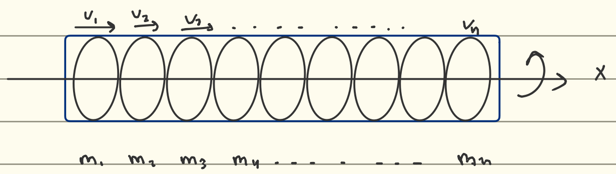
$\frac{ds}{dt} = r\frac{d\theta}{dt} \Rightarrow v = r\omega$

$\frac{d^2s}{dt^2} = r\frac{d^2\theta}{dt^2} \Rightarrow a = r\alpha$

* kientic energy (K.E) in Rotation :-

$K.E = \sum_{i=1}^{n} \frac{1}{2} m_i v_i^2$

$\hookrightarrow v_i = r_i \omega_i$



$\Rightarrow K.E = \sum_{i=1}^{n} \frac{1}{2} m_i (r_i \omega_i)^2$

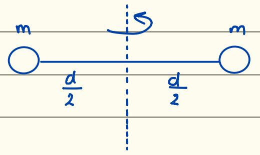
$= \frac{1}{2} \sum_{i=1}^{n} (m_i r_i^2) \omega_i^2$

$\hookrightarrow$ Intria (I). ممانعة دورانية.

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

Inertia (I) :-

Case I :- * (rotational axis through the center of mass.

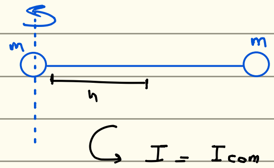


$I_{com} = \Sigma m_i r_i^2$

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

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

* (rotational axis through a part from the center of mass.



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

total mass

distance bt center of mass and rolational axis.

center of mass. المسافة بين محور الدورانة وال

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

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

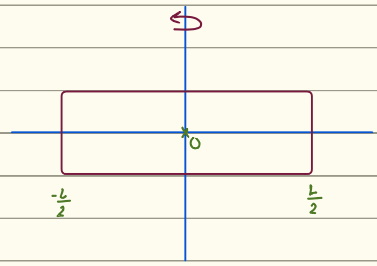
$= md^2.$

or نحسب كل جسم لحال . لنه هلأ اني احنا

كل جسم بحلق وبعيد عن محور الدورانة

$\Rightarrow m(0) + m(d)^2 = md^2$

Case II :- rigid body (solid).



$I = \int r^2 dm$

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

$\therefore I \int_{-\frac{L}{2}}^{\frac{L}{2}} x^2 \frac{m}{L} dx \longrightarrow \frac{1}{12} ML^2$

* $I_{rod} = \frac{1}{12} ML^2$ → شرطها محور الدورانة

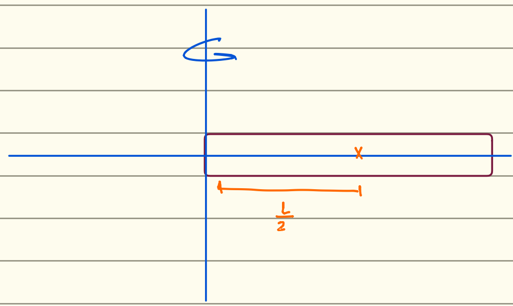
في ال cof

Parrallel-axis theorem.

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

$= \frac{1}{12} ML^2 + M(\frac{L}{2})^2$

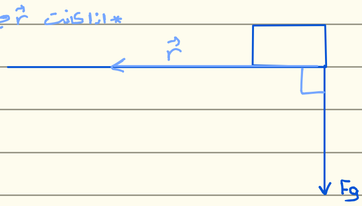
$= \frac{ML^2}{3}$



Tourge :- $(\vec{\tau}) \Rightarrow \vec{\tau} = \vec{r} \times \vec{F}.$

$= |\vec{r}|\,|\vec{F}| \sin\theta.$

*اذا كانت $\vec{r}$ جاي بزاوية باخد فقط العمودية للقوة.



$[\tau] = N.m$

* Newton's second law :- $\Rightarrow \vec{F}_{net} = M\vec{a}.$

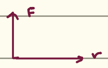
$\vec{\tau}_{net} = I\vec{\alpha}$

$\vec{\tau}_{net}$ → net tourge

I → inertia.

α → angular accelertion.

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



← عشان الاتجاه بحط اصابعي باتجاه

$\vec{r}$ وبعدها بمشي بعند F راتجاه

الإبهام بكونه اتجاه ال τ.

the last part in chapter 10 :-

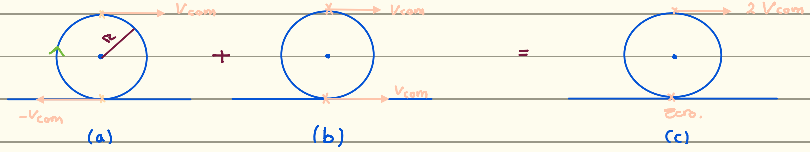
* $W_{net} = \Delta K \longrightarrow K = \frac{1}{2} I \omega^2$

$W = \int_{\theta_i}^{\theta_f} \tau \, d\theta$

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

* Power $\Rightarrow \vec{P} = \frac{dW}{dt} = \vec{\tau} \cdot \vec{\omega}$

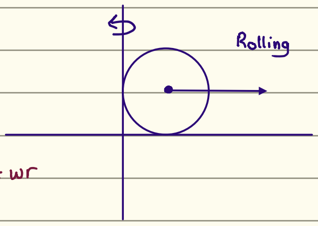
* Rolling: translation + Rotation.



(a) (b) (c)

Pure - rotation. Pure - translation. Rolling.

→ $V_{com} = R\omega$. angular velocity



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

$I_P = I_{com} + M r^2$

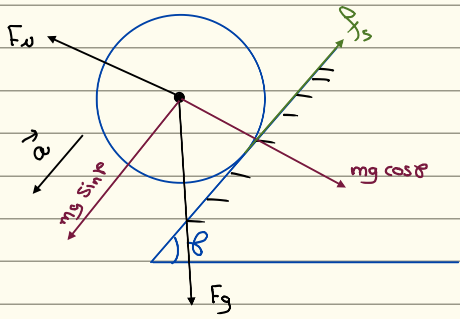
$\therefore K = \frac{1}{2} I_{com} \omega^2 + \frac{1}{2} M \underbrace{r^2 \omega^2}$ → $v = \omega r$

$\therefore K = \frac{1}{2} I_{com} \omega^2 + \frac{1}{2} V^2$.

∴ K.E rolling = K.E rotation + K.E translation.

* 2^{nd} law of newton

أصعب مس.



- translation

$F_{net} = ma$

$F_y = 0$

$F_x = ma$

$mg \sin\theta - f_s = ma$ 1

- rotation

$\vec{\tau}_{net} = I\alpha$

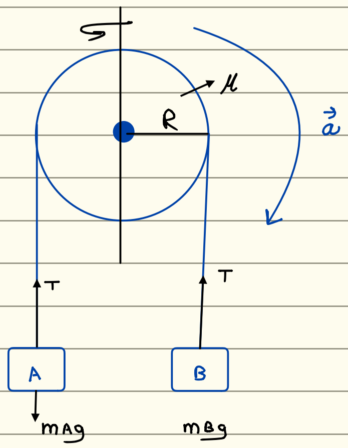
$\vec{\tau} = \vec{r} \times \vec{F}$; f_g, f_N → have no tourge

$R f_s = I\alpha$ .... 2 , $a = r\alpha$.

$R f_s = I\left(\frac{a}{R}\right)$

* $a_{cm} = \dfrac{-g \sin\theta}{1 + I_{com}/MR^2}$

$f_s = \dfrac{I_{com}\,\alpha}{R} = \dfrac{I_{com}\,a_{com}}{R^2}$



$F_{net} = ma$

$T - m_A g = (m_A) a$

$m_B g - T = (m_B) a$

* $\vec{\tau}_{net} = I\alpha$

$TR = I\alpha$, $a = R\alpha$.

Section 4: (Torque Revisited).

$|\tau| = rF\sin\theta$

$\vec{\tau} = \vec{r} \times \vec{F} \Rightarrow$ الأعم.

$\vec{l} = \vec{r} \times \vec{P} \Rightarrow$ $\underline{\underline{11.5}}$

$= m\vec{r}\vec{v} \Rightarrow$ Angular Momentum