اسألني عن الهندسة 2020

أهل الهمة

Physics 101

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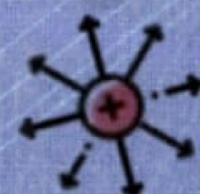
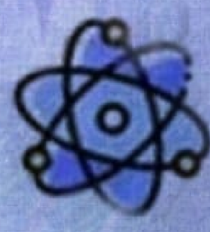
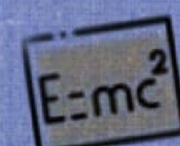






How to study physics:

١- احتفظ بالطابع الإيجابي عن الفيزياء

positive attitued

٢- تعلم المفاهيم وليس حفظ القوانين

٣- حل الكثير من المشكلات

٤- اعمل تجارب

كميات

* ch.1 : units, physical quantities and vectors :-

physical Quantities :-

should be done by victor addition

كميات قياسية

Scalers — can be added using simple algebra

Vectors — cannot be added by simple algebra

phys. qua. that can be fully described by magnitude only (مقدار) with appropriate unit (وحدة مناسبة) (no direction) (دون اتجاه)

[mass, length, time, distance, volume, temperature, electric potential]

V, T, speed

phys. qua. that are fully described by magnitude (مقدار) and direction (اتجاه)

[velocity $\vec{v}$ (سرعة), acceleration $\vec{a}$ (تسارع), force $\vec{F}$ (قوة), weight $\vec{F_g}$ (وزن), electric feel $\vec{E}$, displacement $\Delta\vec{r}$ (ازاحة)]

any victor can be described by $\vec{A} = A$ (الإزاحة متجهة والمسافة قياسية) #

mag of $\vec{A} \equiv |\vec{A}| \equiv A$ # لما يكون بين القيمة المطلقة بكون فقط مقدار دون اتجاه

* 1.7 vectors and victor addition :-

* cordinate system :- (الديكارتي) نظام نستخدم لوصف أي شيء بالكون — موقع

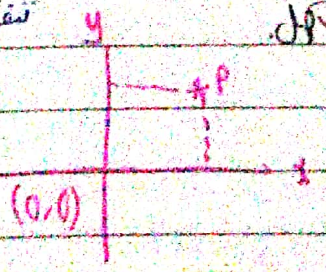
system of coordinates used to define / describe a location in space.

⇒ 2D ⇒ Cartesian C. sys (coodinate system)

plane polar C. syst

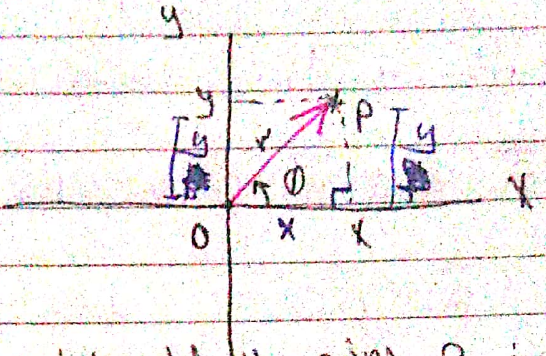
* Cartesian coordinat system. [rectangular]

2 perpendicular (⊥) (عمودي) axis (محور) intersect (تتقاطع) at a point defined as origin (نقطة الاصل) (0,0)



* plan polar coordinate . sys.

2 Coordinates (r, θ)



r = distance between the origin add the point P in space.

θ = the (زاوية) angle (مقاس) measured between aline fixed (ثابت) in space and the Line between the origin and point P

often chosen as the x-axis and θ is often measured as a C.C.W (عكس الدوران) w.r.t +ve x-axis. (بالنسبة)

* +ve positive
* -ve negative
* C.C.W Counter clockwise عكس عقارب
* w.r.t with respect to

① $\cos\theta = \frac{x}{r} \rightarrow x = r\cos\theta$

② $\sin\theta = \frac{y}{r} \rightarrow y = r\sin\theta$

③ $\tan\theta = \frac{y}{x}$

$r = \sqrt{x^2 + y^2}$

$\theta = \tan^{-1}\left(\frac{y}{x}\right)$

حسب الربعة في الحل

ملاحظات

* θ : measured C.C.W w.r.t the x-axis
* take care of ± signs (إشارات)

* Equality of 2 vectors ($\vec{A}$, $\vec{B}$)

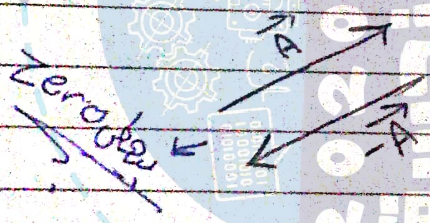
* $|\vec{A}| = |\vec{B}|$ $(A = B)$

* $\vec{A}$ and $\vec{B}$ point in the same direction

($\vec{A} \parallel \vec{B}$)   then $\vec{A} = \vec{B}$

المتجهات المتساوية لا يشترط ان تكون لها نفس البداية ولكن يشترط
نفس المقدار والاتجاه.

* negative of vectore $\vec{A} \equiv -\vec{A}$ = another vectore having same neuative (A) but in opposite direction $\equiv$ anew vectore when added to $\vec{A}$ given zero



Ch.1 »

* 1.7 vectors and vector addition.

* vector additions :-

Graphical method.
≡ head-to-Tail method.
≡ Polygon method.

* method of compounds [illegible]

* propertis of vector addition. 2 vectors $\vec{A}$ and $\vec{B}$

شرط جمع المتجهات ① نفس النوع
② نفس الوحدة.

1- vectors to be added must be of the same type to having same unit

2- $\vec{A} + \vec{B} = \vec{B} + \vec{A}$ v. add. is communitative (order is not important in vector added)

3- $(\vec{A} + \vec{B}) + \vec{C} = \vec{A} + (\vec{B} + \vec{C})$ " " $\Rightarrow$ assosiative

4- max $|\vec{A} + \vec{B}| = |\vec{A}| + |\vec{B}| = A + B$

min $|\vec{A} + \vec{B}| = |A - B|$

1st → First
2nd → second

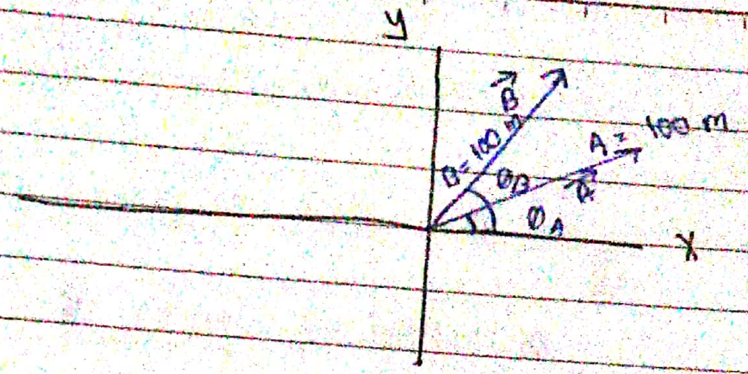
* v. add. by graphical method :-

1- Choose a conventional graph scale
□ cm → unit

2- draw the 1st vector $(\vec{A})$ using the chosen graph scale.

3- From the tip (head) of the 1st vector, draw 2nd vector $(\vec{B})$ using the same graph scale. (* so on)

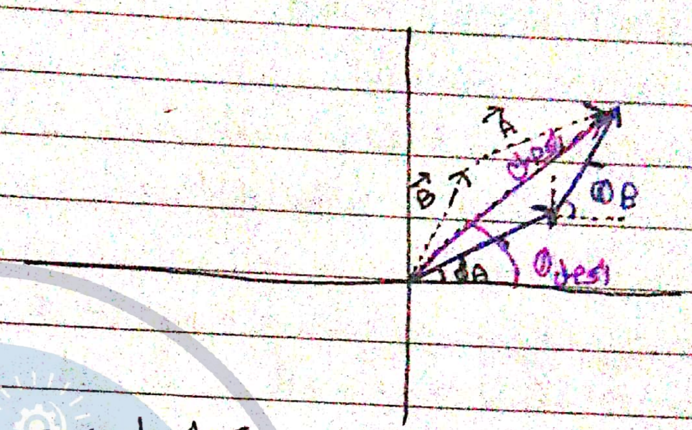
4- The resn that (≡ the sum) will be the vector that closes the polyon (pointing for the tail of 1st to the tip of the last vector)



① نحدد زاوية المتجه الأول ع الاحداثيات الاصليين

② نرسم المتجه بحسب طوله

③ نبدأ من نهاية الأول ونحدد الزاوية بحسب وهكذا نحدد الزاوية

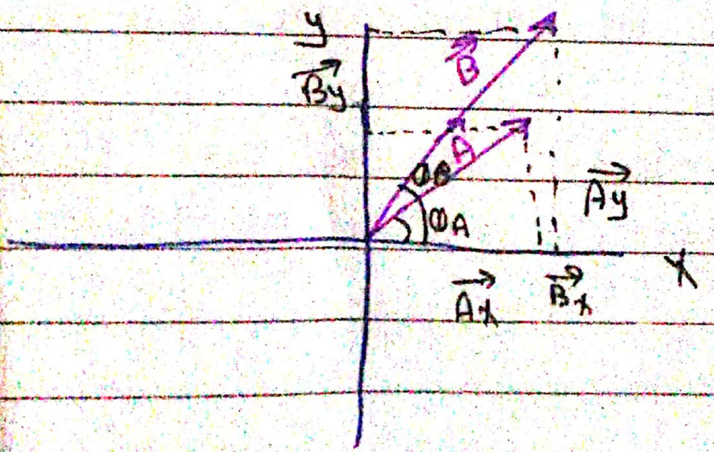


* لو بدأنا بالعكس يبقى الحاصل نفسه

magnitiode $= |\vec{A} + \vec{B}| =$ length * graph scale

*1.8 Components of a vectore and unit vectore :-

* Compounents of a vector ≡ rectangular compounents ≡ progections of the vectore along the coordinate axes



any vector in space can be describded by its components.

$$\vec{A} = \vec{A_x} + \vec{A_y}$$

θ: c.c.w w.r.t the x-axis

$|\vec{A_x}| = |\vec{A}| \cos\theta_A \Rightarrow A_x = A \cos\theta_A$

$A_y = A \sin\theta_A$

$\Downarrow$

$A = |\vec{A}| = \sqrt{A_x^2 + A_y^2}$

$\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)$

$\vec{A} = \vec{A_x} + \vec{A_y} + \vec{A_z}$ in 3D

$\vec{B} = \vec{B_x} + \vec{B_y} + \vec{B_z}$

* unit vectors :- dimension less (unit less) vector with magnitude exactly equals to 1 (one unit)

$\Rightarrow$ give direction only

* $\hat{i}, \hat{j}, \hat{K}$ unit vectors, mutually 1

$|\hat{i}| = |\hat{j}| = |\hat{K}| = 1$ $\hat{i} + \hat{j} + \hat{K}$

$\hat{i} \rightarrow$ points along the x-axis

$\hat{j} \rightarrow$ " " the y-axis

$\hat{K} \rightarrow$ " " the z-axis

$\Rightarrow$ Any vectore in space can be ~~described~~ described ① by its components ② by unit vectors :

$\vec{A} = \vec{A_x} + \vec{A_y} + \vec{A_z}$

$= A_x \hat{i} + A_y \hat{j} + A_z \hat{K}$

$\vec{B} = B_x \hat{i} + B_y \hat{j} + B_z \hat{K}$

* vectore addition by method of components

$\vec{A} + \vec{B} = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j} + (A_z + B_z)\hat{K}$

Ch.1 Phy. Quantities &

* 1.8 * 1.9 Components of vector & unit vectors

$\vec{A} * \vec{B}$

* addition of vectors by method of components

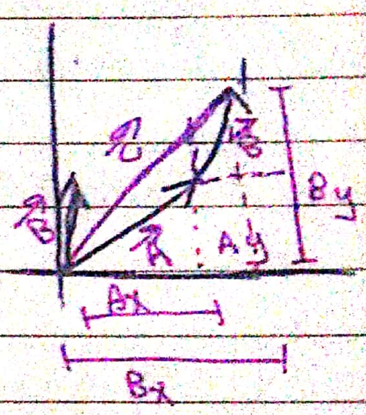
$\boxed{\text{in 2D}}$ if $\vec{A} = A_x \hat{i} + A_y \hat{j}$

$\vec{B} = B_x \hat{i} + B_y \hat{j}$

then $\vec{A} + \vec{B} = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j}$

$\vec{C} = \vec{A} + \vec{B} = C_x \hat{i} + C_y \hat{j}$

$|\vec{C}| = |\vec{A} + \vec{B}| = \sqrt{C_x^2 + C_y^2}$



$\theta_{\vec{C}} = \theta_{\vec{A}+\vec{B}} = \tan^{-1}\left(\frac{C_y}{C_x}\right)$

$\boxed{\text{in 3D}}$ if $\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{K}$

$\vec{B} = B_x \hat{i} + B_y \hat{j} + B_z \hat{K}$

$\vec{C} = \vec{A} + \vec{B} = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j} + (A_z + B_z)\hat{K}$

$|\vec{C}| = \sqrt{C_x^2 + C_y^2 + C_z^2}$

θ_x : angle between $\vec{C}$ and +ve x-axis measured C.C

$\cos\theta_x = \frac{C_x}{C} \Rightarrow \theta_x = \cos^{-1}\left(\frac{C_x}{C}\right)$

similarly for θ_y and θ_z

* Ch.1. physical Quantities

* vector subtraction
- by method of compounents.

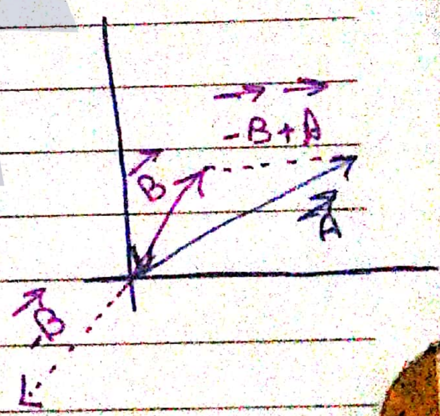
$$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$$

$$\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$$

$$\vec{A} - \vec{B} \equiv \vec{A} + (-\vec{B})$$

$$= (A_x - B_x)\hat{i} + (A_y - B_y)\hat{j} + (A_z - B_z)\hat{k}$$

graphically $\Rightarrow \vec{A} - \vec{B} = \vec{A} + (-\vec{B})$



* Multiplication of a vector by a scaler (m)

$m\vec{A}$

$m\vec{A} \equiv$ vectors

scaler   vector

if $m>0$ (موجبة) of magnitude $m|\vec{A}|$ and direction $\parallel \vec{A}$

$m<0$ (سالبة) → " " $|m||\vec{A}|$ and direction opposite to

* 1.6 Product of vector ≡ vector - vector multiplication

scaler product (Dot product) | vector product (cross product)

$\vec{A} \cdot \vec{B}$ ≡ scaler | $\vec{A} \times \vec{B}$ ≡ vector $= \vec{C}$

$\vec{A} \cdot \vec{B} = |\vec{A}|\,|\vec{B}| \cos\theta$

$= AB \cos\theta$

θ : angle between $\vec{A}$ & $\vec{B}$

$|\vec{C}| = |\vec{A} \times \vec{B}| = |\vec{A}|\,|\vec{B}| \sin\theta$

$= AB \sin\theta$

direct of $\vec{A} \times \vec{B}$ => By R.H.R

- allign you 4 figures along $\vec{A}$
- wrap the into $\vec{B}$ via the smaller angle

=> you upright thumb is along $\vec{C}$

scaler Product (Dot) | (cross) vector product

1- Communitative (order is not important)

$\vec{A} \cdot \vec{B} = \vec{B} \cdot \vec{A}$

2- $\vec{A} \cdot (\vec{B} + \vec{C}) = \vec{A} \cdot \vec{B} + \vec{A} \cdot \vec{C}$

توزيعي distributive

1- non - communitative

$\vec{A} \times \vec{B} \neq \vec{B} \times \vec{A}$

$\vec{A} \times \vec{B} = -(\vec{B} \times \vec{A})$

$|\vec{A} \times \vec{B}| = |\vec{B} \times \vec{A}|$

2- $\vec{A} \times (\vec{B} + \vec{C}) = \vec{A} \times \vec{B} + \vec{A} \times \vec{C}$

3- -ve sign is interchargable

$$-\vec{A}\cdot\vec{B} = \vec{A}\cdot-\vec{B} = -(\vec{A}\cdot\vec{B})$$

3- -ve sing is interchargable

$$-\vec{A}\times\vec{B} = \vec{A}\times-\vec{B} = -(\vec{A}\times\vec{B})$$

dot

1.10 E.g work done by a constant force ($\vec{F}$ is indep. of displacem)

$$W = \overrightarrow{Force}\cdot\overrightarrow{Displacement}$$

$$= \vec{F}\cdot\vec{Dr} = |\vec{F}||\vec{Dr}|\cos\theta$$

$[w] = [F] \cdot [Dr] = N.m = Joule = J$

Cross

Eg. $\overrightarrow{Tourque} = \vec{r}\times\vec{F}$

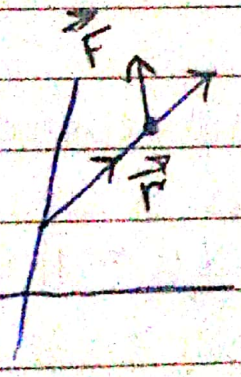
$$\vec{T} = \vec{r}\times\vec{F}$$

Tourque of $\vec{F}$ at point a distance r from the axis of rotation

$$|\vec{T}| = |\vec{r}||\vec{F}|\sin\theta$$

$$= rF\sin\theta$$

$[T] = N.M$



$\vec{T}\perp\vec{r}$

$\vec{T}\perp\vec{F}$

dot product | cross product

[4] if $\vec{A} \parallel \vec{B}$ $(\theta = 0) \Rightarrow \vec{A}\cdot\vec{B} = AB$

if $\vec{A}$ opposite to $\vec{B}$ $(\theta = 180^\circ)$

$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1$ $\quad \vec{A}\cdot\vec{B} = -AB$

[4] if $\vec{A} \parallel \vec{B}$ or anti parallel

$\hat{i}\times\hat{i} = \hat{k}\times\hat{k} = \hat{j}\times\hat{j} = 0$

$\Downarrow$

$\vec{A}\times\vec{B} = 0$

[5] if $\vec{A} \perp \vec{B}$ $\quad \cos 90^\circ = 0$

$\vec{A}\cdot\vec{B} = 0$

$\hat{i}\cdot\hat{j} = \hat{j}\cdot\hat{k} = \hat{k}\cdot\hat{i} = 0$

[5] if $\vec{A} \perp \vec{B}$ $\quad \sin 90 = 1$

$|\vec{A}\times\vec{B}| = AB$

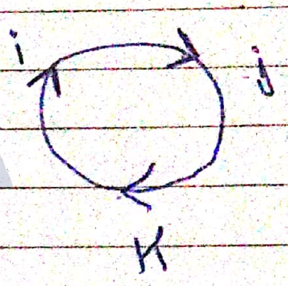
البسيطة

$\hat{i}\times\hat{j} = \hat{k}$

$\hat{j}\times\hat{k} = \hat{i}$

$\hat{k}\times\hat{i} = \hat{j}$

$\hat{j}\times\hat{i} = -\hat{k}$



الاشتقاق

[6] derivative of $\vec{A}\cdot\vec{B}$

$$\frac{d}{dt}\left(\vec{A}\cdot\vec{B}\right) = \vec{A}\cdot\frac{d\vec{B}}{dt} + \vec{B}\cdot\frac{d\vec{A}}{dt}$$

المشتقة الزمنية

(order is not important)

[6] derivative of $\vec{A}\times\vec{B}$

$$\frac{d}{dt}\left(\vec{A}\times\vec{B}\right) \equiv$$

(order is important)

$$\equiv \vec{A}\times\frac{d\vec{B}}{dt} + \frac{d\vec{A}}{dt}\times\vec{B}$$

[7] if $\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$

$* \ \vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$

$\vec{A}\cdot\vec{B} = (A_x\hat{i} + A_y\hat{j} + A_z\hat{k})\cdot(B_x\hat{i} + B_y\hat{j} + B_z\hat{k})$

$= A_xB_x + A_yB_y + A_zB_z = \text{scaler} \equiv AB\cos\phi$

$$\cos\phi = \frac{\vec{A}\cdot\vec{B}}{AB} = \frac{A_xB_x + A_yB_y + A_zB_z}{AB}$$

$\vec{A}\cdot\vec{A} = AA = A^2 = A_x^2 + A_y^2 + A_z^2$

$|\vec{A}| = A = \sqrt{A_x^2 + A_y^2 + A_z^2}$

Five Apple

$\boxed{7}$ $\vec{A} \times \vec{B} = \vec{C}$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$= \hat{i}(A_y B_z - A_z B_y) - \hat{j}(A_x B_z - B_x A_z) + \hat{k}(B_x A_y - A_x B_y)$

$C = \hat{i}\,[A_y B_z - A_z B_y]$ x y z
$+ \hat{j}\,[A_z B_x - A_x B_z]$
$+ \hat{k}\,[A_x B_y - A_y B_x]$

$= C_x\hat{i} + C_y\hat{j} + C_z\hat{k}$

Prob. 1.81   P. 55

$\vec{A}, \vec{B}$

$|\vec{A}| = 12m$

$|\vec{B}| = 12m$

$\vec{A} \cdot \vec{B} = 76\ m^2$

$|\vec{A} \times \vec{B}| = ??$

$\vec{A} \cdot \vec{B} = AB\cos\theta$

$\theta = \cos^{-1}\left[\frac{\vec{A} \cdot \vec{B}}{AB}\right]$

$\cos^{-1}\left[\frac{76\ m^2}{12m \times 12m}\right]$

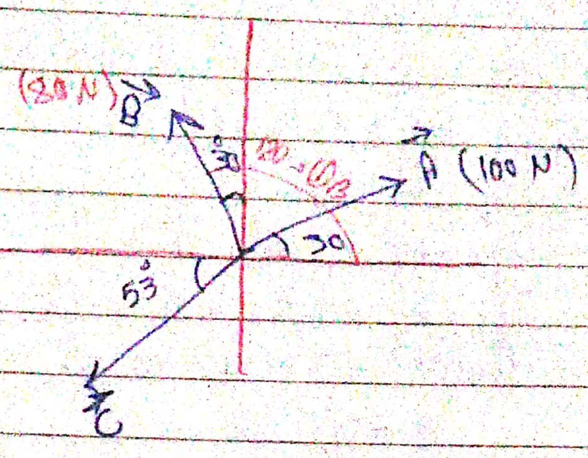
$\cos^{-1}\left[\frac{76}{144}\right]$ #

$= |\vec{A}| \times |\vec{B}| \times \sin\theta$

$|\vec{A} \times \vec{B}| = 12 \times 12 \times \sin\theta = \boxed{}\ m^2$

Prob 1.60 P, 54

Find $\vec{F}$



《Suggested Problems》

P.55 1.81

$|\vec{A}| = 12$ $\quad$ $\vec{A}\cdot\vec{B} = 76$

$|\vec{B}| = 12$ $\quad$ $\vec{A}\cdot\vec{B} = |B||A|\cos\theta$

$76 = 12 \times 12 \times \cos\theta$

$\cos\theta = 0.5$

$\theta = \cos^{-1}(0.5) = 60°$

$\vec{A}\times\vec{B} = |\vec{A}||\vec{B}|\sin 60$

$= 12 \times 12 \times .8$

$= 115.2 \; m^2$

1.60 P.59

$\vec{B} + \vec{A} + \vec{B} + \vec{C} = 0$

$A_x = A\cos\theta$ $\quad$ $A_y = A\sin\theta$

$= 100 \times .8$ $\quad$ $= 100 \times .5$

$= 80 \; m$ $\quad$ $= 50 \; m$

$B_x = B\cos\theta$ $\quad$ $B_y = B\sin\theta$

$= 80\cos 60$ $\quad$ $= 80 \times \sin 60$

$= -40$ $\quad$ $= 64$

$C_x = C\cos\theta$ $\quad C_y = C\sin\theta$

$= 40 \times \cos 53 \quad = 40 \sin 53$

$= -24 \quad = -32$

$\vec{R} = -(\vec{A} + \vec{B} + \vec{C})$

$\vec{R}_x = -(A_x + B_x + \vec{C}_x)\hat{j} \quad R_y = -(A_y + B_y + C_y)$

$\vec{R}_x = -(80 + -40 + -24). \quad = -(50 + 64 - 32)$

$= -16 \quad = -82$

$|\vec{R}| = \sqrt{(-16)^2 + (-82)^2} = 83.6 = 84$

* 1.43 p.53

(a) $\vec{A}\cdot\vec{B} = AB\cos\theta$

$= 8 \times 15 \times \cos\theta$

$= -96\, m^2$ *

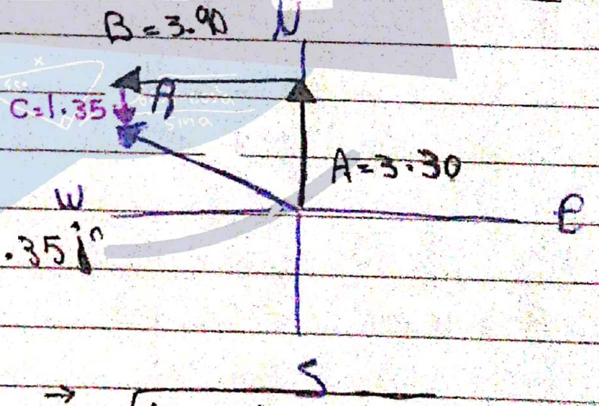
(b) $\vec{B}\cdot\vec{C} = BC\cos\theta$

$= 15 \times 12 \times \cos 145$

$= -96\, m^2$ *

(c) $\vec{A}\cdot\vec{C} = AC\cos\theta = 8 \times 12 \times \cos 65 = 38.4$ *

* 1.33 p.53



$\vec{R} = \vec{A} + \vec{B} + \vec{C}$

$= 3.30\hat{j} + 3.9\hat{j} + -1.35\hat{j}$

$= 1.95\hat{j} - 3.9\hat{i}$

$= -3.9\hat{i} + 1.95\hat{j}$

$\vec{R} = \sqrt{(3.9)^2 + (1.95)^2}$

$\theta = \tan^{-1}\left[\frac{1.95}{3.9}\right]$

* geometrical interpretation of dot product :-

$\vec{A}\cdot\vec{B} = A(B\cos\theta) = |\vec{A}| *$ Projection of $\vec{B}$ onto $\vec{A}$

$= B(A\cos\theta) = |\vec{B}| *$ Projection of $\vec{A}$ onto $\vec{B}$

* geometrical interpretation of vector product $\vec{A}\times\vec{B}$

$|\vec{A}\times\vec{B}| = AB\sin\theta = A(B\sin\theta)$

Ch.2 motion along a straight Lines-(in one dimention) ≡ 1D

بيوحاكه

* Motion ⇒ Continuous change of location of object

↓ translational

↓ rotational
about an axis

يدور حول محور ثابت
عجلة السيارة، مروحة
كل الأجسام، فتح الباب

↓ vibrational الحركة الاهتزازية / ذبذبية
* اهتزاز وطرق *
- بندول الساعة
- زنبرك

translational:
- 1D
  - a car moving along highway
  - Free fall
- 2D
  - Circular
  - projectile

Ch.2 ⇒ - translational motion
- in 1D
- Particle - model
↓
point like object

\# 2.1 position, Displacement and average velocity.

\# position :- the location of an object with respect to chosen referance point.
↓ origin

[vector quantity]
[position] = m

horezantal X ← اذا الحركة افقية *
vertical y ← اذا الحركة عمودية *

\# For motion in 1D
± signs indicate Direction

\+ → along +ve x-axis
\- → along -ve x-axis

-ve 0 +ve

+ve y
0
-ve y

in 2D ⟹ Position vector = $\vec{r} = x\hat{i} + y\hat{j}$

Displacement :- the change in particle's position in contain time interval.

$\Delta x = x_f - x_i$ motion along x

$\Delta y = y_f - y_i$ motion along y

- vector quantity
- $[\Delta x] = m.$

$\Delta x > 0 \rightarrow x_f > x_i$ motion along +ve

$< 0 \rightarrow x_f < x_i$ " " -ve x

$= 0 \rightarrow x_f = x_i$

in 2D # → $\Delta\vec{r} = \vec{r}_f - \vec{r}_i$

Distance :- vs. Displacement → change in position

$= \Delta x = x_f - x_i$

- vector
- +ve, -ve, zero

length of the path travelled

- scaler.
- always +ve no.

Distance ≠ $|\overrightarrow{displacement}|$

depend in initial & final position.

≠ $|\Delta\vec{x}|$ generally

$|\Delta\vec{x}|$ < distance generally

only if in 1D & no reverse.

$|\Delta\vec{x}|$ = distance

* Average velocity :-

≡ the displacement travelled by object per unit time.

$$V_x = V_{x_{avg}} = \frac{\overrightarrow{\text{displacement}}}{\text{time}}$$

$$V_{x_{avg}} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

Δt is along +ve

$\vec{V}_{x_{avg}} \parallel \Delta\vec{x}$

$V_{x_{avg}} > 0$ if $\Delta x > 0$ (moving along +ve x-axis)

- vector
- $[\vec{v}_x] = m/s$
  $= ms^{-1}$

+ve , -ve , zero

« السرعة المتوسطة المتجهة »

verage speed :- distance travelled per unit time

$$\text{speed} = \frac{\text{total distance}}{\text{total time}}$$

↓

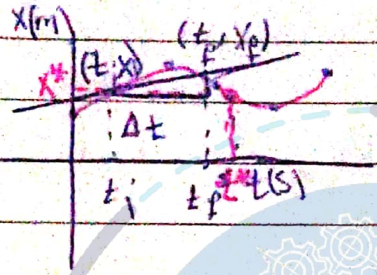
scaler ⇒ along +ve no.

Generally speed $\neq |\vec{V}_{x_{avg}}|$

* Ch2 . Motion in 1D

* 2.1 Position, Displacement and average velocity.

* Graphical representation of position (x versus t)
vs



* graphically average velocity

$$\bar{V}_x = \frac{\text{displacement}}{\text{time}} = \frac{\Delta X}{\Delta t}$$

$$= \frac{X_f - X_i}{t_f - t_i}$$

Inst.

2.2 Instantaneous velocity and instantaneous speed

* Inst. velocity . $\vec{V}$ → vector in 1D ($V > 0$ → along +ve x-axis, $V < 0$ → " -ve ")

the particle's velocity at certain instant of time.
vector

≡ the Limiting value of $\bar{V}_x$ as $\Delta t \to 0$

$$V_x = \lim_{\Delta t \to 0} \bar{V}_x = \lim_{\Delta t \to 0} \frac{\Delta X}{\Delta t} \equiv 1\text{st } t.\text{ derivation of } x$$

" " " = Position w.r.t time.

≡ the slope of the tangent to x-t ___ at instant (of x-t wre)

Inst. speed

≡ magnitude of Inst. velocity

$$\text{speed} = |\overrightarrow{\text{inst. velocity}}|$$
$$= |v_x|$$

2.3 Average to Inst. Acceleration.

Average Acc.

the time rate of the changes in velocity.

$$\vec{a}_x = \vec{a}_{x\,avg} = \frac{\Delta \vec{v}}{\Delta t}$$

vector quality. $[a] = \frac{m/s}{s} = m/s^2 = m s^{-2}$

inst. acc.

the acc. of the partical at certain instent of t

≡ the Limiting value of avg. acc.

$$\vec{a}_x = \lim_{\Delta t \to 0} \vec{a}_x = \lim \frac{\Delta \vec{v}}{\Delta t} \; \frac{\Delta x}{\Delta t} = \text{1st t. derivative of velocity}$$

$$\frac{d^2x}{dt^2} = \text{2nd t. deriviation of } x$$

2.3.3 - Average and Inst. Acc

* Graphical represenation of $x-t$ and $v-t$

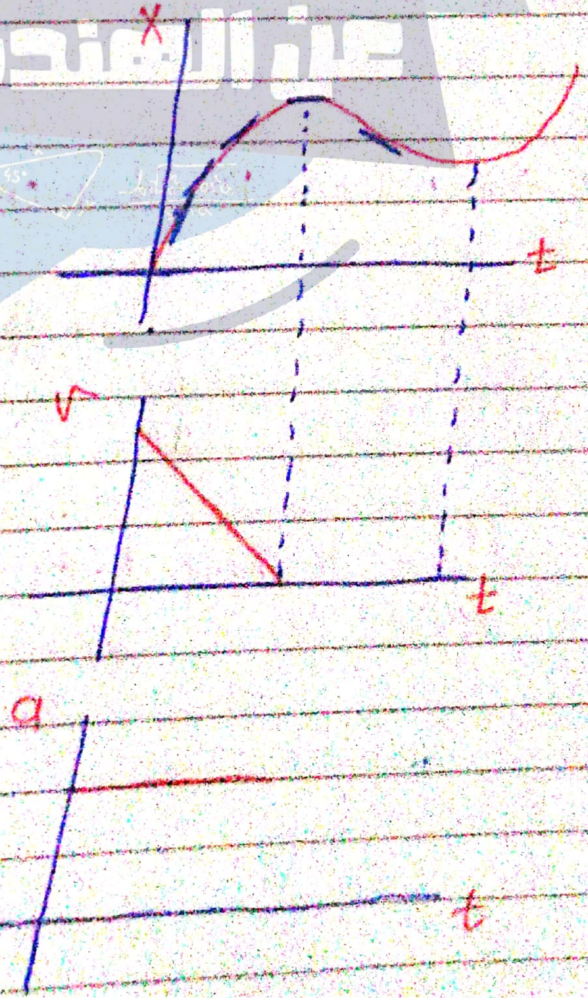
$$v_x = \frac{dx}{dt} = \text{slope of } x\text{-}t \text{ curve}$$

$$a_x = \frac{dv_x}{dt} = \text{slope of } v_x\text{-}t \text{ curve}$$

if slope is +ve ⇒ function is increasing
if slope is −ve ⇒ 〃 〃 decreasing
if slope is Zero ⇒ 〃 〃 const or has max or min
if slope = const ⇒ 〃 〃 straight line.

※ نتنبأ برسمة v أو a
من خلال x

※ بالرجوع لنفس رسمة
المشتقة الأولى.



Direction of $\vec{a}$:-

$$\vec{v}_{avg} = \frac{\Delta x}{\Delta t} \qquad \vec{v}_x \parallel \Delta\vec{x}$$

اتجاه السرعة باتجاه الإزاحة

ليس من الضروري أن يكون اتجاه التسارع باتجاه السرعة

v_x +ve along +ve x-axis
-ve along -ve x-axis

in 1D ⇒ ± Sign indicate direction

$$\vec{a}_{x_{avg}} = \frac{\Delta \vec{v}}{\Delta t} = \vec{a}_x \parallel \Delta\vec{v}_x \quad (\vec{a}_x \parallel \vec{Force})$$

اتجاه التسارع هو اتجاه التغير في السرعة وليس السرعة

if a_x is +ve → along +ve x-axis.
-ve → along -ve x-axis.

ليس كل تسارع سالب هو تباطؤ

-ve $a_x \neq$ Deceleration (slowing down)

if $a \overset{+}{>} 0$ and $v \overset{+}{>} 0$ speeding up

$a \overset{-}{<} 0$ and $v \overset{+}{>} 0$ slowing up

$a \overset{-}{<} 0$ and $v < 0$ speeding up

$a \overset{+}{>} 0$ and $v \overset{-}{<} 0$ slowing down

دائما بتين وبروحوا

if $\vec{a}$ // motion ($\vec{v}$) ⇒ speeding up

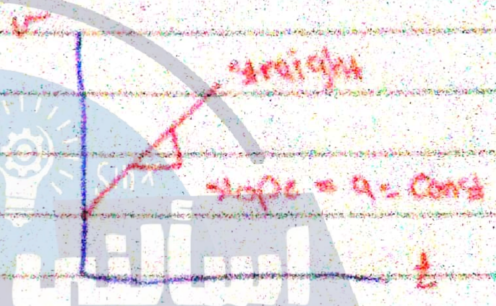
if $\vec{a}$ opposite motion ($\vec{v}$) ⇒ slowing down

2.4 Motion with Const. Acc.

⇓

motion where the acc. is t-independent.

$$\Rightarrow a_{x,avg} = a_{x,inst} = \bar{a}_x = a_x$$



※ Kinematic equation for 1D-motion with const. acc. Δt

$$\vec{a}_x = \frac{\Delta \vec{v}}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

Let ⇒ $0 = t_i$ ← نفرض

∗ call $t_f = t$

$\Delta t = t$

※ $v_x f$ as function of t

∗ نظرية

$$\boxed{a_x = \frac{v_{xf} - v_{xi}}{t}}$$

$$① \quad \boxed{v_{xf} = v_{xi} + a_x t}$$

$v_{xf} = v_{xi} + a_x t$

$x_f = x_i + v_{ix} t + \frac{1}{2} a_x t^2$

$x_f = x_i + \frac{1}{2} (v_{xi} + v_{xf}) t$

$v_{xf}^2 = v_{xi}^2 + 2a_x \Delta x$

Five Apple

$$\bar{v}_x = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t}$$

$$\Delta x = \bar{v}_x \, t$$

$$x_f - x_i = \frac{v_{xi} + v_{xf}}{2} \, t$$

$\frac{v_{xi} + v_{xf}}{2}$ = mathmatical mean

(1)

$$x_f = x_i + \left(\frac{v_{xi} + v_{xf}}{2}\right) t$$

$= \vec{\bar{v}}_x$ only if a_x = Const

$$x_f = x_i + \left[\frac{v_{xi} + v_{xi} + a_x t}{2}\right] t$$

$$\boxed{x_f = x_i + v_x t + \frac{1}{2} a_x t^2}$$

تابع

a_x = Const.

$$v_{f_{x,y}} = v_{i_{x,y}} + a_{x,y} t$$

$$y_f \; x_f = x_i + v_{i_{x,y}} t + \frac{1}{2} a_{x,y} t^2$$

$$y_f \; x_f = x_i \; y_i + \bar{v}_{x,y} t$$

$$v_{xf,y}^2 = v_{yi}^2 + 2 a_y \Delta y$$

$t = \Delta t$

a_x = Const

± Signs indicates direction.

2.5 Freely Falling objects :-

All Objects moving near earth surface under the influence of gravity alone, with absence of air resistance, they all move with almost Const acc. $a_y = g \approx 9.8 \, m/s^2$

g is slightly varying with latitude and altitude. downward

Five Apple

From (★) $t = \dfrac{v_{xf} - v_{xi}}{a_x}$

put in (2)

$$v_{fx}^2 = v_{xi}^2 + 2a_x(\Delta x)$$

---

apply K. Equ with const. acc

$\Rightarrow$ assume the y is upward

$|\vec{a}_y| = g$

$\vec{a}_y = -g\hat{j}$

in 1D ± sign = direction

$$v_{fy} = v_{iy} - gt$$

$$y_f = y_i + v_{iy}t - \frac{1}{2}gt^2$$

$$y_f = y_i + \left[\frac{v_{iy} + v_{fy}}{2}\right]t$$

$$v_{fy}^2 = v_{iy}^2 - 2g(\Delta y)$$

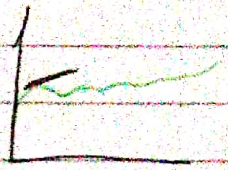
-9.8 التسارع عند اقصى الارتفاع

فهو لا يتغير

2.9 velocity and position by integration:-

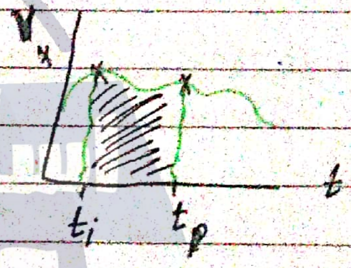
$v_x = \frac{dx}{dt}$ = slope of x-t curve

$a_x = \frac{dv_x}{dt}$ = slope of v_x-t curve

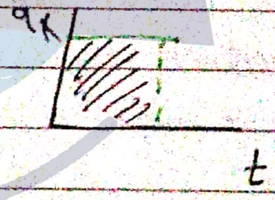


$\int dx = \int v_x \, dt \Rightarrow \Delta x = \int v_x \, dt$ = area under v_x-t curve

$\int dv_x = \int a_x \, dt \Rightarrow \Delta v_x = v_{fx} - v_{ix}$



$= \int a_x \, dt$ = area under a_x-t curve.



« Chapter 3 »

motion in 2 or 3 dimentions:-

4.1 & 4.2 position, velocity, acc. vector.

$\vec{r} = x\hat{i} + y\hat{j}$

$\vec{\Delta r}$ = displacement.

$= \vec{r}_f - \vec{r}_i$

$\vec{\Delta r} = \Delta x \hat{i} + \Delta y \hat{j}$

$\vec{v} = \frac{\Delta \vec{r}}{\Delta t}$ $\quad \vec{v} = \frac{d\vec{r}}{dt} = \frac{d}{dt}(x\hat{i} + y\hat{j}) = v_x \hat{i} + v_y \hat{j}$

$$\vec{a} = \frac{d\vec{v}}{dt} = a_x\hat{i} + a_y\hat{j}$$

2D-motion with const. acc

Const. in magnitude and direction

a_x = const and a_y = const

$$\vec{v}_f = \vec{v}_i + \vec{a}t$$

$$\vec{r}_f = \vec{r}_i + \vec{v}_i t + \frac{1}{2}\vec{a}t^2$$

4.3 Projectile motions

2D motion with const acc. under the influence of gravity only.

a_x = const and a_y = const.

$a_x = 0$, $a_y = -9.8\ m/s^2$

horizontal motion with zero acc. (uniform motion)

v_x = const

$$x_f = x_i + v_x t$$

vertical motion with const acc $= -g$

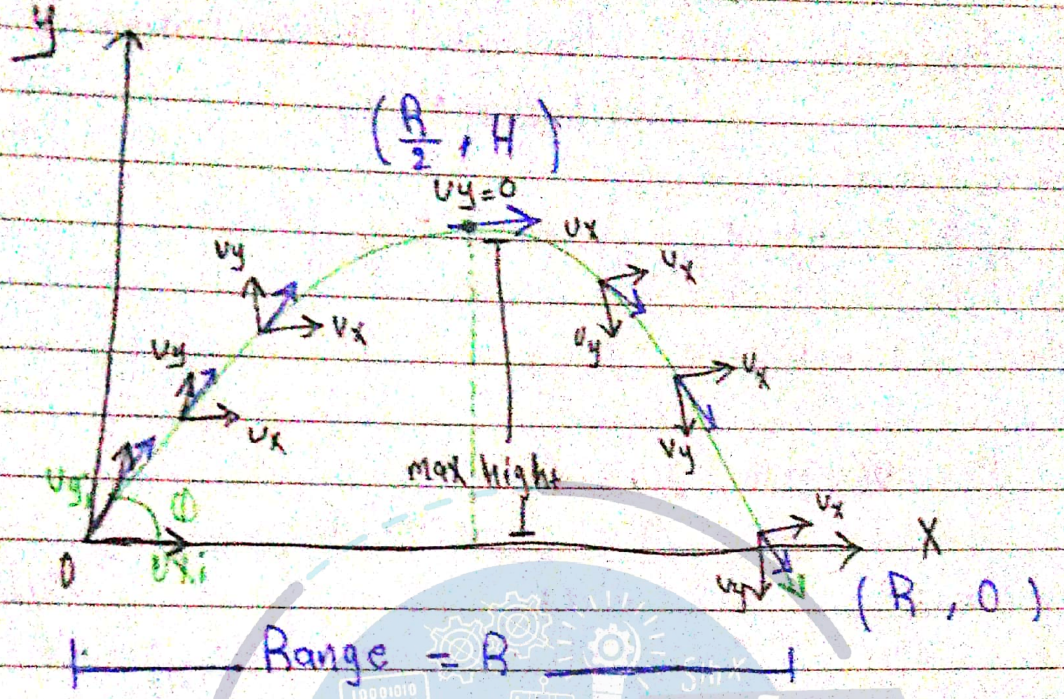
Free fall

$$v_{fy} = v_{iy} - gt$$

$$y_f = y_i + v_{iy}t - \frac{1}{2}gt^2$$

$$y_f = y_i + \left(\frac{v_{iy} + }{2}\right) t$$

Ch.3 :- Motion in 2 Or 3 direction :



$* \; a_y = -g$

$* \; a_x = 0$

θ : launch angle

$\vec{v_i} \Rightarrow v_{xi} = v_i \cos\theta = \text{Const}$ ثابت

$v_{yi} = v_i \sin\theta \neq \text{const}$

$v_{ix} = v_i \cos\theta$

$v_{iy} = v_i \sin\theta$

to find H :-

$$v_{fy} = v_{iy} - gt$$

$$0 = v_i \sin\theta - g \, t_{peak}$$

$$\boxed{t_{peak} = \frac{v_i \sin\theta}{g}}$$ time for max hight

$$y_f = y_i + v_{iy} t_{peak} - \frac{1}{2} g t_{peak}^2$$

$$+H = 0 + v_i \sin\theta \frac{v_i \sin\theta}{g} - \frac{1}{2} g \frac{v_i^2 \sin^2\theta}{g^2}$$

$$H = \frac{v_i^2 \sin^2\theta}{2g}$$

Range = horizontal range = horizontal distance between launching and landing points → symetric

$X_f = X_i + U_x \boxed{t_{flight}} \rightarrow 2\, t_{peak}$

$+R = 0 + U_i \cos\theta \cdot$

$R = U_i \cos\theta \; \frac{2U_i \sin\theta}{g}$ → $\sin 2\theta$

$= \frac{U_i^2}{g} (2\cos\theta \sin\theta)$

علاقة

$t_{peak} \propto U_i$

$\propto \sin\theta$

$$\boxed{t_{peak} = \frac{U_i \sin\theta}{g}}$$

$$\boxed{H = \frac{(U_i)^2 \sin^2\theta}{2g}}$$

\# $H \propto U_i^2$

$\propto \sin^2\theta$

H_{max} at $\sin^2\theta = 1$

at $\theta = 90°$

Free Fall طولي ↓

$H_{max} = \frac{U_i^2}{2g}$

اهم معادلة

* $\boxed{a_c = \frac{v^2}{r}}$ $\boxed{v = \frac{2\pi r}{T}}$ محيط الدائرة $= \boxed{T = \frac{2\pi r}{v}}$

Five Apple

$$R = \frac{v_i^2 \sin(2\theta)}{g}$$

$R \propto v_i^2$

$\quad \propto \sin(2\theta)$

R = max at $\sin(2\theta) = 1$ $\quad \theta = 45°$ $\quad$ at $45°$

$$R_{max} = \frac{v_i^2}{g}$$

The point $(R, 0)$ are be needed by 2 angles

$\theta_1 + \theta_2 = 90°$

at any t, velocity $\vec{v} = \underbrace{v_x \hat{i}}_{\text{const}} + \underbrace{v_y \hat{j}}_{\text{rangeing}}$

the speed $v = |\vec{v}| = \sqrt{\underbrace{v_x^2}_{= v_i \cos\theta = \text{const}} + \underbrace{v_y^2}_{\text{بتتغير بالقيمة}}}$

3.4 Motion in a Circle :-

$\swarrow$ uniform C.M

$\searrow$ non uniform C.M

uniform C.M :

2D motion in a circle of radius r (r = const) with const speed

$|\vec{v}| = v = $ const.

$\vec{v} \neq$ const $\quad$ << التغير بالاتجاه

$\Downarrow \quad\quad$ Changing direction

$\vec{v} \parallel$ tangent to path $\quad\quad \Downarrow$

the particle accelerates.

accelerate is central (centripetal) $\equiv$ radial acc.

$\Downarrow$ center seeking

changing direction

$\vec{a} \perp \vec{v}$

$$|\vec{a}| = \text{const} = \frac{v^2}{r}$$

$$\boxed{a_c = \frac{v^2}{r}}$$

\# period = time needed for 1 complete revolution.

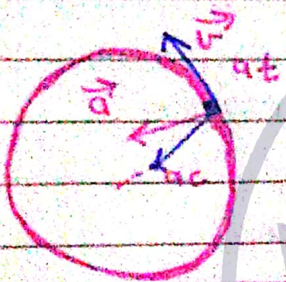
$$\boxed{v = \frac{2\pi r}{T}} \Rightarrow \boxed{T = \frac{2\pi r}{v}}$$

\# Non-uniform C.M :-

2D motion in a circle of radius r with varying speed

$\vec{v} \neq$ const

$|\vec{v}| \neq$ const



\# تغير بمقدار السرعة واتجاه \#

$\vec{a}$ is not only radial

$\vec{a}_{total} = \vec{a}_r + \vec{a}_t$

a_t → tangential → changing the speed

$$|\vec{a}_{total}| = |\vec{a}| = \sqrt{a_t^2 + a_r^2}$$

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

$\vec{a}$ is not $\perp$ $\vec{v}$

$\vec{a}$ makes θ with $\vec{v}$

$\theta \neq 90°$

\# radial acc

$$|\vec{a}_r| = |\vec{a}_c| = \frac{v^2}{r}$$

changing direction of $\vec{v}$

if $\vec{a}_t = \vec{v}$ speeding up.

opposite slowing down.

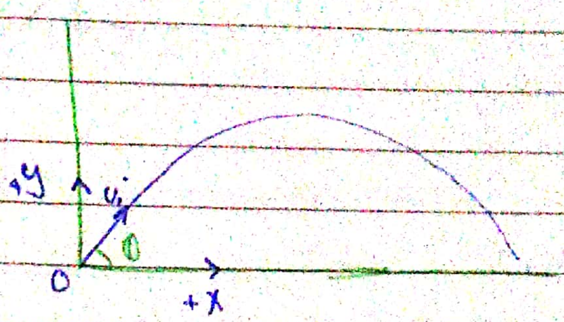
$$|\vec{a}_t| = \left|\frac{dv}{dt}\right|$$

Five Apple

Suggested problems:

Prob 3.16 p.118

$v_i = 71$ m/s
$\theta = 55.9°$



(a) $v_{ix} = v_i \times \cos\theta = 71 \times \cos 55.9 = \boxed{}$
$v_{iy} = v_i \times \sin\theta = 71 \times \sin 55.9 = \boxed{}$

(b) How long

t to reach max. hight

$v_{yf} = v_{iy} - g t_{peak} =$

$x_f = x_i + v_x \, t_{Hight}$

$v_x = v_i \cos\theta$

$R = \dfrac{v_i^2 \sin(2\theta)}{g}$

$= \dfrac{(71)^2 \sin(2 \times 55.9)}{9.8}$

$= \_\_\_\_$ m

(c) $v_{fy} = v_{iy} - gt$

$y_f = y_i + v_{iy} t - \frac{1}{2} g t^2$

Δy

$y_f = y_i + \dfrac{v_{iy} + v_{fy}}{2} t$

$v_{fy}^2 = v_{iy}^2 - 2g \, \Delta y$

at max. hight

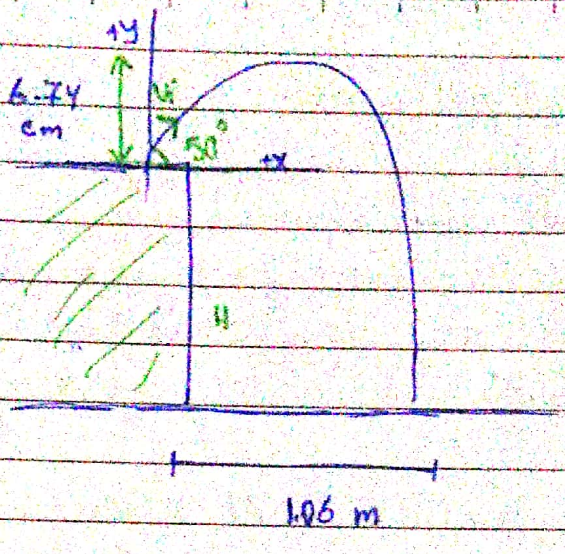
$v_x = v_{ix} = v_i \cos\theta$
$v_y = 0$
$a_x = 0$
$a_y = -9.8$ m/s^2

at max. hieght $v_y = 0$

$0 = (v_i \sin\theta)^2 - 2g(y_f - y_i)$
$0 = (v_i \sin\theta)^2 - 2g(H - 0)$

$\boxed{H = \dfrac{v_i^2 \sin^2\theta}{2g}}$

prob 3.57 P-121



$v_i = ?$ $\quad H = ?$

$v_{fy}^2 = v_{iy}^2 - 2g\Delta y$

$0 = (v_i \sin 50)^2 - 2g(y_f - y_i)$

حولنا لـ m

معادلة بمجهول واحد

$0 = v_i^2 [\sin 50]^2 - 2(9.8)(0.0674 - 0)$

$= + 1.5 \ m/s$

$H = ?$

بنحسب الزمن

$x_f = x_i + v_x t$

$1.06 = 0 + v_i \cos\theta \ t_{(total)}$

$+1.06 = 0 + 1.5 \times \cos 50 \ t_{total}$

$\frac{1.06}{1.5 \cos 50} = t_{total} = 1.09937 \ s$

$t = t_{(total)}$

$y_f = y_i + v_{iy} t - \frac{1}{2} g t$

$-H = 0 + v_i \times \sin 50 \times t_{total} - \frac{1}{2} \times 9.8 \times t_{total}$

$H = 4.66 \ m$

Q41 page 120

if $\vec{r} = bt^2\,\hat{i} + ct^3\,\hat{j}$ c, b positive const

when $\vec{v}$ makes $\theta = 45^\circ$ with x and y-axis

$$\vec{v} = \frac{d\vec{r}}{dt} = \frac{d}{dt}[\quad] = b(2t)\,\hat{i} + c(3t^2)\,\hat{j}$$

$$\vec{v}(t) = \underbrace{[2bt]}_{v_x}\hat{i} + \underbrace{[3ct^2]}_{v_y}\hat{j}$$

$$\text{if } \theta = 45^\circ \quad \tan 45 = 1 = \frac{v_y}{v_x} = \frac{3ct^2}{2bt} = 1$$

$$\boxed{t = \frac{2b}{3c}} \ \divideontimes$$

3.26 P-119

$v = 470 \frac{rev}{min}$ لفة بالدقيقة

[a] v in m/s = ?? [b] a_c ?? in term of g.

1 min = 60 s

1 revolution = $2\pi r$ m

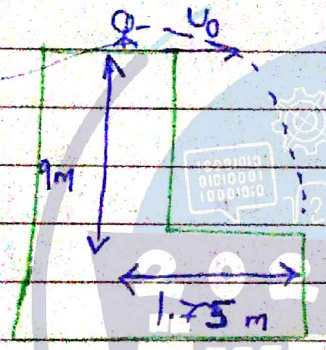
$$v = 470 \frac{rev}{min} = \frac{470 \frac{1\,rev \times 2\pi r}{1\,rev}}{1\,min \times \frac{60\,s}{1\,min}} = \frac{470\,(2\pi(3))}{60}$$

$a_c \quad \frac{[v(m/s)]^2}{[r(m)]} = \frac{\ ^2}{a} = m/s^2$

$1g \longrightarrow 9.8\ m/s^2$

$\_\_\_ g \longrightarrow m/s^2$

3.10 P- 117



$v_{iy} = 0$

$v_{ix} = v_0$

$\theta = 0$

$v_0 = ??$ to miss the ledge

$x_f = x_i + v_x t$

$1.75 = 0 + v_0 t$

$v_0 = \frac{1.75}{t}$

$= \frac{1.75}{1.355} = \boxed{1.29\ m/s}$

$y_f = y_i + v_{iy} t - \frac{1}{2} g t^2$

$0 = 9 + 0 - \frac{1}{2} g t^2$

$\frac{9.8}{2} t^2 = 9$

$t = \sqrt{\frac{2(9)}{9.8}} = \boxed{1.355\ s}$

3.8 P. 117

$\vec{v} = [5 - (0.018) t^2]\hat{i} + [2 + 0.55 t]\hat{j}$

$v_x \qquad v_y$

a) a_x ? a_y ?

b) $|\vec{v}\ (t = 0.87\ s)|$?? · dimention ??

c) $|\vec{a}\ (t = 0.87)|$?? direction ??

$\vec{a} = \frac{d\vec{v}}{dt}$

مشتقة بالنسبة ل t

Chapter 4, 5

Neuten Laws and motion :-

Dynamics → motion of the object considring acting on it.

* Constant → ج قوانين نيوتن

Forces of Introction

Force : $\vec{F}$ → vector quantity

the resultant force (sum. net forces)

should be found vectorially (by vector addition)

$[f]$ = newten = N = in SI unit

* forces concept : the couse of changing objects.

Tow types of forces

Contact forces

forces that need (require) physical contact to act on object e.g

friction forces $f(f_s, f_k)$

normal force : $\vec{F}_N$

tention force $\vec{T}$

field forces

field forces (forces at adistance) forces act on object without needing physical concat e.g بدون تلامس

جاذبية ① gravitation force $\vec{F}_g$

كهربائية electrical forces $\vec{F}_e$

مغناطيسية mag magnetic forses $\vec{F}_B$

نووية neuclear "

* Normal forces = $\vec{F}_N$

contact force exe on objects

by the su.

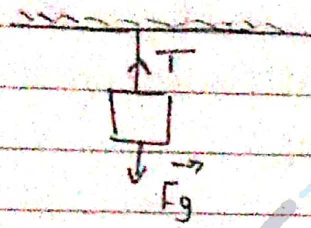
Ch.4 Neuten Laws of Motion:

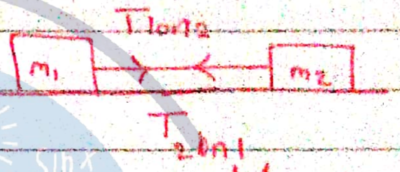
4.1 Force and interactions:

Tention: $\vec{T}$

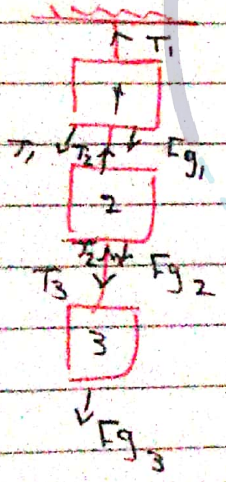
Contact Force exerted on an object attached and a rope (Cable, cord, wire, string)

$\Rightarrow$ always along the rope and away for the object.





if rope is massless or inextensible then T is the same for the rope.



~~Friction~~ Friction = Frictional Force, $\vec{f}$

a contact force exerted on objects when they move or try to move along each other.

$\Rightarrow$ allway parallel to the surface, opposite to the direction of motion or intended motion.

- Kinetic Friction f_k
- Static Friction f_s

4.4 mass and weight

Gravitational Force = $\vec{F_g}$:- Field Force, exerted between 2 masses separated by a distance. attraction

weigh: magnitude of gravitational Force exerted between an object (m_1) and earth (m_E)

$$|\vec{F_g}| \equiv \text{wieght} \equiv mg$$

$\vec{F_g}$ always towards earth.

* weight depends on location not intrinsic property for the object it is a property for a system.

* Mass :- = amount of matter in an object كمية
Scaler = a measure of how much resistance an object shows to any change in its motion.
[Mass] = Kg
- in intrinsic property of object. m↑, a↓
- independent of location. $m \propto \frac{1}{a}$ عكسي

$W = mg$ ↓ gravitational mass

$\sum F = ma$ ↓ inertial mass.

$m_{grav} = m_{inertial}$ ↓ Proved experimentally.

4.6 Free-body diagram. مخطط الجسم الحر

pictorial representation (sketch) of an object showing only forces acting on the object.
↳ Point like particle.

4.2 Newton's First Law :-
* Inertial Frame of Refrence (إطار مرجعي قصوري)
قصوري إطار مرجع

the frame of refrence in which an object that does not interact with other objects, experiances acceleration.
≡ the frame in which N. Laws is valid.

Five Apple

- any frame of reference that is moving with const. velocity w.r.t an inertial frame is also ~~inertial~~ inertial.

⇒ Earth is approximately inertial frame of ref.

\# N. 1st. Law ≡ Law of Inertia.

in absence of net force and when viewed from inertial frame, the object experiences zero acc. $\vec{a}=0$

≡ In absense of net force , , , , and object at rest remains at rest and and object in uniform motion. (const velocity)

≡ (Const speed in ~~a~~ straight line)

Continues its motion unless a net force is exerted on it.

\# الجسم قاصر بذاته عن تغير حركته مالم تؤثر عليه قوة \#

\# 4.3 N. 2nd Law :- ≡ Law of motion / Law of force.

of a net force acts on an object of mass m, it produce an acceleration that is directly proportional to force and inversely proportional to mass.

$\vec{F} \propto \vec{a}$ $|\vec{F}| \propto |\vec{a}|$, $\vec{F} \parallel \vec{a}$ $|\vec{a}| \propto \frac{1}{m}$

4.3 \# Newten :- the SI unit of force

إذا أثرت قوة على جسم كتلته ١كغ أكسبته تسارع ١م/ث²

\# SI - units ≡ MKs system $a = m/s^2$

length [M] mass [Kg] time [S] [F] = N

\# CGS - units

length [cm] mass [g] time [S]

[a] = cm/s^2 [f] = dyne = dyn

\# British - [length] = foot = ft [t] = S

[mass] = slug [a] = ft/s^2 [F] = pound = lb

Five Apple

Scanned with CamScanner

4.5 N. 3rd law :- [action - Reaction Law]

For 2 interacting objects (obj.1 and obj.2), the force exerted by obj 1 on obj 2 ($\vec{F}_{1on2}$) is equal in magnitude and opposite in direction to force exerted by 2 on 1 ($\vec{F}_{2on1}$)

عكس الاتجاه $\vec{F}_{1on2} = -\vec{F}_{2on1}$

نفس المقدار

$|\vec{F}_{1on2}| = |\vec{F}_{2on1}|$ $\quad$ $\vec{F}_{1on2}$ opposite $\vec{F}_{2on1}$

$F_{1on2} = F_{2on1}$

For every action, there is reaction equal in magnitude and opposite in direction.

⇒ all forces exist in nation as pairs

Notes

1- Action and reaction forces are of the same tipe.

2- the act on 2. dift. obj [no meaning to find net force]

Ch.13. Gravity

13.1 Newten's Law and Gravitation.

⇒ Universal law of gravitation.

Gravitational force ≡ $\vec{F_g}$

Field force : attractive force between 2 objects (of masses m_1 and m_2) separated by distance r.

$|\vec{F_g}| \propto m_1 m_2$

$\propto \frac{1}{r^2} \Rightarrow F_g = \text{Const} \frac{m_1 m_2}{r^2}$

universal grav. Const (indep of the medium separating m_1 and m_2)

$G = 6.67 \times 10^{-11}$
$N \cdot m^2 / g^2$

$F_g = \frac{G m_1 m_2}{r^2}$

$\Rightarrow$ if $m_2 = m_{Earth}$

$|\vec{F_g}| = \frac{G m\, m_{Earth}}{r^2_{Earth}} = \text{weight} = mg$

نق الارض

acc. due gravity $= g = \frac{G\, m_{Earth}}{r^2_{Earth}} \simeq 9.8\ m/s^2$ near Earth surface

(G: const)

at altitude h above earth surface: $g = \frac{G\, m_{Earth}}{(r_E + h)^2}$

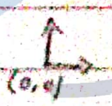
$g \propto \frac{1}{h^2}$

g decreasing with increasing altitude

Steps to apply N. laws involving problems

① Draw a sketch for the problems.

② Choose / assign convenience system of coordinates / ref.



③ Draw Free-body diagram for every particle.

④ Analy forces into components (if need)

⑤ Apply N. 2nd law: $\Sigma \vec{F} = m\vec{a}$

$\Sigma F_x = m a_x$

$\Sigma F_y = m a_y$

if

$a = 0 \Rightarrow$ equilibrium

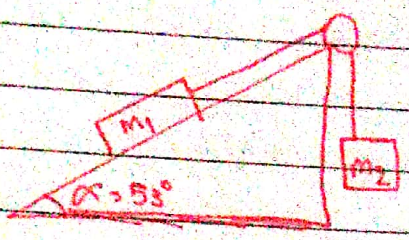
⑥ Solve the equations

equ.s = # of unknowns

Chapter 5: Applying Newton's laws 8

5-1 and 5-2 Applying N. laws.

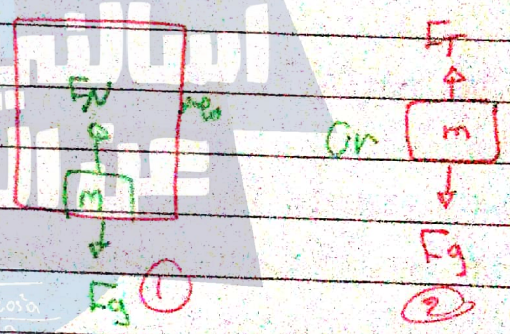
prob 5.74.



Friction اهمال

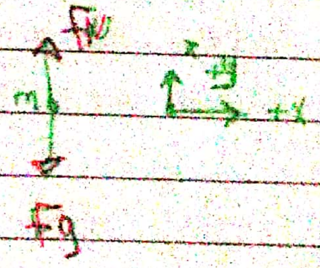
* An object in an elevator ≡ Appearant weight. ظاهري

Force exerted by elevator
$= F_N$ (or T)
≡ apparent weight
≡ reading of a scale in elevator.



طريقتين لتمثيل السؤال

$$\Sigma F_y = m a_y$$



① if the elevator is acc. upward تسارع $F_N - F_g = m a_y$

$\Rightarrow a_y = +ve$ $F_N = F_g + m a_y$

$F_N = mg + m a_y$

$F_N = mg + +ve$ $\boxed{F_N = m(g + a_y)}$

$\Rightarrow F_N > mg$

② if is acc. downward تباطؤ

$a_y = -ve$ $F_N = mg + -ve$

$\Rightarrow F_N < mg$

③ if elevator is moving with const. velocity

$\Rightarrow a_y = 0$

$\boxed{F_N = mg}$

9) if the elevator's cord was broken $\Rightarrow F_N = 0$

$0 = mg + ma_y$

$-\cancel{m}g = \cancel{m}a_y$

$\boxed{-g = a_y}$ free falling   weightlessness ظاهرة انعدام الوزن

prob 5.90 [illegible]

5.3 Frictional Forces :-
- static f_s
- Kinetik f_K

always parallel to surface and opposite to the motion.

Properties of forces of friction & Cobtained.

1- $|\vec{f}| \propto |\vec{F_N}|$ (non-vector equ)

2- statitic friction. $\Rightarrow 0 \leq f_s \leq f_{s(max)}$
↳ the max possible static friction.

3- Kinetic friction $f_K < f_{s\,max}$

force needed to start motion for rest is larger than force needed to continue motion. if $f_{app} > f_{s\,max} \Rightarrow$ motion $f = f_K$

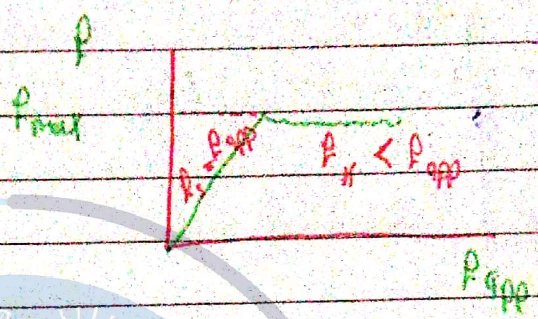
4- $f_{s\,max} = \mu_s F_N$, μ_s = coeff. of static friction (dimensionless)
$0 < \mu_s < 1$

5- $f_K = \mu_K F_N$, μ_K = coff of kinetic friction.
$0 < \mu_K < 1$

always $\mu_K < \mu_s$

6- μ depends on the type of materials of object and surface.
7- μ_s or μ_k is independent of the area of contact.
8- μ_k is almost independent of the speed of object.

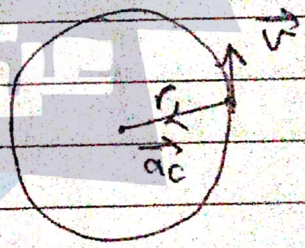
التلخيص برسمة



5.4 Dynamics of circular motion

Uniform circular motion : الحركة الدائرية المنتظمة

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



$\vec{v}$ tangent to the path
$\vec{a}_c$ always $\perp \vec{v}$ → centripital acc. التسارع المركزي
[toward the center]

It is circulating becomes of $\vec{\Sigma F_c}$ → centripital Force. (center seeking)
→ responsible for $\vec{a}_c$
$\vec{\Sigma F} = m a_c$
→ if it becomes zero. → move in straight line with const $\vec{v}$

$\boxed{\Sigma F_c = m\frac{v^2}{r}}$ uniform C.M.
→ net centripital force.

Notes :

- centripital force is not a new kind of force
- $\sum f_c$ = net force towards the center

Find the max speed in horizontal circle.

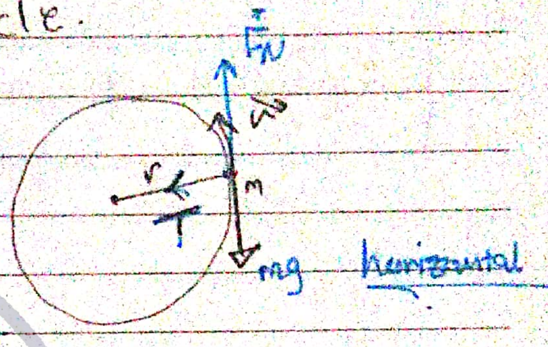
$\sum F_y = 0$

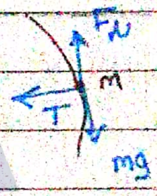
$\boxed{F_N = mg}$

$\sum F_c = \frac{m v^2}{r} \Rightarrow + T_{max} = \frac{m v_{max}^2}{r}$

$\boxed{v_{max} = \sqrt{\frac{r T_{max}}{m}}}$

أقصى سرعة



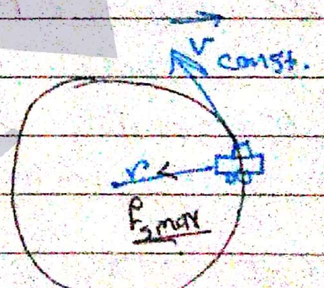


max. speed of a car on flat curved path.

↓ allowed

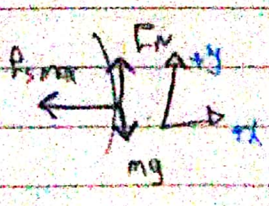
أقصى سرعة مسموحة .

الاحتكاك السكوني لأنها تمنع الانزلاق . [مقاومة]



the force responsible for keeping the car on circular track $\Rightarrow f_s \rightarrow$ Prevents skidding v_{max} = max allowed v

$f_s = f_{s\,max}$



$\sum F_y = 0$ $\boxed{F_N = mg}$

$\sum F_c = \frac{m v^2}{r}$

$\boxed{f_{s\,max} = \frac{m v_{max}^2}{r}}$

$\mu_s F_N = \frac{m v_{max}^2}{r}$

$\mu_s \cancel{m} g = \frac{\cancel{m} v_{max}^2}{r}$

$v \propto \sqrt{r}$

v_{max} is mass indep

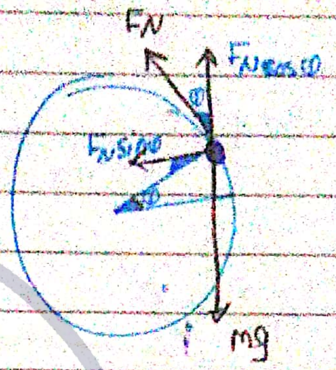
$v_{max} = \sqrt{r \mu_s g}$

a car on an banked curved path.

the path is slightly tilted (inclined) towards its inside.

to compensate for friction when the road is icy or oily.

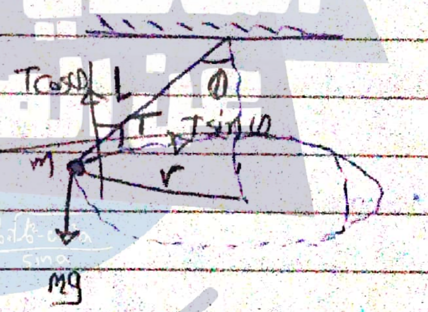
$$\boxed{\Sigma F_y = F_N \cos\theta = mg}$$



5.4 Dynamics of circular motion:-

uniform circular motion:

Conical pendulum



m ⇒ uniform C.M

v = const

r = const

$\Sigma F_y = 0 = T\cos\theta = mg$

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

$\Sigma F_c = \frac{mv^2}{r} = \boxed{T \sin\theta = \frac{mv^2}{r}}$

$\frac{mg}{\cos\theta} \sin\theta = \frac{mv^2}{r}$ $\cancel{m}g \tan\theta = \frac{\cancel{m}v^2}{r}$

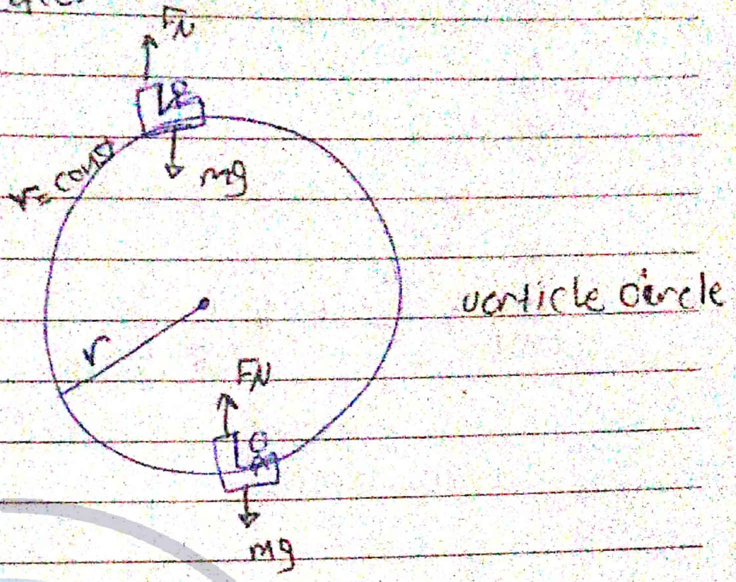
$v = \sqrt{g\, r \tan\theta}$ # $\boxed{g = \frac{v^2}{\tan\theta\, r}}$

uniform CM in vertical circle.

↳ v = const

r = const

Fernis wheel



Fild Force exerted by seat on passenger.

at botton

$$\Sigma F_c = \frac{mv^2}{r}$$

$$+F_N - mg = \frac{mv^2}{r}$$

$$\boxed{F_{N_{botton}} = mg + \frac{mv^2}{r}} > mg$$

at top

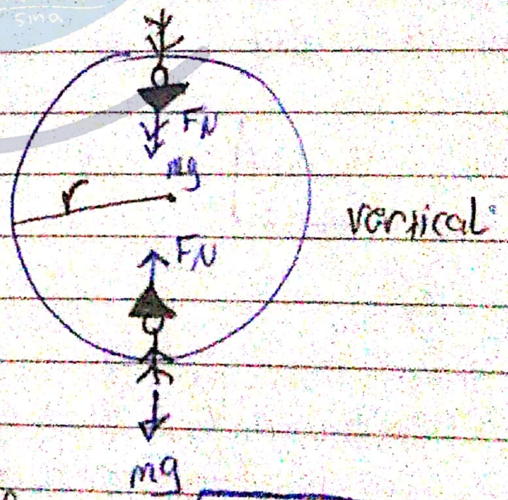
$$\Sigma F_c = \frac{mv^2}{r}$$

$$-F_N + mg = \frac{mv^2}{r}$$

$$\boxed{F_{N_{top}} = mg - \frac{mv^2}{r}} < mg$$

Apilot in vertical circle.

Force exerted by seat on pilot



at botton :-

$$\Sigma F_c = \frac{mv^2}{r}$$

$$+F_{N_{botton}} - mg = \frac{mv^2}{r}$$

$$\boxed{F_{N_{botton}} = mg + \frac{mv^2}{r}} > mg$$

at top

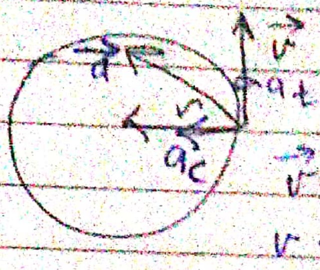
$$\Sigma F_c = \frac{mv^2}{r}$$

$$+F_N + mg = \frac{mv^2}{r}$$

$$\boxed{F_{N_{top}} = \frac{mv^2}{r} - mg}$$

Non uniform C.M

السرعة متزايدة
لا مقداراً ولا اتجاهاً



$\vec{v} \neq$ const

$v \neq$ const

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

$\vec{a}_{total} = \vec{a}_c + \vec{a}_t$

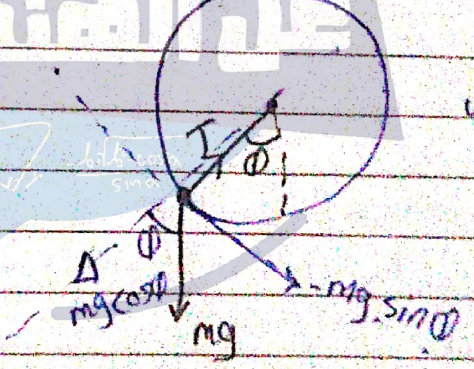
$\vec{a}_c \hookrightarrow$ changing direction

$\vec{a}_t \hookrightarrow$ changing speed $\quad |\vec{a}_t| = \left|\frac{d\vec{v}}{dt}\right|$

$$\sum \vec{F} = \sum \vec{F}_c + \sum \vec{F}_t$$

$$\boxed{\sum \vec{F}_c = \frac{m v^2}{r}} \qquad \boxed{\sum \vec{F}_t = m a_t}$$

e.g Tension in vertical circle :-



$\sum F_t = m a_t$

$\cancel{m} g \sin\theta = \cancel{m} a_t$

$$\boxed{a_t = g \sin\theta}$$

$\sum F_c = \frac{m v^2}{r}$

$+T - mg\cos\theta = \frac{m v^2}{r}$

$$\boxed{T = mg\cos\theta + \frac{m v^2}{r}}$$

* bottom $\quad \theta = 0$

$T_{bottom} = mg + \frac{m v^2_{bottom}}{r}$

\# top $\quad \theta = 180$

$T_{top} = -mg + \frac{m v^2_{top}}{r}$

Five Apple

ملاحظة القوية "المسائل"

For a system of particles (2 or more particles)

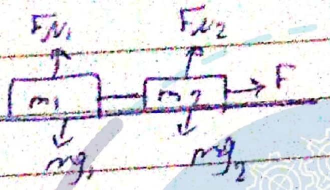
Free body diagram for every particles | as one system

$\sum F_{system} = ma$

↓

any F // direction of +ve

$\sum F_{system} = m_{tot} a$



$+F - \cancel{T} + \cancel{T} = (m_1 + m_2) a$

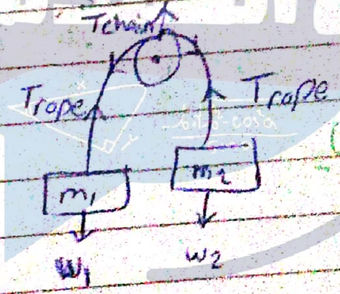
$\sum F_x = m_1 a$

$T = m_1 a$

#5.1 p.184.

$w_1 = mg = 23\,N$

$w_2 = 23\,N$



m_1

$\sum F_y = 0$

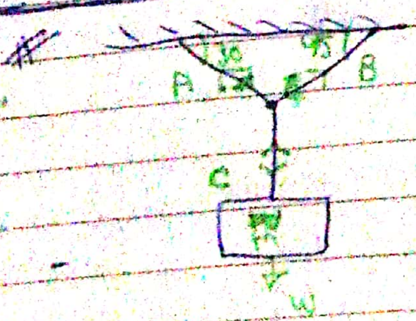
$T_{rope} = w_1 = 23\,N$

Polly

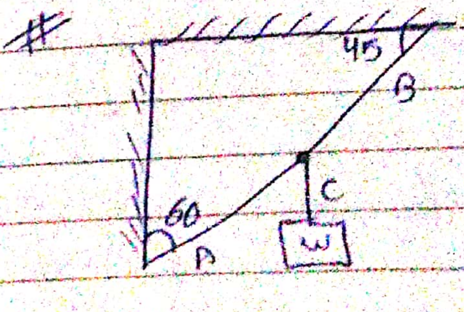
$T_{chain} - (T_{rope} + T_{rope}) = 0$

$T_{chain} = 46$ #

#



#



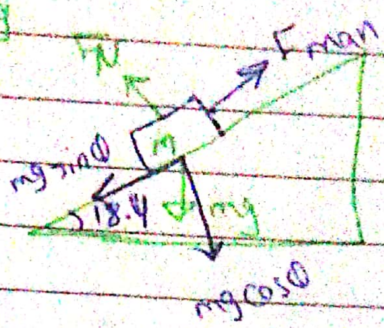
5.9 p.184

m = 180 kg

State 1

v = const

a = 0 ثابتة يعني

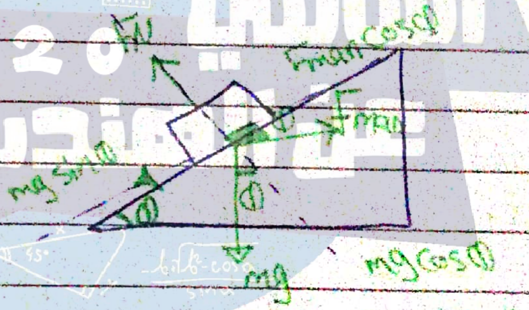


$\Sigma F_y = 0$

$\Sigma F_x = 0$

a = 0

State 2



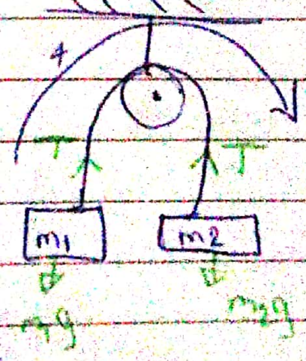
5.15 p.185

Atwood's machine

T = ??

a = ??

} جاهز system



m1

$\Sigma F_y = m_1 a$

$\boxed{T - m_1 g = m_1 a}$

m2

$\Sigma F_y = m_2 a$

$\boxed{m_2 g - T = m_2 a}$

as one system

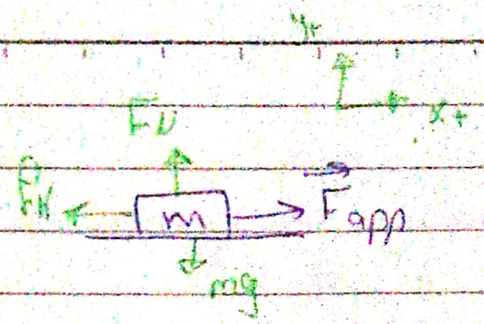
$\Sigma F_{sys} = m_{total}\, a$

$= + m_2 g - T + T - m_1 g = (m_1 + m_2) a$

$\Rightarrow a = \dfrac{(m_2 - m_1)}{m_1 + m_2} g$

Five Apple

Q 27 . p 185



$m = 18.6\ kg$

$v = 3.5\ m/s$ Const

$a = 0$

$\mu_k = 0.2$

$\boxed{F_N = mg}$

$f_k = F_N \mu_k = \mu_k mg$ #

[a] $F_{app} = ?$

$\Sigma F_x = ma = 0$

$F_{app} - f_k = 0$

$F_{app} = f_k = \boxed{\ }$

[b] If $F_{app} = 0$

$\Delta x = ?$

to rest $v_f = 0$ #

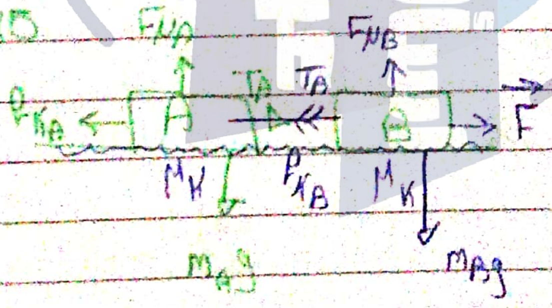
$\Sigma F_x = ma_x$

$-f_k = ma_x$

$a = \boxed{\ }$

$v_f^2 = v_i^2 + 2a\Delta x$ ← [illegible]

5.37 . p . 185



v = Const

$a = 0$

$F = ?$

$T = ?$

m_A

$F_{NA} = m_A g$ = $\boxed{f_{kA} = \mu_k m_A g}$

$\Sigma F_x = 0 \quad T - f_{kA} = 0$

$\boxed{T = \mu_k m_A g}$

m_B

$\Sigma F_y = 0 = F_{NB} = m_B g \Rightarrow f_{kB} = \mu_k m_B g$

$\Sigma F_x = 0 \quad F - T - f_{kB} = 0$

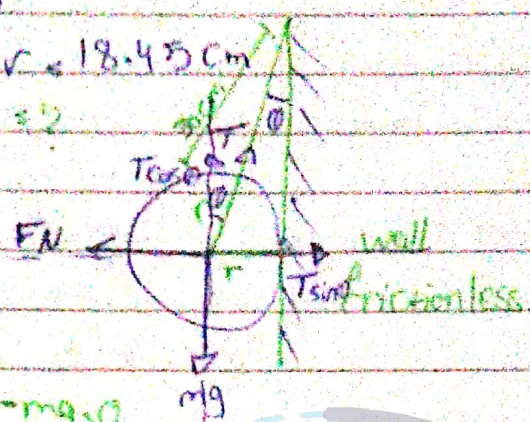
$F = T + f_{kB} = \mu_k m_A g + \mu_k m_B g$

Prob. 5.65

$m = 59.2\ Kg$

$D = 38.9\ cm \rightarrow r = 18.45\ cm$

$T = ??$ $\quad \vec{F_N} = ?$



$\Sigma F_y = 0$

$T\cos\theta - mg = 0$

$\boxed{T = \frac{mg}{\cos\theta}}$ $= 415\ N$ #

$\Sigma F_x = 0$

$T\sin\theta - F_N = 0$

$F_N = T\sin\theta$

$= 158\ N$ #

prob 5.74 . p.190

$\alpha = 53.1$

$m_1 = 20\ Kg$

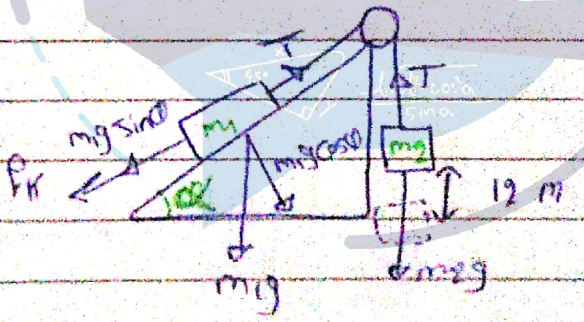
$\mu_k = 0.4$

$m_2 = ?$

$\Delta y = 12\ m$

$v_i = 0$

$\Delta t = 3\ sec$



m_1

$\Sigma F_y = 0$

$F_N = m_1 g \cos\theta$

$f_k = \mu_k m_1 g \cos\theta$

$y_f = y_i + v_{iy} t + \frac{1}{2} a t^2$

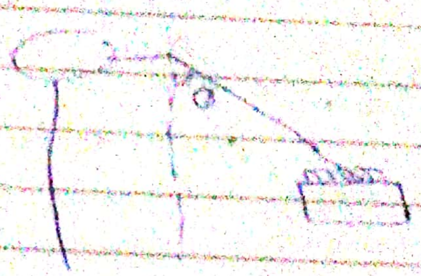
$12 = 0 + 0 + \frac{1}{2}\ a \times 9$

$\boxed{a =}$

$\Sigma F_{sys} = m_{tot}\ a$

$+m_2 g - T + T - m_1 g \sin\theta - f_k = (m_1 + m_2)\ a$

5.50



4.40

4.49 p.151

$F = 74N$

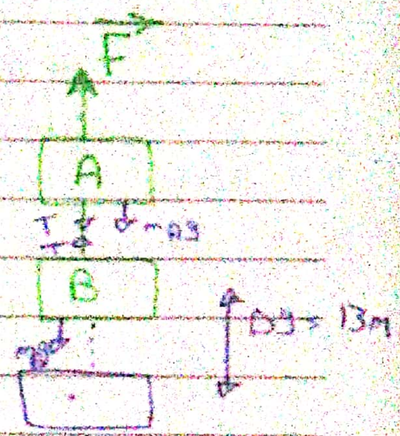
$V_i = 0$

$\Delta t = 3.4$ sec

$T = 40N$

$m_B = ??$

$m_A = ??$



$\Sigma F_{sys} = m_{tot}\, a$

$m_B g - T + T + m_A g - F = (m_A + m_B)a$

$y_f = y_i + v_i t + \frac{1}{2} a t^2$

$13 = 0 + 0 + \frac{1}{2} a (3.4)^2$

4.7 p.148

$m = 68.5$ kg

$V_i = 2.4$ m/s

$V_f = 0$

a = const

$\Delta t = 3.52$ s

$\Sigma F = ma$

$F_K = mg$

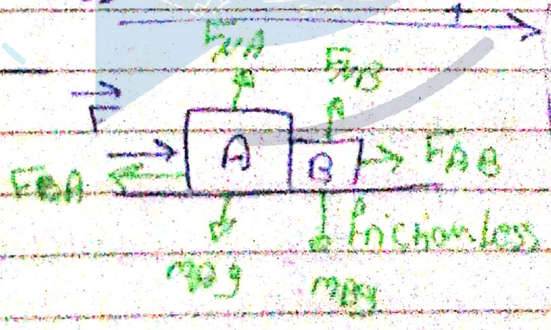
$\frac{\Delta v}{\Delta t} = \frac{0 - 2.4}{3.52} =$

4.23 p.149

$m_A = 25$ kg

$m_B = 8$ kg

$F = 100N$



FBD B

$m_B g - T = m_B a$

$T + m_A g - F = m_A a$

$\Sigma F_{sys} = m_{tot}\, a$

$\cancel{F_{AB}} - \cancel{F_{BA}} + F = (m_A + m_B)a$

$F_{total} = (m_A + m_B)a$

$100 = 33a$

$a = 3\ m/s^2$

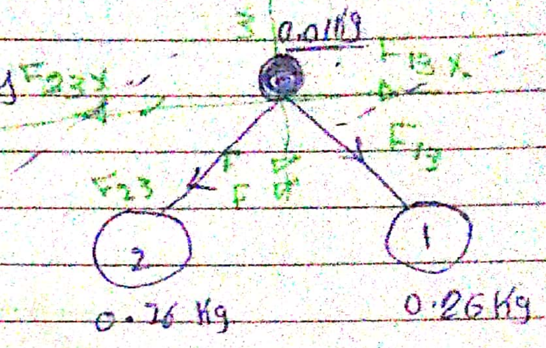
FBD B

$F_{AB} = m_B a$

$= 8 \times 3$

$= 24N$

to mesure μ_s experimentally



put the object on horizontal surface and increase the inclination gradually until θ_c

Critical angle

at the verge of slipping

$f_s = f_{s\,max} = \mu_s F_N$

$F_g = \frac{G m_1 m_2}{r^2}$

$a = 0$ · كاوشك ازلق #

$\sum F_y = 0 \quad F_N = mg\cos\theta_c$

$f_{s\,max} = \mu_s\, mg\cos\theta$

$\sum F_x = 0 \quad f_{s\,max} - mg\sin\theta_c = 0$

$\mu_s\, \cancel{mg}\cos\theta = \cancel{mg}\sin\theta$

$\mu_s = \tan\theta_c$ #

Ch.6 : Work and Kinetic Energy :-

6.1 work done by constant force :-

Force is independent of displacement.

$\text{Work} = \vec{\text{Force}} \cdot \vec{\text{Displace}}$

$= \vec{F} \cdot \vec{\Delta r}$

$\boxed{W = F\,\Delta r \cos\theta}$

work = transfer of energy

scaler (+, - or zero)

$[W] = [\text{energy}] = N\cdot m = \text{Joule} = J$ in SI units

W +ve → $0 < \theta < 90$ Energy is transferred into the system

-ve → $90 < \theta < 180$ " " form the system.

0 → $\theta = 90$ $(\vec{F} \perp \Delta\vec{r})$

$W_{net} = W_{total} = W_1 + W_2 + W_3 + \dots$

$= \sum \vec{F} \cdot \Delta\vec{r}$

6.3. Work done by a Varying Force.

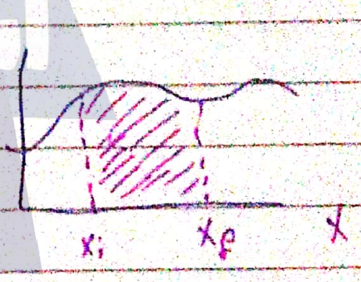
↳ Force is dependent on displacement.

التكامل

$$W = \int_{r_i}^{r_f} \vec{F} \cdot d\vec{r}$$

in 1D $\vec{F} = F_x \hat{i}$, $d\vec{r} = dx\,\hat{i}$

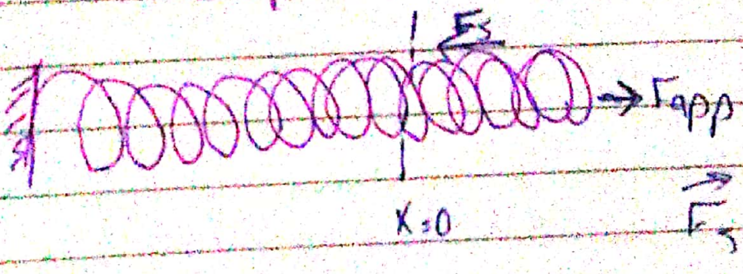
$$W = \int_{x_i}^{x_f} F_x \cdot dx$$



= area under F_x - vs - X curve

Spring Force ≡ F_s ≡ restoring force

Contact force, exerted on an object attached to a spring, when it is compressed or streched from its equilibrium position.



$\vec{F}_s$ opposite to displacement from its equilibrium.

Hook's Law

$|\vec{F}_s| \propto |\Delta\vec{x}|$ $\boxed{F_s = -kx}$

↳ k: spring const

= Force const

= stiffness const

6.2 Kinetic Energy and Work - K.E Theorem

energy : associated with object's motion.

$K.E = \frac{1}{2} m v^2$ → speed, ↓ mass

- scaler (always +ve)

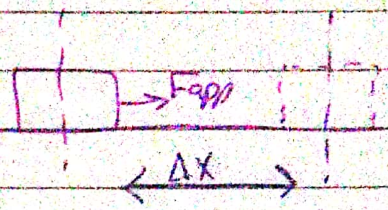
$[K.E] = $ Joule

$K.E \propto m$

$\propto v^2$

work - K.E theorem :

$W = \int F_x \cdot dx$



$= \int ma \cdot dx$

W - K.E theorem.

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

⇒ if a work is done on an object, and the only change was in its speed then $W_{net} = \Delta K.E = KE_f - KE_i$

$W_{net} = \int_{x_i}^{x_f} \sum F \, dx$

$= m \int_{x_i}^{x_f} a \, dx$

$= m \int_{x_i}^{x_f} v \frac{dv}{\cancel{dx}} \cancel{dx}$

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

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

$a = \frac{dv}{dt}$

$= \frac{dv}{dx} \times \frac{dx}{dt}$

$a = v \frac{dv}{dx}$

6.4 Power ≡ the time rate of work done (or of energy transfered)

average power $\bar{P} = \frac{\Delta E}{\Delta t} = \frac{W}{\Delta t}$

* scaler,

$[P] = J/s = $ watt

Inst. Power $P = \frac{dE}{dt} = \frac{dW}{dt}$, special case if $\vec{F} \neq f(t)$

$\vec{W} = \vec{F} \cdot \vec{\Delta r}$

$P = \frac{dw}{dt} = \frac{d}{dt}(\vec{F} \cdot \vec{\Delta r}) = \vec{F} \cdot \vec{v}$

horse power = hp = 746 W
non SI unit of power

Kilowatt · hour = KW * 3600 s

non SI unit of energy

$10^3 J/s * 3600 s = 3.6 \cancel{*10} 10^6 J$
$= 3.6 MJ$

Chapter 7 :- Potential Energy and Energy conservation:-

Potential Energy :- $P.E \equiv U$ scaler [P.E] = Joule.

energy associated with the configuration of a system.

Notes :-

$\boxed{1}$ P.E is associated with a system (not with a particle)

$\boxed{2}$ always choose a refrence configuration at which the P.E has a refrence value (often chosen as Zero) U_0 = Const → Zero.

$\boxed{3}$ the choice of a referense configuration is arbitrary

$\boxed{4}$ potential Energy as a value isn't Physically important what matters is ΔU (change in P.E) and ΔU is indep. of the choice of ref. conf.

$\boxed{5}$ P.E is associated with conservative force.

Two types of P.E :-

1- Gravitational $P.E \equiv U_g$

2- Elastic $P.E \equiv U_s$

7.1 Gravitational P.E = U_g

energy associated withe the location (hieght) of an object above earth surface.

$$U_g = mgy$$

m → mass of particle

g → acc. due to gravity

y → hieght from earth surfase

$U_g = U_0$ at $y = 0$

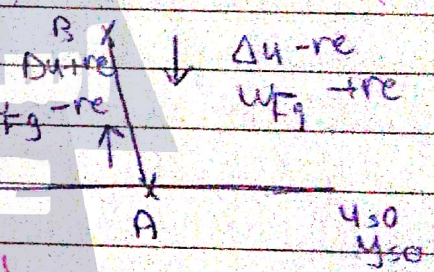
$= 0$

$U_g \propto y$ → hieght from earth's surface.

$W_{F_g} = -\Delta U_g$

$W_{F_{app}} = +\Delta U_g$

$v = const$



7.2 Elastic P.E = U_s

Energy stored in a spring-object syst. when the spring is deformed (either streched or compressed from its equilibrium position)

$$U_s = \frac{1}{2} K X^2$$

X → displacement from equilibrium position when the spring is relaxed → always +re

K → spring constant

$F_s = -KX$

with $U_s = U_0 = 0$

at $X = 0$

$$\Delta U_s = U_{s_f} - U_{s_i}$$

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

$$W_{F_s} = -\Delta U_s$$

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

7.3 Conservation and Non-Conservation Forces:-

total Mechanical Energy:

the sum of K.E and P.E of a system.

$$E_{mech} = U + K = P.E + K.E$$

Internal Energy:-

energy asociated with the temp. of system.

Conservative Forces:-

Forces that conserve the total Mech Energy of the system. ($K \leftrightarrow U$) without loss

e.g $\vec{F_g}$, $\vec{F_s}$

الجاذبية الزنبرك

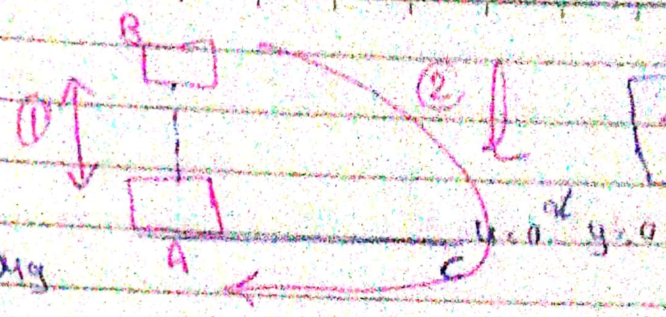
* they have 2 equivalent propendies:-

[1] the work done is path-independent

[2] the " " over closed path is zero (initial point = final point)

e.g

$(A \to B)$



$\boxed{\sin\theta = \frac{y_B}{L}}$

$$W_{F_g} = -\Delta U_g$$

$$= -(U_B - U_A)$$

$$= -(mgy_B - 0)$$

$$= -mgy_B$$

$$W_{F_g}\ (A \to C \to B)$$

$$= W_{A \to C} + W_{C \to B}$$

$$= \underbrace{-mg\hat{j} \cdot D x \hat{i}}_{\text{Zero}} + (mg\sin\theta)L \cdots$$

$$= mg\ \boxed{L\sin\theta}^{\,y_B}$$

$$= -mgy_B$$

$(B \to A)$

$$W_{F_g} = -\Delta U_g$$

$$= -(U_A - U_B)$$

$$= -(0 - mgy_B)$$

$$= +mgy_B$$

$$W_{A \to B \to A} = 0$$

اذا بدك تقوم تشتغل علاجسم طاقتها محافظة بقول لك
تقليل ~~[illegible]~~ طاقة الوضع

$$W_{cons\ F} = -\Delta U$$

Non conservative forces :- dissipative forces.

= Forces that do not conserve the total mech energy [they transfer E_{mech} in to other forces (E_{int})]

e.g (friction, air resistance)

Five A

7-4 Force and Potential Energy:

$W_{cons\ force} = -\Delta U = \int \vec{F}_{cons} \cdot \vec{dr}$

$$\boxed{F_x = \frac{-dU}{dx}}$$

in 1D $\Rightarrow$ $W_{cons} = \int F_{cons} \cdot dx = -\Delta U$

$U = U(x, y, z)$

in 3D $\quad F_x = -\frac{dU}{dx}$

$F_y = \frac{-dU}{dy}$ $\quad \vec{F} = -\frac{dU}{dx}\hat{i} - \frac{dU}{dy}\hat{j} - \frac{dU}{dz}\hat{k}$

$F_z = \frac{-dU}{dz}$

---

e.g. $U_g = mgy = U(y)$

$F_y = \frac{-dU}{dy} = -mg(1) = -mg = F_g$

e.g. $U_s = \frac{1}{2}Kx^2 = U(x)$

$F_{(x)} = \frac{-dU}{dx} = \frac{-1}{2}K\,2x = -Kx = F_s$

Conservation of total Energy:-

Total Energy:-

$E_{tot} = E_{mech} + E_{int}$

Cons. of E_{total} :-

The total energy is conserved.
Energy is not created nor destroyed but transfered from one to another.

$E_{total} = E_{mech} + E_{int}$

$\Delta E_{mech} = \underbrace{-f_k d}_{-\Delta E_{int}} + W_{other(ext)}$

system

isolated — non-isolated

isolated: cons — non-cons

non-isolated: cons — non-con

cons: $\Delta E_{mech} = 0$

non-cons: $\Delta E_{mech} = -f_k d$

cons: $\Delta E_{mech} = W_{other}$

non-con: $\Delta E_{mech} = -f_k d + W_{other}$

[3] choose ref. configuration → $U_g = 0$ at $y = \sim$

[4] Assign the initial and final configuration

[5] Apply cons. law of Energy

↓

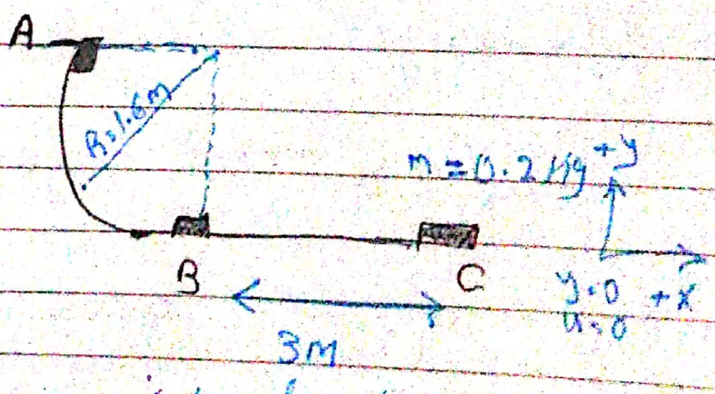
solve for the unknown.

#Prob 7.57 p.257

$v_A = 0$

$v_B = 4.9$ m/s

$v_C = 0$



[1] μ_k (B→C)

isolated and non.cons

[2] W_{f_k} (A→B)

$\Delta E_{mech} = -f_k d$

$\Delta K + \Delta U$ ←

$K_i = K_B = \frac{1}{2} m v_B^2$] $K_f = K_C = 0$ $\quad \Delta K = -\frac{1}{2} m v^2$

physics

$\sum F = ma$ → اهم قانون بقوانين نيوتن

Circular motion :-

مماسي $\sum F_t = ma_t$

$v = \frac{2\pi R}{T}$ → مسافة $= \frac{2\pi R N}{t}$

مركزي $\sum F_r = ma_r$

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

في حالة البندول المخروطي

$r = l \sin\theta$

طول الخيط ← l ، بين الخيط والعامود ← θ

$T = \frac{mg}{\cos\phi}$ $v = \sqrt{rg\tan\theta}$

في حالة سيارة تدور على دوار

$v = \sqrt{rg\mu_s}$

العربة في مدينة الملاهي

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

$v_{max} = \sqrt{rg}$

work

$W = F.d = F.d.\cos\theta$

$W = \Delta K.E = \frac{1}{2}m(v_2^2 - v_1^2)$

دائماً $W_N = \text{Zero}$

$W = \int F.dx$

$W =$ المساحة تحت المنحنى

work due to spring

$F_{app} = K\Delta x$ $F_s = -K\Delta x$

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

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

$W = \int P.dt$

Power

$P = \frac{\partial w}{\partial t}$ $P = \frac{dw}{dt} = \frac{dFx}{dt} = F\frac{dx}{dt} = \vec{F}.\vec{v}$

$P_{avg} = \frac{\Delta W}{\Delta t}$ $P_{ins} = \frac{dw}{dt}$

$P \xrightarrow{\text{تكامل}} W$ ، $W \xrightarrow{\text{اشتقاق}} P$

$U = \underbrace{mgh}_{\text{جذب أرض}} + \underbrace{\frac{1}{2}Kx^2}_{\text{نابض}}$

$E_{mech} = U + K.E$

$E_{mech} = mgh + \frac{1}{2}Kx^2 + \frac{1}{2}mv^2$

$E_1 + W_f = E_2$

$W_f = f_k \cdot d \cdot \cos\theta$

Prob 33 . p: 254

$m = 0.04\ Kg$

$U(x, y) = 5.85x^2 - 3.65y^3$

$|\vec{a}| = ?$ and direction at point $P(0.28\ m, 0.57\ m)$

S → $F_x = -\frac{dU}{dx} = -[5.85(2x) - 0]$

يعني نعوض x بعدها ·

$F_x|_P = -5.85(2 * 0.28) = \_\_\_ N$

$F_y = 0 - -3.65(3y^2)$

$F_y|_P = +3(3.65)(0.57)^2 = \_\_\_ N$

$\vec{F} = \_\_\_ \hat{i} + \_\_\_ \hat{j}$

$\Sigma\vec{F} = m\vec{a}$

$\vec{a} = \frac{\quad}{m}\hat{i} + \frac{\quad}{m}\hat{j}$ A

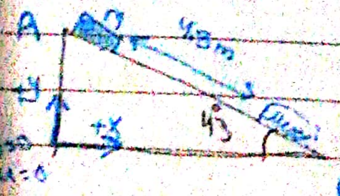
7. 30 p. 254 8-

$mg = 86\ N$

$v_A = 0$

$v_B = ?$

$f_k = 22\ N$



isolated and non-cons

$E_{mech} = -f_k d$

$K_i = 0$

ΔK { $K_f = \frac{1}{2}mv^2$

$U_i = mgy_A = mg\ 4.8\sin(45)$ } ΔU

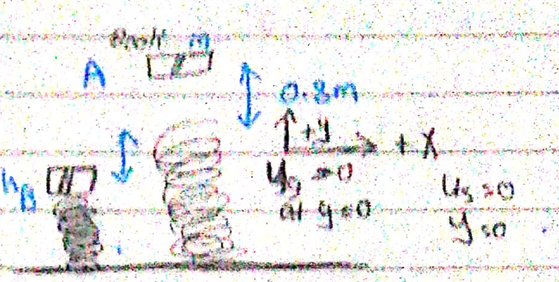
$U_f = 0$

7.21 p.253

$K = 1000\ N/m$

(a) $U_s = 13.2\ J \Rightarrow x = ?$

$\frac{1}{2} K x^2_{\text{inm}} = 3.2\ J$



$m = 1.2\ Kg$

$v_A = 0$

$\Delta E_{mech} = 0$ # isolated and cons.

$X_{max} = ??\quad v_B = 0$

$E_{mech_i} = E_{mech_f}$

$K_i + U_i = K_f + U_f$

$K_A + U_{g_A} + U_{sA} = K_B + U_{gB} + U_{sB}$

$0 + mg(0.8) + 0 = 0 + mg(-h) + \frac{1}{2} K(-h)^2$

$mg(0.8) = -mgh + \frac{1}{2} Kh$

6.79 # 6.71

Ch 8: Momentum, Impulse and Collision:

8.1 : Momentum and Impulse:

** linear momentum: the product of object's mass and its velocity

$\vec{P} = m\vec{V}$ $\quad \vec{P} \parallel \vec{v}$.

mass ← velocity

vector quantity $\vec{P} \parallel \vec{V}$

in 3D $\Rightarrow P_x = mV_x \quad P_y = mV_y \quad P_z = mV_z$

$[P] = [m][V]$ Kg.m/s in SI system.

$\boxed{\Sigma \vec{F} = m\vec{a}}$

Generalized form of Newton 2nd Law

= the relationship between the momentum of a particle/system and the net force acting on it.

$$\Sigma \vec{F}_{particle} = \frac{d\vec{P}_{particle}}{dt} \qquad \Sigma \vec{F}_{system} = \frac{d\vec{P}_{tot}}{dt}$$

$$\Sigma \vec{F} = m\vec{a} \qquad \vec{a} = \frac{d\vec{v}}{dt}$$

$$= m\frac{d\vec{v}}{dt}$$

$$= \frac{d\, m\vec{v}}{dt} = \frac{dP}{dt}$$

$\Sigma \vec{F} = m\vec{a}$ → a particular case

valid if m = const + indep. of time

impulse = دفع = $\vec{J}$ or $\vec{I}$

vector quantity ~~X~~ وله نفس اتجاه التغير في

= change in linear momentum

= the time integral of the net force acting on the particle/system

$$\Delta \vec{P} = \int \Sigma \vec{F} \cdot dt = \text{area the } \Sigma F - t \text{ curve}$$

$$= |\text{impulse}|$$

$[\text{impulse}] = [P] = Kg \cdot m/s$

$[F][\Delta t] = N \cdot s$

special cases: if $\Sigma F \neq$ function of time

$$\Delta \vec{P} = \Sigma \vec{F} (\Delta t)$$

$$\Sigma \vec{F} = \frac{\Delta \vec{P}}{\Delta t}$$

"impulse — force theorem"

* Impulse Approximation: * If there are many forces acting on a system, such that one of them is much strong than all other forces and acts only for a short time, then the net force (ΣF) can be considered as this force only.

* Conservation of linear momentum:

$$\Sigma \vec{F}_{sys} = \frac{d\vec{P}_{tot}}{dt}$$

the total linear momentum of a syst. is conserved (constant) if the net force on the system equals zero.

if $\Sigma \vec{F}_{sys} = 0$ then $\vec{P}_{tot} = $ const $\rightarrow$ $\vec{P}_{total\ initial} = \vec{P}_{total\ final}$

* Collisions: التصادم

is an event in which two particle interact with each others by means of forces.

- It can happen between macroscopic object or microscopic particles

"physical contact" / "physical contact"

* at the moment of collision (short - internal), forces of interaction (F_{12} and F_{21}) $\gg$ other forces $\Rightarrow$ impulse Approximation can be used.

internal to the system.

$\Sigma \vec{F}_{system} = 0$

$\Rightarrow \vec{P}_{\substack{total\\system}} = Const$

$$\vec{P}_{tot_i} = \vec{P}_{tot_f}$$

$$\vec{P}_{1i} + \vec{P}_{2i} = \vec{P}_{1f} + \vec{P}_{2f}$$

$\boxed{\text{in 1D}}$ $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$

$\pm$ Sign = direction.

$\boxed{\text{in 2D}}$

$$m_1 v_{1ix} + m_2 v_{2ix} = m_1 v_{1fx} + m_2 v_{2fx}$$

$$m_1 v_{1iy} + m_2 v_{2iy} = m_1 v_{1fy} + m_2 v_{2fy}$$

$\Rightarrow$ valid for any collision.

($\vec{P}_{tot}$ is conserved)

\# Types of collision go [based on whether the total K.E is conserved or not]

[$\vec{P}_{tot}$ = Const in all type]

$\boxed{1}$ Elastic Collisions:

total K.E = Const (conserved)

$$\vec{P}_{i\,tot} = \vec{P}_{f\,tot}$$

\# $K.E_{i\,tot} = K.E_{f\,tot}$

$\boxed{2}$ Inelastic Collisions:-

- total KE is not conserved

$$P_{tot_i} = P_{tot\,f}$$

$$K.E_{f\,total} < K.E_{i\,total}$$

- perfectly elastic collisions occur on atomic scale.
- On macroscopic scale elastic collision are approximately elastic.

Five Apple

5 Completely inelastic collisions: (perfectly inelastic)

huge lose in total K.E

$\vec{P}_{tot} = const$

$K.E_{tot\,f} \ll K.E_{tot\,i}$

Pefectly (completely = totally) inelastic Collision.

$K.E_{tot\,f} \ll K.E_{tot\,i} \Rightarrow \vec{P}_{tot\,i} = \vec{P}_{tot\,f}$

the 2 colliding particles stick together after collision (entangled)

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

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

8.4 Elastic collisions:

10 Head on — before — After.

Find v_{1f} and v_{2f}

$\vec{P}_{tot} = Const = m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$ ①

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

② ⇒ $m_1(u_{1i}^2 - u_{1f}^2) = m_2(u_{2f}^2 - u_{2f}^2)$

rewrite ③ $m_1(u_{1i} - u_{1f}) = m_2(u_{2f} - u_{2f})(u_{2f} + u_{2f})$

rewrite ① ⇒ $m_1[u_{1i} - u_{1f}] = m_2[u_{2f} - u_{2i}]$ ④

divide $\frac{③}{④}$

$u_{1i} + u_{1f} = u_{2f} + u_{2i}$

$u_{1i} - u_{2i} = u_{2f} - u_{1f}$

Elastic ⑤ $\boxed{u_{1i} - u_{2i} = -[u_{1f} - u_{2f}]}$

$$u_{1f} = \left[\frac{m_1 - m_2}{m_1 + m_2}\right] u_{1i} + \left[\frac{2m_2}{m_1 + m_2}\right] u_{2i}$$

$$u_{2f} = \left[\frac{2m_1}{m_1 + m_2}\right] u_{1i} + \left[\frac{m_1 - m_2}{m_1 + m_2}\right] u_{2i}$$

special cases:

1 if $m_1 = m_2 = m$ كمرات البلياردو   تبادل سرعات

[identical collision particles]

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

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

2 if m_2 at rest before collision $u_{2i} = 0$

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

2 Spicial cases

$\boxed{2.1}$ if $m_2 \ggg m_1$ جسم خفيف يخبط بحيط

$v_{1f} \simeq -v_{1i}$

$v_{2f} \simeq$ Zero

$\boxed{2.2}$ if $m_1 \ggg m_2$ شاحنة تخبط سيكل

$v_{1f} \simeq v_{1i}$

$v_{2f} \simeq 2v_{1i}$

8.5 Canter of mass ≡ C.M

The possition of apoint in the space such that if the mass of the object was consentrated in this point its will ~~[illegible]~~ have translat̲ional motion same as the entive object.

$$X_{C.M} = \frac{\sum m_i x_i}{\sum_{i=1} m_i} = \frac{m_1 x_1 + m_2 x_2 + \cdots}{m_1 + m_2 + \cdots}$$ → for a system of discreat particles

$$Y_{C.M} = \frac{m_1 y_1 + m_2 y_2 + \cdots}{m_1 + m_2 + \cdots}$$

$$\vec{r}_{C.M} = X_{C.M}\,\hat{i} + Y_{C.M}\,\hat{j} + Z_{C.M}\,\hat{k}$$

$$= \frac{\sum m_i \vec{r_i}}{\sum m_i}$$

$\sum m_i$ = total mass

for contenus object: $\int \vec{r_i}\, dm$ ✗

C.M. for homogenous symetric objects $\Rightarrow$ at the geometical center

C.M closer to massive particles.

C.M is the same as C.G Center of gravity

$\Downarrow$

Ch. 11

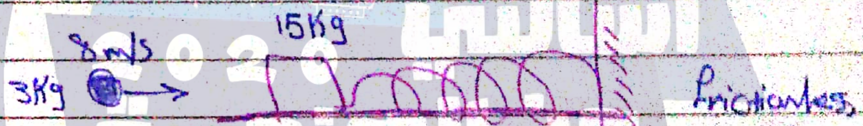
$$X_{C.G} = \frac{\Sigma m_i x_i}{\Sigma m_i}$$

$\boxed{w = mg}$

$$Y_{C.G} = \frac{\Sigma m_i y_i}{\Sigma m_i}$$

$[C.M] = [C.G] = m$

8.44 Prob p. 290



isolated

$K = 575$ N/m

$m_{block} = 15$ Kg

$m_{stone} = 3$ Kg

$v_{stone\,i} = 8$ m/s right $\Rightarrow 8\hat{i}$

$v_{stone\,f} = 2$ m/s left $\Rightarrow -2\hat{i}$

$\Delta x_{max} = ??$

$v_{f\,block} = 0$

Cons. of mech. energy

$E_{mech\,i} = E_{mech\,f}$

$K_i + \underset{0}{U_{si}} = \underset{0}{\cancel{K_f}} + U_{sf}$

$\frac{1}{2} m_b v_{fb}^2 = \frac{1}{2} K (\Delta x_{max})^2$

$\vec{P}_{tot\,i} = \vec{P}_{tot\,f}$

$m_s v_{si} + \cancel{m_b v_{bi}} = m_s v_{sf} + m_b v_{fb}$

$3(8\hat{i}) = 3(-2\hat{i}) + 15\, v_{fb}$

$v_{fb} = 2$

Suggested Problems

51 prob   p. 291

$m_1 = 0.31\ Kg \quad r_{C.M_1} = (0.19m, 0.3m)$

$m_2 = 0.41\ Kg \quad r_{C.M_2} = (0.1\ m, -0.38\ m)$

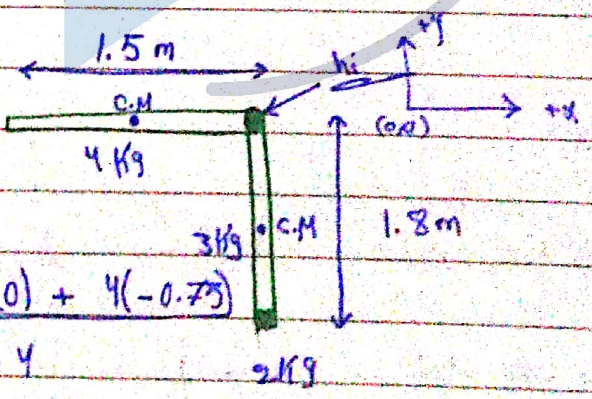
$m_3 = 0.19\ Kg \quad r_{C.M_3} = (-0.2m, 0.63\ m)$

$$X_{C.M} = \frac{(0.31)(0.19) + (0.41)(0.1) + (0.19)(-0.2)}{(0.31) + (0.41) + (0.19)} = \boxed{}$$

$$Y_{C.M} = \frac{(m_1 y) + (m_2 y) + (m_3 y)}{m_1 + m_2 + m_3} = *$$

$$\vec{r} = X_{C.M}\ \hat{i} + Y_{C.M}\ \hat{j} = \boxed{}\ \hat{i} + *\ \hat{j}$$

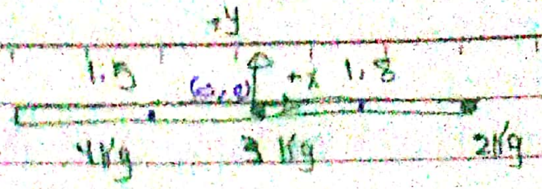
8.55   p. 291



initially :-

$$X_{C.M} = \frac{2(0) + 3(0) + 4(-0.75)}{2 + 3 + 4} = \boxed{}\ m$$

$$Y_{C.M} = \frac{2(-1.8) + 3(.9) + 4(0)}{2 + 3 + 4} = *\ m$$



$$X_{CM} = \frac{2(1.9) + 3(0.9) + 4(-0.75)}{2+3+4}$$

$$= \boxed{\quad}\, m$$

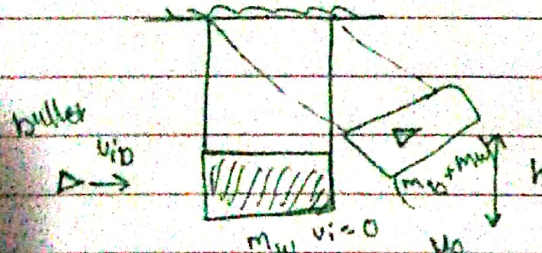
$$Y_{CM} = \frac{2(0) + 3(0) + 4(0)}{2+3+4}$$

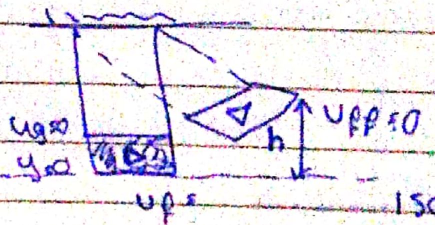
$= \text{Zero}$

※ 8.13

$|\vec{Impulse}| = |\Delta \vec{p}|$ = area under ~

Example 8.0 Ballistic pendulum → completely inelastic





Isolated and Conservation

$$\underbrace{m_b v_{ib} + m_w v_{iw}}_{\text{zero}} = m_b v_{fb} + m_w v_{fw} = (m_b + m_w) v_f$$

$\Delta E_{mech} = 0$

$E_{mech\,i} = E_{mech\,f}$

$K_i\ U_i = K_f\ U_f$

$$v_{ib} = \left(\frac{m_b + m_w}{m_b}\right) v_f$$

$\frac{1}{2}(m_b + m_w) = 0 + (m_1 m_2) gh$

$v_f = \sqrt{2gh}$

Chapter 9 : Rotation of Rigid Bodies about a fixed axis

Rigid objects :
= non-deformable objects :
(object with relation distance between the particle constitutes the object is const)

9.1 Angular velocity and Acceleration :

Angular position : $= \theta$ $[\theta] =$ radian
the angle subtended between a line fixed in the object . a line fixed in space

Chosen +x-axis.

2π rad $\Rightarrow 360^\circ \Rightarrow$ 1 revolution.

Ang. Displacement $= \Delta\theta$

$$\Delta\theta = \theta_f - \theta_i$$

$[\Delta\theta] =$ radian.

$\Delta\theta > 0$ if rotating C.C.W
$\Delta\theta < 0$ " " C.W.

Angular velocity

Average ang velocity $= \bar{\omega} = \omega_{avg} = \dfrac{\Delta\theta}{\Delta t}$

Inst. ang. velocity $= \omega = \dfrac{d\theta}{dt}$

$[\omega] =$ rad/s inst.

Ang. Acc.

average ang. acc $= \bar{\alpha} = \alpha_{avg} = \dfrac{\Delta\omega}{\Delta t}$

Inst. " " $= \alpha = \dfrac{d\omega}{dt} = \dfrac{d^2\theta}{dt^2}$

$[\alpha] =$ rad/s^2 $= s^{-2}$

as the object rotates (with ω) every point on it (P) circulates. (with V)

Five Apple

$\vec{\alpha}$ and $\vec{\omega}$ (instantaneous) # vectors
$\vec{\alpha}$ and $\vec{\omega}$ (scalers)
$\Delta\theta$ don't
add as vector.

$\vec{\omega}$ # rotation c.c.w # +ve
c.w # -ve

$\vec{\alpha}$ # if rotation c.c.w and ω is speeding up.
or rotation c.w and ω is slowing down.
α is +ve

9.2 Rotation with const avg. acc. $\bar{\alpha} = \alpha = \text{const}$

$\omega_f = \omega_i + \alpha t$

$\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2$

$\theta_f = \theta_i + \frac{\omega_i + \omega_f}{2} t$

$\omega_f^2 = \omega_i^2 + 2\alpha(\Delta\theta)$

$\boxed{t \equiv \Delta t \quad \alpha = \text{const}}$

9.3 Relating Linears and Angular Kinematics :-

relation ship between translation quantities of point P and avg quantities of the object.

$\omega \rightarrow$ قيمة لكل الكرة

[illegible] $\leftarrow s = r\theta$

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

[illegible] $v = r\omega$, $a_t = r\alpha$ $\quad a_c = \frac{v^2}{r} = r\omega^2$

$(v_i = r_i\,\omega)$

Final ... 7/1/2020 all subject.

9.4 Energy in Rotational Motion :

	translation	Rotational
Position	x or y	θ
displacement	$\Delta x , \Delta \vec{r}$	$\Delta \theta$
velocity	$\vec{v}$	$\vec{\omega}$
acc.	$\vec{a}$	$\vec{\alpha}$
mass m		moment of inertia $\equiv I$

K.E	$\frac{1}{2} m v^2$	$\frac{1}{2} I \omega^2$
	$\vec{F}$	$\vec{\tau}$ (torque)
	$\Sigma \vec{F} = m\vec{a}$	$\Sigma \vec{\tau} = I \vec{\alpha}$
	$dw = \vec{F} \cdot d\vec{r}$	$dw = \Sigma \tau \cdot d\theta$

عزم القصور [القصور الذاتي]

Moment of inertia $\equiv I$

a messure of the resistance of the object to any change in its rotation motion.

- scaler.

$I_{tot} = I_1 + I_2 + I_3 + \dots$

$[I] = kg . m^2$

for a system of discrete particles.

$I = \Sigma m_i r_i^2 = m_1 r_1^2 + m_2 r_2^2 + \dots$

⇒ I depends on the choice of axis of rotation.

there is no uniqe value of I

$I = I_{min}$ for axis of rotation passing though C.M

$= I_{C.M}$

* for continuous object

↓ integration تكامل

وبالتالي

See table 9.2 page . 310

work $w = \vec{F} \cdot \Delta \vec{r}$	$w = \Sigma \tau \Delta \theta$
Power $P = \frac{w}{\Delta t}$	" "
$P = \vec{F} \cdot \vec{v}$	$\tau . \omega$
momentum linear $\vec{P} = m\vec{v}$	angular $\vec{L} = \vec{r} \times \vec{P}$

for rigid object $L_z = I \omega_z$

Five Appl

Rotational K.E :-

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

انتبه!

$$K.E_R = \Sigma K.E_i$$

$$= \Sigma \frac{1}{2} m_i v_i^2 \rightarrow \boxed{v_i = r_i \omega}$$

$$\frac{1}{2} \left[\Sigma m_i r_i^2\right] \omega^2$$

9.5 Parallel axis :- theorem

$$I_p = I_{C.M} + Md^2$$

Chapter 10 :- Dynamics of Rotational Motion.

Q.1 Torque $\equiv \vec{\tau}$

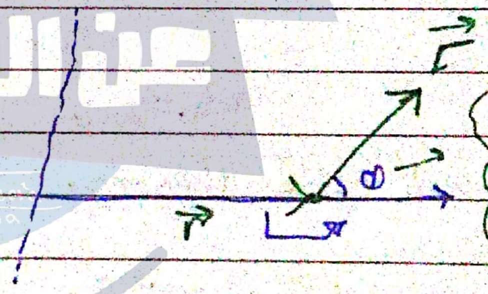
the tendency of a force to rotate an object about an axis.

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

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

$$[\tau] = N.m$$

vector $\vec{\tau}_{net} = \vec{\tau}_1 + \vec{\tau}_2 + \dots$



يجب ان تكون المتجهين رأسين أو ذيلين

$\tau = max \quad \theta = 90^\circ \quad \vec{r} \perp \vec{F}$

$\tau = 0 \quad \theta = 0$ or $180 \quad \vec{r} \parallel \vec{F}$

$\vec{r}$: Position vector of the Point of application of $\vec{F}$, w.r.t axis of rotation.

θ : Smaller angle.

10.2 Torque and ang. acc. for a rigid body.

* Rotational version of Newton's 2nd Law.

$$\Sigma\vec{\tau} = I\vec{\alpha}$$

↑ relation to same axis of rotation

10.3 α

10.4 work and Power in Rotational Motion.

$$dW = \Sigma\tau\, d\theta$$

$$\text{work} = \Sigma\tau\, \Delta\theta$$

radian

Power $= \frac{\text{work}}{\Delta t}$

$$P = \tau\vec{\omega}$$

ang. velocity. ←

work - K.E theorm.

$$W = \Delta K.E_{Rot}$$

$$= \frac{1}{2} I \omega_f^2 - \frac{1}{2} I \omega_i^2$$

10.5 Angular momentum $\equiv \vec{L}$

vector → $\vec{L}_{tot} = \vec{L}_1 + \vec{L}_2 + \dots$

$\vec{L} = \vec{r} \times \vec{p}$

$\vec{p} = m\vec{v}$: linear momentum

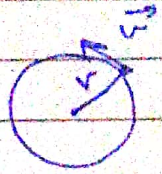
$\vec{r}$: position vector w.r.t axis of rotation

$|\vec{L}| = rp\sin\theta$

$= mvr\sin\theta$

$\vec{L} \perp \vec{r}$ and $\vec{p}$

e.g. $\vec{L}$ for a particle in uniform circular motion.



$\vec{L} = \vec{r} \times \vec{p}$

$= rmv \cancel{\sin\theta} \rightarrow 1$

$\boxed{|\vec{L}| = L = mvr}$

For a rigid object.

$L = I\omega$

$\omega \rightarrow$ ang. velocity

Mais Malkawi.

10.6 Conservation of Ang. motion.

N. 2nd Law $\quad \Sigma \vec{T} = \dfrac{d\vec{L}}{dt}$

$$\Sigma \vec{T}_{ext} = \frac{d\vec{L}_{tot}}{dt}$$

if $\Sigma \vec{T}_{ext} = 0$

$$\vec{L}_{tot} = \text{const}$$

$$\vec{L}_{tot_i} = \vec{L}_{tot\,f}$$

$$I_i w_i = I_f w_f$$