Unit 1 As Edxcel Revision

Topic 2 Materials:
- → 2A Fluids
- → 2B Solids

2A Fluids:
- → Liquid
- → Gas

"has the ability to flow"

* Density: $\rho = \frac{m}{V}$ [$kg\,m^{-3}$ or $g\,cm^{-3}$]

Note: Conversions

- $cm \xrightarrow{\times 10^{-2}} m$, $m \xrightarrow{\times 10^{2}} cm$
- $cm^2 \xrightarrow{\times 10^{-4}} m^2$, $m^2 \xrightarrow{\times 10^{4}} cm^2$
- $cm^3 \xrightarrow{\times 10^{-6}} m^3$, $m^3 \xrightarrow{\times 10^{6}} cm^3$

- $1\,kg\,m^{-3} = \frac{1000\,g}{10^6\,cm^3}$

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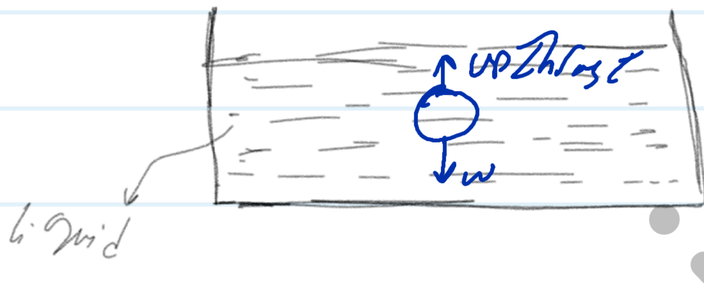
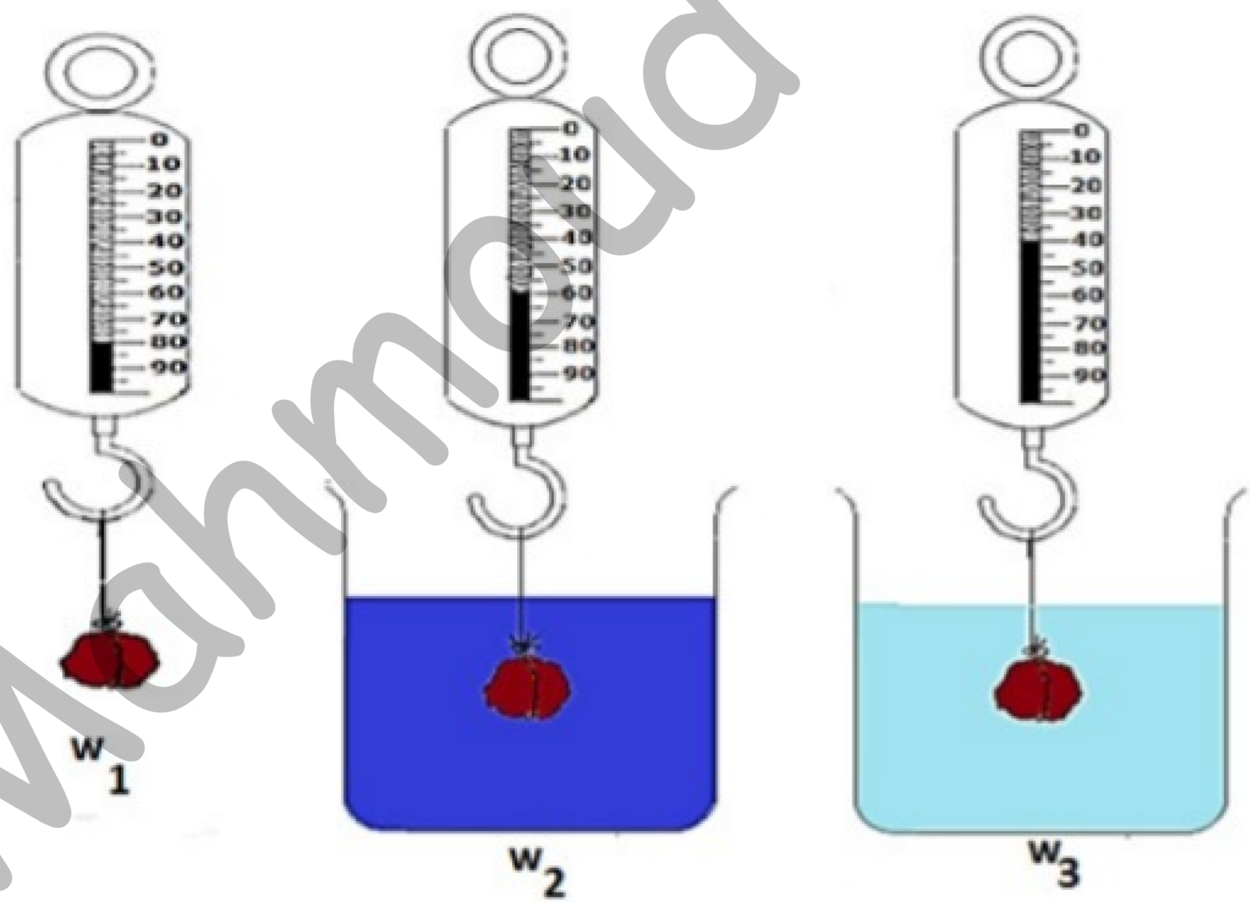
* UPThrust:



• 3 Cases:

↳ 1- Moving up ⟹ UPThrust > weight
↳ 2- Moving down ⟹ UPThrust < weight
↳ 3- Floating ⟹ UPThrust = weight



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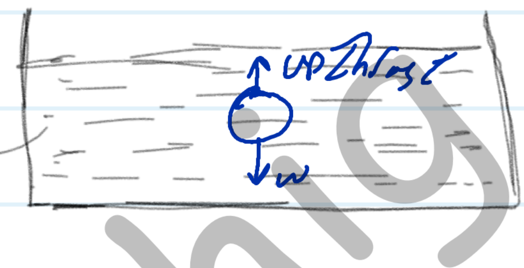
* If the object is floating and totally immer (case 3):



upthrust = weight of object

upthrust is the weight of liquid displaced by the object.

weight of liquid displaced = weight of object

$m_l g = m_o g$

(mass of liquid ← m_l; mass of object → m_o)

$m = \rho V$

$(V_l = V_o) \Longrightarrow \rho_l V_o g = m_o g$

where: V_o (sphere) $= \frac{4}{3}\pi r^3$

• For object at rest $F_R = 0$

↳ up force = down force

$\rightarrow r = \frac{D}{2}$ Page 62 student book

4. A golf ball has a diameter of 4.27 cm.

(a) If a golf player hits the ball into a stream, what upthrust does it experience when it is completely submerged? (Assume density of water = 1000 kg m^{-3}.)

(b) If the mass of the ball is 45 g, what is the resultant force on it when underwater?

(c) Referring to Newton's laws of motion, explain what will happen to the submerged golf ball.

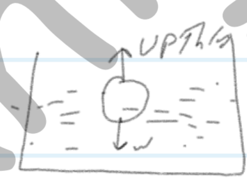
(a) upthrust = weight of liquid displaced

$= m_l g$

$= \rho_l V_{ball} g$

$= 1000 \times \frac{4}{3}\pi (2.135 \times 10^{-2})^3 \times 9.8$

$= 0.40$ N



(b) weight of ball $= mg = 45 \times 10^{-3} \times 9.8$

$= 0.441$ N

$F_R = W -$ upthrust

$= 0.441 - 0.40 = 0.041$ N

(c) There is a resultant downwards force, so it will accelerate to the bottom (Newton's first law). There, an additional reaction force (Newton's third law) from the bed of the stream will cause a net force of zero so the ball will rest on the bottom stationary (Newton's first law). Extra: initially on reaching the bottom the upwards reaction will be slightly greater to decelerate to rest. Students may also comment on drag forces affecting the rate of acceleration during descent (Newton's second law).

SUBJECT VOCABULARY

fluid any substance that can flow
density a measure of the mass per unit volume of a substance
upthrust an upwards force on an object caused by the object displacing fluid
Archimedes' principle the upthrust on an object is equal to the weight of fluid displaced
hydrometer an instrument used to determine the density of a fluid

* Fluid Movement:
  - → laminar
  - → Turbulent

- laminar flow (streamline) occurs at lower speeds. (velocity constant).
- Turbulent flow when velocity increases past a certain value.

SUBJECT VOCABULARY

laminar flow/streamline flow a fluid moves with uniform lines in which the velocity is constant over time

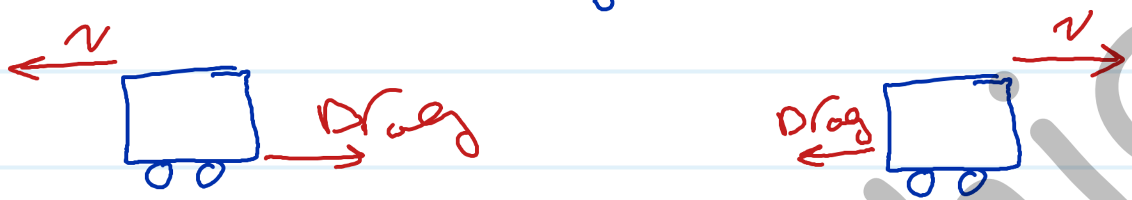
turbulent flow fluid velocity in a particular place changes over time, often in an unpredictable manner

streamlines lines of laminar flow in which the velocity is constant over time

* Viscosity:
  - → low viscosity 

  - → High viscosity 

- Drag force: The friction between solid body and fluid. (force opposing motion)



- η is the coefficient of viscosity.

- For high η, The fluid is high viscous and The drag is high.

- For low η, The fluid is less viscous and The drag is low.

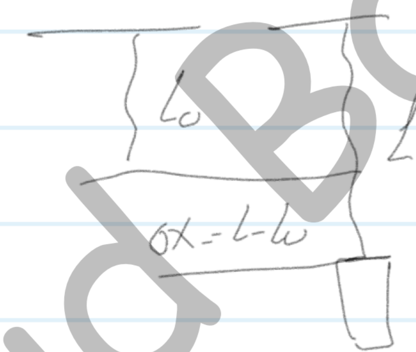
SUBJECT VOCABULARY

viscosity how resistant a fluid is to flowing
coefficient of viscosity a numerical value given to a fluid to indicate how much it resists flow

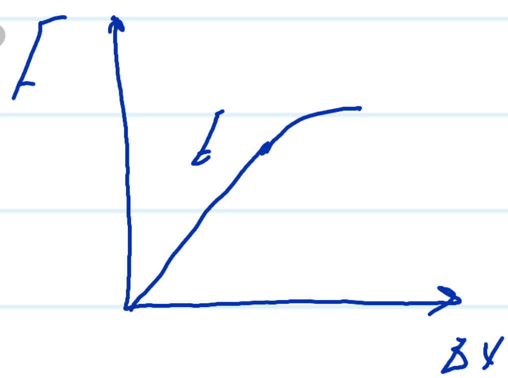
2B Materials

* Hooke's law:

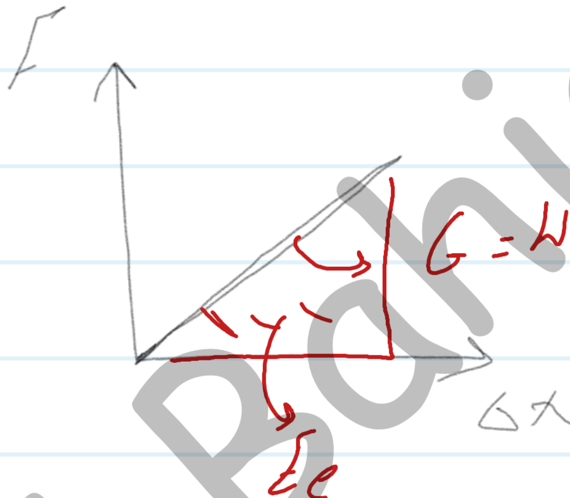
$$F = k\,\Delta x$$



• If spring obey's hooke's law
↳ $F \propto \Delta x$



* Elastic strain energy:



Gradient = stiffness k

Area under graph = E_e

$$G = \frac{F}{\Delta x} = k$$

$$\text{Area} = \tfrac{1}{2} F \Delta x = E_e$$

$$E_e = \tfrac{1}{2} F \Delta x = \tfrac{1}{2} k \Delta x^2$$

Q. Prove that the two eqns equal?

using units $\tfrac{1}{2} F \Delta x = \tfrac{1}{2} k \Delta x^2$

L.H.S = N.m

R.H.S = $\frac{N}{m} \cdot m^2$ = N.m

so eqns equal

* Deformation of solids:

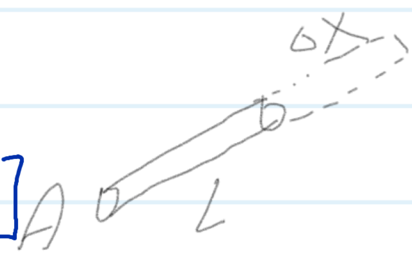
- **Elasticity**: "The ability of a solid material to regain its shape after it has been deformed or distorted."

- **Tensile**: is the stretches of an object.

- **Compressive**: is the deformation of an object.

* Tensile stress and strain:

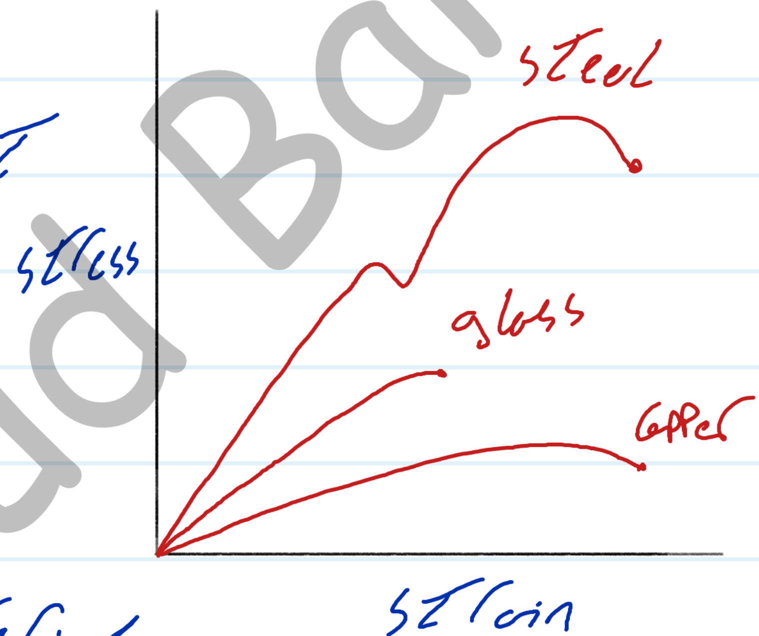
$$\text{stress},\ \sigma = \frac{F}{A}$$, [Pa = N m^{-2}]



$$\text{strain},\ \varepsilon = \frac{\Delta x}{x}$$, [no unit]

Young modulus, $E = \dfrac{\text{stress}}{\text{strain}} = \dfrac{\sigma}{\varepsilon}$, [Pa]

* stress-strain curves for different materials



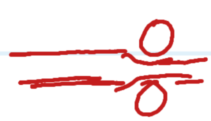
- The stiffness of different materials can be [found] using gradient (E)

  ↑ E → stiffer ↑

- The strength of material is its (UTS), steel is stronger.

- A brittle material, like glass breaks without any noticeable yield.

- A ductile material, like copper can be drawn into a wire.



less A, more L

1A Mechanics

1 Velocity & acceleration:

- vector: has magnitude & direction.
- scalar: has magnitude only.

Distance (scalar) —÷t→ speed (s) —÷t→ acceleration (vector)

Displacement (vector) —÷t→ velocity (v) —÷t→ acceleration

- Acceleration: "rate of change in velocity"

$$a = \frac{\Delta v}{\Delta t} = \frac{v-u}{t}$$

- +ve → in same dir of velocity ($+a \rightarrow$, $v \rightarrow$)
- −ve → in opposite dir of velocity ($a \leftarrow$, $v \rightarrow$)

- If a is:
  - → +ve the body accelerate (inc v)
  - → -ve The body decelerate (dec. v)

- If the question asked for deceleration
  → calculate $a = \frac{\Delta V}{\Delta T} = -ve$ $(-2ms^{-2})$
  → so deceleration $= 2ms^{-2}$

- $V_{average} = \frac{\text{Total distance moved}}{\text{Total time taken}}$

→ Hint: 1- $V_{avg} < V_{max}$

2- $V = \frac{d}{T}$
- → $V_{average}$
- → $V = \text{constant}$ $(a=0)$

If the $a \neq 0 \Rightarrow$ you have to use equations of motion with uniform acceleration:

Kinematics eqns

1. $a = \frac{V-U}{T} \Rightarrow V = U + aT$ — ①

2. $S = UT + \frac{1}{2}aT^2$ — ②

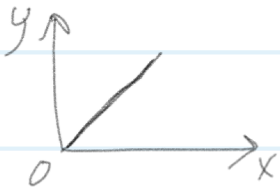
3. $S = \left(\frac{U+V}{2}\right) t$ — (3)

4. $V^2 = U^2 + 2aS$ — (4)

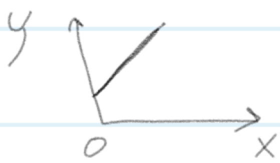
Check point:

2 Motion Graphs:

- Graph: is a relation between two variables.
- Variable: 1- Independent variable. x-axis
  2- Dependent variable y-axis
  3- Control variable. Conditions
- Relations: 1- Direct and linear

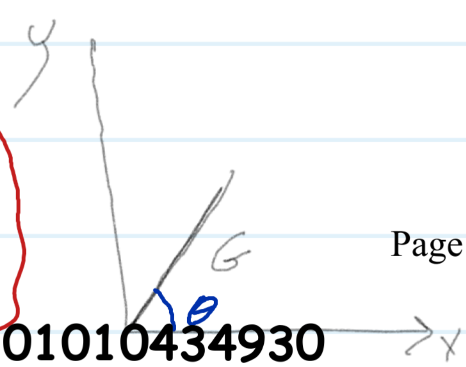


2- linear but not direct

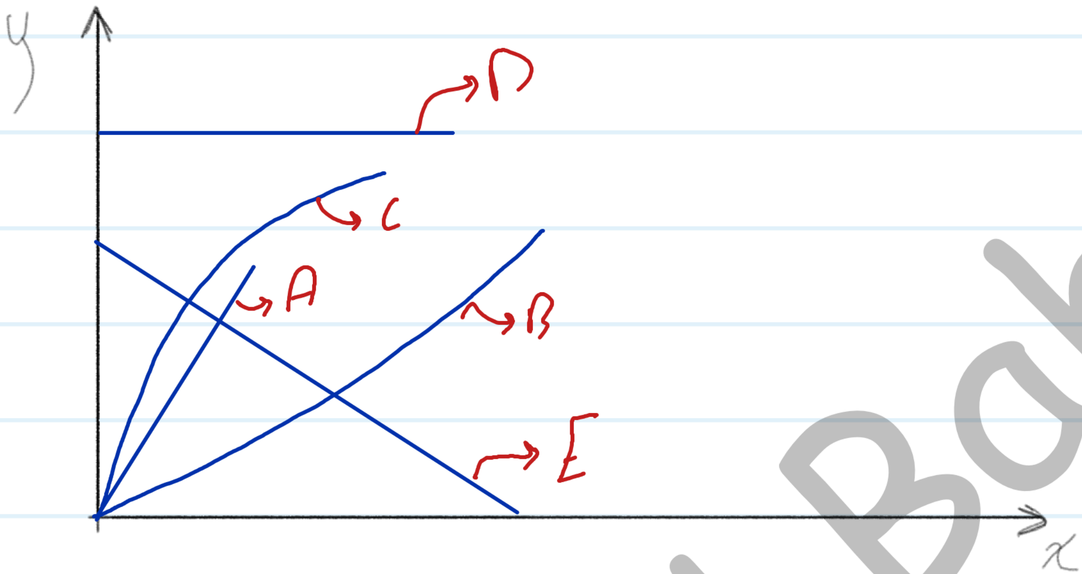


- Gradient:

$$G = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1} = \tan\theta$$



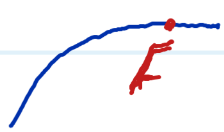
* Types of gradient:



A: constant gradient (line) = $\tan\theta$ = const

B: increasing gradient (curve) = $\tan\theta$ = increase

C: decreasing gradient (curve down) = $\tan\theta$ = dec.



$G_F = 0$ $(\theta = 0)$

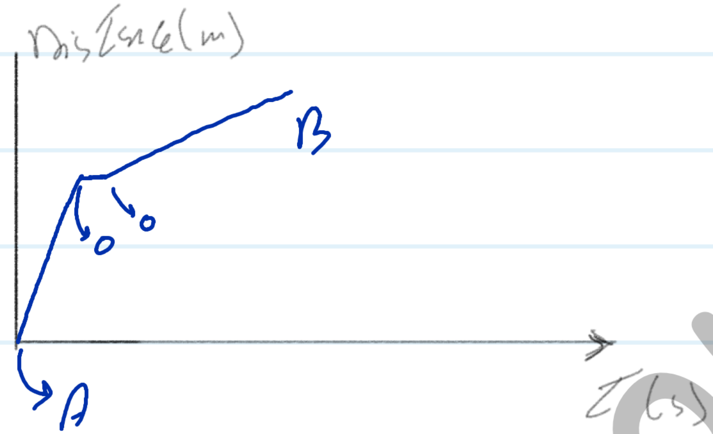
D: gradient = zero $(\theta = 0)$

E: -ve constant gradient

* Motion Graphs:

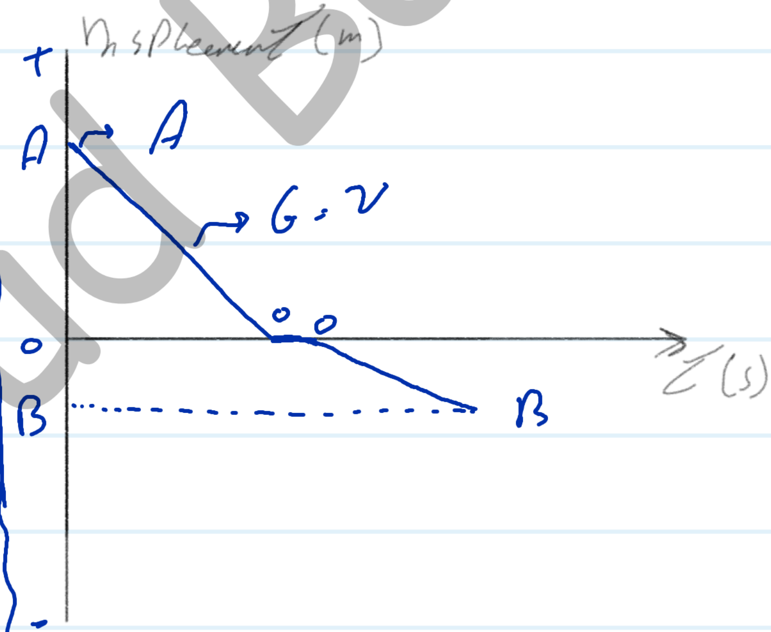
Distance

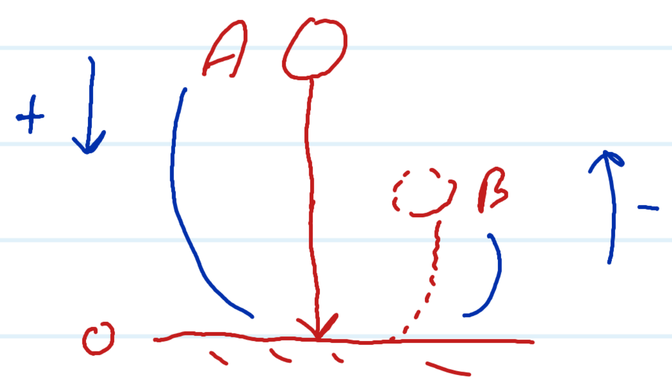
G → speed



Displacement

G → velocity

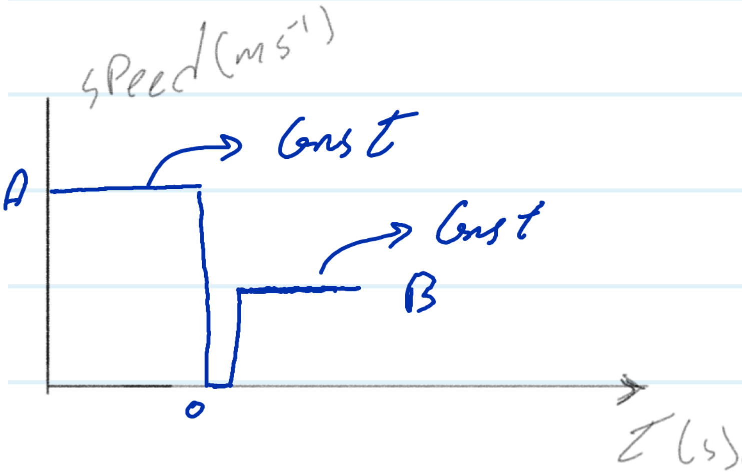


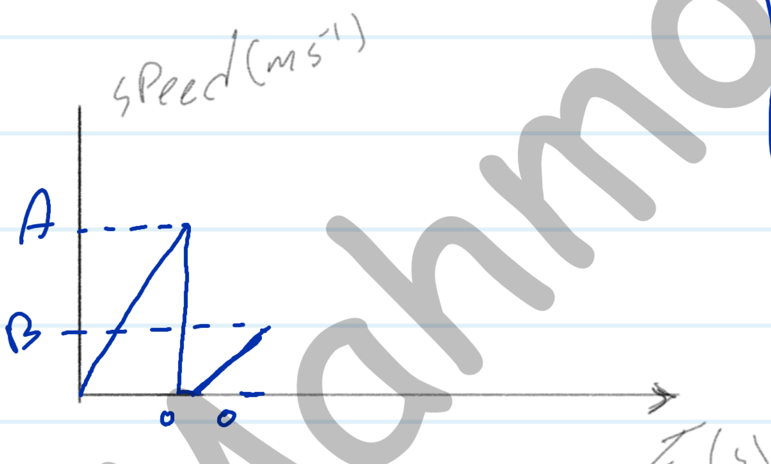


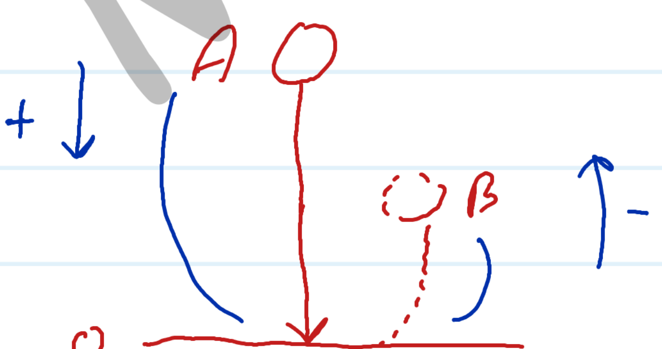
Speed

G → accelration

Area → distance



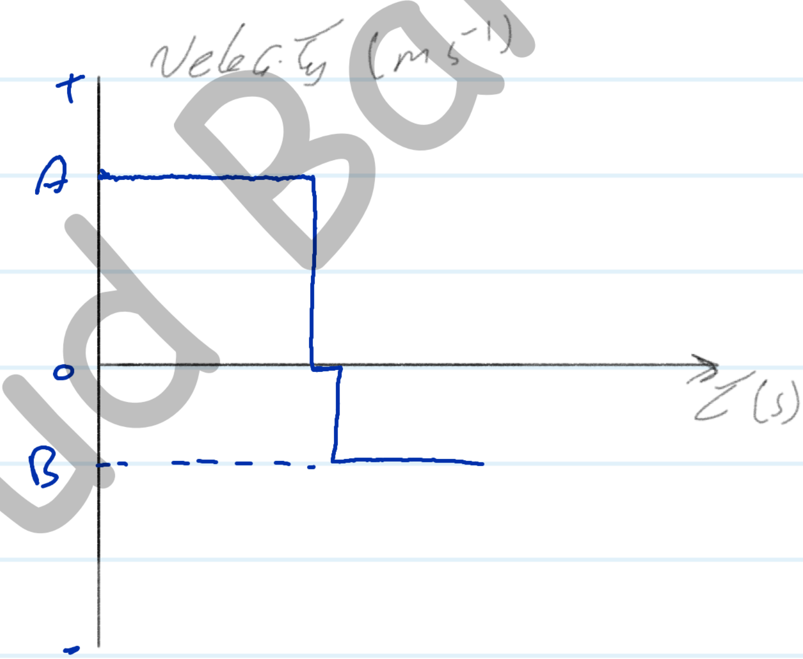


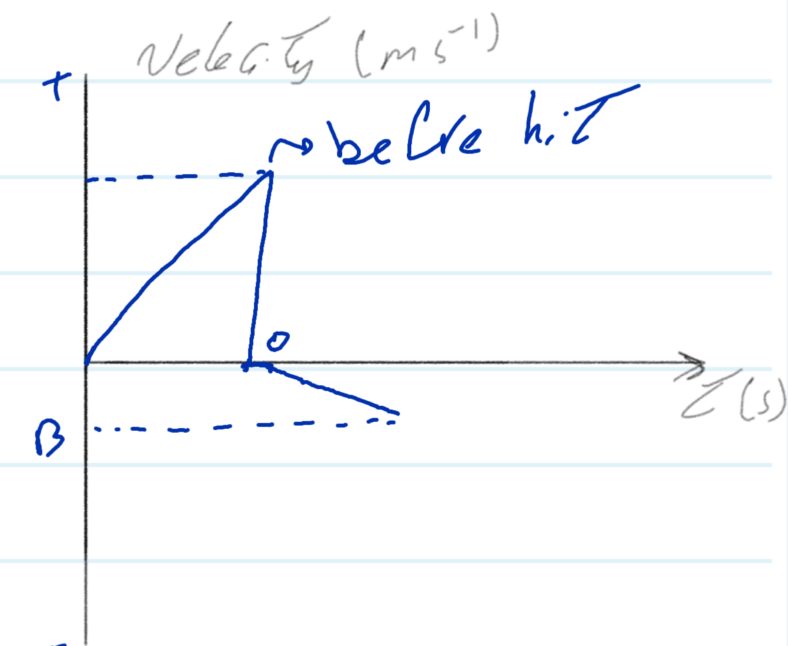


Velocity

G → accelration

Area → displacement





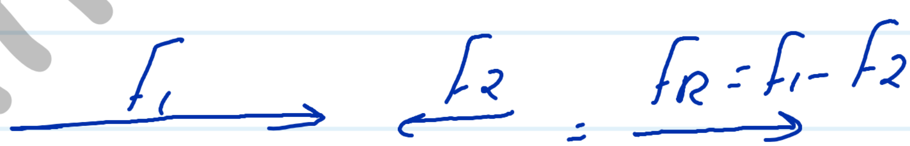
3 Adding Force:

- Force is a vector quantity. 

- Resultant Force:
  1. same line, same dir

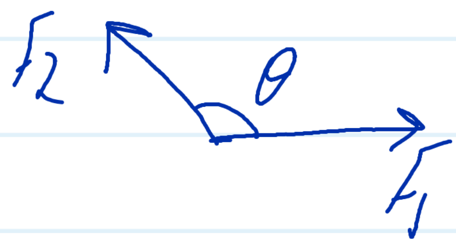
$F_R = F_1 + F_2$

  2. opposite dir.



$F_R = F_1 - F_2$

  3. has an angle

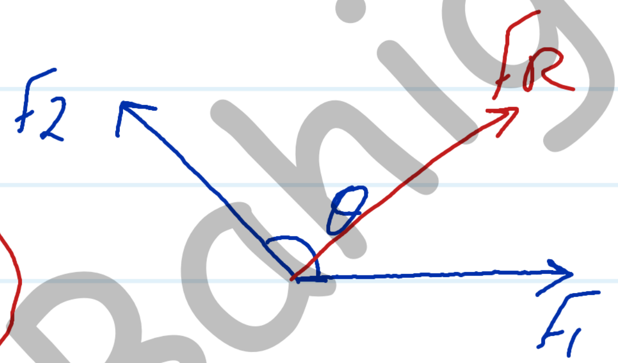


3. To find the FR

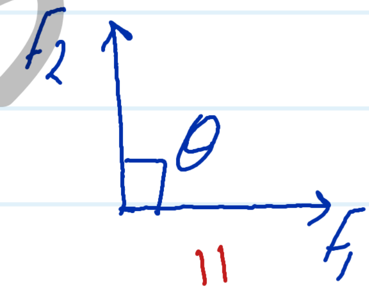
a) By calculation:

$$F_R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$$

→ Mag

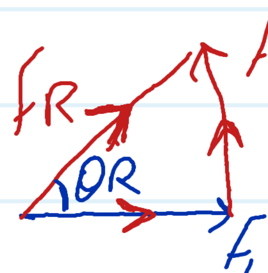


$$F_R = \sqrt{F_1^2 + F_2^2}$$



$$\tan\theta_R = \frac{F_y}{F_x} = \frac{F_2}{F_1}$$

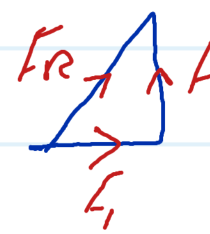
→ $\theta_R = \tan^{-1} \frac{F_y}{F_x}$



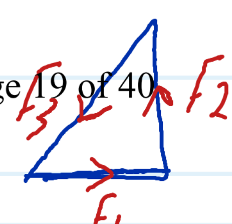
Force Triangle

Hint:

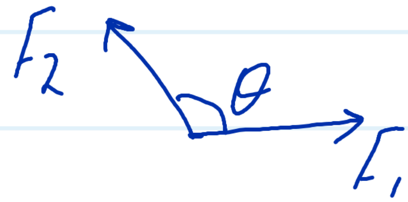
Triangle of force → 2 Forces and FR

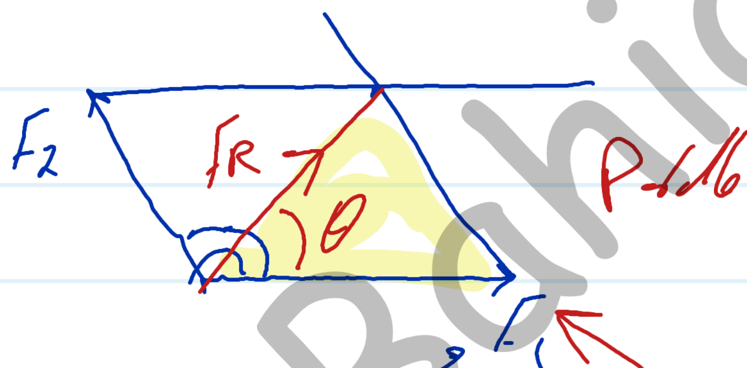


Triangle of force → 3 Forces in equilibrium



b) By Drawing: → Parallelogram / Triangle





1. scale (N - cm)

ex. F = 50 N

1 cm = 10 N

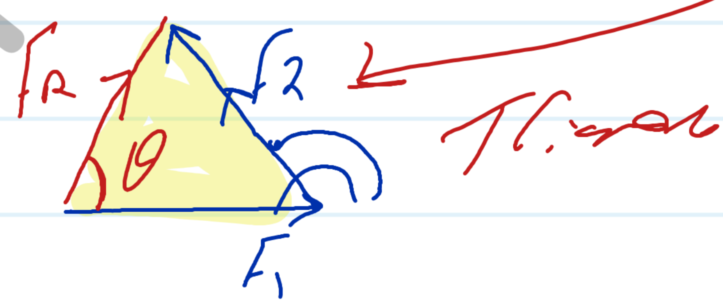
5 cm = 50 N

8 cm = 80 N

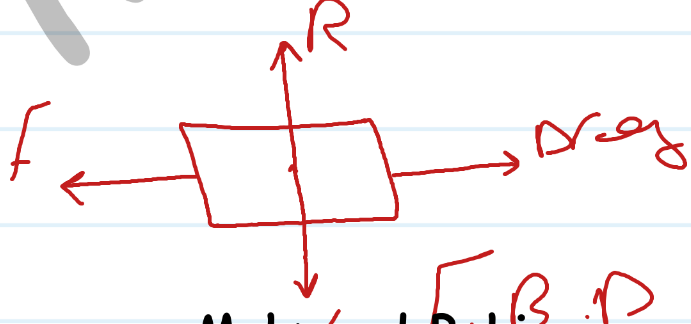
F_R = 8 cm

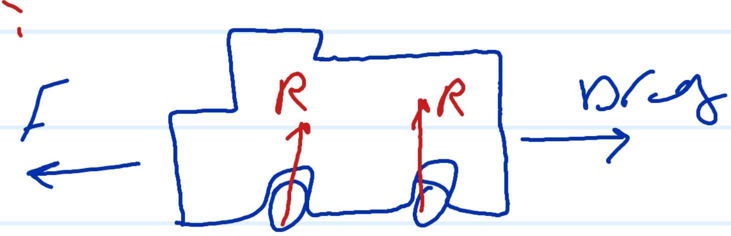
F_R = 80 N

Dir = 25° with F_1



* Free body diagram:



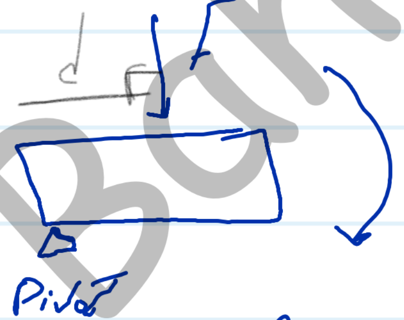


4) Moment of Force:

• Moment: "The turning effect of the force"

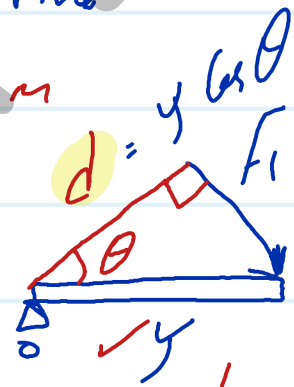
vector

• $M = F \cdot d$ → must be perp. on force



$N.m$, $N.cm$, $N.mm$

• Ex.:



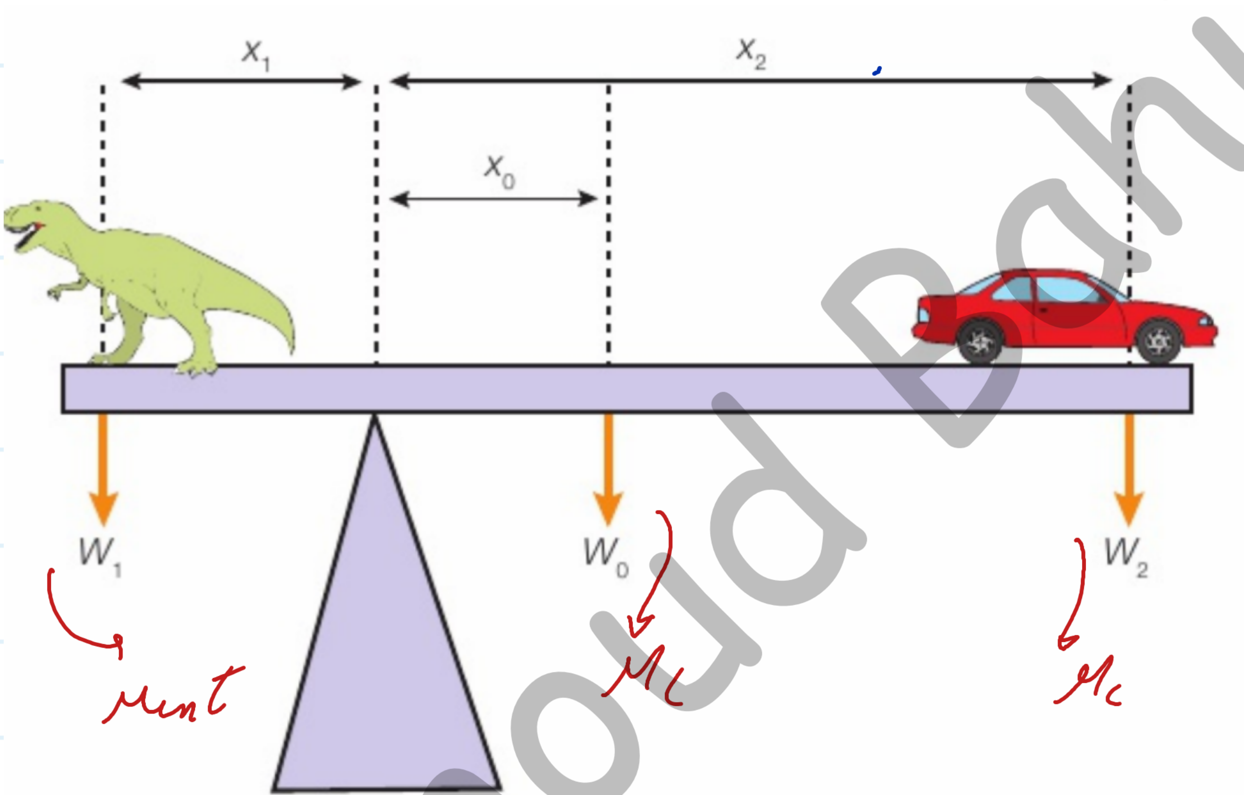
$M = F \cdot y \cos\theta$

$\cos\theta = \frac{d}{y}$

$d = y \cos\theta$

* Principle of moment:

For balance ⟹ Total $M_{clockwise}$ = $M_{anticlockwise}$

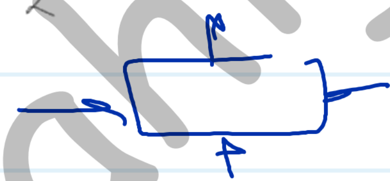


Total M_c = Total M_{ant}

$$W_0 x_0 + W_2 x_2 = W_1 x_1$$

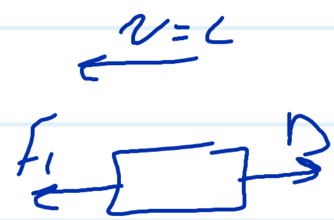
5) Newton's law:

- 1st law: book
- 2nd law: $F_R = ma$ (N, kg, ms^{-2})



$$N = kg\ m s^{-2}$$

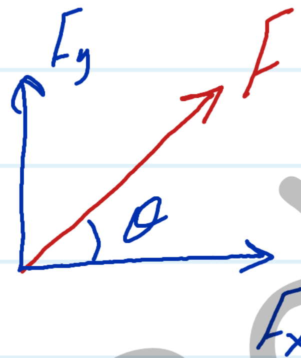
* $F_R = 0$
- → at rest
- → moving with const speed



$F_1 = D$

$F_R = 0$

7 Resolving vectors:

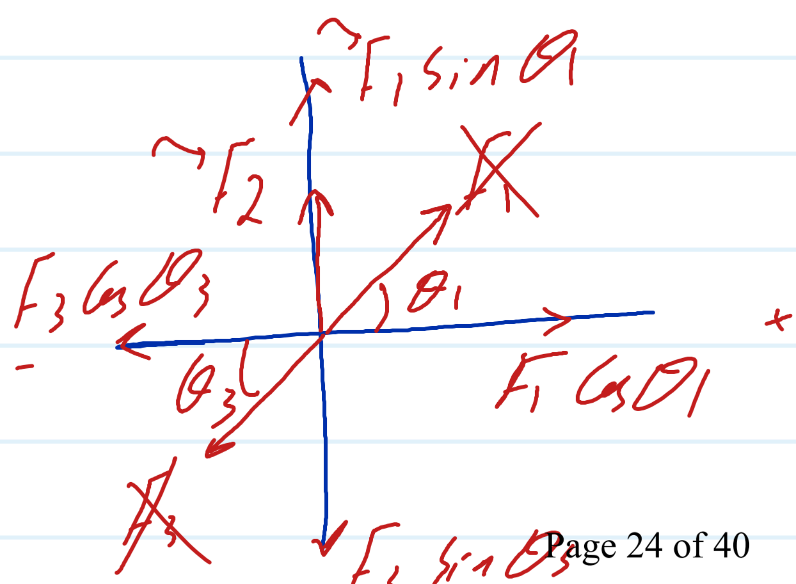


- Horizontal comp. = $F \cos\theta$
- vertical comp. = $F \sin\theta$

→ $F = \sqrt{F_x^2 + F_y^2}$ → mag

$\theta = \tan^{-1}\left(\frac{F_y}{F_x}\right)$ → dir.

- Ex. Find the F_R of the diagram.



Sol.

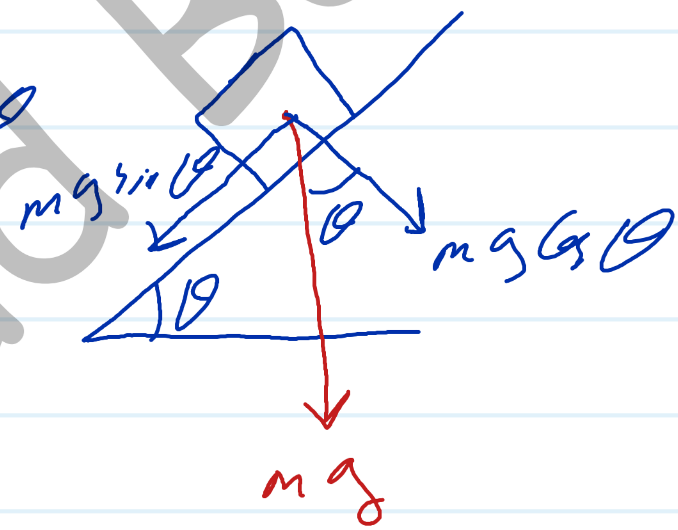
$F_x = F_1 \cos\theta_1 - F_3 \cos\theta_3$

$F_y = F_1 \sin\theta_1 + F_2 - F_3 \sin\theta_3$

$$F_R = \sqrt{F_x^2 + F_y^2} = Mag$$

$$\theta_R = \tan^{-1}\left(\frac{F_y}{F_x}\right) = dir$$

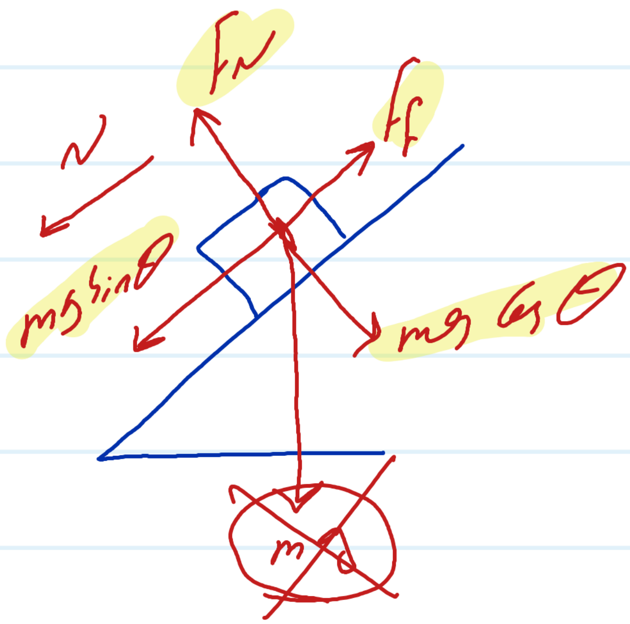
* slope example:



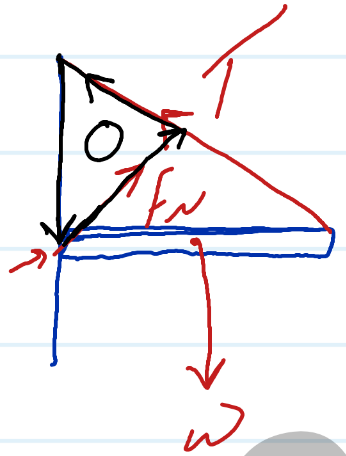
- Parallel to slope = mg sin θ

- Perp. to slope = mg cos θ

* F.B.D slope:

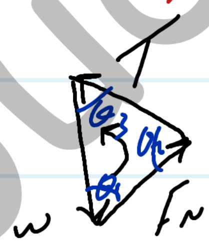


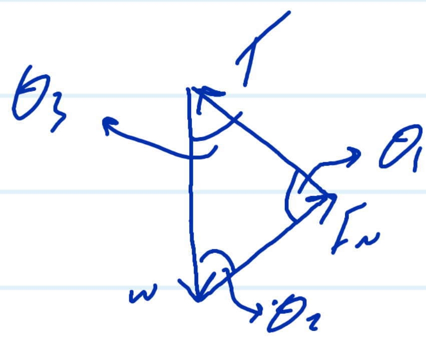
* Balance Forces:



In balance you can easily solve by finding Triangle of force:

1- Parallel
2- fix
3- extend



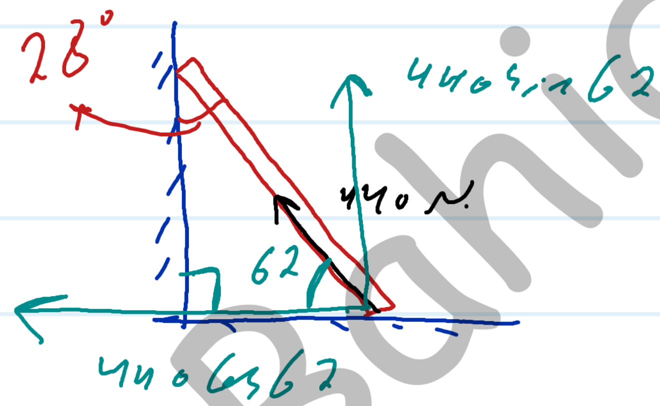


Then use sin law:

$$\frac{w}{\sin\theta_1} = \frac{T}{\sin\theta_2} = \frac{F_N}{\sin\theta_3}$$

find angles

3. A ladder is leant against a wall, at an angle of 28° to the wall. The 440 N force from the floor acts along the length of the ladder. Calculate the horizontal and vertical components of the force from the floor that act on the bottom of the ladder.



8 Projectiles:

- Horizontal projection
- Vertical projection

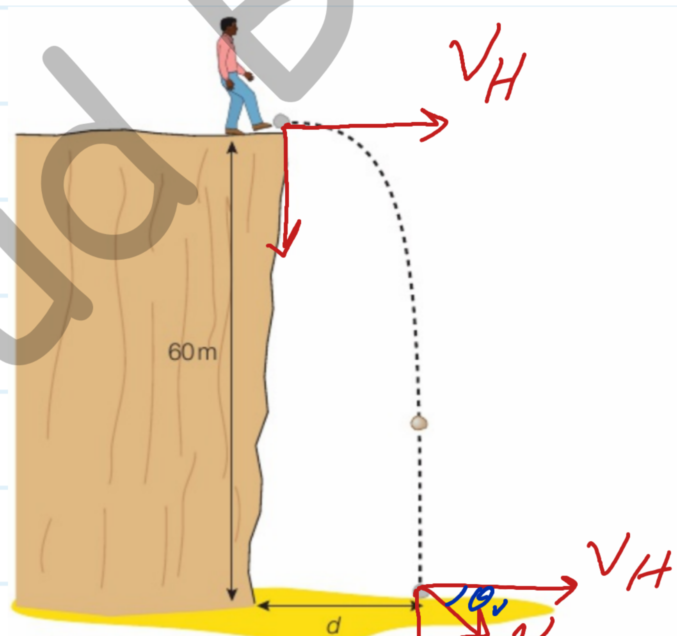


fig A Vertical acceleration on a horizontally moving stone.

* V_H = constant

To find d

$$d = V_H\, t \quad —— (1)$$

* Vertical motion: $U_v = 0$, $V_v = ?$, $h = 60\ m$

$a = g = -9.8\ ms^{-2}$

By using SUVAT eqn.

↳ $V_H = U + g t$ ✓

$V^2 = U^2 + 2 g s \rightarrow h$ ⟶ (2)

To find find velocity V of The object

$$V = \sqrt{V_H^2 + V_V^2} \rightarrow Mag$$

(1) (2)

$$dir = \tan^{-1}\left(\frac{V_V}{V_H}\right) = \theta_V$$

VERTICAL THROWS

Imagine throwing a ball to a friend. The ball goes up as well as forwards. One common idea in these calculations is that an object thrown with a vertical upwards component of motion will have a symmetrical trajectory. At the highest point, the vertical velocity is momentarily zero. Getting to this point will take half of the time of the whole flight.

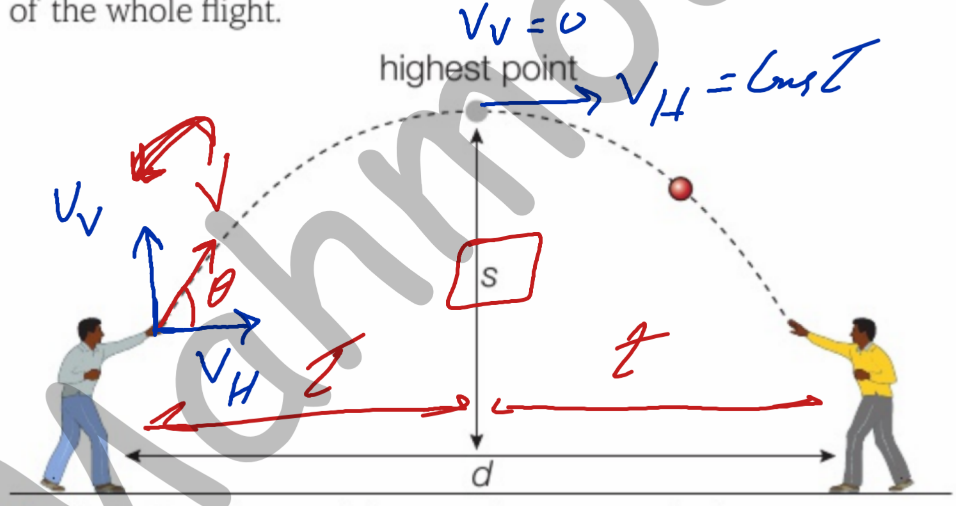


fig C Considering only the vertical component of velocity.

* Horizontal motion:

• To find d: $d = V_H t$

$V_H \rightarrow V \cos\theta$

* Vertical motion: (suvat)

$V_v^2 = U_v^2 + 2gs$ → find

(U_v → $V\sin\theta$; g → -9.81)

V_v → 0 at maximum height

$V_H = U_H + gt$ → time taken to highest point

3. A basketball is thrown with a velocity of 6.0 m s^{-1} at an angle of 40° to the vertical, towards the hoop.

(a) If the hoop is 0.90 m above the point of release, will the ball rise high enough to go in the hoop?

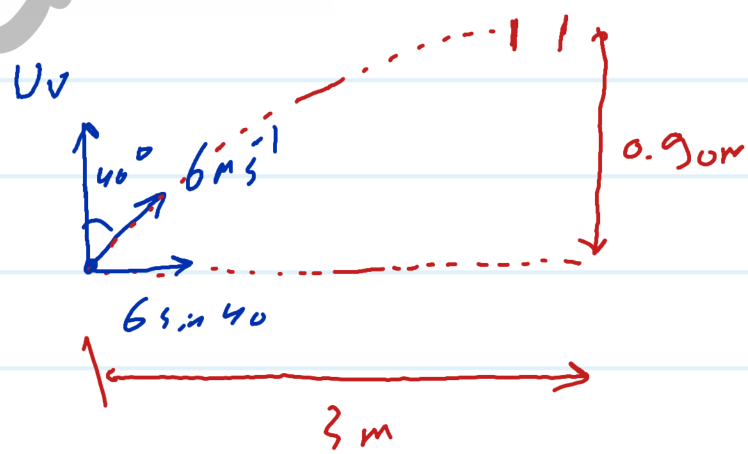
(b) If the centre of the hoop is 3.00 m away, horizontally, from the point of release, explain whether or not you believe this throw will score in the hoop. Support your explanation with calculations.

a) $U_V = 6\cos 40^\circ = 4.6\ \text{m s}^{-1}$

→ $U_H = 6\sin 40$

$a = -9.81\ \text{m s}^{-2}$

$V_V = 0$



$V^2 = U^2 + 2as$

$0 = (4.6)^2 + 2(-9.8)\,s$

↳ $s = 1.08\ \text{m} > 0.90\ \text{m}$ will reach

b) $d = V_H \cdot T$

$= 6 \sin 40 \times 0.47$

$= 1.81\,m < 3\,m$

$V_V = U_V + aT$

$0 = 4.6 + (-9.8)\,T$

$\hookrightarrow T = 0.47\,s$

∴ will not scored ✗

Mahmoud Bahig

* Energy:

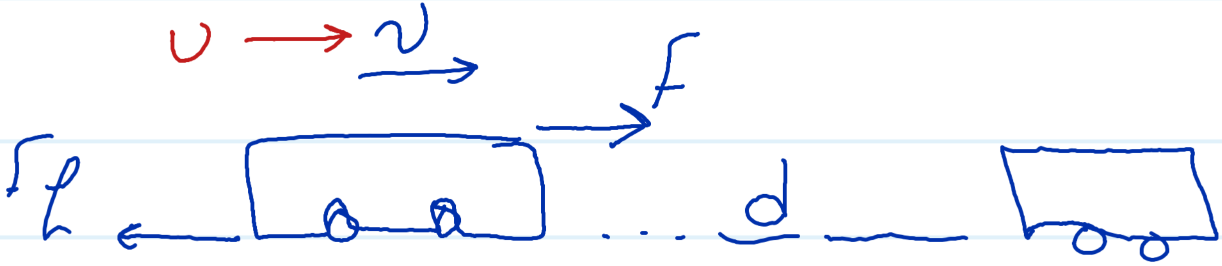
- Energy is the capacity of doing work.
- Measured in $J = N.m = kg\,m^2 s^{-2}$

$$W = F \cdot d$$
$$J = N \cdot m = kg\,m^2 s^{-2}$$
$$F = ma$$
$$N = kg\,m\,s^{-2}$$

- work $= F.d$

→ work done = Energy transfer

Ex.: a work done by a driving force of a car is equal to the increase in KE of the car plus the work due to friction.



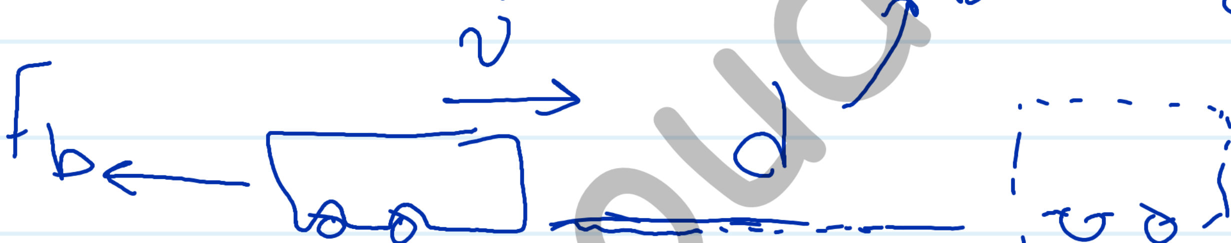
$$W = E_k + W_f$$

• If $f_f = 0 \Rightarrow W = E_k$

$$f \cdot d = \frac{1}{2} m v^2$$

Ex. Braking car

Braking distance



↳ work done due to f_b = loss in K.E

$$f_b \times d = \frac{1}{2} m v^2$$

• **Power**: is the rate of doing work.

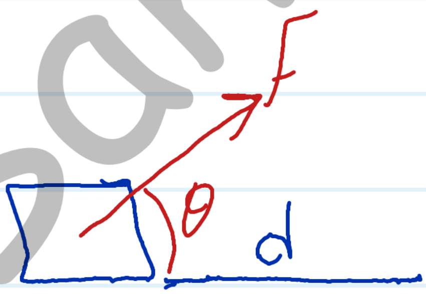
$$P = \frac{W}{t} = \frac{E}{t}$$

- units: $W = J/s = \frac{kg\,m^2 s^{-2}}{s} = kg\,m^2 s^{-3}$

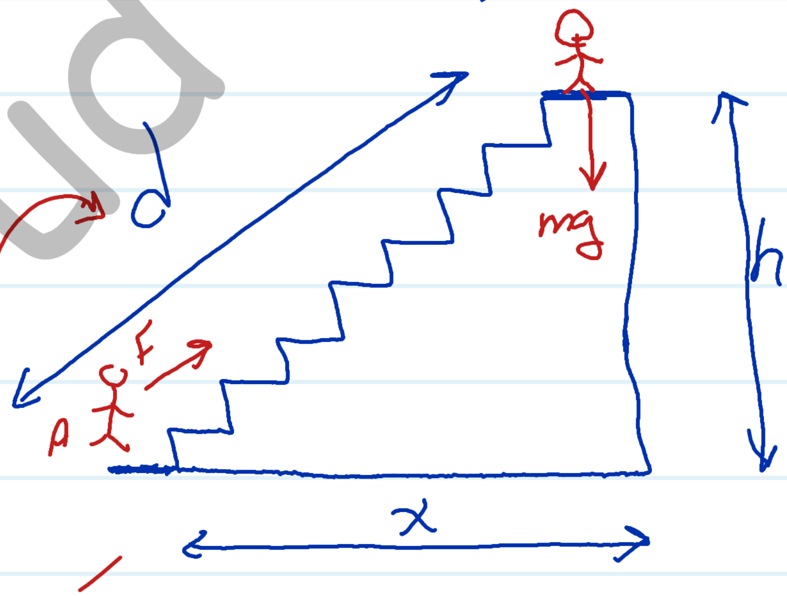
- $W = F \cdot d$ → must be Parallel to line of Path.

- If d NoT Parallel

  - $W = F \cos\theta \cdot d$



- Ex.

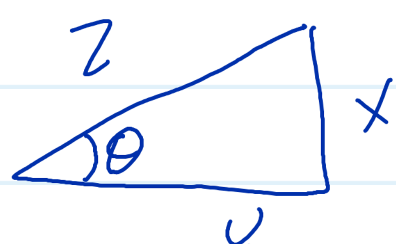


1) work done due to force $= F \cdot d$

2) work done due to gravity $= mg \cdot h$

- Pyth

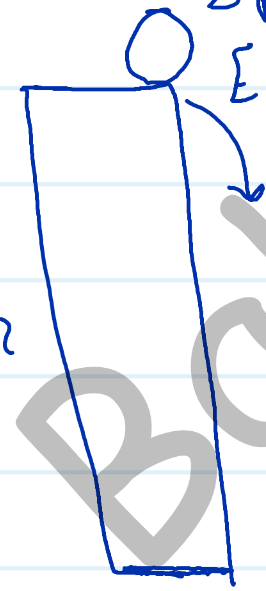
$$Z = \sqrt{x^2 + y^2}$$



$y = Z \cos\theta$ $\quad x = Z \sin\theta$

• Energy Conservation:

1) No air



less Ep = gain Ek

2) Air

Ep = Ek + work done against resistance

$$mgh = \frac{1}{2}mv^2 + R \cdot d$$

Ex. Find height of building.
m = ✓ , v at the end = ✓
assume no air resistance

G.P.E = Ek

$$mgh = \frac{1}{2}mv^2$$

$$gh = \frac{1}{2}v^2 \Longrightarrow h = \frac{v^2}{2g}$$

- Find v

$$gh = \frac{1}{2} v^2$$

$$v^2 = 2gh \Rightarrow v = \sqrt{2gh}$$

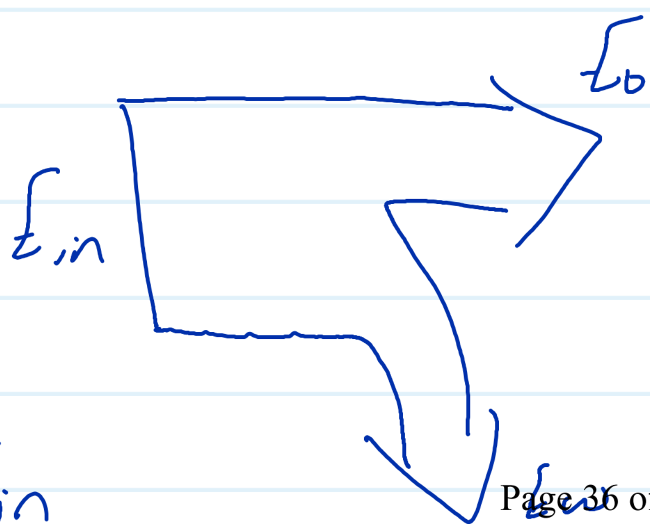
- Efficiency:

$E_{in} = E_o + E_w$

$$\eta = \frac{E_o}{E_{in}} = \frac{P_o}{P_{in}}$$

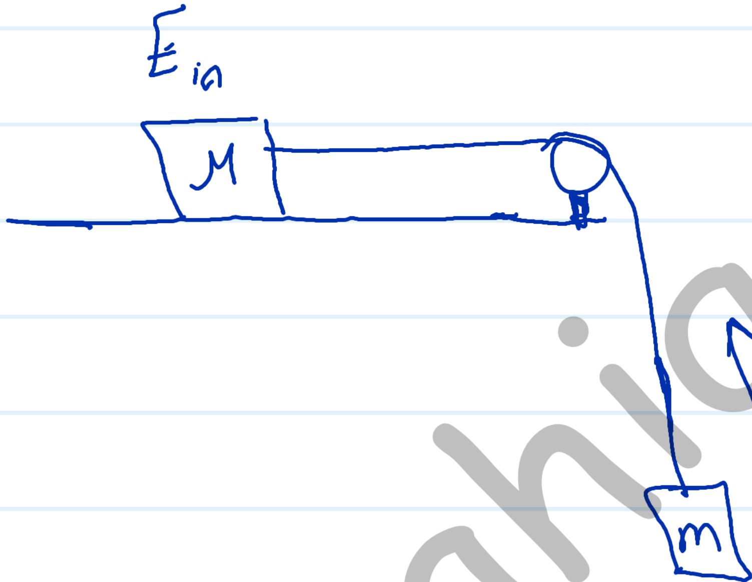
- Rate of doing work = Power
- Rate of energy = Power

Sankey diagram



* Take care of given
E wasted $\rightarrow E_o, E_{in}$

- System
- $E_{in} = VIT$
- $E_{out} = mgh$
- $E_w = E_{in} - E_{out}$



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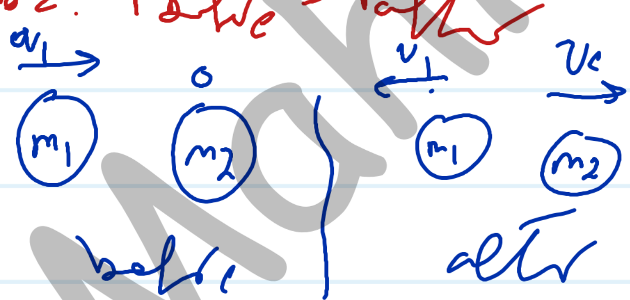
* Momentum:

- $P = mv$ $(kg\,m\,s^{-1})$
- P is a vector $\begin{cases} \to +ve \\ \to -ve \end{cases}$ depends on v

Momentum

→ Collision

T.o.Z. $P_{before} = P_{after}$



$\overset{+}{\to}$

$$m_1 v_1 + 0 = m_1(-v_1) + m_2 v_2$$

→ Explosion

$P_{forward} = P_{backward}$

$$m_r v_r = m_g v_g$$

Thanks for [illegible] :) In a close system

- Types of Collision:

1) Elastic: $P_{before} = P_{after}$

E_k before $= E_k$ after (conserved) no losses

2) Inelastic: $P_{before} = P_{after}$

E_k before $> E_k$ after (losses) → heat, sound

- Forces of momentum (2nd law)

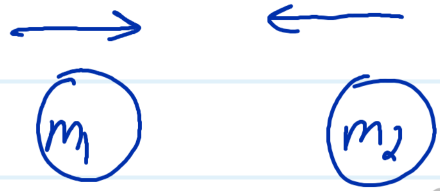
$$F = ma \quad , \quad a = \frac{v - u}{t}$$

$$F = \frac{mv - mu}{t} = \frac{\Delta P}{\Delta t}$$

($mv = P_f$, $mu = P_i$)

Force is rate of change in momentum.

- momentum & Newton's 3rd:



ball m_1 exert a force F_1 on ball m_2 same force F_2 exerted on ball m_1 by m_2.