General trick to approach questions in physics :

Steps to follow while solving any numerical :

(1) Read the Question and understand it.

(2) Write what is given.

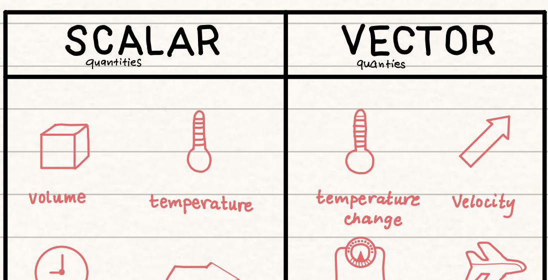
(3) Write the theory, concept, and definition of important terms relative to the Question.

(4) Draw diagram or graphs (iff applicable)

(5) Write formulae used :
+ Dimensional formula
+ Units of measurement
+ Conclusion of the formula in a single Statement.

(6) Solve the numerical (math part) and represent the final answer with its SI unit

Basic Math



Sometimes Scalar quanties have direction:

e.g. Electric Current <it has direction but doesn't follow vector algebra>

e.g. Electric flux <it is scalar but has direction>

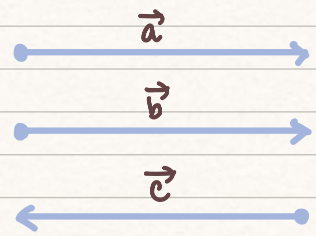
a physical Scalar quantity Can also have a negative

time Speed	weight thrust
quanties ⟨ Physical ⟩ that have only magnitude.	quantities that cannot be studied without direction i.e. they have magnitude & direction.
they follow normal algebra.	they follow vector algebra.
Eg: Speed, volume, mass, temperature, power, work, energy, time etc.	Eg: area, displacement, torque, impulse, force, velocity, dipole moment, magnetic field etc.

value :

e.g. work ⟶ when θ = 180° b/w $\vec{F}$ and $\vec{S}$

SOME important terms of Vectors



here $\vec{a} = \vec{b}$

$\vec{a} \neq \vec{c}$

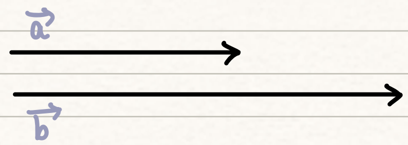
$\vec{b} \neq \vec{c}$

but

$\vec{a} = -\vec{c} = \vec{b}$

here, the magnitude of All the three vectors is equal. Thus, $|\vec{a}| = |\vec{b}| = |\vec{c}|$

Parallel vectors



here, $\vec{a} \parallel \vec{b}$

i.e. the vectors are in the same direction

∴ anti-parallel means the vectors are in the opposite direction.

zero / null vectors

$|\vec{A}| = 0$

when the magnitude of the vector becomes zero but there is an indeterminate direction.

trigonometric Ratios to remember

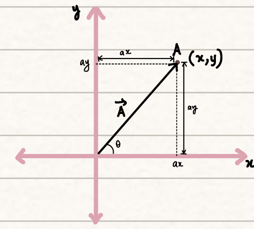
- $\sin 37° = \frac{3}{5}$
- $\sin 53° = \frac{4}{5}$
- $\tan 37° = \frac{3}{4}$
- $\tan 53° = \frac{4}{3}$

Components of a Vector

$a_x = A\cos\theta$

$a_y = A\sin\theta$

$\vec{A} = a_x\hat{i} + a_y\hat{j}$



denotion as Scalar ⟶ $A(x,y)$

denotion as vector ⟶ $\vec{A}(a_x\hat{i} + a_y\hat{j})$

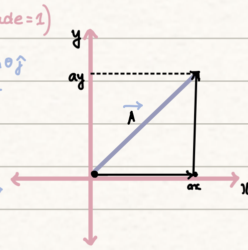
unit vectors ⟶ $\hat{i}, \hat{j}, \hat{k}$ (magnitude = 1)

General form of unit vector $\hat{n} = \cos\theta\hat{i} + \sin\theta\hat{j}$

magnitude of $\vec{A} = \sqrt{a_x^2 + a_y^2}$ ⟨2D⟩

OR

$|\vec{A}| = \sqrt{a_x^2 + a_y^2 + a_z^2}$ ⟨3D⟩



Laws of Motion and Work, Power & Energy

INERTIA

- If the net external force is zero, a body continues to be in its state of motion (with uniform velocity) or at rest. [this property of the body is called as inertia]

Gives the first law of motion :

If the body is at rest or moving with a constant speed in a straight line, it will remain at rest/keep moving in a straight line with a constant speed unless it is acted upon by a force.

Second law of motion

- the rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts.

$$\vec{F} \propto \frac{d\vec{p}}{dt}$$

for a body having constant mass,

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

Hence, $\vec{F} = m\vec{a}$

Impulse

- The product of force and time, which is the change in momentum of a body is known as **Impulse**. [vector quantity]

Impulse (I or J) = Force × time duration

i.e. = change in momentum

It can also be defined as :

$$J = \int_{t_1}^{t_2} F(t)\,dt$$

Centripital Force

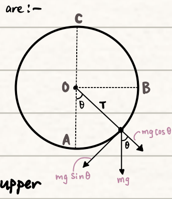
- In uniform circular motion, the force acting on the particle along the radius and towards the centre keeps the body moving along the circular path, so called as Centripital force.

$$\text{Centripital force} = \frac{mv^2}{r} = mr\omega^2$$

Vertical Circular Motion

- when a particle is whirled in a verticle circle then the three possibly results are :-

CASE I : Particle oscillates in the lower half circle AB.



CASE II : moves to the upper half but unable to complete the loop.

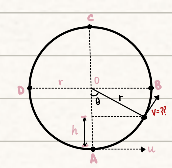
CASE III : Particle completes the whole loop.

Velocity @ any point on the loop ???

$$v = \sqrt{u^2 - 2gh}$$

i.e. $= \sqrt{u^2 - 2gr(1-\cos\theta)}$

$[h = r - r\cos\theta = r(1-\cos\theta)]$



Tension @ any point on the loop ???

net force towards the centre = centripital force

$$T - mg\cos\theta = \frac{mv^2}{r}$$

$$T = mg\cos\theta + \frac{mv^2}{r}$$

$$\therefore T = \frac{m}{r}\left[u^2 - gr(2-3\cos\theta)\right]$$

{ as $v = \sqrt{u^2 - 2gr(1-\cos\theta)}$

Condition for completing the loop

- the particle will complete the loop if the string doesn't slack at highest point C.

Hence $T_C = \frac{mu^2}{r} - 5mg \geq 0$

Third Law

To every action, there is an equal and opposite reaction.

WORK

work = Force × component of $\vec{F}$ along the displacement.

$W = (F\cos\theta)\, d$

$= F(d\cos\theta)$

Hence, in vector form $W = \vec{F} \cdot \vec{d}$
<work is scalar>

Unit : Nm OR Joule (J)

Dimension = ML^2T^{-2}

work can be negative, positive or zero depending upon the angle between the force and displacement.
[0 when $\theta = 90°$]

Centrifugal Force

the psuedo force experienced by a body in uniform circular motion due to the accelerated frame of reference along the radius & away from the centre.

$\therefore\ u \geq \sqrt{5gr}$

FORCE

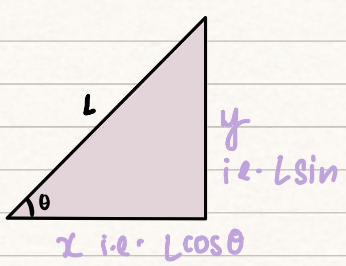
- interaction b/w two bodies, that when not opposed will change some factors. (generally motion)
- S.I. unit = Newton (N)
- Dimentional formula = $[MLT^{-2}]$

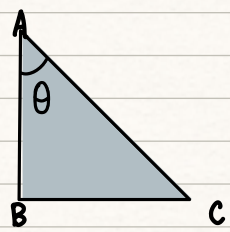
how? $F = ma$

i.e. $= m \times \frac{\text{metre}}{s^2}$

i.e. $= M \times L \times T^{-2}$

Basic Trigonometry





here $x = L\cos\theta$
$y = L\sin\theta$

$$\sin\theta = \frac{BC}{AC}\left[\frac{\text{opposite}}{\text{hypotenuse}}\right] = \frac{1}{\text{Cosec}\,\theta}$$

$$\cos\theta = \frac{AB}{AC}\left[\frac{\text{adjescent}}{\text{hypotenuse}}\right] = \frac{1}{\text{Sec}\,\theta}$$

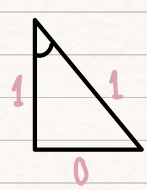
$$\tan\theta = \frac{BC}{AB}\left[\frac{\text{opposite}}{\text{adjescent}}\right] = \frac{\sin\theta}{\cos\theta} = \frac{1}{\text{Cot}\,\theta}$$

Identities

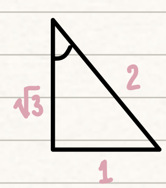
$\sin^2\theta + \cos^2\theta = 1$

$1 + \tan^2\theta = \sec^2\theta$

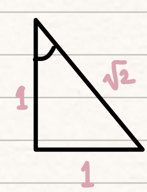
$1 + \cot^2\theta = \text{Cosec}^2\theta$



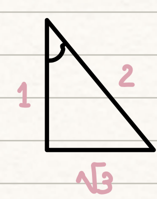
$\theta = 0°$



$\theta = 30°$



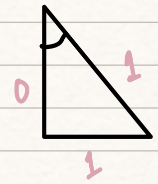
$\theta = 45°$



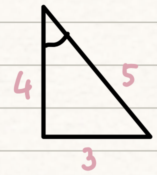
$\theta = 60°$

$\sec^2\theta - \tan^2\theta = 1$

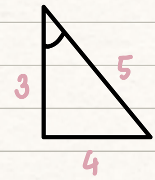
$\operatorname{cosec}^2\theta - \cot^2\theta = 1$



$\theta = 90°$



$\theta = 37°$



$\theta = 53°$

Some angles & ratios you need to remember.