VSAQ problems
chapter - 4

1) Vertical component = horizontal component.

$\sin\theta = \cos\theta$

$\tan\theta = 1$

$\theta = 45^\circ$.

2) $A = i + j$. Find angle between vector & x axis.

$\cos\theta = \frac{A}{|A|}$ $\cos\theta = \frac{1}{\sqrt{1^2+1^2}}$

$\cos\theta = \frac{1}{\sqrt{2}}$

$\theta = 45^\circ$.

3) $P = 2i + 4j + 14K$ $Q = 4i + 4j + 10K$

Find magnitude of $P+Q$.

$P+Q = 6i + 8j + 24K$

$|P+Q| = \sqrt{6^2 + 8^2 + 24^2}$

$= \sqrt{676}$

$= 26$ units.

) when 2 right angled vectors (→ 90°) of magnitude 7, 24 combine find resultant.

$R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$

$R = \sqrt{7^2 + 24^2 + 2 \times 7 \times 24 \cos 90}$

$= \sqrt{625}$

$R = 25$ units

5) 2 vectors 3, 5 angle = 60° (→ isosceles), find resu.

$R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$

$R = \sqrt{3^2 + 5^2 + 2 \times 3 \times 5 \times \cos 60}$

$= \sqrt{49}$

$R = 7$ units

Chapter 2

1) Percentage error in mass & speed are 2%, 3%. Calculate error in K.E

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

$\frac{\Delta K}{K} \times 100 = \frac{\Delta m}{m} \times 100 + 2\left(\frac{\Delta v}{v} \times 100\right)$

$= 2 + 2 \times 3$

$= 2 + 6$

$= 8$

2) The error in measurement of radius of sphere is 1%. Find error in volume.

volume of sphere $V \propto r^3$

$\frac{\Delta V}{V} = 3 \times \frac{\Delta r}{r}$

$= 3 \times 1$

$= 3\%$

3) Significant figures of following numbers

a) $6.729 \rightarrow 4$

b) $0.024 \rightarrow 2$

c) $0.08240 \rightarrow 4$

d) $6.032 \rightarrow 4$

e) $4.57 \times 10^8 \rightarrow 3$

Chapter 3

1) A parachutist flying in an aeroplane - - -

Initially the path is parabola for an observer on the ground. The path is straight line for a pilot.

when he opens parachute, it moves vertically downwards with decreasing velocity and finally reaches the ground.

Chapter -5

1) Calculate time needed for force of 5N to change velocity of 2 m/s, mass 10kg.

$F = m\left(\frac{v-u}{t}\right)$

$5 = 10\left(\frac{2}{t}\right)$

$t = 4 \text{ sec}$

1) A batsman hits back a ball without changing its initial speed of 12 m/s. If mass of ball is 0.15 kg. Find impulse.

$$\text{Impulse} = (u - v)\,m$$

$$= (12 - (-12))\,0.15$$

$$= 3.6\ \text{NS}$$

Chapter 10

1) A copper wire of 1mm diameter is stretched by applying force 10N. Find stress.

$d = 1\,mm$

$r = \frac{1}{2}\,mm$

$= \frac{1}{2} \times 10^{-3}\,m$

$$\text{Stress} = \frac{F}{A}$$

$$= \frac{F}{\pi r^2}$$

$$= \frac{10}{3.14 \times \left(\frac{1}{2} \times 10^{-3}\right)^2}$$

$$= 1.27 \times 10^{7}\ \text{Pa}.$$

2) wire of length 20cm is stretched by 0.1cm. Find strain

$$\text{Strain} = \frac{\text{elongation}}{\text{original length}}$$

$$= \frac{0.1}{20}$$

$$= \frac{1}{10 \times 20} = \frac{1}{200} = 0.005$$

3) An iron wire is stretched by 1%. Find strain

$$\text{Strain} = \frac{\text{elongation}}{\text{original length}}$$

$$= \frac{1}{100} = 0.01$$

Chapter 11

1) Find excess pressure in soap bubble of radius 5mm. (Surface tension = 0.04 N/m)

$$P = \frac{4T}{r}$$

$$P = \frac{4 \times 0.04}{5 \times 10^{-3}} = 32\ \text{Pascal}$$

2) If diameter of soap bubble is 10mm, Surface tension is 0.04 N/m

$$P = \frac{4T}{R}$$

$d = 10mm$
$R = 5mm.$

$$P = \frac{4 \times 0.04}{5 \times 10^{-3}}$$

$= 32$ Pascal

Chapter 12

1) Find increase in temperature of aluminium rod if length is increased by 1% ($\alpha = 25 \times 10^{-6}$)

~~$t_2 - t_1 = \frac{l_2 - l_1}{\alpha l_1}$~~

$$\Delta t = \frac{\Delta l}{\alpha l_1}$$

$\Delta l = 1\%$
$l_1 = 1$

$$= \frac{1}{100 \times 25 \times 10^{-6} \times 1}$$

$= 400°C$

2) At what temperature Kelvin, Fahrenheit scales are same?

574.25 K

3) If maximum intensity of black body radiation is 2.65 µm, what is the temp of body? (wiens constant = 2.9×10^{-3} mK)

$$T = \frac{b}{\lambda}$$

$$T = \frac{2.9 \times 10^{-3}}{2.65 \times 10^{-6}}$$

$= 1094K$

Chapter 14

1) Absolute temp of gas is increased 3 times. what is increase in rms velocity.

$$V_{rms} \propto \sqrt{T}$$

$\Rightarrow V_{rms}$ increase by $\sqrt{3}$ times

) Find ratio of rms speed of oxygen & hydrogen at same temp.

$$V_{rms} = \sqrt{\frac{3RT}{m}}$$ → molecular weight

For oxygen,

$$V_{rms} = \sqrt{\frac{3RT}{32}}$$

For hydrogen

$$V_{rms} = \sqrt{\frac{3RT}{2}}$$

$$\frac{V_{oxy}}{V_{hy}} = \sqrt{\frac{2}{32}} = \sqrt{\frac{1}{16}} = \frac{1}{4}$$

$\Rightarrow 1 : 4$

3) Four molecules of a gas have speeds 1, 2, 3, 4 km/s. Find rms speed.

$$V_{rms} = \sqrt{\frac{v_1^2 + v_2^2 + v_3^2 + v_4^2}{4}}$$

$$= \sqrt{\frac{1^2 + 2^2 + 3^2 + 4^2}{4}}$$

$$= \sqrt{7.5} \text{ km/s}$$

I year

LAQ Problems (Chapter-6)

1) A machine gun - - - -

$$P = \frac{\frac{1}{2}mv^2 \times n}{t}$$

$P = 5400$ watt.

2) An elevator can carry max load - - -

$$P = (mg + F_r)v$$ (if $g = 9.8$)

$P = 43280$ watt.

$P = 44000$ watt. (if $g = 10$)

3) A pump is required to lift - - -

$$P = \frac{mgh + \frac{1}{2}mv^2}{t}$$

$P = 15000$ watt.

4) In a ballistic demonstration.

$$KE_i = 10\% \ KE_f$$

$$\frac{1}{2}mu^2 = \frac{10}{100} \times \frac{1}{2}mv^2$$

$v = \sqrt{4000} = 63.2$ m/s

5) Find total energy - -

$$TE = KE + PE$$

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

$TE = 500J$

Chapter-8

(1) What is length of simple pendulum which ticks seconds.

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$2 = 2 \times 3.14\sqrt{\frac{l}{9.8}}$

$\therefore l = 100cm$

2) On an average, a human heart beat is found to be 75 times. Calculate freq, time period.

Heart beat $= \frac{75}{1min} = \frac{75}{60}$

freq $= 1.25$ Hz.

$T = \frac{1}{frequency} = 0.8S$

3) Calculate change in length of simple pendulum of length 1m, when period changes from 2S to 1.5 S

$$\boxed{\frac{l_2}{l_1} = \frac{T_2^2}{T_1^2}}$$

$$\frac{l_2}{1} = \frac{(1.5)^2}{2^2}$$

$$l_2 = \frac{9}{16}.$$

change in length $= l_1 - l_2$

$$= 1 - \frac{9}{16}$$

$$= \frac{7}{16} \text{ m.}$$

4) what happens to time period of simple pendulum if length is increased upto four times..

$$\boxed{\frac{l_2}{l_1} = \frac{T_2^2}{T_1^2}}$$

$$\frac{4l}{l} = \frac{T_2^2}{T_1^2}$$

$$4 \cdot T_1^2 = T_2^2$$

$$T_2 = \sqrt{4T_1^2}$$

$$T_2 = 2T_1.$$

$\Rightarrow$ Time period doubles.

Can a simple pendulum be used in an artificial satellites

A)

No.★

All bodies are weightless in satellite.

6) A particle executes simple harmonic motion such that maximum velocity is equal to half the maximum acceleration what is time period.

~~$A\omega = \frac{1}{2} A\omega^2$~~

$v = A\omega$

$a = A\omega^2$

$A\omega = \frac{1}{2} A\omega^2$

$\omega = 2$

$$T = \frac{2\pi}{\omega}$$

$T = \frac{2\pi}{2} = \pi$ Sec

★★★

7) what is seconds pendulum.

A simple pendulum whose timeperiod of oscillation is 2 seconds.

SAQ (I year)

Q) Explain Conduction, Convection, Radiation

A) Conduction: Transfer of heat from one place to another without actual movement of particles.

Ex: Heat transfer in solids.

Convection: Transfer of heat from one place to another with actual movement of particles

Ex: Boiling water

Radiation: Transfer of heat from one place to another without any medium

Ex: Sun rays.

Q. Define Stress and explain types.

A. Restoring force per unit area is called stress.

Types

Longitudinal Stress: Normal force per unit area changes length of the body

Volume Stress: " " " " " " volume "

Shearing stress: Restoring force per unit area developed due to tangential force.

Q. Define Youngs modulus, Bulk modulus, Shear modulus

A. Youngs modulus: within the elastic limit, ratio of longitudinal stress to longitudinal strain.

Bulk modulus: within the elastic limit, ratio of hydraulic stress to hydraulic strain.

Shear modulus: within the elastic limit, ratio of shear stress to shear strain.

Q. Define Strain energy. ~~Derive~~ Derive equation.

A. The energy stored in a body due to deformation is called strain energy.

Consider a wire of length l, area A.

$F = \frac{YAx}{L}$

$W = \int F.S$

$W = \int \frac{YAx}{L} dx$

$W = \frac{1}{2} \cdot \frac{YAx}{L} \times \frac{x}{L} \cdot AL$

$\therefore U = \frac{1}{2} \times \text{Stress} \times \text{Strain} \times \text{volume}$

Q. What is geostationary satellite? State its uses

A. A Satellite whose time period of revolution is equal to time period of rotation of earth.

uses: 1) Used in weather forecasting

2) " " telecommunication

3) " to know size and shape of earth.

Q. State Keplers laws of planetary motion

A. Keplers 1st law: All the planets revolve around the Sun in elliptical orbit with Sun as one of its foci

Kepler's 2nd law: The line that joins Sun to planet sweeps equal areas in equal intervals of time

Keplers 3rd law: Square of time period of a planet is proportional to cube of semi major axis

$T^2 \propto a^3$

Q. Define escape velocity. Obtain expression

A. Minimum velocity required by a body to escape from the earth

DATE

Consider a body of mass m.

let mass of earth = M

let radius " " = R.

$$KE = -PE$$

$$\frac{1}{2}mv^2 = \frac{GMm}{R}$$

$$\boxed{v = \sqrt{2gR}}$$

Q. What is orbital velocity? Obtain expression.

A. velocity required for a body to revolve around a planet.

Consider a body of mass m

let mass of earth = M

let radius " " = R

$$F_c = F_G$$

$$\frac{mv_0^2}{R+h} = \frac{GMm}{(R+h)^2}$$

$$v_0 = \sqrt{\frac{GM}{R+h}}$$

If h is neglected, $v_0 = \sqrt{\frac{GM}{R}}$

$$\boxed{v_0 = \sqrt{gR}}$$

Q. Prove that angle between $|a+b| = |a-b|$ is 90°.

A. $|a+b| = |a-b|$

$$\sqrt{a^2+b^2+2ab\cos\theta} = \sqrt{a^2+b^2-2ab\cos\theta}$$

$$4ab\cos\theta = 0$$

$$\theta = 90^\circ$$

Q. Distinguish between center of mass and center of gravity

A.

Center of mass	Center of gravity
1) Does not depends on 'g'	① Depends on 'g'
2) may or may not lie inside the body.	② Always lies inside the body.
3) Refers to mass of the body	③ Refers to weight of the body
4) Explains motion of the body	④ explains stability of the body.

Q. Pendulum clock generally go fast in ~~sum~~ winter and slow in Summer. why?

A.

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$T \alpha \sqrt{l}$$

Pendulum clock expands in Summer. So, time period increases.

Pendulum clock contracts in winter. So, time period decreases.

Q. what is anomalous behaviour of water and why is it advantageous for aquatic animals.

A. 1. when temperature increases from $0^{\circ}C$ to $4^{\circ}C$, water contracts.

2. water has maximum density at $4^{\circ}C$.

3. During winter, when temperature is below $0^{\circ}C$, Surface of the water in lakes becomes ice.

4. Ice is a bad conductor of heat.

5. So, aquatic animals can survive their lives in lakes during winter.

Q. Define angular velocity. Derive $v = r\omega$.

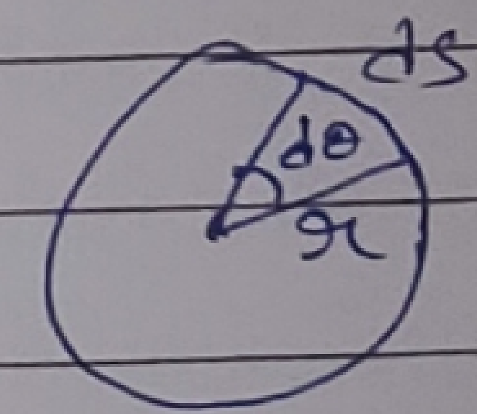
A. Rate of change of angular displacement

$$\omega = \frac{d\theta}{dt}$$

Consider a particle moving in circular motion

$$r\, d\theta = ds$$

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



$$\therefore r\omega = v$$

$$\boxed{\therefore v = r\omega}$$

Q. Explain advantages and disadvantages of friction

A. Advantages

1) help us to walk
2. " " " pick and hold the things
3. " " " drive nails.

Disadvantages

1. produces unwanted heat
2. Decreases speed of the vehicles
3. Reduces wear and tear of machine parts.

Q. Mention methods to decrease friction

A. Polishing: By polishing the surface, friction can be reduced
Ball bearing: By using ball bearings, " " "
Lubricants: " " lubricants like oil, " " "
Stream lining: Aeroplanes are stream lined to reduce the friction.

Q. State newtons second law. Hence derive $F = ma$.

Rate of change of momentum is directly propotional to force applied.

$$F \propto \frac{dP}{dt}$$

$$F = K\frac{dP}{dt}$$

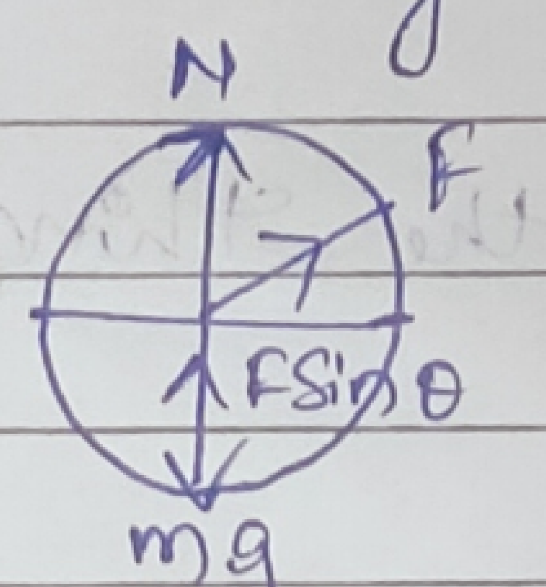
$$F = K\frac{d(mv)}{dt} \qquad (P = mv)$$

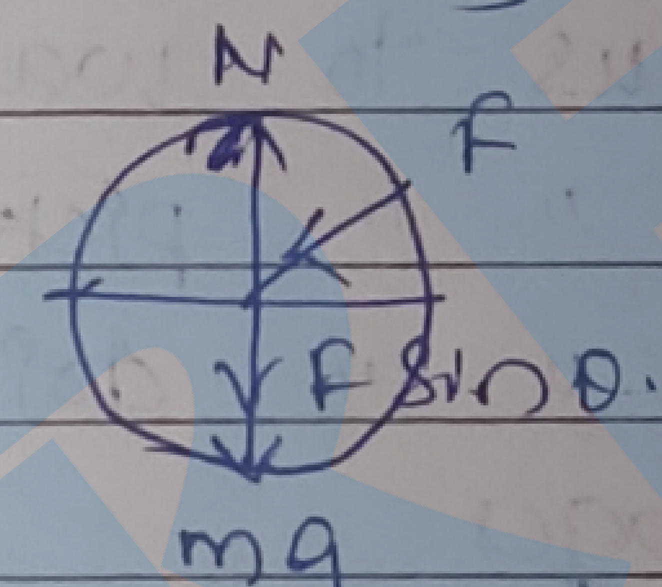
$$F = Kma. \qquad (K = 1)$$

$$\boxed{F = ma.}$$

Q. Why pulling lawn roller is preferred to pushing

A. Pulling | Pushing





~~N+FSinθ = mg~~

$N = mg - FSin\theta$

$f_r = \mu_r(mg - FSin\theta)$

$N = mg + FSin\theta$

$f_r = \mu_r(mg + FSin\theta)$

Q

A. ~~Rate of change of angular diplacement~~

~~$\omega = \frac{d\theta}{dt}$~~

Q. Describe the behaviour of wire under increasing load.

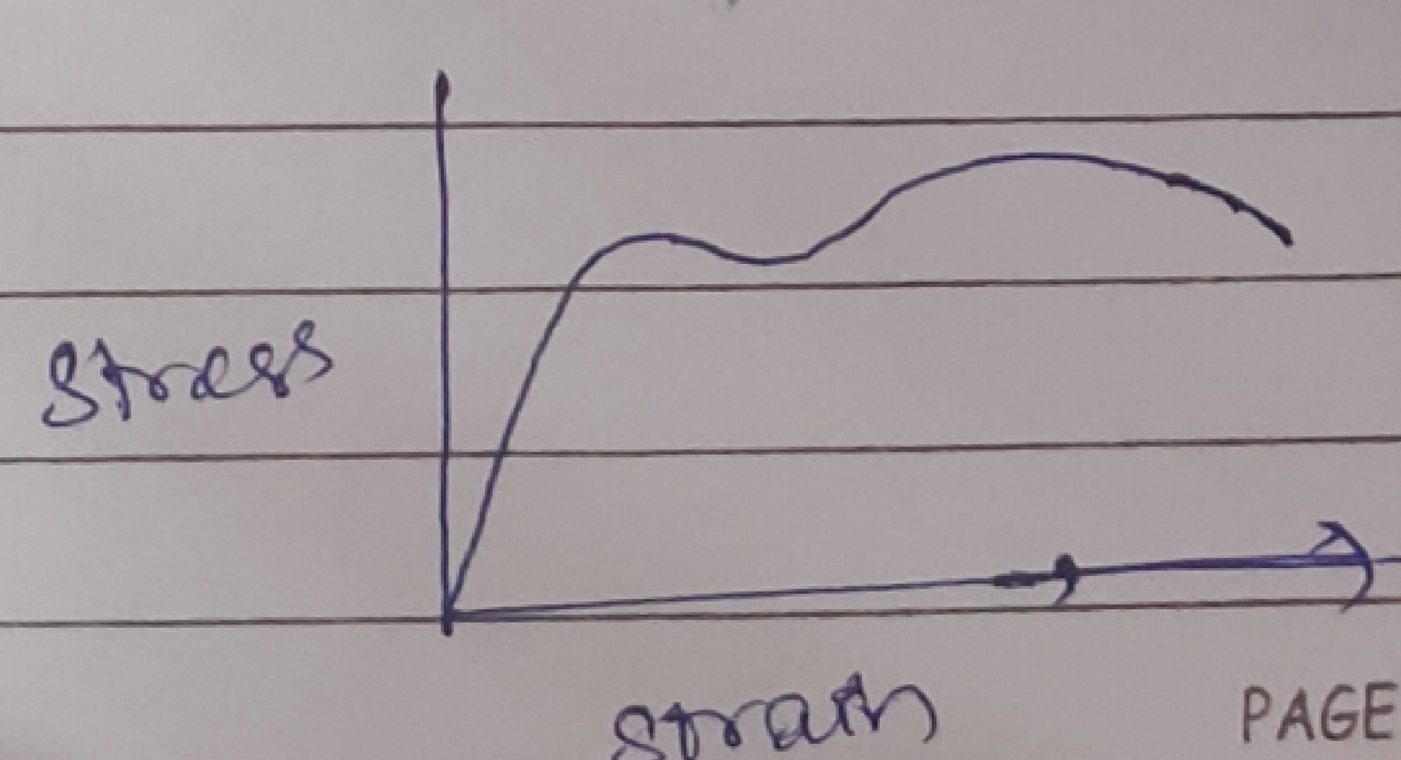
Propotionality limit

Elastic limit

Permanent Set

Yielding point

Breakingpoint.



Q. Define vector product. Explain properties with example

A. <u>Vector product</u> :- Product of magnitude of two vectors and Sine of angle between them.

<u>Properties</u>
① Do not obey commutative law
② Obeys distributive law.

<u>Examples</u> $\vec{T} = \vec{r} \times \vec{F}$, $\vec{L} = \vec{r} \times \vec{p}$

Q. Define angular acceleration and torque. Obtain relation between them

A. Angular acceleration : Rate of change of angular velocity

$$\alpha = \frac{d\omega}{dt}$$

Torque : Rate of change of angular momentum.

$$\tau = \frac{dL}{dt}$$

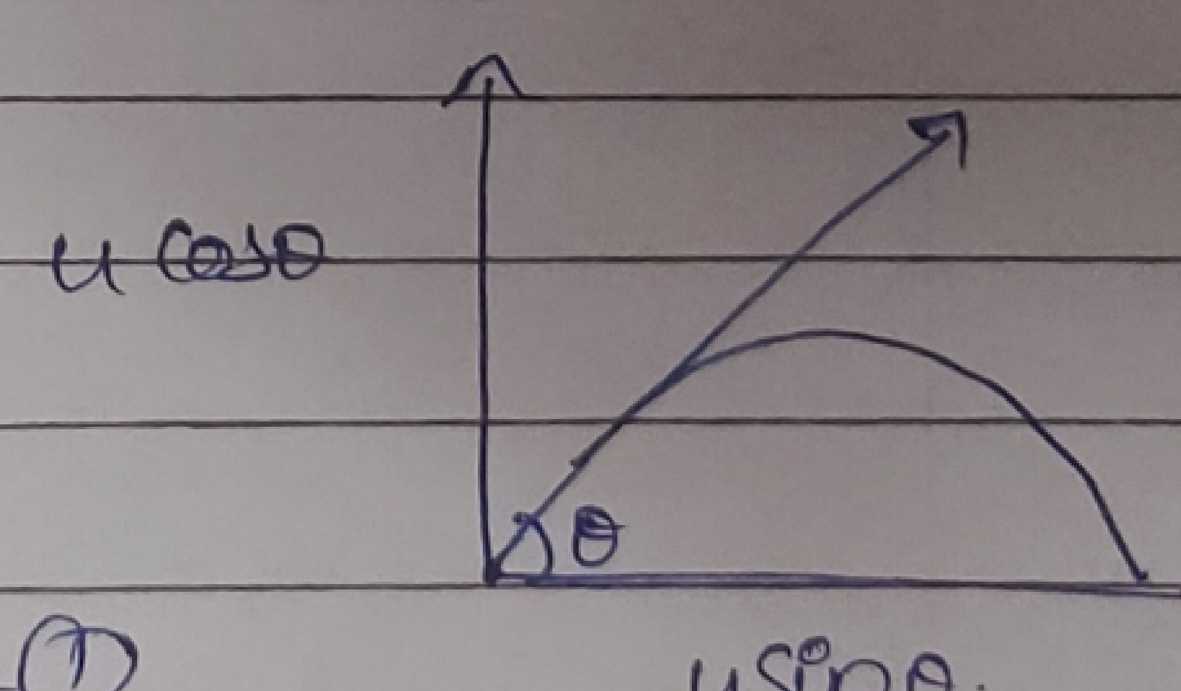
$$\tau = \frac{d}{dt}(I\omega) \quad (L = I\omega)$$

$$\boxed{\tau = I\alpha}$$

Q. Show that the trajectory of an object thrown at an angle with horizontal is parabola.

A. Consider a body moving with initial velocity u making an angle θ.

Horizontal component $= u\cos\theta$
vertical " $= u\sin\theta$.



$$S = ut + \frac{1}{2}at^2$$

Along x axis, $x = u\cos\theta\, t$ —①

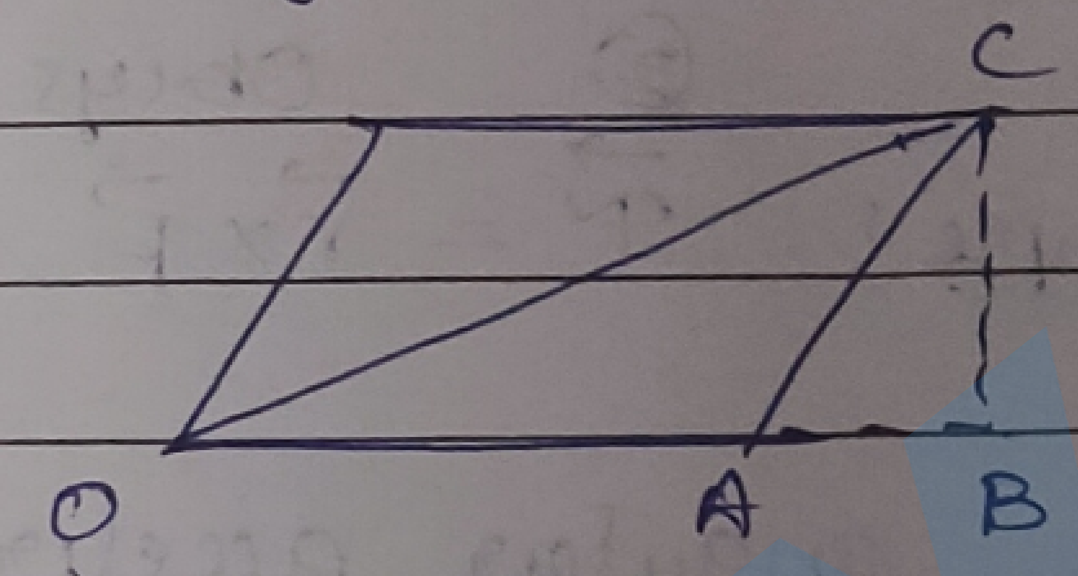
Along y axis, $y = u\sin\theta - \frac{1}{2}gt^2$ —②

Sub ② in ①

$$y = Ax - Bx^2.$$

Q. State Parallelogram law of vectors. Derive expression for magnitude and direction

A. If 2 vectors are represented by 2 adjacent sides of a parallelogram from a point then diagonal gives resultant of 2 vectors.



From triangle OBC

$OC^2 = OB^2 + BC^2$

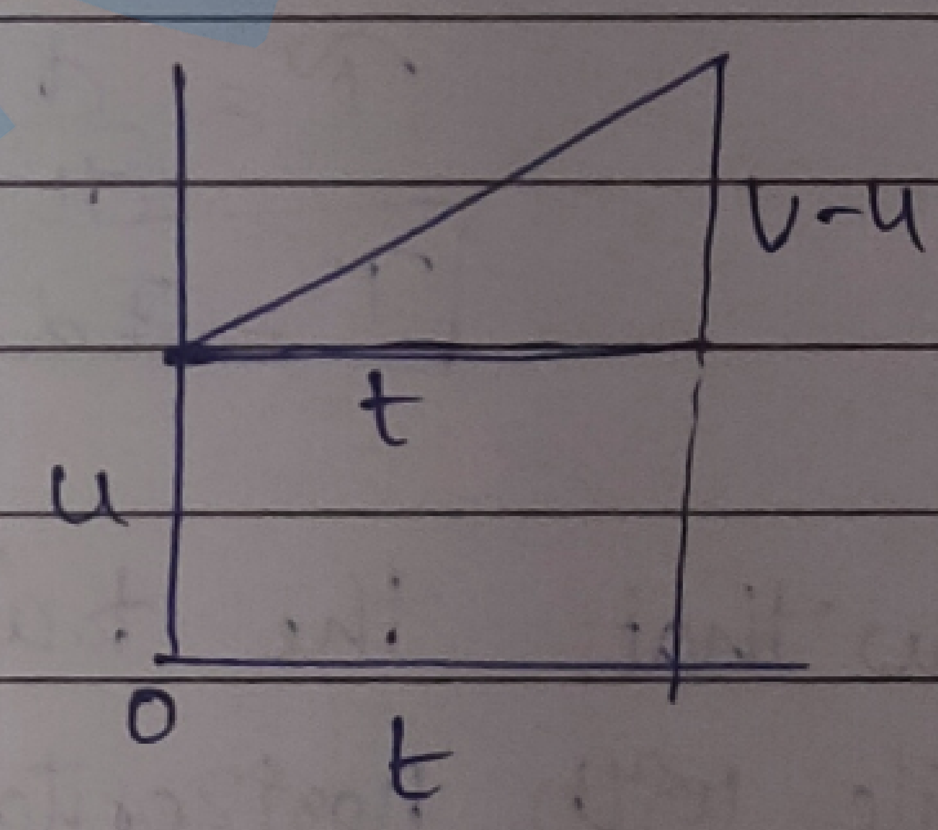
$R^2 = (OA + AB)^2 + BC^2$

$R^2 = (P + Q\cos\theta)^2 + (Q\sin\theta)^2$

$$R^2 = P^2 + Q^2 + 2PQ\cos\theta$$

$\tan\alpha = \dfrac{Q\sin\theta}{P + Q\cos\theta}$

Q. Derive $S = ut + \frac{1}{2}at^2$



S = area of triangle + area of rectangle

$= \frac{1}{2} \times t \times (v-u) + ut$

$$S = ut + \frac{1}{2}at^2$$