Engineering Physics – I – Unit I

Part –C (5 Mark questions and answers)

1. Write the conventions to be followed in writing S.I unit.

The following conventions to be followed while writing the S.I. unit symbols and numerical values.

1) The units named after scientists are not written with capital initial letter. (e.g.) newton and not Newton.
2) Symbol for units named after scientists should be written by capital letter. (e.g.) N for newton and J for joule
3) Small letters are used as symbols for units not derived from proper name.
4) Only the singular form of the unit is to be used. (e.g.) m for meter; kg for kilogram.
5) Don't use full stop at the end of the symbol. (e.g.) kg and not kg.
6) The degree notation (°) is omitted for temperature. (e.g) 273K and not 273°K
7) Use only accepted symbols. (e.g) for ampere : A, for second : s
8) Express the numerical value in scientific notation. (e.g.) density of mercury is 1.36×10^4 kgm^{-3} and not 13600 kgm^{-3}

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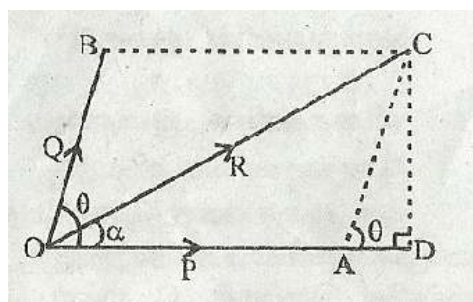
2. Derive expressions for magnitude and directions of the resultant of two forces acting at a point with an acute angle between them.



Consider two forces P and Q acting at a point O are represented in magnitude and direction by the two adjacent sides OA and OB. Complete the parallelogram OACB and draw the diagonal OC. Let θ be the angle between them.

To draw right angled triangle LODC extend the line OA upto D. Draw the perpendicular line CD. According to parallelogram law of forces the diagonal OC gives the magnitude and direction of the resultant R.

Magnitude

In the right angled triangle ODC

$OC^2 = OD^2 + CD^2$

$= (OA+AD)^2 + CD^2$ (OD=OA+AD)

$= OA^2 + AD^2 + 2OA.AD + CD^2$

$= OA^2 + AC^2 + 2OA.AD$ ($AC^2 = AD + CD^2$)

In $\triangle$ADC

$\cos\theta = \frac{AD}{AC}$ AD = AC cosθ = Q cosθ

$\sin\theta = \frac{CD}{AC}$ $\qquad\qquad$ $CD = AC \sin\theta = Q \sin\theta$

$OC^2 = OA^2 + AC^2 + 2OA.AC \cos\theta$

In figure OC = R, OA=P & OB =AC = Q

$$R^2 = P^2 + Q^2 + 2PQcos\theta$$

$$\boxed{R = \sqrt{P^2 + Q^2 + 2PQcos\theta}}$$

This is the expression for the magnitude of the resultant.

Direction

Let α be the angle between P and R. This gives the direction of the resultant.

In ΔODC, $\tan\alpha = \frac{CD}{OD} = \frac{CD}{OA+AD} = \frac{AC\sin\theta}{OA+AC\cos\theta}$

$\tan\alpha = \frac{Q\sin\theta}{P+Q\cos\theta}$ (i.e) $\alpha = \tan^{-1}\left(\frac{Q\sin\theta}{P+Q\cos\theta}\right)$

This is the expression for the direction of the resultant.

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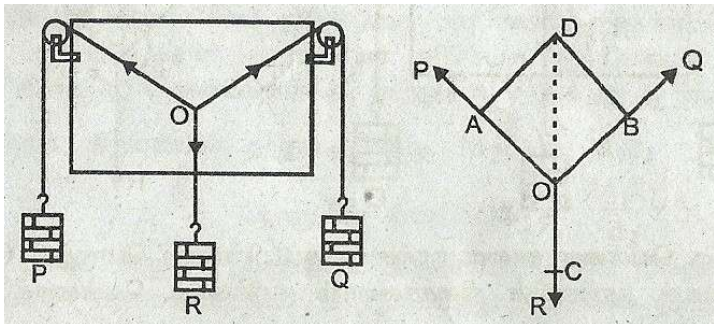
3. Describe an experiment to verify parallelogram law of forces.

A wooden drawing board is fixed vertically by two rigid supports. Two smooth pulleys are fixed at the top two comers of the drawing board. Three light and inextensible strings are tied together to form a common knot at a point O. Two strings are passed over the two pulleys and third string is allowed to hang freely downwards. The free ends of the string are tied with weights, P,Q and R/ Due to the action of three forces the point O is the equilibrium.

A white sheet is placed just behind the string. The point O and the directions of the forces are marked on the paper. Then the paper is taken from the board and the points are joined.

Using suitable scale the line OA, OB and OC are drawn to represent the forces P,Q and R respectively. The parallelogram OADB and the diagonal OD are drawn. The length OD and < COD are measured. The experiment is repeated for different values of P,Q and R and the readings are tabulated.

In all cases, it is found that OC = OD, < COD = 180°. Thus the diagonal OD is the equilibrant which is equal and directly opposite to the resultant R of the forces P and Q. Hence the parallelogram law is verified.



Sl.No.	P	Q	R	OA	OB	OC	OD	< COD
1								
2								
3								

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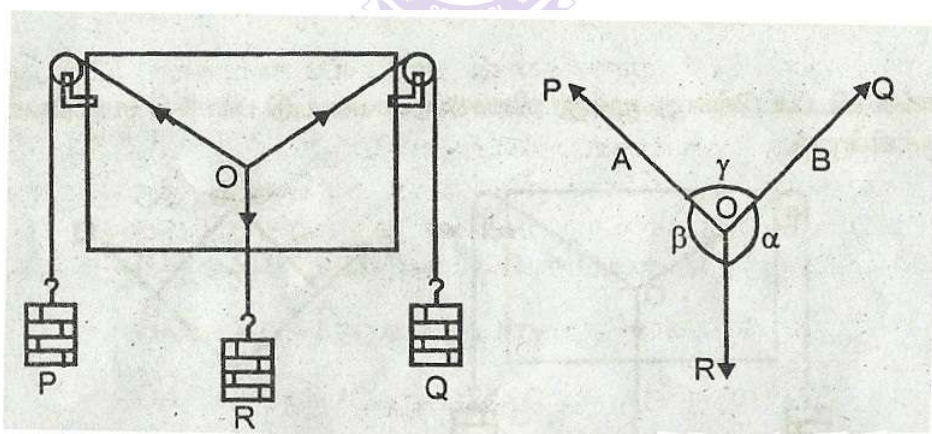
4. Describe how Lami's theorem is verified in the laboratory.

A wooden drawing board is fixed vertically by two rigid supports. Two smooth pulleys are fixed at the top two comers of the drawing board. Three light and inextensible strings are tied together to form a common knot at a point O. Two strings are passed over the two pulleys and third string is allowed to hang freely downwards. The free ends of the string are tied with weights, P,Q and R/ Due to the action of three forces the point O is the equilibrium.



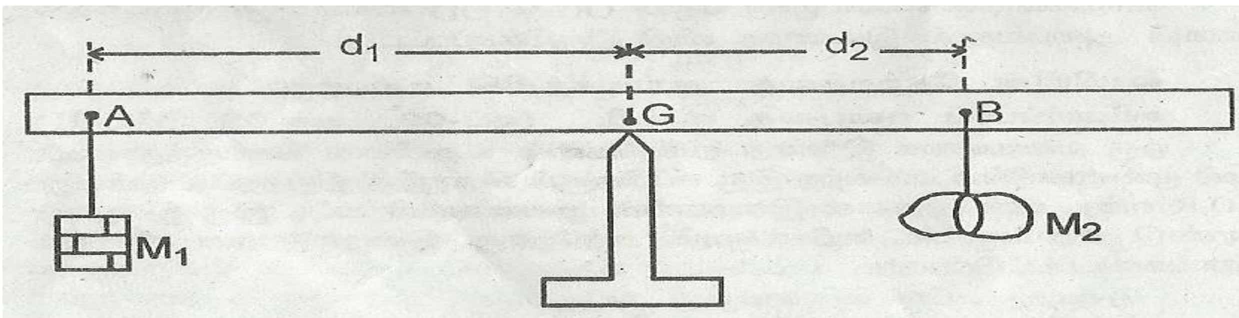
A white sheet is placed just behind the string. The point O and the directions of the forces are marked on the paper. Then the paper is taken from the board and the points are joined.

The angles α, β and γ are measured. The experiment is repeated for different values of P,Q and R and the readings are tabulated.

In all cases, it is found that $\frac{P}{\sin \alpha} = \frac{Q}{\sin \beta} = \frac{R}{\sin \gamma}$. Hence Lami's theorem is verified.

Sl.No.	P	Q	R	A	β	γ	$\frac{P}{\sin\alpha}$	$\frac{Q}{\sin\beta}$	$\frac{R}{\sin\gamma}$
1									
2									
3									

5. Describe an experiment to determine the mass of the given body using principle of moments



A metre scale is balanced on a knife edge such that it is in equilibrium position. It is pivoted at the centre of gravity G. Suspend a known mass M1 on that left side and suspend the given body on the right side of the scale. Let the mass of the body be M_2.

Adjust the positions of M_1 and M_2 until the scale comes to the exact equilibrium position. Now measure the distance d_1 and d_2 from the point G.

According to principle of moments, $\mathbf{M_2 d_2 = M_1 d_1}$

Mass of the body $\mathbf{M_2} = \frac{M_1 d_1}{d_2}$

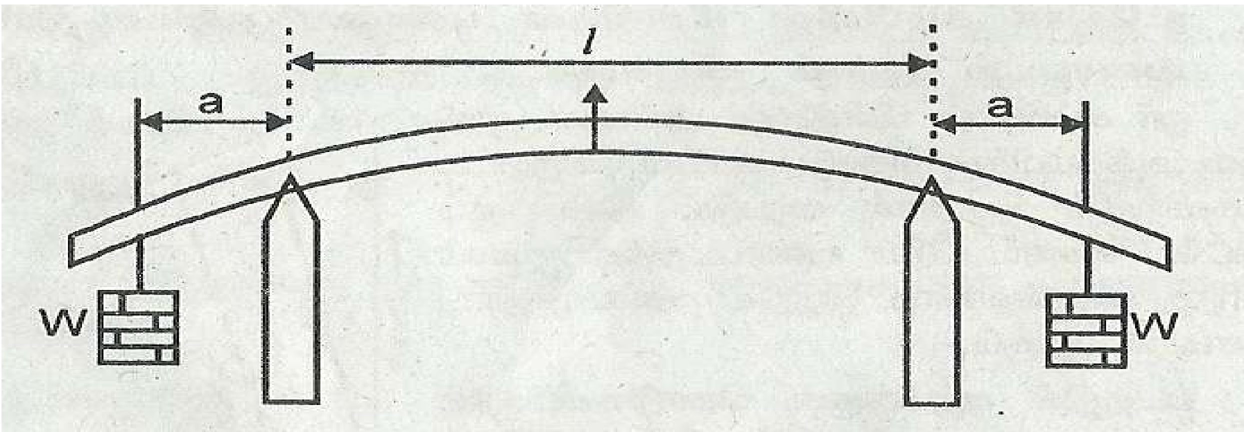
The experiment may be repeated by changing the values of the known weight M_1 and distances d_1 and d_2. The readings are tabulated. The average value of the last column is the mass of the given body.

Sl. No.	Mass M_1	Distances		$\mathbf{M_2} = \frac{M_1 d_1}{d_2}$
		d_1	d_2	
1				
2				
3				

Average =

Part –C (5 Mark questions and answers)

1. Describe an experiment to determine the Youngs Modulus of a beam by uniform bending method



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The uniform bending arrangement is shown below. The given beam (meter scale) is symmetrically supported horizontally on two knife edges. A pin is fixed vertically at the centre. Two weight hangers with dead load “W” are suspended at a distance “a” from each knife edge outwards.

The microscope is focused such that the image of the tip of the pin coincides with the horizontal cross-wire. The reading in the vertical scale of the microscope is noted. The load in each hanger is increased in steps of 50 grams and the corresponding readings are noted. Similarly the readings are taken while unloading and they are tabulated.

The distance “l” between the two knife edges and the distance “a” are measured. The breadth “b” and thickness “d” of the beam are measured using vernier calipers and screw gauge respectively. The mean elevation “y” for a particular mass M is calculated.

Load	Microscope reading		Mean	Elevation for a load of M kg (y)
	Loading	Unloading		
W				
W+ 50				
W + 100				
W + 150				
W + 200				

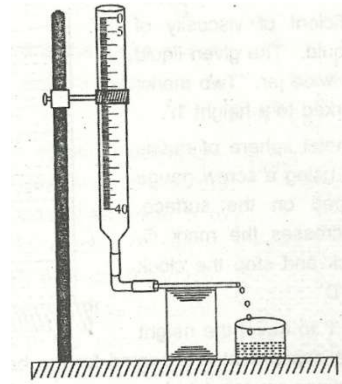
The Young’s Modulus of the material can be calculated using the formula,

$$\boxed{E = \frac{3Mgal^2}{2bd^3y}}$$

2. Describe an experiment to compare the coefficient of viscosities of two low viscous liquids.

A graduated burette is fixed vertically and a capillary tube fixed horizontally. They are connected by a rubber tube.

The given first liquid of coefficient of viscosity η_1 is filled in the burette till the level is above the zero mark. Adjust the burette such that the liquid comes out of the tube drop by drop. When the burette level of the liquid reaches the zero mark, start a stop clock. The time is noted when the liquid reaches 5,10,15,20,25,30,35 c.c gradually. The experiment is repeated for the second liquid of coefficient of viscosity. η_2 The readings are tabulated.



Range in cc	Time of flow		t_1/t_2
	Liquid – I (t_1)	Liquid – II (t_2)	
0 - 5			
5 - 10			
10 - 15			
15 - 20			
20 - 25			
25 - 30			
30 - 35			

The time taken by the two liquids for the same range of flow t_1 and t_2 are calculated. From this find the mean value t_1/t_2. If ρ_1 and ρ_2 are the densities of the two liquids the ratio of coefficient of viscosities of two liquids is calculated using the formula,

$$\boxed{\frac{\eta_1}{\eta_2} = \frac{\rho_1}{\rho_2} \times \frac{t_1}{t_2}}$$

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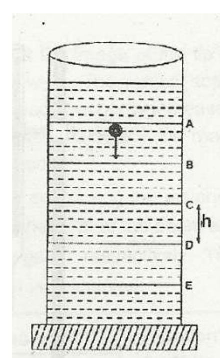
3. Describe an experiment to determine the coefficient of viscosity of a highly viscous liquid by Stoke's method.

Stokes method is used to determine the coefficient of viscosity of highly viscous liquids. The given liquid is taken in a tall glass jar. Two marks C and D are marked to a height "h".



A small metal sphere of radius "r" is determined using a screw gauge and it is dropped on the surface. When the metal ball crosses the mark C, start a stop clock and stop the clock when it reached D. The time "t" to travel (from C to D) height "h" is noted. The experiment is repeated for the balls of different radii and the readings are tabulated.

From the tabular column the average value of 'r^2t", the density of the sphere ρ and the density of the casteroil σ and the value of the h are substituted in the Stoke's formula. Thus we can find the coefficient of viscosity of caster oil.

$$\boxed{\eta = \frac{2\,g(\rho-\sigma)}{9h}\,(r^2t)}$$

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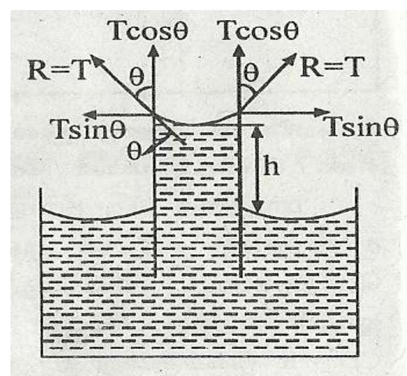
4. Derive an expression for the surface tension of a liquid by capillary method.

When a uniform capillary tube of radius 'r' is dipped vertically in a liquid of density ρ. Because of capillarity the liquid rises to a height "h". Let θ be the angle of contact and T the surface tension of liquid.

The surface tension T acting tangential to the liquid surface and the reaction R =T acts at angle "θ" to the vertical. The reaction T can be resolved vertically as T cosθ and horizontally as T sinθ. The horizontal component along the circumference are equal and opposite in direction so they get cancelled.

The total upward force along the circumference ($2\pi r$) = $2\pi r T\cos\theta$

This force balances the weight of the cylindrical liquid column of height "h" and radius "r".



Weight of the liquid column = $\pi r^2 h \rho g$
Total Upward force = Weight of the liquid column

(ie) $2\pi r T\cos\theta = \pi r^2 h \rho g$

Therefore,

$$\boxed{T = \frac{hr\rho g}{2\cos\theta}}$$

For water, angle of contact θ° = 0,hence cos 0° = 1.

Therefore, surface tension of water $\boxed{T = \frac{hr\rho g}{2}}$

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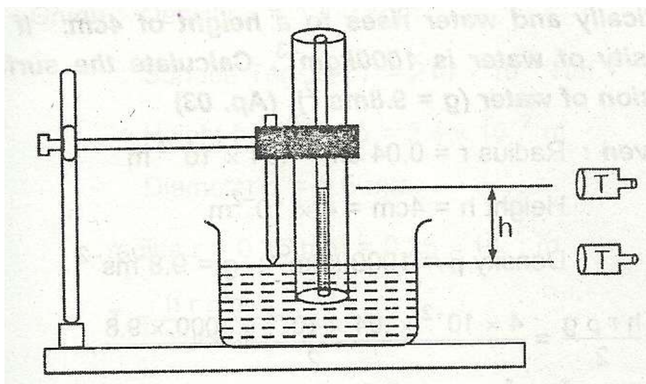
5. Describe an experiment to determine the surface tension of water by capillary rise method.

A capillary tube of uniform radius is cleaned well and dipped vertically in water. Due to capillary the water rises to a certain height. A pointer is mounted vertically such that its tip just touches the surface of water.

The horizontal cross-wire of the eye piece is focused with the lower meniscus image of the water in the tube. The vertical scale reading is taken as h_1. The beaker is removed and the microscope is lowered. The tip of the pointer is focused and the reading is taken as h_2. The difference between h_1 and h_2 gives the height “h”.



Repeat the experiment for three times and tabulate the readings. Hence calculate the average capillary rise h.

Sl.No.	Water level (Capillary tube) h_1	Water level (Capillary tube) h_2	Capillary rise h

The diameter and hence the radius r of the capillary tube is determined with the microscope. Know the value of density of water ρ, then the surface tension of water is calculated using the formula.

$$\boxed{T = \frac{h\,r\,\rho\,g}{2}} \quad Nm^{-1}$$

Part –C (5 Mark questions and answers)

1.Derive the equations of motion for a body in horizontal motion.

Here u- initial velocity v – final velocity,

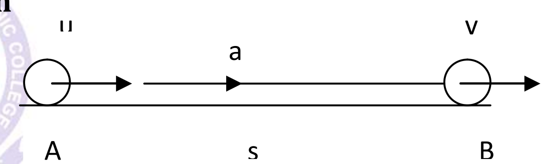
a – acceleration s - displacement, t – time taken

Acceleration = **a** = $\frac{\boldsymbol{Change\ in\ velocity}}{\boldsymbol{Time\ taken}}$

$$a = \frac{v-u}{t} \quad \text{(ie) } at = v - u$$

v = u + at………………(1)

Average velocity in time t = $\frac{\textbf{Distance travelled}}{\textbf{Time taken}}$



$$\frac{u+v}{2} = \frac{s}{t}$$

Therefore, $s = \left(\frac{u+v}{2}\right) t$

Using equation (1), $s = u + u + at\left(\frac{t}{2}\right)$

$$s = 2u + at\left(\frac{t}{2}\right)$$

$$\mathbf{s} = \boldsymbol{ut} + \frac{\mathbf{1}}{\mathbf{2}}\mathbf{at^2} \text{…………..(2)}$$

From equation (1), v = u + at

(ie) v - u = at

$$\mathbf{t} = \frac{\boldsymbol{v-u}}{\boldsymbol{a}}$$

But average velocity, $\frac{u+v}{2} = \frac{s}{t}$

$$\left(\frac{u+v}{2}\right) t = s$$

Substituting for t, $s = \left(\frac{v+u}{2}\right) \times \left(\frac{v-u}{a}\right)$

$s = \frac{v^2-u^2}{2a}$ (ie) $\boxed{\boldsymbol{v^2 = u^2 + 2as}}$

$v = u + at$

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

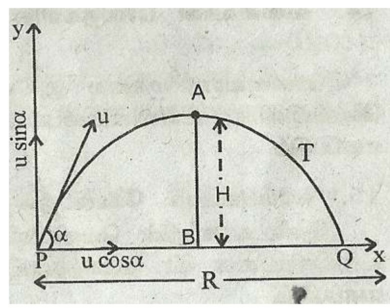
$v^2 = u^2 + 2as$

These are the equations of motion.

2. Derive the expression for the maximum height reached by the projectile.

Let a body be projected with a velocity u and at an angle of projection α. The velocity of projection u can be resolved to u cosα in the horizontal direction and u sin α in the vertical direction. The body describes a parabolic path.

At the highest point u sin α becomes zero. The distance from the ground to the highest point is the maximum height H. (i.e) AB = H.



Equation of motion is $v^2 = u^2 + 2as$

Considering the motion from P to Q,

u = u sin α ; v = 0 ; a = - g ; s = H,

Substituting these values in the equation,

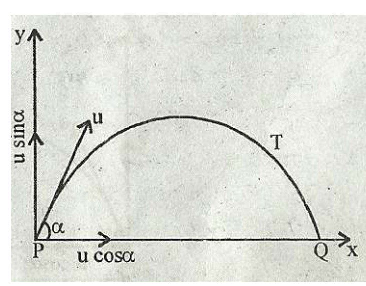
$$0 = u^2 \sin^2 \alpha - 2gH$$

$$2gH = u^2 \sin^2 \alpha$$

Therefore, $\boxed{H = \frac{u^2 \sin^2 \alpha}{2g}}$

3. Derive an expression for the time of flight of a projectile.

Let T be the time taken by a particle to travel from P to Q.
During the time interval vertical displacement is **zero**



Equation of Motion is $s = ut + \frac{1}{2}at^2$

Substituting **s = 0** ;**u = u sin α, a = - g ; s = H,**

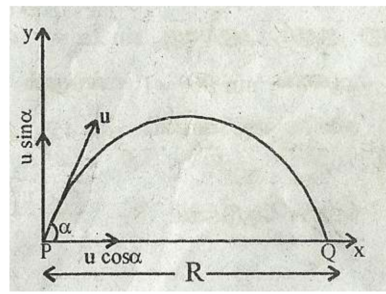
We get $0 = u \sin \alpha T - \frac{1}{2}gT^2$

$$\frac{1}{2}gT^2 = u \sin \alpha \, T$$

$$\boxed{T = \frac{2u \sin \alpha}{g}}$$

4. Derive the expression for the range of the projectile.

Let a body be projected with a velocity u and an angle of projection α. The velocity of projection u can be resolved to ucosα in the horizontal direction and u sinα in the vertical direction.
Range is the horizontal displacement made by the projectile in the time of flight T.
(i.e.) PQ =R.



Range = Horizontal component of velocity x time of flight

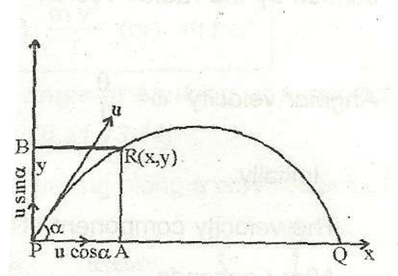
$$R = u \cos \alpha \times \frac{2 u \sin \alpha}{g}$$

$$R = \frac{u^2}{g} \times 2 \sin \alpha \cos \alpha$$

Range $\boxed{R = \frac{u^2 \sin 2\alpha}{g}}$

5. Prove that the path of a projectile is a parabola.

Consider a body which is projected with a velocity u and an angle of projection α.
The velocity of projection u can be resolved to u cosα in the horizontal dir
After "t" seconds, the body reaches the point R(x,y).
Here x and y are the coordinates of the point R.
After ' t ' seconds



The displacement along the x axis PA x = u cos α t ....(1)

The displacement along the y axis PB y = u sin αt - $\frac{1}{2}gt^2$.....(2)

From equation (1) we get, $t = \frac{x}{u \cos \alpha}$

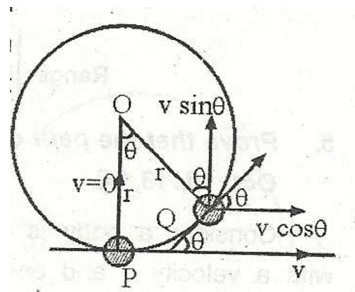
Substituting the value of " t " in equation (2)

$$y = u \sin \alpha \frac{x}{u \cos \alpha} - \frac{1}{2} g \frac{x^2}{u^2 \cos^2 \alpha}$$

$$\boxed{y = x \tan \alpha - \frac{gx^2}{2 u^2 \cos^2 \alpha}}$$

6. Derive expressions for normal acceleration and centripetal force of a body in circular motion.

Consider a particle moving along a circular path of radius r with uniform velocity v and angular velocity ω. Let tbe time taken to move from the point P to Q. Let θ be the angle described by the radius vector.



Angular velocity $\omega = \frac{\theta}{t}$

Initially,

The velocity component at P in PO direction = 0

After t seconds,

The velocity component at Q in PO direction = $v \sin \theta$

Change in velocity $= v \sin \theta - 0$

$= v \sin \theta$

Acceleration in vertical direction $= \frac{v \sin \theta}{t}$

If θ *is very small,* $\sin \theta = \theta$

Normal acceleration $a = \frac{v\theta}{t}$

Since $\omega = \frac{\theta}{t}$ $a = v\,\omega$,

Since $v = r\omega$, $a = r\,\omega^2$

since $\omega = \frac{v}{r}$ $a = \frac{v^2}{r}$

Normal acceleration = $\boxed{a = v\,\omega, \text{ or } r\,\omega^2 \text{ or } \frac{v^2}{r}}$

Let m is the mass of the particle and a is the normal acceleration. According to Newton's II law of motion F = ma

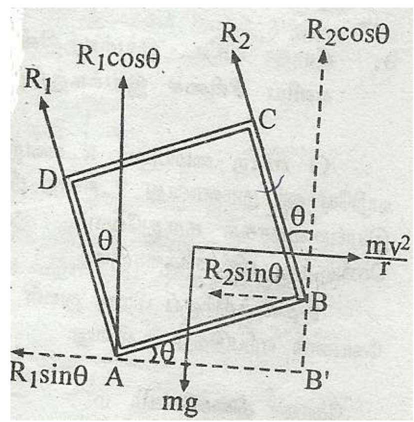
(i.e.) Centri petal force is = $\boxed{F = mv\,\omega, \text{ (or) } m\,r\,\omega^2 \text{ (or) } \frac{m\,v^2}{r}}$

7. Derive an expression for the angle of banking of a curved railway track.

A railway carriage of mass m travelling along a curved track of radius r with a speed v . Let ABCD is the vertical section of a carriage. As the outer rail is raised over the inner rail by an angle θ, the floor of the carriage is also inclined to the horizontal by an angle θ. This angle θ is known as the angle of banking.

Let R_1 and R_2 be the reaction of the inner and outer rails.

The total vertical component of R_1 and R_2
$=R_1\cos\theta+R_2\cos\theta = (R_1 + R_2)\cos\theta$



This balances the weight of the carriage
$(R_1 + R_2)\cos\theta = W = mg$ ………………(1)

The total horizontal component of R_1 and R_2
$=R_1\sin\theta+R_2\sin\theta = (R_1 + R_2)\sin\theta$

This gives the necessary centripetal force and it balances the centrifugal force.

$(R_1 + R_2)\sin\theta = F = \frac{m\,v^2}{r}$……………(2)

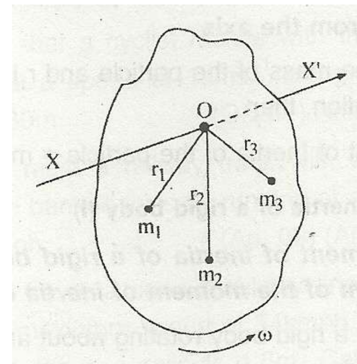
Eq $\left(\frac{2}{1}\right)$ = $\tan\theta = \frac{v^2}{rg}$

Angle of banking = $\boxed{\theta = \tan^{-1}\left(\frac{v^2}{rg}\right)}$

Engineering Physics – I – Unit IV
Part –C (5 Mark questions and answers)

1. Derive an expression for kinetic energy of a rigid body rotating about an axis:

Consider a rigid body rotating about a fixed axis XOX'. The rigid body consists of a large number of particles. Let m_1, m_2, m_3,….. ... etc., be the masses of the particles situated at distances. r_1, r_2, r_3,... etc., from the fixed axis.



All the particles rotate with the same angular velocity ω. But the linear velocities of the particles are different.

Kinetic energy of the 1st particle is $= \frac{1}{2} m_1 \ v_1{}^2$

$$= \frac{1}{2} m_1 \ r_1{}^2 \omega^2 \quad (v_1 = \ r_1 \omega)$$

The kinetic energy of the whole body is the sum of kinetic energy of all the particles.

Kinetic energy of the rigid body is $= \frac{1}{2} m_1 \ r_1{}^2 \omega^2 + \frac{1}{2} m_2 \ r_2{}^2 \omega^2$ $+ \ldots \ldots \ldots \ldots \ldots . . \frac{1}{2} m_n \ r_n{}^2 \omega^2$

$$= \frac{1}{2} \omega^2 (m_1 \ r_1{}^2 + m_2 \ r_2{}^2 + m_3 \ r_3{}^2 + \cdots \ldots \ldots \ldots . m_n \ r_n{}^2)$$

$$= \frac{1}{2} \omega^2 \sum_{i=1}^{i=n} m_i \ r_i{}^2 \left(\sum_{i=1}^{i=n} m_i \ r_i{}^2 = I \right)$$

Kinetic energy of the rigid body is $=$ $\boxed{I = \frac{1}{2} I \omega^2}$

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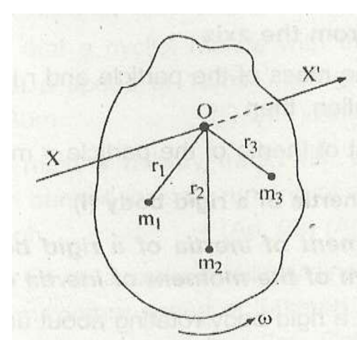
2. Expression for Angular momentum of a Rigid body rotating about an axis.

Consider a rigid body rotating about a fixed axis XOX'. The rigid body consists of a large number of particles. Let m_1, m_2, $m_{3\ldots}$ etc., be the masses of the particles situated at distances r_1, r_2, r_3 ... etc., are the distances from the fixed axis. All the particles rotate with the same angular velocity ω, but with different linear velocities depending on the values of 'r'

Angular momentum of the first particle = $m_1 v_1 \times r_1 = m_1 \ r_1{}^2 \omega \ (v_1 = \ r_1 \omega)$



The angular momentum of the whole body is the sum of the angular momentum of all particles.

The angular momentum of the rigid body,

$L = m_1 \ r_1{}^2 \omega + m_2 \ r_2{}^2 \omega + m_3 \ r_3{}^2 \omega + \ldots\ldots\ldots m_n \ r_n{}^2 \omega$

$L = \omega(m_1 \ r_1{}^2 \omega + m_2 \ r_2{}^2 \omega + m_3 \ r_3{}^2 \omega + \ldots\ldots\ldots m_n \ r_n{}^2 \omega)$

$\boxed{L = \omega I}$ $\left(\sum_{i=1}^{i=n} m_i \ r_i{}^2 = I \right)$

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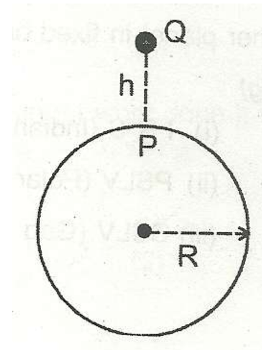
3. Derive the expression for the variation of acceleration due to gravity with altitude (height).

Let P be a point on the surface of the Earth and Q be a point at an altitude h. Let M be the mass of the Earth and R radius of the Earth . Consider the earth as a spherical shaped body.



The acceleration due to gravity at P,

$$g = \frac{GM}{R^2} \text{ .... } (1)$$

The acceleration due to gravity at Q,

$$g_h = \frac{GM}{(R+h)^2} \text{...... } (2)$$

$$\frac{(2)}{(1)} \text{ gives, } \frac{g_h}{g} = \frac{R^2}{(R+h)^2}$$

By simplifying and expanding using binomial theorem,

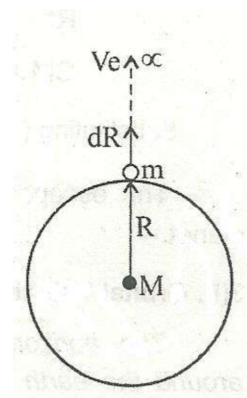
$$\boxed{g_h = g\left(1 - \frac{2h}{R}\right)}$$

That is, the value of "g" decreases with increase in height.

---

4. Derive an expression for the escape velocity.

A body of mass m is projected with an escape velocity V_e on the surface of the earth. Let M be the mass and R be the radius of the earth.



By Newton's law of gravitation, the force of attraction on m is

,F $= \frac{GMm}{R^2}$ $\quad where$ G is gravitational constant.

Work done in carrying the body from the surface of earth to infinity is

$$W = \int_R^{\infty} \frac{GMm}{R^2} dR = \frac{GMm}{R} \qquad \text{... ... } (1)$$

If the body is thrown with this amount of work done it will escape from the earth's gravitational pull.

If V_e is the escape velocity, then the kinetic energy$= \frac{1}{2} mV_e^2$ ....(2)

This kinetic energy is converted into work done to escape the body from the gravitational field.

Equating the equations (2) and (1)

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

$$V_e = \sqrt{\frac{2GM}{R}} \quad \ldots\ldots\ldots\ldots.(3)$$

On the surface of the earth,the gravitational force is equal to the weight of the body.

$$\frac{GMm}{R^2} = mg$$

$$GM = gR^2 \ldots\ldots\ldots\ldots(4)$$

Substituting, (4) in (3) we have, $\boxed{V_e = \sqrt{2gR)}}$

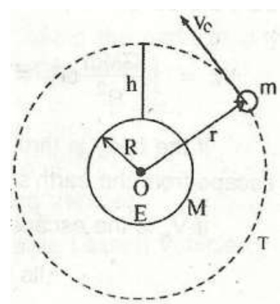
---

5. Derive an expression for the orbital velocity of a satellite.

Let M be the mass and R be the radius of the earth. Let us assume a satellite of mass "m" revolves around the earth with an orbital velocity V_o. Let the satellite be placed at a height of (R+h) from the centre of the earth O.

For stable orbital motion of the satellite,

The gravitational force is equal to the centrifugal force.



$$\frac{mV_0^2}{R+h} = \frac{GMm}{(R+h)^2}$$

$$V_0^2 = \frac{GM}{R+h} \ldots\ldots\ldots\ldots(1)$$

When the satellite is on the surface of the earth,

the gravitational force is equal to the weight of the satellite.

$$\frac{GMm}{R^2} = mg$$

$$GM = gR^2 \ldots\ldots(2)$$

Substituting (2) in equation (1) we get,

$$\text{Orbital velocity } V_o = \sqrt{\frac{gR^2}{R+h}}$$

If the satellite is at a few hundred kilometres, R +h = R

$$\text{Then } V_o = \sqrt{\frac{gR^2}{R}}$$

Orbital velocity = $\boxed{V_o = \sqrt{gR)}}$

---

6. Explain the uses of artificial satellites.

There are many type of artificial satellite used for different purpose.

They are :

1) Communication satellites:

   These satellites are used to receive the radio, television and telephone signals from ground station and transmit them over long distance throughout the world.

2) Weather monitoring satellites :

   These satellites are used to photograph the clouds from space and measure the amount of heat radiated from the earth. Force this information scientists can announce better forecasts about weather.

3) Remote Sensing Satellites:

   These satellites are used to collect data's in agriculture, forestry drought assessment, estimation of crop yield, fishing zones, mapping and surveying.

4) Navigation Satellites:

   These satellites are used for navigations to guide their ships or planes in all kinds of weather.

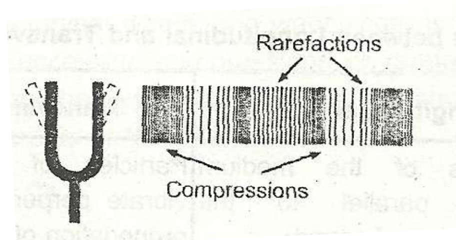
Engineering Physics – I – Unit V

Part –C (5 Mark questions and answers)

1.Explain longitudinal and transverse wave motion.

(i) **Longitudinal wave motion:**

If the particles of the medium vibrate parallel to the direction of propogation of the wave, the wave is known as longitudinal wave.

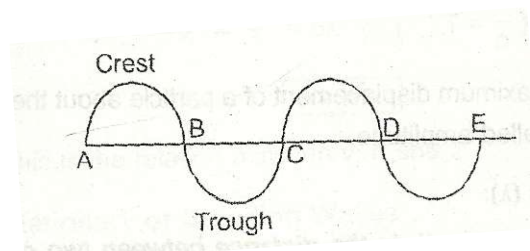


Ex: The propagation of sound in air or gas
The propagation of sound inside the liquid.

The longitudinal wave travel in a medium in the form of compressions and rarefactions. The place where the particles of the medium crowded together are called compressions and the places where the particles spread out are called rarefactions.

(ii) **Transverse wave motion:**

If the particles of the medium vibrate perpendicular to the direction of propagation of the wave, the wave is known as transverse wave.



Ex: (i) Waves produced on the surface of water
(ii) Waves travelling along a rope
(iii) Other waves like light waves, thermal radiations, radio waves etc.,

The transverse waves travel in a medium in the form of crests and troughs. Crests are points having maximum upward displacement and troughs are points having maximum downward displacement.

---

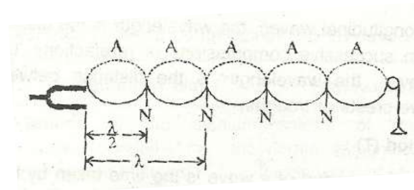
2. Distinguish between Longitudinal wave motion and transverse wave motion.

No.	Longitudinal wave motion	Transverse wave motion
1.	Particles of the medium vibrate parallel to the propagation of sound	Particles of the medium vibrate perpendicular to the propagation of sound.
2.	Compressions and rarefactions are formed	Crests and troughs are formed
3.	Travels through solids, liquids and gas	Travels through solids, and on liquid surfaces
4.	Can be reflected, refracted and diffracted but not polarized.	Can be reflected, refracted, diffracted and also polarized.
5.	Distance between two successive compressions or rarefactions is called wave length	Distance between two successive crests or troughs is called a wave length.

3. What are stationary waves? How they are formed?

When a progressive wave strikes against a hard surface, it gets reflected. The reflected wave superimposes on the incident wave to form stationary wave.

When two identical waves having equal wavelength and amplitude travel in opposite directions they superimpose on each other forming stationary waves.



A stationary wave formed by a vibrating string (PQ) is as shown in the figure.

In a stationary wave, at certain points the particles of the medium are at rest, such points are called nodes.

At certain other points, the displacement of the particles are maximum, such points are called anti-nodes.

The points N,N,N are called Nodes and A,A,A are called anti-nodes.

The distance between two successive nodes (or) anti-nodes is = $\frac{\lambda}{2}$

The distance between a node and an anti-node is = $\frac{\lambda}{4}$

---

4. Explain the laws of vibrations of a stretched string and obtain an expression for the frequency of the vibrated string.

When a stretched string vibrates its frequency depends on (i) the tension in the string T, (ii) linear density of the string m (iii) length of the vibrating segment ℓ

Laws of vibrations in stretched strings:

First law: The frequency of vibrating string is inversely proportional to its length, when the tension and linear density of the string are kept constant.

$$\boxed{n \infty \frac{1}{\ell}}$$

Second law: The frequency of vibration is directly proportional to the square root of tension, when the length and linear density of the string are kept constant.

$$\boxed{n \infty \sqrt{T}}$$

Third law: The frequency of vibration is inversely proportional to the square root of the linear density of the string, when the tension and length of the string are kept constant.

$$\boxed{n \infty \frac{1}{\sqrt{m}}}$$

According to the above laws,

$$n \infty \frac{1}{\ell}\left(\sqrt{T/m}\right)$$

Note: If tension T = Mg, $n = \frac{1}{2\ell}\left(\sqrt{Mg/m}\right)$

$$\text{Frequency} = n = \frac{1}{2}\sqrt{\frac{M}{\ell^{2}}\frac{g}{m}}$$

The linear density , m = $\frac{\text{mass}}{\text{length}} = \frac{\text{mass}}{\ell} = \frac{V\rho}{\ell}$, where ρ *is the density of the wire.*

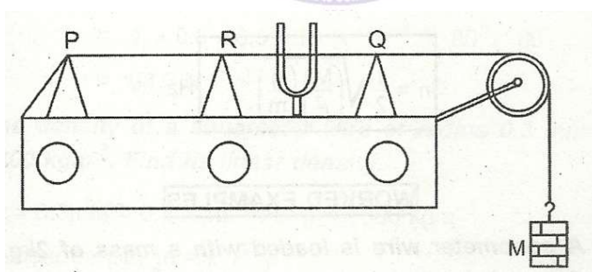
$$\text{But volume} = V = \pi r^2 \ell$$

Linear density = m = $\frac{\pi r^2 \ell \rho}{\ell}$, therefore $\boxed{m = \pi r^2 \rho}$

---

5. Describe an experiment to determine the frequency of a tuning fork using sonometer.

Sonometer is used to find the frequency of a given tuning fork. It consists of a hollow wooden box with a thin wire. One end of the wire is tied to the nail and the other end passes over a smooth pulley and carries a weight hanger. The string is supported by the three knife edges P,Q, and R. A movable knife edge R is placed between two fixed knife edges P and Q.



A suitable load (T = Mg) is applied to the hanger. A small paper rider is placed on the wire. A tuning fork of unknown frequency is excited and its stem is placed on the wooden box. The length of the wire is adjusted until the paper rider violently falls down. The paper rider falls because of resonance. Now the vibrating length of the string ℓ is measured. The experiment is repeated for different loads and the average value of $\frac{M}{\ell^{2}}$ is calculated.

Let r be the radius of the string measured using a screw gauge and ρ is the density of the material of the wire, then the linear density m is calculated using the formula m= $\pi r^2 \rho$.

The frequency of the tuning fork is calculated using the formula, Frequency = $\boxed{n = \frac{1}{2}\sqrt{\frac{M}{\ell^2}\frac{g}{m}}}$ Hz

S.No	Load	Vibrating length	ℓ^2	$\frac{M}{\ell^2}$
1.				
2.				
3.				
4.				
5.				

---

6. Explain noise pollution.

Noise pollution:

Definition: The human environment is polluted by unwanted noise is known as noise pollution.

Types: (i) Air borne noise. ii) Structure borne noise iii) Inside noise.

Noise reaches the hall through open windows, doors are called air borne noise. Echos and reverberation are produced by the wrong structure of building are called structure borne noise. The noise produced inside the hall is known as inside noise.

Effects:

1. It produce mental fatigue and irritation
2. It reduced the efficiency of work
3. It lowers the quality of sleep
4.Strong noise leads to hearing imparment.

Control measures:

1. Construct the building without echo and reverberation
2.Construct the industries, airport and railway station outside the city
3.Use noise free machines
4. Use vibrating mounts, leather washers and sound filters in noise machines.
5.Use air plug and muffs while working inside the factories.

---

6. Write a note on acoustics.

Acoustics of buildings deals with the design and construction of building so as to have good acoustic properties. Here buildings refer to auditorium, cinema theatre, lecture halls, etc.,

While constructing buildings the following properties must be taken into consideration.

1. The sound heard by the audience in any part of the hall must be sufficiently loud.
2. The quality of speech and music must be unchanged.

3. The successive sounds must be clearly heard.
4. Outside noise must be completely eliminated.
5. There should not be any vibrations due to resonance.

For achieving the above conditions, the following factors should also be considered while designing a building.

1. Echo. 2. Reverberation 3. Reverberation time.

i). Echo: The first reflected sound is called as echo. If the time interval between the direct and reflected sound is $\frac{1}{15}$ second the echo is clearly heard. During speeches the echo will produce confusion, so it is undesirable. But for music it is desirable.

ii) Reverberation: Reverberation is multiple reflection of sound from the walls, floors and ceiling of a hall.

Reverberation is heard for a small time with low intensity of sound and after that it becomes inaudible.

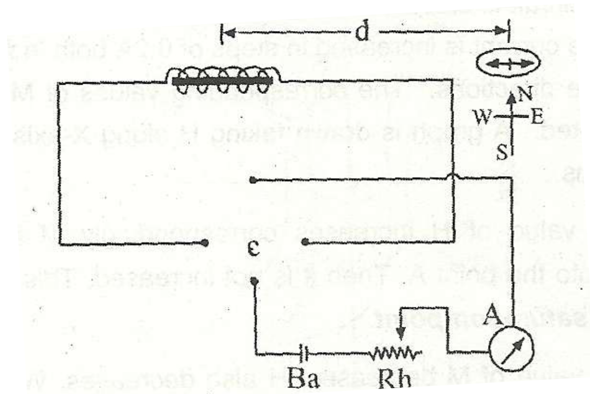
The echo and reverberation must be avoided. To rectify these defects the walls and other surfaces must be covered with sound absorbing materials like curtains, and porous tiles. It can also be avoided by providing number of doors and windows.

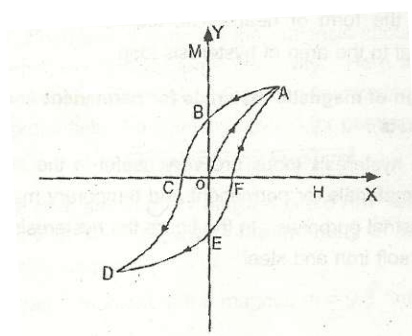
iii) Reverberation time: The time taken by the sound to fall in intensity to one millionth of original sound is called reverberation time. For good quality of loudness an optimum reverberationtime must be maintained.

---

7. Describe an experiment to draw the hysteresis loop (M-H Curve) for a given specimen.

The experimental arrangement is as shown in the diagram. The specimen in the form of rod is placed inside the solenoid. The deflection Magnetometer in Tan A position is placed at a distance.





The Magnetising field can be calculated as H = $\frac{NI}{L}$, where N is the number of turns of the solenoid and L is the length of the solenoid and is the strength of the current.

The intensity of Magnetisation can be calculated as M = k tanθ. where k is constant and θ is the angle of deflection.

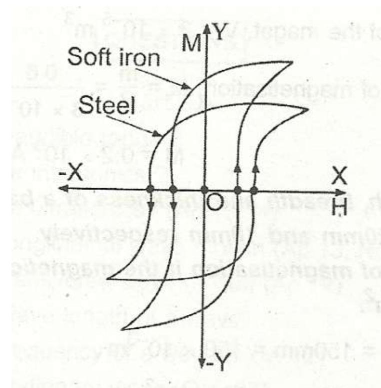
The circuit is closed with the help of rheostat and commutator. The current is increased in steps of 0.2 amps both in forward and reverse directions. The corresponding values of M and H are calculated. A graph is drawn taking H along the X axis and M along the Y axis.

The specimen is taken through a cycle of magnetization . A closed loop ABCDEFA is obtained. This is known as hysteresis loop. In the graph A is the saturation point. OB is retentivity and OC is coercivity of the specimen.

---

7. Explain the usefulness of the hysteresis loop in the selection of magnetic materials for industrial applications . (or) Explain the useful ness of hysteresis loop.

The hysteresis loops are very useful in the selection of magnetic materials for permanent and temporary magnets and other industrial purposes. In the figure the hysteresis loops are drawn both for soft iron and steel.



The area of the hysteresis loop for steel is more than that of soft iron. So the energy loss in steel is more than that of soft iron. For this reason, soft iron is selected as a core material for transformers, chokes, dynamo, AC motors, etc.,

The soft iron possesses (i) Large retentivity (ii) small coercivity and (iii) large M for small H and (iv) Minimum hysteresis loss. So soft iron is selected for temporary magnets.

Engineering Physics – I – Unit IV

Part – B (3 Mark questions and answers)

1. Derive the moment of inertia of a rigid body about and axis.

Consider a rigid body rotating about an axis. Let $m_1, m_2, m_3 \ldots\ldots m_n$ are the masses of the particles and $r_1, r_2, r_3 \ldots\ldots r_n$ are the distance from the axis of rotation.
Moment of Inertia of the rigid body

$$I = m_1r_1^2 + m_2r_2^2 + m_3r_3^2 + \ldots\ldots + m_nr_n^2$$

$$I = \sum_{i=1}^{i=n} m_i r_i^2$$

2. State and explain Newton's law of gravitation.

Everybody in the universe attracts every other body with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

Consider two particles of masses m_1 and m_2 are the separated by a distance r. Then the force of attraction F is

$$F \propto m_1 m_2$$

$$F \propto \frac{1}{r^2}$$

$$F \propto \frac{Gm_1 m_2}{r^2}$$ where G is known as a gravitational constant

3.Define escape velocity and orbital velocity.

Escape velocity:

The minimum velocity required to project upwards a body from the surface of the planet, so that it just escapes from the gravitational pull of the planet is called escape velocity

Orbital velocity:

The horizontal velocity with which a satellite rotating around the earth in circular path at predetermined height is called orbital velocity.

4. Write any three uses of orbital satellite.

1. It is used in weather monitoring
2. It is used in remote sensing.
3. To navigate ships and aero planes during all kinds of weather.

Engineering Physics – I – Unit III

Part – B (3 Mark questions and answers)

1.State Newton's laws of motion.

I law: Everybody continues to be in its state of rest or of uniform motion in a straight-line unless compelled by an external force to change that state.

II law: The rate of change of momentum of a body is directly proportional to the force acting on it and it takes in the direction of the force.

III law: For every action, there is an equal and opposite reaction.

2.Define maximum height, time of flight and range of a projectile.

Maximum height: Maximum height is the maximum vertical displacement of the projectile from the horizontal plane through the point of projection.

Time of flight: The time taken by the projectile from the instant of projection to the instant when it again reaches the horizontal plane through the point of projection.°

Range: The distance between the point of projection and the point where the trajectory meets the plane through the point of projection is called as range.

---

3. Derive the condition for the maximum range (R_{max}) of a projectile.

Let a body be projected with a velocity u and at an angle of projection α.

Then, range R of the projectile is $R = \frac{u^2 \sin 2\alpha}{g}$

For a given velocity of projection,the range is maximum only if the value of 2α is maximum.

$$\text{(ie) } \sin 2\alpha = 1$$

Since $\sin 90° = 1$, $2\alpha = 90°$ **(ie)** $\boldsymbol{\alpha = 45°}$

The range is maximum when the angle of projection is 45°

4.Derive the relation between linear velocity and angular velocity of a body in circular motion.

Consider a particle moving along the circumference of a circle of radius r with a linear velocity v and angular velocity ω. Let t be the time taken to move from the point P to Q.

Let θ be the angle described in t seconds.

$$\omega = \frac{\theta}{t}$$

Linear velocity $= v = \frac{\text{distance travelled}}{\text{time taken}} = \frac{\text{Length of the arc PQ}}{\text{time taken}} = \frac{\text{Angle x radius}}{\text{time taken}}$

(ie) $v = \frac{r\theta}{t} = r\left(\frac{\theta}{t}\right) = r\omega$

Therefore, $\boxed{\mathbf{v = r\omega}}$

---

5. Define centripetal force and centrifugal force.

Centripetal force: For circular motion, a constant force should act on the body, along the radius towards the centre and perpendicular to the velocity of the body. This force is known as centripetal force.

Centrifugal force: According to Newton's III law of motion, there is an equal and opposite force for centripetal force. This reactive force which is away from the centre is called as centrifugal force.

Engineering Physics – I – Unit V

Part – B (3 Mark questions and answers)

1.Define audible range, infrasonics and ultrasonics

Audible range: Normal human ear can hear the sound of frequencies ranging from 20 Hz to 20,000 Hz. This is called as audible range of frequency.

Infrasonics: Sound waves of frequency below 20 Hz is known as infrasonics.

Ultrasonics: Sound waves of frequency more than 20,000 Hz is known as ultrasonics.

---

2. Derive the relation between velocity, frequency and wave length of a sound wave.

Let n be the frequency and λ be the wave length of the wave.

Time taken for one oscillation is = $\frac{1}{n}$ second.

Distance travelled = λ

The velocity is the distance travelled by the sound wave in one second.

That is velocity is = $\frac{\text{Distance travelled}}{\text{Time taken}}$

$$v = \frac{\lambda}{\left(\frac{1}{n}\right)} = n\lambda$$

$$\boxed{V = n\lambda}$$

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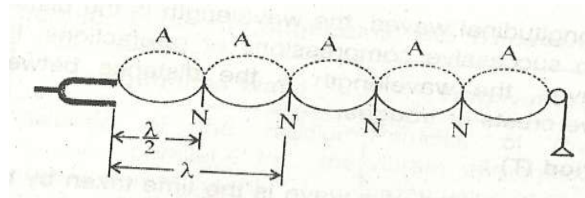
3. Explain stationary waves or standing waves.



When two identical waves having equal wave length and amplitude travel in opposite directions, they superimpose on each other, forming a stationary wave.
In a stationary wave, at certain points, the particles of the medium are at rest, they are called as nodes
At certain points, the displacement of the particles are at maximum, they are called as antinodes.

The nodes are represented as N and antinodes as A

The distance between any two successive nodes or antinodes is = $\frac{\lambda}{2}$

The distance between between a node and adjacent nodes is = $\frac{\lambda}{4}$

4.Explain hysteresis.

When a rod of iron or steel is kept inside a solenoid through which a current is passed, the rod gets magnetized. As the strength of the current in the solenoid is increased the magnetism induced in the rod also increases upto a certain level. Beyond this the induced magnetism is not increased whatever may be the magnetizing field. Now the rod is said to be saturated.

If the magnetizing field is gradually decreased, the induced magnetism in the specimen also decreases. However, when the magnetizing field is reduced to zero, the induced magnetism in the specimen is not reduced to zero. There is some residual magnetism left in the specimen.

The lagging of induced magnetism behind magnetizing field is known as Hysteresis.
