CBSE SAMPLE PAPER

CLASS-XI

PHYSICS-SET(2)

SOLUTIONS

Q. No	Value Points	Marks
1.	No. it is true only for an isolated system.	$\frac{1}{2}$
	$\vec{F}_{ext} = \frac{d\vec{p}}{dt}$	
	if $\quad \vec{F}_{ext} = 0 \quad \Rightarrow \quad \frac{d\vec{p}}{dt} = 0$	$\frac{1}{2}$
	$\Rightarrow \vec{p} = \text{constant}$	
2.	The statement is wrong. Work done is zero because the centripetal force cannot do any work on the earth.	1
3.	Skidding will occur in the event of: (a) v (the speed of the cyclist) being large. (b) r being small (c) The road surface being slippery.	1
4.	By lowering his hands, the cricket player increases the interval in which the catch is taken. This increase in time interval results in the less rate of change of momentum. Therefore, in accordance with Newton's second law of motion, less force acts on his hands and the player saves himself from being hurt.	1
5.	Excess pressure in a bubble $= \frac{4\sigma}{r}$	$\frac{1}{2}$
	Less the value of radius of bubble (r), greater is the excess pressure.	$\frac{1}{2}$
6.	(a) Reversible process	$\frac{1}{2}$
	(b) Cyclic process	$\frac{1}{2}$

7. Inside a satellite, the body is in a state of weightlessness So that the effective value of g is zero.

$$\because \quad T = 2\pi\sqrt{l/g}$$

$$T = 2\pi\sqrt{l/0} \qquad \frac{1}{2}$$

$$T = \infty$$

Thus, the pendulum will not oscillate at all and therefore the experiment cannot be performed. $\frac{1}{2}$

8. False, water moves in a clockwise direction because on heating, water rushes from higher pressure area near B to lower pressure area near A. 1

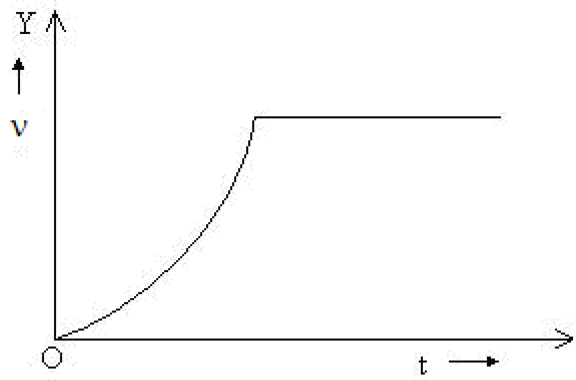
9. Since $a \alpha t$ $\frac{1}{2}$

$v \,\alpha\, t^2$

For $a = 0$

v = constant $\frac{1}{2}$

The corresponding velocity- time graph is



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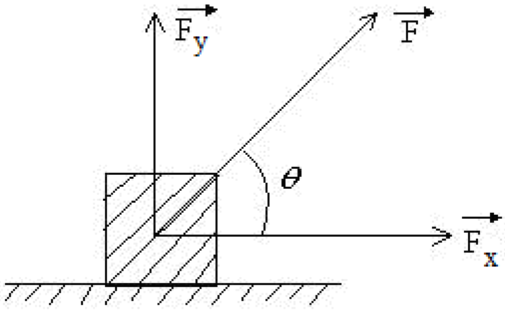
10. The two perpendicular forces acting on the body are shown below in the figure.



$\frac{1}{2}$

Let $F_x = 8N$

$F_y = 6N$

$\therefore \quad F = \sqrt{F_x^2 + F_y^2}$

$= \sqrt{(8)^2 + (6)^2}$

$F = 10N$ $\frac{1}{2}$

Acceleration $(a) = \frac{F}{M} = \frac{10}{5} = 2ms^{-2}$ $\frac{1}{2}$

Direction of acceleration (a) will be the direction of force F, i.e.,

$\cos\theta = \frac{F_x}{F} = \frac{8}{10}$

$\theta = \cos^{-1}\left(\frac{4}{5}\right)$, with 8 N force. $\frac{1}{2}$

11. Let m be the mass of the body.

When the body falls from some height, potential energy at the top equals the gain in kinetic energy. The body loses some kinetic energy and again rises to some different height. $\frac{1}{2}$

$\therefore \quad \text{Percentage loss in K.E.} = \frac{(12mg - 9mg)}{12mg} \times 100\%$ $\frac{1}{2}$

$$= \frac{3 \cancel{mg}}{12 \cancel{mg}} \times 100\%$$ $\frac{1}{2}$

= 25% $\frac{1}{2}$

12. According to the law of conservation of angular momentum,

$$I_1 \, \omega_1 = I_2 \, \omega_2$$ $\frac{1}{2}$

$$I_1^2 \, \omega_1^2 = I_2^2 \, \omega_2^2$$

$$I_1 \left(I_1 \, \omega_1^2 \right) = I_2 \left(I_2 \omega_2^2 \right)$$

As $I_1 < I_2, \quad I_1 \, \omega_1^2 > I_2 \, \omega_2^2$ $\frac{1}{2}$

Or $\frac{1}{2} I_1 \omega_1^2 > \frac{1}{2} \, I_2 \omega_2^2$ $\frac{1}{2}$

Thus, the rotational kinetic energy of the system increases on decreasing its moment of inertia.

$\frac{1}{2}$

13. The gravitational force of attraction between the Earth and the Sun provides the necessary centripetal force. $\frac{1}{2}$

$\therefore \quad \frac{M_e v^2}{r} = \frac{G M_s M_e}{r^2}$

or $\quad v = \sqrt{\frac{G M_s}{r}}$ $\frac{1}{2}$

But $\quad \mathrm{v} = \frac{2\pi \mathrm{r}}{\mathrm{T}}$

$\therefore \quad \frac{4\pi^2 r^2}{T^2} = \frac{G M_s}{r}$

or $\quad M_s = \frac{4\pi^2 r^3}{G T^2}$ $\frac{1}{2}$

Substituting the values and simplifying, we get

$$M_s = \frac{4\times(3.14)^2\times\left(1.5\times10^{11}\right)^3}{6.7\times10^{-11}\times(365\times24\times60\times60)^2}$$

$$M_s \simeq 2\times10^{30}\,kg \qquad \frac{1}{2}$$

OR

Since, g at height h is given by

$$g_h = \frac{gR^2}{(R+h)^2}$$

$$= \frac{gR^2}{R^2\left(1+\frac{h}{R}\right)^2}$$

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

$$g_h = g\left(1-\frac{2h}{R}\right) \qquad (\text{for } h << R) \qquad \frac{1}{2}$$

and similarly, we have g at depth d is given by

$$g_d = g\left(1-\frac{d}{R}\right) \qquad \frac{1}{2}$$

But $g_h = g_d$ $\qquad \frac{1}{2}$

$$\therefore \qquad g\left(1-\frac{2h}{R}\right) = g\left(1-\frac{d}{R}\right)$$

$$1-\frac{2h}{R}-1-\frac{d}{R}$$

$$\frac{h}{d} = \frac{1}{2} \qquad \frac{1}{2}$$

14. (i) An isothermal process is that process in which the temperature (T) of the system remains constant though other variables (P and V) may change.

Here, $\Delta T = 0$ $\frac{1}{2}$

In an adiabatic process, the total heat content (Q) of the system remains constant though other variables (P and T) may change

In this process, $\Delta Q = 0$ $\frac{1}{2}$

(ii) A process in which volume (V) remains constant though other variables (P and T) may change, is called an isochoric process.

In this process, $\Delta V = 0$ $\frac{1}{2}$

An isobaric process is that for which pressure (P) of the system remains constant though other variables (V and T) may change. In this process, $\Delta P = 0$ $\frac{1}{2}$

15. Since, $\frac{V_t}{V_0} = \sqrt{\frac{T}{T_0}} = \sqrt{\frac{273+t}{273+0}}$ $\frac{1}{2}$

Where V_t, V_0 are the velocities of sound at T and T_0 respectively.

$$\therefore \quad \frac{V_t}{V_0} = \left(1 + \frac{t}{273}\right)^{\frac{1}{2}} = 1 + \frac{1}{2} \times \frac{t}{273} \qquad \frac{1}{2}$$

Neglecting the higher power

$$\therefore \quad V_t = V_0\left(1 + \frac{t}{546}\right) = V_0 + V_0\frac{t}{546} \qquad \frac{1}{2}$$

Thus, the velocity of sound increases by 61 cm / s for every $1^{o}C\ \left(or\, 1^{o}K\right)$ rise in the temperature.

16. Since work done $W = mgh$ $\frac{1}{2}$

$W = m \times 980 \times 100 \times 100\,\text{ergs}$ $\frac{1}{2}$

$\because \quad J = 4.2 \times 10^{7}$ ergs/cal

We know, heat energy $H = \frac{W}{J} cal$ $\frac{1}{2}$

$$mcQ = \frac{980 \times 100 \times 100 \times m}{4.2 \times 10^7}$$

$$Q = \frac{98}{420} = 0.23^o C$$ $\frac{1}{2}$

17. Since $PV = RT$

We are given $VP^2 = \text{costant}$ $\frac{1}{2}$

$$\therefore \quad V\left(\frac{RT}{V}\right)^2 = \text{constant}$$

$$\frac{T^2}{V} = \text{constant}$$ $\frac{1}{2}$

Using $\frac{T_1^2}{V_1} = \frac{T^2}{V}$ $\frac{1}{2}$

$$T_1^2 = 2V \times \frac{T^2}{V} = 2T^2$$

$$T_1 = \sqrt{2}T$$ $\frac{1}{2}$

18. (i) The pulse does not have a definite wavelength or frequency but has a definite speed of propagation (in a non – dispersive medium).

1

(ii) The frequency of the note produced is not equal to $0.05Hz,$ it is the frequency of pulse repetition. 1

19. $\because \quad S = \left[M^1 L^0 T^{-2}\right]$ $\frac{1}{2}$

$$\beta = \frac{1}{\text{Bulk modulus}} = \frac{1}{\left[ML^{-1} T^{-2}\right]}$$ $\frac{1}{2}$

$$\beta = \left[M^{-1} LT^2\right]$$ $\frac{1}{2}$

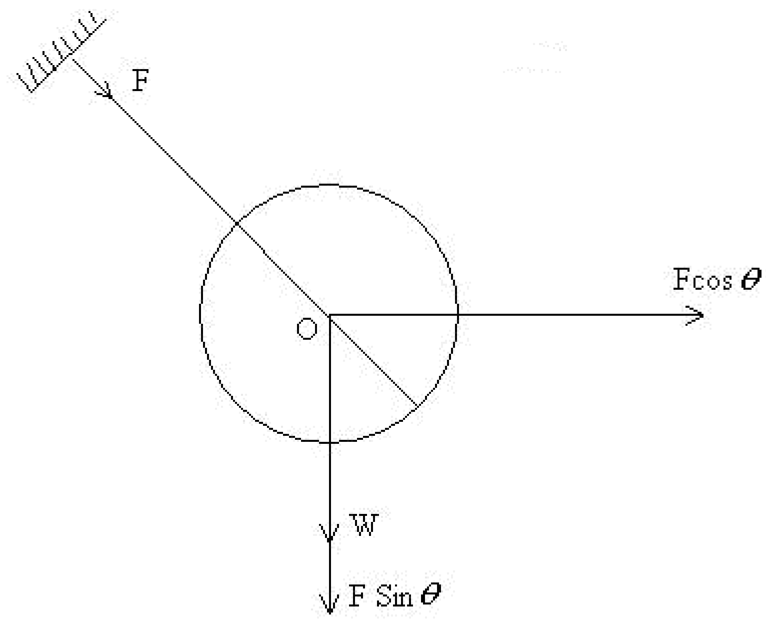
Now, $S^3 \beta^4 = \left[M^1 L^0 T^{-2}\right]^3 \left[M^{-1} LT^2\right]^4$ $\frac{1}{2}$

$$=\left[M^{-1}L^{4}T^{2}\right]=k$$ $\frac{1}{2}$

Thus, k is not a dimensionless constant but a dimensional constant.

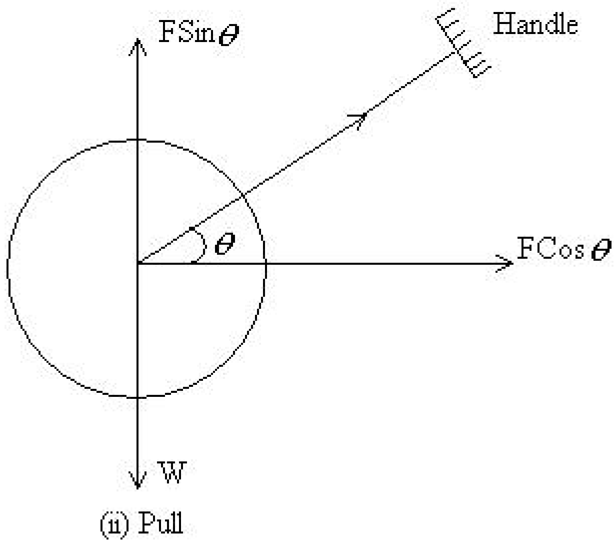
$\frac{1}{2}$

20.



(i) : Push

$\frac{1}{2}$



$\frac{1}{2}$

W is weight of the lawn roller. When pushed by applying a force $\vec{F}$ at an angle θ. $F\cos\theta$ moves it forward while the apparent weight becomes $W + F\sin\theta$. 1

However, when pulled, the apparent weight becomes $W - F\sin\theta$.

Since the force of friction is directly proportional to normal reaction (equal to apparent weight of the roller), it is more when it is pushed than when is pulled.

1

21. Initial momentum of one of the balls (say A) = 0.05 $\times$ 6

$= 0.3 kgms^{-1}$ $\frac{1}{2}$

Final momentum of ball A $= 0.05 \times (-6)$

$= -0.3 kg\, ms^{-1}$. $\frac{1}{2}$

Assuming the two balls A and B moving in opposite directions collide and rebound with the same speed.

$\therefore$ Impulse received by ball A = Total change of momentum for ball A

$= (-0.3) - (0.3) = -0.6 kgms^{-1}$ 1

Thus, an equal and opposite impulse will be received by the other ball B. 1

22. The coin will only revolve with the record if the maximum force due to friction is sufficient enough to balance the centripetal force. $\frac{1}{2}$

Maximum force due to static force $\geq \frac{mv^2}{r} \geq mr\omega^2,$ $\frac{1}{2}$

or $r \leq \frac{\mu g}{\omega^2}$

Given: $\mu = 0.15, \omega = 33\frac{1}{3}\,\text{rev/ min}$ $\frac{1}{2}$

$\omega = \left(\frac{100}{3} \times \frac{2\pi}{60}\right) rad/s$ $\frac{1}{2}$

$\therefore \quad r \leq \frac{0.15 \times 9.8}{\left(\frac{200\pi}{180}\right)^2}$

Solving we get, $r \leq 0.120m \leq 12cm$ $\frac{1}{2}$

Thus, the coin placed at 4 cm will revolve with the record. $\frac{1}{2}$

23. Power $P = Fv$ $\frac{1}{2}$

$= m\frac{dv}{dt}v$ $\frac{1}{2}$

or $vdv = \frac{P}{m}dt$ $\frac{1}{2}$

Integrating both sides, we get, $\frac{1}{2}$

$\frac{v^2}{2} = \frac{P}{m}t + \text{constant}$

or $v^2 \alpha\, t$ $\frac{1}{2}$

i.e. $v \alpha \sqrt{t}$ $\frac{1}{2}$

24. We know,

$\vec{F} = \frac{d\vec{P}}{dt}$ or $\vec{F}dt = d\vec{P}$ $\frac{1}{2}$

If the impact lasts for a small time dt and the momentum of the body changes from $\vec{P}_1 to \vec{P}_2$ then,

$\int_0^t \vec{F}dt = \int_{P_1}^{P_2} d\vec{P} = \vec{P}_2 - \vec{P}_1$ $\frac{1}{2}$

or $\int_0^t \vec{F}dt = \vec{P}_2 - \vec{P}_1$ $\frac{1}{2}$

$\vec{F}$ varies with time and does not remain constant.

$\left(\int_0^t \vec{F}dt\right)$ is a measure of the impulse of the force. $\frac{1}{2}$

Let $\vec{F}_{av}$ be the constant force during the impact, then

$\int_0^t \vec{F}\, dt = \int_0^t \vec{F}_{av}\, dt$ $\frac{1}{2}$

$$= \vec{F}_{av} \int_0^t dt = \vec{F}_{av}\, t$$

$\therefore$ $\vec{F}_{av} t = \vec{P}_2 - \vec{P}_1$ $\frac{1}{2}$

Thus, the impulse received during an impact is equal to the total change in momentum produced during the impact.

25. In case of the Earth, $G\frac{M_e m}{r_e^2} = mg_e$ $\frac{1}{2}$

In case of the planet, $G\frac{M_p m}{r_p^2} = mg_P.$ $\frac{1}{2}$

Dividing these two equations, we get,

$\left(\frac{M_P}{M_e}\right)\left(\frac{r_e^2}{r_P^2}\right) = \frac{g_P}{g_e};$ $\frac{1}{2}$

but $g_P = 2g_e$ $\frac{1}{2}$

and $r_P = \frac{r_e}{2}$ $\frac{1}{2}$

$\therefore \quad \frac{M_P}{M_e} = \frac{2}{4} = \frac{1}{2}$ $\frac{1}{2}$

Thus the ratio of the mass of the planet to the mass of the Earth is $1/2$.

26. The surface tension of water is more than that of oil. Therefore, when oil is powered over water, greater value of surface tension of water pulls the oil in all directions and as such it spreads on the water. On the other hand, when water is powered over oil, it does not spread over it because the surface tension of oil being less than that of water, it is not able to pull water over it. 3

27. (i) Hydrogen.

As 2 g of hydrogen contains N molecules, I kg of hydrogen contains $\frac{N}{2} \times 1000 = 500N$ molecules, where $N = 6.023 \times 10^{23}$, In case of N_2, 28 g of nitrogen contains N molecules.

Therefore, 1 kg of nitrogen contains 1

$$\frac{N}{28} \times 1000 \simeq 36N$$

(ii) Hydrogen

As $P = \frac{1}{3}\frac{M}{V}c^2$, $P \alpha c^2$

Since M and V are the same in both the cases, $C_{H_2} > C_{N_2}$,

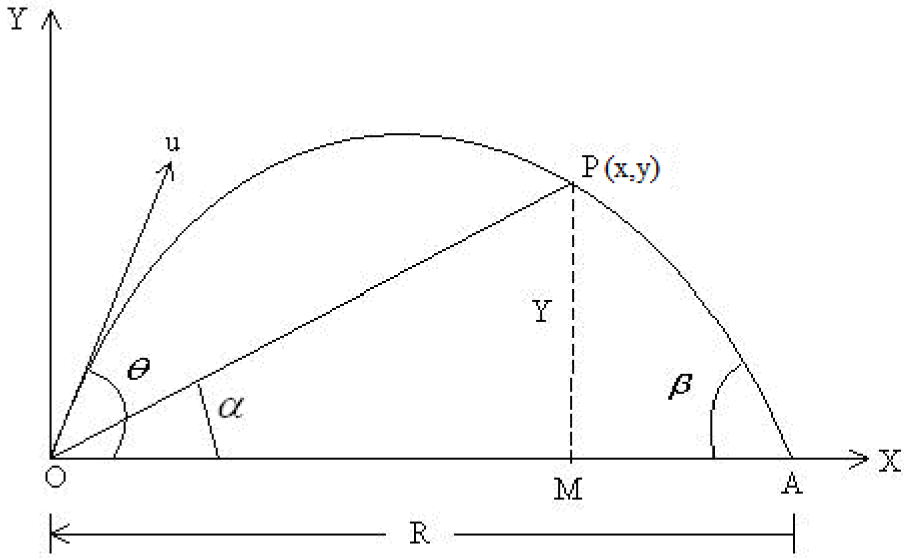
Therefore, the pressure exerted by hydrogen is more than that by nitrogen. 1

(iii) $\frac{V_{H_2}}{V_{N_2}} = \sqrt{\frac{P_{N_2}}{P_{H_2}}} = \sqrt{\frac{14}{1}} \simeq 3.74$ 1

$\therefore \quad V_{H_2} = 3.74\, V_{N_2}$

28. The statement in the question is shown in the diagram.

$\because$ $\tan \alpha = y/x$



$$\frac{1}{2}$$

$$\tan\beta = \frac{y}{MA} = \frac{y}{R-x} \qquad \frac{1}{2}$$

where R is horizontal range.

$$\therefore \tan\alpha + \tan\beta = \frac{y}{x} + \frac{y}{R-x}$$

$$= \frac{(R-x+x)y}{x(R-x)}$$

$$= \frac{YR}{x(R-x)}$$

or $\tan\alpha + \tan\beta = \dfrac{YR}{x(R-x)}$ $\qquad (i) \qquad \frac{1}{2}$

Again, $x = (u\cos\theta)t$ $\qquad (ii) \qquad \frac{1}{2}$

$$y = (x\sin\theta)t - \frac{1}{2}gt^2 \qquad (iii) \qquad \frac{1}{2}$$

From eq. (ii) and (iii)

$$y = x\tan\theta\left[1 - \frac{xg}{2u^2\cos^2\theta\tan\theta}\right] \qquad \frac{1}{2}$$

Putting $R = \frac{2u^2\sin\theta\cos\theta}{g}$, we get $\qquad \frac{1}{2}$

$$y = x\tan\theta\left[1 - \frac{xg}{2u^2\cos^2\theta\sin\theta}\right] \qquad \frac{1}{2}$$

$$= x\tan\theta\left[1 - \frac{x}{R}\right]$$

or $\quad \frac{y}{x} = \tan\theta\left(\frac{R-x}{R}\right) \qquad (iv) \qquad \frac{1}{2}$

Putting $(iv) and (i)$ we get,

$$\tan\alpha + \tan\beta = \frac{YR}{x(R-x)} = \tan\theta$$

$\therefore \quad \tan\alpha + \tan\beta = \tan\theta \qquad \frac{1}{2}$

OR

(a) When the packet is dropped, it has a velocity of $14ms^{-1}$ in the upward direction. Taking the upward direction as +ve and down ward direction as –ve.

We have

$$v(0) = 14\ m/s$$
$$a = g = -g.8\ m/s^2 \qquad \frac{1}{2}$$
$$x(t) - x(0) = h = -98m$$

or $\quad -98 = 14\times t - \frac{1}{2}\times 9.8\times t^2$

or $\quad 4.9t^2 - 14t - 98 = 0. \qquad 1$

or $\quad 49t^2 - 140t - 980 = 0$

or $\quad 7t^2 - 20t - 140 = 0$

$\therefore \qquad t = \dfrac{20 \pm \sqrt{(-20)^2 + 4 \times 7 \times 140}}{2 \times 7}$

$= 20 \pm \sqrt{\dfrac{400 + 3920}{14}}$ $\qquad \dfrac{1}{2}$

$= \dfrac{20 \pm 65.73}{14} = 6.125$

(Considering only the +ve sign

$v(t) = v(0) + at$

$= 14 - 9.8 \times 6.12$

$= 14 - 59.97$ $\qquad 1$

$= -45.97\ m/s$

Thus, the final velocity of the body is along the downward direction.

1

(b) Both the graphs represent non-uniform motion. 1

29. (i) Let there be a gas at constant pressure P and volume V. When the pressure increases from P to $P + \triangle p$, the volume decreases from $V to V - \triangle V$. $\qquad \dfrac{1}{2}$

Bulk modulus, $K = \dfrac{-V \triangle P}{\triangle V}$ $\qquad \dfrac{1}{2}$

When the gas is impressed isothermally, Boyle's law holds good, i.e.

PV = constant,

Differentiating w. r. t. V, we get

$P + V \dfrac{dP}{dV} = 0$

or $\quad \dfrac{dP}{-\dfrac{dV}{V}} = P = K \text{ is} 0$ $\qquad \dfrac{1}{2}$

Thus the isothermal elasticity of a gas is equal to its pressure.

$\dfrac{1}{2}$

When the gas is compressed adiabatically,

$$PV^{\gamma} = \text{constant,}$$

$$\gamma = \frac{C_P}{C_V}$$ $\frac{1}{2}$

Differentiating w. r. t. V ,

$$P\gamma V^{\gamma-1} + V^{\gamma}\frac{dP}{dV} = 0$$ $\frac{1}{2}$

or $$\frac{dP}{dV} = -\frac{\gamma P}{V}$$

or $$\frac{-dP}{\frac{dV}{V}} = \quad = k_{adi}$$ 1

Thus, the adiabatic elasticity of a gas is γ times the pressure of the gas.

$$\therefore \frac{K_{adi}}{K_{iso}} = \frac{\gamma P}{P} = \gamma$$ 1

OR

At a given temperature, let the length of the brass rod be L_1, and that of the steel rod be L_2. If $L_2 > L_1$, the difference between the lengths $= L_2 - L_1 = \Delta L$

Let the temperature be raised to $t\,^{o}C$.

$\therefore$ Length of the brass rod at $t\,^{o}C = L_1 + L_1\alpha_1 t$. 1

Length of the steel rod at $t\,^{o}C = L_2 + L_2\alpha_2 t$ 1

$\therefore$ Here α_1 and α_2 are the coefficients of brass and steel respectively.

Difference between the lengths of the rods at $t^{o}C,$ say

$$\Delta L' = (L_2 + L_2\alpha_2 t) - (L_1 + L_1\alpha_1 t)$$

$$= (L_2 - L_1) + L_2\alpha_2 t - L_1\alpha_1 t$$ 1

The difference remains that same at all temperatures,

$$\Delta L' = \Delta L$$

$orL_2 \ \alpha_2 t = L_1\alpha_1 \ t$

or $\quad \frac{L_2}{L_1} = \frac{\alpha_1}{\alpha_2}$ 1

Thus, the length of the rods must be inversely proportional to the linear coefficient of their materials. 1

30. Let a body of man m be dropped in a straight hole in the Earth of them M and radius R. The body will be attracted towards the center of the Earth with a force given by,

$$F = \frac{GMm}{R^2} \qquad 1$$

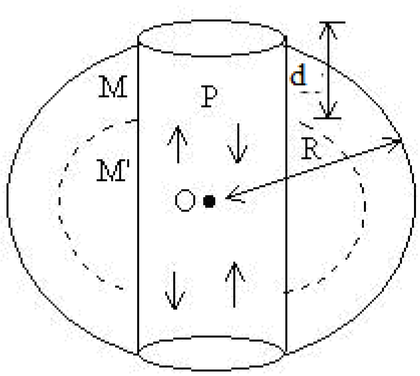
But $F = mg$

$$\therefore \qquad mg = \frac{GMm}{R^2} \quad \text{or} \quad g = \frac{GM}{R^2}$$

$$= \frac{G\,4/3\,\pi R^3 \rho}{R^2}$$

Or $$g = \frac{4\pi GR\rho}{3} \qquad (i) \qquad 1$$

where ρ is mean density of the Earth.



$\frac{1}{2}$

When the body is dropped into the straight hole and it falls through the depth d, the value of acceleration due to gravity at the point P is given by,

$$g' = \frac{GM'}{(R-d)^2} \qquad \frac{1}{2}$$

Where M' is the mass of the sphere of radius $(R-d)$

$$\therefore \qquad g' = \frac{4\pi G(R-d)\rho}{3} \qquad \frac{1}{2}$$

Thus, $g'/g = \frac{(R-d)}{R^2}$

$$\text{or} \qquad g' = \frac{g'}{R^2}(R-d) \text{ or } g' \propto (R-d) \qquad \frac{1}{2}$$

i.e., acceleration (in magnitude) of the body is proportional to the displacement from the centre of the earth O. Thus, the motion is SHM.

Time period,

$$T = 2\pi\sqrt{\frac{\text{Displacement}}{\text{Acceleration}}}$$

$$= 2\pi\sqrt{\frac{(R-d)}{\left[\frac{R-d}{R}\right]g}} = 2\pi\sqrt{\frac{R}{g}} \qquad 1$$

OR

(i) The radar waves sent form the Earth strike the approaching aeroplane. Here the radar is a source which is stationary and the aeroplane is an observer which is moving towards the stationary source. We have to determine the velocity to the approaching plane.

$\frac{1}{2}$

$$\therefore \qquad \text{Apparent frequency}, n' = \left[\frac{v+v_s}{v}\right]n \qquad \frac{1}{2}$$

where v is the velocity of the radar waves and v_s is the velocity of the aero plane.

Now the aero plane receives waves of frequency n' and acts as a source moving towards stationary observer, i.e. radar on the Earth. Since on reflection, the frequency does not change, the aero plane will reflect waves of frequency n'. $\frac{1}{2}$

$\therefore$ Apparent frequency received by the radar is given by,

$$n_1 = \left[\frac{v}{v - v_s}\right] n' \qquad \frac{1}{2}$$

$$= \left[\frac{v}{v - v_s}\right]\left[\frac{v + v_s}{v}\right] n$$

$$= \left[\frac{v + v_s}{v - v_s}\right] n = \left[1 + \frac{v_s}{v}\right]\left[1 - \frac{v_s}{v}\right]^{-1} n$$

$$= \left[1 + \frac{v_s}{v}\right]^2 n \qquad \frac{1}{2}$$

[Using the binomial theorem as $\frac{v_s}{v} << 1$

$$= \left[1 + \frac{2vs}{v}\right] n$$

or $\quad \frac{n_1}{n} = 1 + \frac{2vs}{v}$

$$2v_s = \frac{(n_1 - n)}{n} v \qquad \frac{1}{2}$$

$$v_s = \frac{\Delta n}{2n} v$$

Thus, velocity of an approaching aero plane is $\frac{\triangle n}{2n} v$. 1

(ii) Substituting the values given in the above expression we have,

$$v_s = \frac{1500 \times 600}{2 \times 45000} = 10\, m/s \qquad 1$$

Thus, the speed of the submarine is $10 m/s$.