WS-8 gravitation 9th integrated

Thank

(1)

(1)

From Newton's law of gravitation

$$F = G\frac{m_1 m_2}{r^2} \qquad m = d \times V = d \times \frac{4\pi}{3} r^3$$

$$\Rightarrow F = \frac{G d^2 \left(\frac{4\pi}{3}\right)^2 r^{\cancel{6}}}{\cancel{r^2}}$$

$$\Rightarrow F \propto r^4$$

d = constant because both are made up of same metal

$F_1 = F \rightarrow r_1 = r$

$F_2 = ? \rightarrow r_2 = 2r.$

$$\frac{F_2}{F_1} = \left[\frac{r_2}{r_1}\right]^4 \Rightarrow \frac{F_2}{F} = \left(\frac{2\cancel{r}}{\cancel{r}}\right)^4 = 2^4$$

$$\Rightarrow F_2 = 2^4 F = 16F$$

(2)

$g_e = 10\ m/s^2$

$M_p = \frac{1}{5} m_e \qquad r_p = \frac{1}{2} r_e$

From $g = \frac{GM}{R^2}$

$$\Rightarrow \frac{g_p}{g_e} = \frac{M_p}{M_e}\left[\frac{R_e}{R_p}\right]^2$$

$$\Rightarrow g_p = g_e\left[\frac{\frac{1}{5}\cancel{M_e}}{\cancel{M_e}}\right]\left[\frac{\cancel{R_e}}{\frac{1}{2}\cancel{R_e}}\right]^2$$

$$\Rightarrow g_p = \cancel{10}^{2} \times \frac{1}{\cancel{5}} \times [2]^2 = 2 \times 2^2 = 8\ m/s^2$$

(3)

$R_e' = \frac{R}{2}$; $M_e' = \frac{1}{8} M$

From $g = \frac{GM}{R^2}$ $\Rightarrow g \propto \frac{M}{R^2}$

$\Rightarrow \frac{g_e'}{g} = \frac{M_e'}{M} \times \left[\frac{R}{R_e'}\right]^2$

$\Rightarrow \frac{g_e'}{g} = \frac{\frac{1}{8}\cancel{M}}{\cancel{M}} \left[\frac{\cancel{R}}{\frac{\cancel{R}}{2}}\right]^2$

$\Rightarrow g_e' = g \times \frac{1}{8} \times 2^2 = \frac{g}{2}$.

(4)

$M = 80\ kg$ $A = 0.6\ m^2$.

Force Pressure $= \frac{Force}{Area}$

$\Rightarrow$ Pressure $= \frac{mg}{0.6} = \frac{80 \times 10}{0.6}$

$\Rightarrow \frac{8000}{6} = 1.33 \times 10^3\ N/m^2$

(5)

Area of foot $= 80\ cm^2 = 80 \times 10^{-4}\ m^2$

$m = 80\ kg$

Pressure $= \frac{F}{A} = \frac{mg}{2 \times Area} = \frac{80 \times 10}{2 \times 80 \times 10^{-4}}$

$= \frac{10 \times 10^4}{2} = 5 \times 10^4\ N/m^2$

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(6)

$P_{at} = 10^5$ Pa , Area $= 40 \times 80$

$= 3200 \times cm^2$

$= 3200 \times 10^{-4} m^2$

Force $= P \times$ Area

$= 10^5 \times 3200 \times 10^{-4}$

$= 32 \times 10^3$ N. or 3.2×10^4 N.

(7)

$W_{air} = 25$ N, $W_w = 20$ N.

upthrust = weight of liquid displaced

= loss of weight of body in liquid

$= W_{air} - W_{water}$

$= 25 - 20$

$= 5$ N

(8)

$W_{water} = \frac{1}{3} W_a$

$W_2 = \frac{1}{3} W_1$

∴ The apparent loss of weight of the body

$= W_a - W_{water}$

$= W_a - \frac{1}{3} W_a$

$= \frac{2}{3} W_a = \frac{2}{3} W_1$

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(9)

$w_{air} = 100\ N$; $w_{kerosene} = 70\ N.$

The apparent loss of weight of the body

$= w_{air} - W_{kerosene}$

$= 100 - 70$

$= 30\ N.$

(10)

Pressure on ground floor $= 270\ kPa$

$= 270 \times 10^3\ Pa$

variation of Pressure with height

$P = \rho g h$

where ρ = density of liquid (or) water

Here $\rho_w = 10^3\ kg/m3$

$\therefore \quad 27\cancel{0} \times \cancel{10^3} = \cancel{10^3} \times \cancel{10} \times h$

$\Rightarrow h = 27\ m$

(12)

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(12)

The density of Sea water > density of river water

The weight of a man gets balanced by the less immersed part of his body in sea water as compared to river water.

Thus it is easier for a person to swim in sea water than in river water.

(11)

According to law of floatation, the weight of the floating body is equal to the weight of the liquid displaced by the floating body.

∴ the apparent weight of an isolated floating body is zero.

∴ option (B) correct.

(13), (14)

For a body floating in a liquid (water) it's apparent weight is zero.

Because the weight of water displaced acting vertically upwards is just equal to the weight of the body acts vertically downwards

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(15), (16), (17)

$h_{water} = 10 \text{ cm} = 10^{-1} \text{ m}$

bottom Area of glass $= 10 \text{ cm}^2 = 10 \times 10^{-4} \text{ m}^2$

Top area of glass $= 30 \text{ cm}^2 = 30 \times 10^{-4} \text{ m}^2$

volume $= 1 \text{ lit} = 10^{-3} \text{ m}^3$

Given $d_w = 10^3 \text{ kg/m}^3$; $g = 10 \text{ m/s}^2$; $P_{at} = 1.01 \times 10^5 \text{ N/m}^2$

* Force on bottom = $F = (P_0 + \rho g h) A_{bottom}$

$F_1 = [1.01 \times 10^5 + 10^3 \times 10 \times 10^{-1}] \times 10^{-3}$

$F_1 = 102$ downward

Resultant force exerted by the sides of glass on water

Net upward force = Net downward force

$F + F_3 = W + F_2 \rightarrow (1)$

W = weight of water = volume × density × g

$= 10^{-3} \times 10^3 \times 10 = 10 \text{ N} \downarrow$

F_2 = Force exerted by atmosphere on water $= P_0 A_{Top}$

$\Rightarrow 1.01 \times 10^5 \times 3 \times 10^{-3}$

$= 303 \text{ N} \downarrow$

$F_3 \Rightarrow$ Buoyant force $= -F_1 = 102$ upward

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(15), (16), (17) continuation

From (1)

$$F = F_2 + 10 - F_3$$

$$= 303 + 10 - 102$$

$$= 211\ N \text{ (upwards)}$$

If the air inside the Jar is completely pumped out.

$$F = \rho g h . A_{base}.$$

$$= 10^3 \times 10 \times 10^{-1} \times 10^{-3}$$

$$= 1N \text{ downwards}$$

LTask

Jee main's level

(1)

$d_1 = d$; $d_2 = 2d$

$F_1 = F$ $\quad F_2 = ?$

From Newton's law of gravitation

$$F = \frac{G m_1 m_2}{d^2} \Rightarrow F \propto \frac{1}{d^2}$$

$$\Rightarrow \frac{F_1}{F_2} = \left[\frac{d_2}{d_1}\right]^2 = \left[\frac{2d}{d}\right]^2$$

$$\Rightarrow \frac{F}{F_2} = 4 \Rightarrow F_2 = \frac{F}{4}.$$

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(12)

$P_{atm} = 10^5$ Pa ; Area of window $= 10\,cm \times 20\,cm$

$= 200\ cm^2$

$= 200 \times 10^{-4}\ m^2$

Force $= P \times$ Area

$= 10^5 \times 200 \times 10^{-4}$

$\Rightarrow 2 \times 10^3 = 0.2 \times 10^4\ N$

(13)

$d_{atm} = 1.29\ kg/m^3$; $h = ?$; $P_{atm} = 1.01 \times 10^5\ Pa$

Pressure $= \rho g h$

$\Rightarrow 1.01 \times 10^{5} = 1.29 \times \cancel{10} \times h$

$\Rightarrow h = \dfrac{1.01}{1.29} \times 10^4 = 7829\ m \simeq 8\,km$

(14)

$h = 5\,m$; $\rho_w = 10^3\ kg/m^3$; $g = 10\,m/s^2$

variation of pressure with depth $P = P_a + \rho g h$

$\Rightarrow P = 10^5 + 10^3 \times 10 \times 5$

$= 1.5 \times 10^5 = 1.5$ atm

$1\,atm = 10^5$ Pa

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(15)

$W_{air} = 50 N$; $W_{w} = 35 N$.

upthrust acting on body = loss of weight in liquid

$= W_{air} - W_{water}$

$= 50 - 35$

$= 15 N$.

(16)

$W_{Liquid} = \frac{1}{5} W_{air}$ $\Rightarrow W_2 = \frac{1}{5} W_1$.

Then apparent loss of weight $= W_{air} - W_{liquid}$

$= W_1 - \frac{1}{5} W_1$

$= \frac{4}{5} W_1$

(17)

$W_a = 75$; $W_{alcohol} = 50 N$.

The apparent loss of weight of the body

$= W_{air} - W_{alcohol}$

$= 75 - 50$

$= 25 N$.

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(18)

$P_{ground} = 100 \text{ kPa} = 100 \times 10^3 \text{ Pa}$

$h = ?$ $\rho_{water} = 10^3 \text{ kg/m3}$

$P = \rho g h$

$\Rightarrow 100 \times \cancel{10^3} = \cancel{10^3} \times 10 \times h$

$\Rightarrow h = 10 m$

(19)

$g_p = \frac{1}{6} g_e$; $R_p = \frac{1}{3} R_e$

From $g = \frac{GM}{R^2}$

$\Rightarrow \frac{g_p}{g_e} = \frac{M_p}{M_e} \times \left[\frac{R_e}{R_p}\right]^2$

$\Rightarrow \frac{\frac{1}{6} \cancel{g_e}}{\cancel{g_e}} = \frac{M_p}{M_e} \times \left[\frac{\cancel{R_e}}{\frac{1}{3} \cancel{R_e}}\right]^2$

$\Rightarrow \frac{1}{6} = \frac{M_p}{M_e} \times 3^2 \Rightarrow \frac{M_p}{M_e} = \frac{1}{6 \times 9} = \frac{1}{54}$

(20)

Given $m_2 = 5 \text{ kg}$; $m_1 = 10 \text{ kg}$; $r = 5 m$

From Newton's law of gravitation $F = \frac{G m_1 m_2}{r^2}$

$\Rightarrow F = \frac{6.67 \times 10^{-11} \times \cancel{5} \times \cancel{10}^{2}}{\cancel{5^2}} = 6.67 \times 10^{-11} \times 2$

$= 1.334 \times 10^{-10} N$

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21

If earth stops rotating, then there will be no centripetal force acting on the body, and gravitational force increases, therefore the value of g will increase in some places and remain the same in other places.

option. A & D are correct

22

From kepler's law $T^2 = \frac{4\pi^2}{GM} R^3$

As G decreases, Time Period of rotation of Earth increases, hence length of years increases

$K.E = \frac{GMm}{2R}$.

As G ↓, K.E also decreases

$\therefore$ a, c are correct

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23

R:- The level of water does not change.
because on drinking the water [say m gm] the weight of man increases by m gm and hence water displaced by man increased by m gm, tending to raise the level. However, this much amount of water has already been consumed by the man. Therefore the level of pond remain same.

27, 28

$m = 4\ kg$: Area $= 2\ m^2$; $g = 10\ m/s^2$

weight of the body $= mg$

$= 4 \times 10$

$= 40N$

Pressure $= \frac{F}{A} = \frac{mg}{A} = \frac{40}{2}$

$= 20\ N/m^2$

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