

WS-8 gravitation 9th integrated

①

Task

①

From Newton's law of gravitation

$$F = G \frac{m_1 m_2}{r^2}$$

$$m = d \cdot V \\ = d \cdot \frac{4\pi}{3} r^3$$

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

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

$d = \text{constant}$ because both are made up of same metal

$$F_1 = F \rightarrow r_1 = r$$

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

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

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

②

$$g_e = 10 \text{ m/s}^2$$

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

$$\text{From } g = \frac{G M}{R^2}$$

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

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

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

(3)

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

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

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

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

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

(4)

$$M = 80 \text{ kg} \quad A = 0.6 \text{ m}^2$$

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

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

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

(5)

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

$$m = 80 \text{ kg}$$

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

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

(6)

$$P_{at} = 10^5 \text{ Pa} \quad , \quad A_{area} = 40 \times 30 \\ = 3200 \text{ cm}^2 \\ = 3200 \times 10^{-4} \text{ m}^2$$

$$\text{force} = P \times A_{area} \\ = 10^5 \times 3200 \times 10^{-4} \\ = 32 \times 10^3 \text{ N} \quad \approx 3.2 \times 10^4 \text{ N}$$

(7)

$$W_{air} = 25 \text{ N} \quad , \quad W_w = 20 \text{ N}$$

$$\begin{aligned} \text{up thrust} &= \text{weight of liquid displaced} \\ &= \text{loss of weight of body in liquid} \\ &= W_{air} - W_{water} \\ &= 25 - 20 \\ &= 5 \text{ N} \end{aligned}$$

(8)

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

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

$$\begin{aligned} \therefore \text{The apparent loss of weight of the body} \\ &= W_a - W_{water} \\ &= W_a - \frac{1}{3} W_a \\ &= \frac{2}{3} W_a = \frac{2}{3} W_1 \end{aligned}$$

(9)

$$W_{\text{air}} = 100 \text{ N} ;$$

$$W_{\text{kerosene}} = 70 \text{ N}.$$

The apparent loss of weight of the body

$$= W_{\text{air}} - W_{\text{kerosene}}$$

$$= 100 - 70$$

$$= 30 \text{ N}.$$

(10)

Pressure on ground floor = 270 kPa

$$= 270 \times 10^3 \text{ Pa}$$

variation of pressure with height

$$P = \rho gh$$

where ρ = density of liquid (or water)

$$\text{Here } \rho_w = 10^3 \text{ kg/m}^3$$

$$\therefore 270 \times 10^3 = 10^3 \times 10 \times h$$

$$\Rightarrow h = 27 \text{ m}$$

(12)



(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.

$\therefore$ the apparent weight of an isolated floating body is ~~not~~ zero.

$\therefore$ option B correct.

(13), (14)

For a body floating in a liquid (water) its apparent weight is zero.

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

(15), (16), (17)

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

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

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

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

$$\text{Given } \rho_w = 10^3 \text{ kg/m}^3 ; g = 10 \text{ m/s}^2 ; P_0 = 1.01 \times 10^5 \text{ N/m}^2$$

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

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

$$F_1 = 102 \text{ downward}$$

Resultant force exerted by the sides of glass on water

Net upward force = Net downward force

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

$$\begin{aligned} w = \text{weight of water} &= \text{volume} \times \text{density} \times g \\ &= 10^{-3} \times 10^3 \times 10 = 10 \text{ N} \downarrow \end{aligned}$$

$$F_2 = \text{Force exerted by atmosphere on water} = P_0 A_{\text{top}}$$

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

$$= 303 \text{ N} \downarrow$$

$$F_3 = \text{Buoyant force} = -F_1 = 102 \text{ upward}$$



(15), (16), (17) continua

From ①

$$F = F_g + w - F_3$$

$$= 303 + 10 - 102$$

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

If the air inside the jar is completely pumped out.

$$F = \rho g h \cdot A_{\text{base}}$$

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

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

LTASK

Jee main's level

⑪

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

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

From Newton's law of gravitation

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

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

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

(12)

$$P_{atm} = 10^5 \text{ Pa} \quad ; \quad \text{Area of window} = 100 \text{ cm} \times 200 \text{ cm}$$

$$= 200 \text{ cm}^2$$

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

$$\text{Force} = P \times \text{Area}$$

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

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

(13)

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

$$\text{Pressure} = \rho g h$$

$$\Rightarrow 1.01 \times 10^5 = 1.29 \times 10 \times h$$

$$\Rightarrow h = \frac{1.01 \times 10^4}{1.29} = 7989 \text{ m} \approx 8 \text{ km}$$

(14)

$$h = 5 \text{ m} \quad ; \quad \rho_w = 10^3 \text{ kg/m}^3 \quad ; \quad g = 10 \text{ m/s}^2$$

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

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

$$= 1.5 \times 10^5 = 1.5 \text{ atm}$$

$$P_{atm} = 10^5 \text{ Pa}$$

(3)

(15)

$$w_{\text{air}} = 50 \text{ N} ; w_{\text{w}} = 35 \text{ N.}$$

$$\begin{aligned} \text{upthrust acting on body} &= \text{loss of weight in liquid} \\ &= w_{\text{air}} - w_{\text{water}} \\ &= 50 - 35 \\ &= 15 \text{ N.} \end{aligned}$$

(16)

$$w_{\text{Liquid}} = \frac{1}{5} w_{\text{air}} \quad \Rightarrow w_2 = \frac{1}{5} w_1.$$

$$\begin{aligned} \text{Then apparent loss of weight} &= w_{\text{air}} - w_{\text{liquid}} \\ &= w_1 - \frac{1}{5} w_1 \\ &\Rightarrow \frac{4}{5} w_1 \end{aligned}$$

(17)

$$w_a = 75 ; w_{\text{alcohol}} = 50 \text{ N.}$$

$$\begin{aligned} \text{The apparent loss of weight of the body} &= w_{\text{air}} - w_{\text{alcohol}} \\ &= 75 - 50 \\ &= 25 \text{ N.} \end{aligned}$$

(18)

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

$$h = ?$$

$$\rho_{\text{water}} = 10^3 \text{ kg/m}^3$$

$$P = \rho g h$$

$$\Rightarrow 100 \times 10^3 = 10^3 \times 10 \times h$$

$$\Rightarrow h = 10 \text{ m}$$

(19)

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

From

$$g = \frac{G M}{R^2}$$

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

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

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

(20)

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

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

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

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

(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 $T^2 = \frac{4\pi^2 R^3}{GM}$

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

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

As $G \downarrow$, K.E also decreases

$\therefore$ A, C are correct

(23)

Ans- The level of water does not change.

because on drinking the water (say $m \text{ gm}$)

The weight of man increases by $m \text{ gm}$ and

hence water displaced by man increased by

$m \text{ gm}$, 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)

$$m = 4 \text{ kg} : \text{Area} = 2 \text{ m}^2 : g = 10 \text{ m/s}^2$$

$$\underline{\text{weight of the body}} = mg$$

$$= 4 \times 10$$

$$= 40 \text{ N}$$

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

$$= 20 \text{ N/m}^2$$