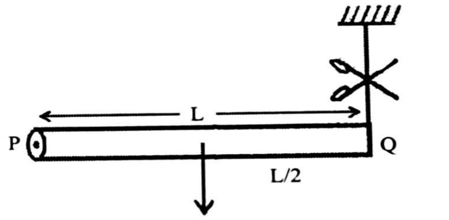
1. Sol.
Pressure, P = hρg. Since water is filled upto same height so pressure at the bottom will be same.

2. Sol.

(d)



Weight of the rod will produce the torque

$\tau = mg\frac{L}{2} = I\alpha = \frac{mL^2}{3}\alpha \quad \left[\because I_{rod} = \frac{ML^2}{3}\right]$

Hence, angular acceleration, $\alpha = \frac{3g}{2L}$

3. Sol.

(d) Potential energy stored in spring (U) is given by

$U = \frac{1}{2}Kx^2$

Initially

$U_i = \frac{1}{2}K(2)^2$ where $x = 2$ cm

$\Rightarrow U_i = \frac{1}{2}(K)\cdot(4) = 2K$ (i)

Finally

$U_f = \frac{1}{2}K(8)^2 = \frac{1}{2}K \times 64 = 32K$ (ii)

On dividing (i) by (ii)

$\frac{U_i}{U_f} = \frac{2K}{32K} = \frac{1}{16}$

$\Rightarrow U_f = 16U$

4. (d) Since body does not move hence it is in equilibrium.

f_r = frictional force which is less than or equal to limiting friction.

Now $N = mg$. If F_{ext} is applied, then

Contact force $\vec{F} = \vec{N} + \vec{f}_r$

$|\vec{F}| \le \sqrt{(mg)^2 + (\mu mg)^2} \quad [\because (f_r)_{max} = \mu mg]$

$|\vec{F}| \le mg\sqrt{1+\mu^2}$

5. Sol.

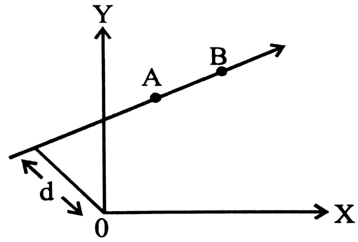
(c) Here, $h_{oil} \times \rho_{oil} \times g = h_{water} \times \rho_{water} \times g$

$\rho_0 g \times 140 \times 10^{-3} = \rho_w g \times 130 \times 10^{-3}$

$\rho_{oil} = \frac{130}{140} \times 10^3 \approx 928 kg/m^3 \quad [\because \rho_w = 1 kgm^{-3}]$

6. Sol.

(a) Angular momentum = Linear momentum × distance of line of action of linear momentum about the origin.



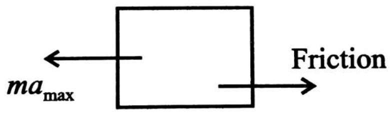
$L_A = p_A \times d, L_B = p_B \times d$

As linear momenta are p_A and p_B equal, therefore, $L_A = L_B$.

7. Sol.

8. Sol.

(c)



As the body remains stationary,

$\therefore ma_{max} = \mu_s mg$

$\Rightarrow a_{max} = \mu_s g = 0.15 \times 10 = 1.5 m/s^{-2}$

9. Sol.

(a) Inflow rate of volume of the liquid = Outflow rate of volume of the liquid

$\pi R^2 V = n\pi r^2(v) \Rightarrow v = \frac{\pi R^2 V}{n\pi r^2} = \frac{VR^2}{nr^2}$

10. Sol.

$F_{net} = \sqrt{3^2 + 4^2} = 5F$

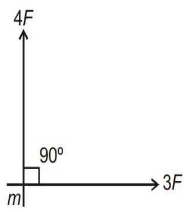
So, $F_{net} = ma$

$5F = ma'$

$\Rightarrow a' = \frac{5F}{m}$

$a' = 5a$

$\frac{F}{m} = a$



11. Sol.

$$U_i + k_i = U_f + k_f$$

$$0 + \frac{1}{2}(0.5)(1.5)^2 = \frac{1}{2}(50)x^2 + 0$$

$$x = 0.15\text{ m}$$

12. Sol.
Venturi-meter works on the Bernoulli's principle.

13. Sol.
Centre of mass, CoM of rocket follows the same path not the fragments. It is because the explosion takes place due to internal forces.

14. Sol.
By stretching coil's, shape changes whereas its length of wire remains same. Due to which shear modules of elasticity is involved so assertion is correct. Elasticity of steel is more than that of copper and also has more tensile stress. So reason is false.

15. Sol.

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

$$P.E = -\frac{GMm}{r}$$

$M \rightarrow$ mass of planet

$m \rightarrow$ mass of satellite

$r \rightarrow$ radius of orbit

When r is decreased,

Kinetic energy increases,

Potential energy decreases (becomes more negative).

16. Sol.

$$\frac{H}{R} = \frac{1}{4}\tan\theta$$

$\Rightarrow H = R$, given,

$\boxed{\tan\theta = 4}$

$\Rightarrow \boxed{\theta = \tan^{-1}(4)}$

17. Sol.

(d) Power = rate of production of heat = F.V

$= 6\pi\eta r V_T \cdot V_T = 6\pi\eta r V_T^2$

($\because$ F = $6\pi\eta V_T r$ Stoke's formula)

$V_T \propto r^2$

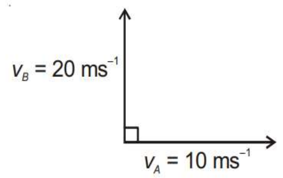
$\because \quad V_T = \frac{2}{9}\frac{r^2(\rho - \sigma)}{\eta}g$

$\therefore \quad$ Power $\propto r^5$

18. Sol.

$$\vec{v}_{AB} = \vec{v}_A - \vec{v}_B$$

$$v_{AB} = \sqrt{v_A^2 + v_B^2}$$



$$|\vec{v}_{AB}| = \sqrt{10^2 + 20^2} = \sqrt{100 + 400} = \sqrt{500} \simeq 22\text{ ms}^{-1}$$

19. Sol.

(c) Bulk modulus is given by

$$B = \frac{p}{\left(\frac{\Delta V}{V}\right)} \quad \text{or} \quad \frac{\Delta V}{V} = \frac{p}{B}$$

$3\frac{\Delta R}{R} = \frac{p}{B}$ (here, $\frac{\Delta R}{R}$ = fractional decreases in radius)

$$\Rightarrow \frac{\Delta R}{R} = \frac{p}{3B}$$

20. Sol.
If angle of contact is greater than 90°, then liquid does not wet the solid surface.

21. **(c)** Energy stored per unit volume

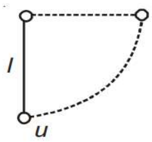
$= \frac{1}{2} \times$ stress $\times$ strain

$= \frac{1}{2} \times$ stress $\times$ (stress/Young's modulus)

$= \frac{1}{2} \times (\text{stress})^2/(\text{Young's modulus}) = \frac{S^2}{2Y}$

22. Using conservation of energy

$U_i + k_i + U_f + k_f$



$$0 + \frac{1}{2}mu^2 = mgl + \frac{1}{2}mv'^2$$

$$\sqrt{u^2 - 2gl} = v'$$

Change in velocity $(\Delta v) = v'\hat{j} - u\hat{i}$

$$|\Delta v| = \sqrt{v'^2 + u^2}$$

$$= \sqrt{u^2 - 2gl + u^2}$$

$$= \sqrt{2(u^2 - gl)}$$

23. Sol.

Since trajectory is same, so range and maximum height both will be identical from earth and planet. So equating maximum height (Answer can be obtained by equating range also)

$$\frac{u_e^2 \sin^2\theta}{2g_e} = \frac{u_p^2 \sin^2\theta}{2g_p}$$

$$\frac{2.5}{9.8} = \frac{9}{g_p}$$

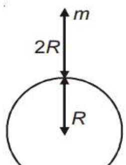
$$g_p = 3.5 \text{ m/s}^2$$

24. Sol.

Answer (3)

Potential energy at surface $= -\frac{GMm}{R}$

Potential energy at height, $2R = -\frac{GMm}{3R}$



Change in potential energy $= -\frac{GMm}{3R} + \frac{GMm}{R}$

$$= \frac{GMm}{R}\left(\frac{-1+3}{3}\right)$$

$$= \frac{2}{3}\frac{GMm}{R}$$

$$= \frac{2}{3}\left(\frac{GM}{R^2}\right)mR$$

$$= \frac{2}{3}mgR$$

25. Amount of energy required to form a soap bubble

$$= [S \times \Delta A] \times 2$$

$$= [0.03 \times 4 \times \pi \times 4 \times 10^{-4}] \times 2 = 3.015 \times 10^{-4}\,\text{J}$$

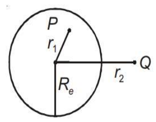
26. Stress $= \frac{\text{force}}{\text{cross-section area}} = \frac{Mg}{A}$

Strain $= \frac{\text{change in length}}{\text{original length}} = \frac{\Delta L}{L} = \frac{L_1 - L}{L}$

Young's modulus, $Y = \frac{\text{stress}}{\text{strain}} = \frac{MgL}{A(L_1 - L)}$

27. $M_e \rightarrow$ Mass of earth

$R_e \rightarrow$ Radius of earth

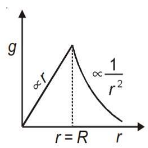


The acceleration due to gravity at a distance r_1 from the centre of earth such that $r_1 < R$,

is given by $gr_1 = \frac{GM}{R^3}r_1$

$\Rightarrow g \propto r$

The acceleration due to gravity at a distance r_2 from the centre of earth such that $r_2 > R$,

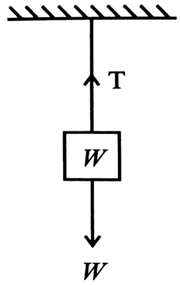


is given by $gr_2 = \frac{GM}{r_2^2}$

$\Rightarrow g \propto \frac{1}{r^2}$

28. **(A)**

29.



Longitudinal stress

$$= \frac{\text{Internal restoring force}}{\text{Area}} = \frac{F_{ext}}{\text{Area}}$$

$$\therefore \text{ Stress} = \frac{W}{A}$$

30. It is safer to jump from a height of 3 m on earth,

$\Rightarrow$ Corresponding velocity attained $= \sqrt{2g_1h_1}$

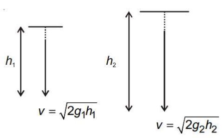
It will be safer to jump from a height on other planet

If the velocity attained is same $= \sqrt{2g_2h_2}$

$\Rightarrow \sqrt{2g_1h_1} = \sqrt{2g_2h_2}$

$9.8 \times 3 = 1.96 \times h_2$

$\Rightarrow h_2 = 5 \times 3 = 15$ m



31. $Fs\cos\theta = 25$

$5(10)\cos\theta = 25$

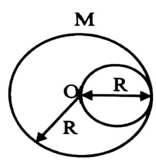
$\cos\theta = \frac{1}{2}$

$\theta = 60°$

32. When the energy of a satellite-planet system is positive, satellite escapes away from the gravitational field of the planet with speed greater than the escape speed.

33. **(b)** Moment of inertia of complete disc about point 'O'.

$I_{\text{Total disc}} = \frac{MR^2}{2}$



Mass of removed disc

$M_{\text{Removed}} = \frac{M}{4}$ (Mass $\propto$ area)

Moment of inertia of removed disc about point 'O'.

I_{Removed} (about same perpendicular axis)

$= I_{cm} + mx^2$

$$= \frac{M}{4}\frac{(R/2)^2}{2} + \frac{M}{4}\left(\frac{R}{2}\right)^2 = \frac{3MR^2}{32}$$

Therefore the moment of inertia of the remaining part of the disc about a perpendicular axis passing through the centre,

$I_{\text{Remaing disc}} = I_{\text{Total}} - I_{\text{Removed}}$

$$= \frac{MR^2}{2} - \frac{3}{32}MR^2 = \frac{13}{32}MR^2$$

34. **(b)** From Stoke's formula,
Viscous drag force
$F = 6\pi\eta r V_t$
$F = 6\times\pi\times 0.9\times 5\times 10^{-3}\times 10\times 10^{-2} = 84.78\times 10^{-4}$
$\therefore F = 8.478 \times 10^{-3}$ N

35. **(c)** K.E. $= \dfrac{L^2}{2I}$

The angular momentum L remains conserved about the centre.
That is, L = constant.
$I = mr^2$

$\therefore$ K.E. $= \dfrac{L^2}{2mr^2}$

In 2nd case, K.E. $= \dfrac{L^2}{2(mr'^2)}$

But $r' = \dfrac{r}{2}$

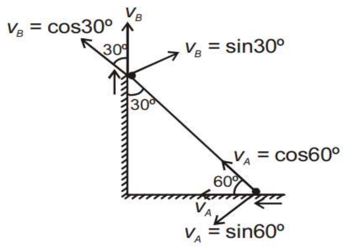
$\therefore K.E' = \dfrac{L^2}{2m.\dfrac{r^2}{4}} = \dfrac{4L^2}{2mr^2} \Rightarrow$ K.E.' = 4 K.E.

$\therefore$ K.E. is increased by a factor of 4.

36. $v_A \cos 60° = v_B \cos 30°$

$10 \times \dfrac{1}{2} = v_B \times \dfrac{\sqrt{3}}{2}$

$\boxed{v_B = \dfrac{10}{\sqrt{3}}}$



37. **(C)**
38. **(A)**
(A) Is true because a perfectly plastic body cannot regain its shape even when the deforming forces are removed because restoring forces are absent
(R) Is true and correct explanation for (A)

39. **(A)**
40. **(D)**
41. **(C)**
Due to upward acceleration pseudo force will act downwards so value of acceleration due to gravity will increase by 'a'

$\therefore \quad g' = (g + a)$

$P = \rho g' h$

$\Rightarrow \quad P = \rho\,(g + a)h \qquad$ (Substitute g')

42. We know

$\Delta x = \dfrac{FL}{AY} = \dfrac{FL}{\pi r^2 Y}$

$\Rightarrow \quad \Delta x \propto \dfrac{L}{r^2}$

Δx directly proportional to L
And Δx inversely proportional to r^2
For option (1)

$\dfrac{L}{r^2} = \dfrac{400\times 10}{(0.8)^2} = 6250$

For option (2)

=> $\dfrac{L}{r^2} = \dfrac{300\times 10}{(0.6)^2} = 8333.33$

For option (3)

$\dfrac{L}{r^2} = \dfrac{200\times 10}{(0.4)^2} = 12{,}500$

For option (4)

$\dfrac{L}{r^2} = \dfrac{100\times 10}{(0.2)^2} = 25{,}000$

For option (4) we are getting maximum value of $\dfrac{L}{r^2}$

$\Rightarrow \quad \Delta x$ also maximum for L = 100 cm and r = 0.2 mm

43. **(B)**
44. **(C)**
45. Pressure in a liquid is divided equally so we can say pressure at both the pistons should be same

$\Rightarrow \quad \dfrac{F_1}{A_1} = \dfrac{F_2}{A_2}$

Where,
$F_1 = F$
$A_1 = 10\ cm^2$
$A_2 = 10\ m^2 = 10\times 10^4\ cm^2$
$F_2 = 8000$ N

Substituting values,

$\dfrac{F}{10} = \dfrac{8000}{10\times 10^4}$

$\Rightarrow \quad F = 0.8$ N

Take $g = 10\ m/s^2$

46. $\vec{v} = \vec{\omega} \times \vec{r}$

$= \begin{vmatrix} i & j & k \\ 3 & -4 & 1 \\ 5 & -6 & 6 \end{vmatrix}$

$i(-18) - j(13) + k(2)$

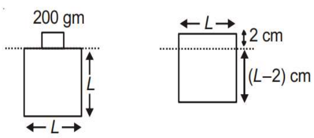
$= -18i - 13\hat{j} + 2\hat{k}$

47. Mass × g = Volume of part of cube × ρ × g

$\Rightarrow \quad 200 \times g = L^2\,(2 \times \rho_w \times g)$

$\Rightarrow \quad 100 = L^2 \qquad \{\because \rho_w = 1\}$

$\Rightarrow \quad 10$ cm $= L$



From the two figures we can see that the 200 gm block is provided with required buoyant force but a part of cube which is afloat in 2nd figure.

48. $V = A \cdot L$

$Y = \dfrac{FL}{A\Delta L} \Rightarrow \Delta L = \dfrac{FL}{\dfrac{V}{L}Y}$

$\Delta L = \dfrac{FL^2}{VY}$

$\Rightarrow \quad \Delta L \propto L^2$

Thus, ΔL versus L^2 is straight line.

49. $F = \eta A \frac{V}{d}$

$$\begin{cases} \text{Where,} \\ F = \text{Drag Force} \\ \eta = \text{Viscosity of fluids} \\ A = \text{Area} \propto \text{size of body} \\ V = \text{Velocity} \end{cases}$$

50. A : is true
R : is true
And reason is also the correct explanation.