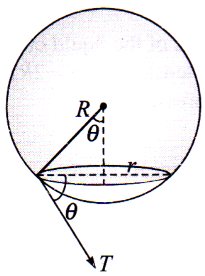
WEEKLY TEST TARGET - JEE - TEST - 17
SOLUTION Date 01-09-2019

[PHYSICS]

1. Force acting on bubble due to surface tension $= \int T dl \sin\theta$

$$F_{\text{surface}} = (T\sin\theta)\int dl = T\left(\frac{r}{R}\right)(2\pi r)$$



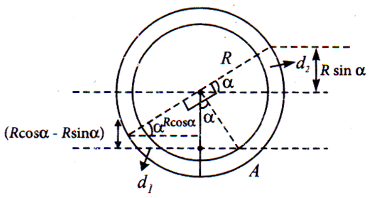
This force will balance the force of buoyancy.

So, $T(2\pi r)\left(\frac{r}{R}\right) = \left(\frac{4}{3}\pi R^3\right)\rho_W g$

$\Rightarrow \quad r^2 = \frac{2}{3}\frac{\rho_W g}{T}R^4 \Rightarrow r = R^2\sqrt{\frac{2\rho_W g}{3T}}.$

None of given options is correct.

2. Equating pressure at A



$$(R\cos\alpha + R\sin\alpha)\, d_2 g = (R\cos\alpha - R\sin\alpha)\, d_1 g$$

$$\Rightarrow \quad \frac{d_1}{d_2} = \frac{\cos\alpha + \sin\alpha}{\cos\alpha - \sin\alpha} = \frac{1+\tan\alpha}{1-\tan\alpha}$$

3. Force from right hand side of the liquid on left hand side liquid.
   i. Due to surface tension force = $2RT$ (towards right)
   ii. Due to liquid pressure force

$$= \int_{x=0}^{x=h} (p_0 + \rho g h)(2Rx)\,dx$$

$$= (2p_0 Rh + R\rho g h^2) \text{ (towards left)}$$

$\therefore$ Net force is $|\, 2p_0 Rh + R\rho g h^2 - 2RT \,|$

4. From Archemedes' principle, this apparent loss in weight is equal to the weight of the liquid displaced by the body.

Also, volume of candle = Area × length

$$= \pi\left(\frac{d}{2}\right)^2 \times 2L$$

Weight of candle = Weight of liquid displaced

$$V\rho g = V'\rho' g'$$

$$\Rightarrow \quad \left(\pi\frac{d^2}{4} \times 2L\right)\rho = \left(\pi\frac{d^2}{4} \times L\right)\rho'$$

$$\Rightarrow \quad \frac{\rho}{\rho'} = \frac{1}{2}$$

Since candle is burning at the rate of 2 cm/h, then after an hour, candle length is $2L - 2$

$$\therefore \quad (2L-2)\rho = (L-x)\rho'$$

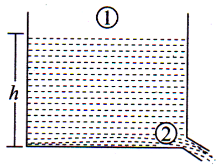
$$\therefore \quad \frac{\rho}{\rho'} = \frac{L-x}{2(L-1)}$$

$$\Rightarrow \quad \frac{1}{2} = \frac{L-x}{2(L-1)}$$

$$\Rightarrow \quad x = 1 \text{ cm}$$

Hence, in one hour it melts 1 cm and so it falls at the rate of 1 cm/h.

5.



The velocity of fluid at the hole is $V_2 = \sqrt{\dfrac{2gh}{1 + (a^2/A^2)}}$

Using continuity equation at the two cross-sections (1) and (2):

$$V_1 A = V_2 a \Rightarrow V_1 = \frac{a}{A} V_2$$

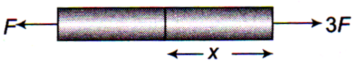
$\Rightarrow$ Acceleration of top surface $= -V_1 \dfrac{dV_1}{dh}$

$$= -\frac{a}{A}V_2\frac{d}{dh}\left(\frac{a}{A}V_2\right)$$

$$a_1 = -\frac{a^2}{A^2}V_2\frac{dV_2}{dh} = -\frac{a^2}{A^2}\sqrt{2gh}\sqrt{2g}\cdot\frac{1}{2\sqrt{h}}$$

$$\Rightarrow \quad a_1 = \frac{-ga^2}{A^2}$$

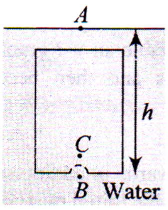
6. Tension in rod at a distance x from right edge is



$$T = F\left(3 - 2\frac{x}{L}\right)$$

$$\therefore \text{ Net extension in rod} = \int_0^L \frac{T}{4A}dx = \frac{2F}{YA}L$$

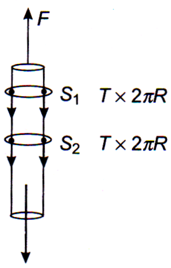
7.



Let the container is dipped to depth h, so the contact angle becomes θ

$$P_A = P_0$$
$$P_B = P_0 + \rho gh$$
$$P_C = P_0 + \rho gh - \frac{2T}{r}\cos\theta = P_0$$
$$\cos\theta = \frac{\rho ghr}{2T} \le 1$$
$$h \le \frac{2T}{\rho gr} \quad \Rightarrow \quad h_{max} = \frac{2T}{\rho gr}$$

8. The free body diagram of the capillary tube is as shown in the figure.
Net force F required to hold tube is
S_1 and S_2 are the forces due to surface tension at cross-section



Free body diagram
of capillary tube

$\Rightarrow \quad F = (S_1 + S_2)$ + weight of tube
$= (2\pi RT + 2\pi RT) + mg = 4\pi RT + mg$

Here $R = 2\text{mm} = 2 \times 10^{-3}$ m, $T = 0.1$ N/m and $m = \pi \times 10^{-3}$ kg

$F = 4\pi(2 \times 10^{-3})(0.1) + (\pi \times 10^{-3}) \times 10 = 10.8\pi \times 10^{-3}\,N$
$= 10.8\pi$ mN

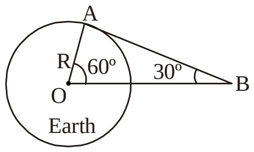
9. According to Bernoulli's principle

$$P+\frac{1}{2}\rho v^2 = \text{constant}$$

At the sides the velocity is higher, so the pressure is lower. But the pressure at a given horizontal level must be equal, therefore the liquid rises at the sides to some height to compensate for this drop in pressure.

10. (a) In Δ AOB : – $\cos 60^\circ = \frac{R}{OB} \Rightarrow OB = 2R$ (where OB is orbital radius)

Here gravitational force will provide the required centripetal force.



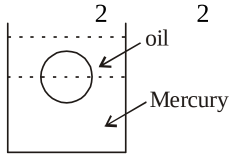
Hence $\frac{GMm}{(OB)^2} == m(OB)\ \omega^2$

$$\Rightarrow \omega = \sqrt{\frac{GM}{(OB)^3}} = \sqrt{\frac{GM}{(2R)^3}} \quad \Rightarrow \quad \omega = \sqrt{\frac{GM}{8R^3}}$$

11. (c) Weight = Buoyant force

$$V\rho_m g = \frac{V}{2}\rho H_g g + \frac{V}{2}\rho_{oil} g$$

$$\rho_m = \frac{\rho_{Hg}+\rho_{oil}}{2} = \frac{13.6+0.8}{2} = \frac{14.4}{2} = 7.2$$



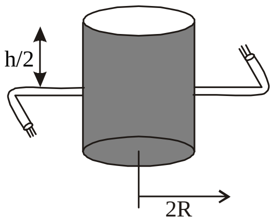
12. (a) Velocity of efflux of water (v) = $\sqrt{2g\left(\frac{h}{2}\right)} = \sqrt{gh}$

force on ejected water = Rate of change of momentum of ejected water.

$= \rho(av)(v) \qquad = \rho\, av^2$

Torque of these forces about central line

$= (\rho av^2)\, 2R.2 \qquad = 4\rho av^2 R = 4\rho\, agh\, R$



13. (b) For the given situation, liquid of density 2 ρ should be behind that of ρ.

From right limb :

$P_A = P_{atm} + \rho gh$

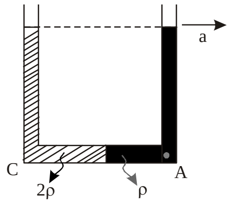
$P_B = P_A + \rho a\frac{l}{2} = P_{atm} + \rho\, gh + \rho a\frac{l}{2}$

$P_C = P_B + (2\rho)\, a\frac{l}{2} = P_{atm} + \rho\, gh + \frac{3}{2}\rho\, a\, l$ ....(1)

But from left limb :

$P_C = P_{atm} + (2\rho)\, gh$ ....(2)

From (1) adn (2) :



$P_{atm} + \rho gh + \frac{3}{2}\rho a \lambda = P_{atm} + 2\rho gh \Rightarrow h = \frac{3a}{2g}l$

14. (a) Viscous force = mg sin q

$\therefore \eta A \frac{V}{t} = mg\sin\theta$ or $\eta a^2 \frac{V}{t} = a^3 \rho g \sin\theta$

15. (a)

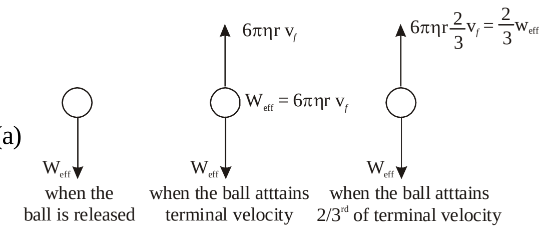


Figure (1) Figure (2) Figure (3)

when the ball is just released, the net force on ball is W_{eff}(= mg – buoyant force)
The terminal velocity 'v_f' of the ball is attained when net force on the ball is zero.

$\therefore$ Viscous force $6\pi\eta r\, v_f = W_{eff}$

When the bal acquires $\frac{2}{3} W_{eff}$.

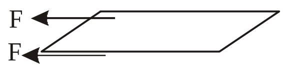
Hence net force is $W_{eff} - \frac{2}{3} W_{eff} = \frac{1}{3} W_{eff}$

$\therefore$ required acceleration is $= \frac{a}{3}$

16. (b) Velocity gradient $= \frac{0.52 \times 2}{2.5 \times 10^{-2}}$

Also, $F = 2\eta A \frac{dv}{dz} = 2 \times \eta \times (0.5) \frac{0.5}{1.25 \times 10^{-2}}$

$\Rightarrow \eta = 2.5 \times 10^{-2}$ kg – sec/m^2



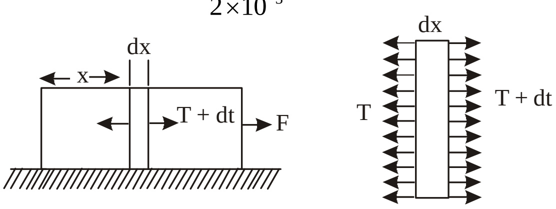
17. (a) $\Delta l = \frac{Fl}{AY}$ $\qquad \frac{\Delta l}{(F/A)} = \frac{l}{Y} = \text{slope of curve}$

$\frac{l}{Y} = \frac{(4-2)\times 10^{-3}}{4000 \times 10^3}$

Given $l = 1$ m $\rightarrow$

$Y = \frac{4000 \times 10^3}{2 \times 10^{-3}} = 2 \times 10^9 \text{ N/m}^2$

18.



Acceleration A = F/m

then $T = \frac{mx}{l} \times \frac{F}{m} = \frac{Fx}{l}$

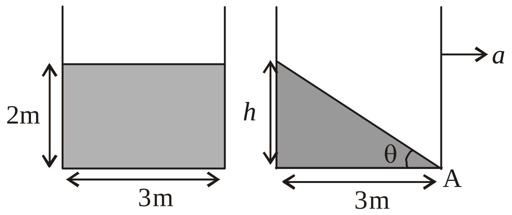
Extension in 'dx' element – $d\delta = \frac{Tdx}{AY} = \frac{Fxdx}{lAY}$

Total extension $\delta = \int_0^l \frac{Fxdx}{lAY} = \frac{Fl}{2AY}$

19. (a) From continuity equation, velocity at cross-section (1) is more than that at cross-section (2).
Hence ; $P_1 < P_2$
Hence (A)

20. (c)

21. (b)



Volume equality gives

$$2 \times 3 = \frac{1}{2} \times h \times 3 \Rightarrow h = 4m$$

$$\therefore \tan\theta = \frac{4}{3} = \frac{a}{g} \Rightarrow a = \frac{4}{3}g$$

22. (a) As the vessel is falling freely, the pressure at all the points in the liquid is same and equal to the atmosphere pressure and hence buoyance becomes zero.

23. (d) The point *A* and *C* in same horizontal level hence $P_C - P_A = \rho al$
(refer to figure in question to idenfity *A*, *B*, *C*)
Now, $P_B - P_C = \rho gh$
$\Rightarrow P_B = (P_1 + \rho al) = \rho gh \Rightarrow P_B - P_A = h\rho g + l\rho a$

24. (b) As the weight of wire acts at centre of gravity.
Therefore, only half the length of wire gets extended.

Now $Y = \frac{F}{A}.\frac{(L/2)}{\Delta l} = \frac{Mg(L/2)}{A\Delta l}$

$$\Rightarrow \Delta l \frac{MgL}{2AY} \Rightarrow \Delta l \frac{AL\rho gL}{2AY}$$

$$\therefore \Delta l = \frac{\rho L^2 g}{2Y}$$

25. (a) $Y = \frac{F/a}{\Delta l / l} = \frac{Fl}{a\Delta l}$

or $Y = \frac{Fl \times 4}{\pi D^2 \times \Delta l}$ or $\Delta l \propto \frac{1}{D^2}$ or $\frac{\Delta l_2}{\Delta l_1} = \frac{D_1^2}{D_2^2} = \frac{n^2}{1}$

26. (d) $Y = \frac{F/a}{\Delta l / l} = \frac{Fl}{a\Delta l}$ or $\Delta l \propto \frac{1}{D^2}$

(a) $\frac{100}{l^2} = 100$ (b) $\frac{400}{4} = 50$

(c) $\frac{300}{9} = 33.33$ (d) $\frac{50}{(1/2)^2} = 200$

27. (a) Energy density $= \frac{1}{2} \times \text{Stress} \times \text{Strain}$

$$= \frac{1}{2} \times \text{Stress} \times \frac{\text{Strain}}{Y} = \frac{(\text{Stress})^2}{2Y} \propto \frac{1}{D^4}$$

Now, $\frac{u_A}{u_B} = \frac{D_B^4}{D_A^4} = [2]^4 = 16$

28. (c) Thermal stress = $Y\alpha t$

In the given problem,

$Y\alpha$ = constant

$$\frac{Y_1}{Y_2} = \frac{\alpha_2}{\alpha_1} = \frac{3}{2}$$

29. (c) $Y = \frac{Fl}{a\Delta l}$

Y, l and a are constants

$\therefore \frac{Fl}{\Delta l}$ = constant or Dl $\propto$ F

Now, $l_1 - l = T_1$ and $l_2 - l = T_2$

Dividing, $\frac{l_1 - l}{l_2 - l} = \frac{T_1}{T_2}$

or $l_1T_2 - lT_2 = l_2T_1 - lT_1$ or $T(T_1 - T_2) = l_2T_1 - l_1T_2$

or $l = \frac{l_2T_1}{T_1 - T_2}$ or $l = \frac{T_1l_2 - lT}{T_3 - T_1}$

30. (b) T = $T = \frac{2m_1m_2}{m_1 + m_2} g = \frac{2\times1\times2}{1+2}\times10N = \frac{40}{3} N$

If r is the minimum radius, then

Breaking stress $= \frac{\frac{40}{30}}{\pi r^2}$ or $\frac{40}{3\pi}\times10^6 = \frac{40}{3\pi r^2}$

or $r^2 = \frac{1}{10^6}$ or $r = \frac{1}{10^3} m$

or $r = \frac{1}{10^3}\times10^3 m = 1m$

[CHEMISTRY]

31.
32.
33.

Octahedral complex has 6 centres for coordination to the central metal ion. EDTA has 6 centres for coordination. Hence, only **one** molecule is required.

34.
35.

Six C-atoms of each of the two benzene rings are equidistant from Cr atom but the π-bonds are fully delocalised.

EAN of Cr = 24 (At. No.) + 2 × 6 e^- from each benzene ring = 24 + 12 = 36

36.
37.

Since, 2 moles of AgCl are formed, out of 3Cl only two give precipitates which are in ionic sphere. C.N. of Co is 6.

38.

The given formula $CoCl_3 \cdot 6NH_3$ confirms the (b) answer only. Moreover,

$$\text{Moles of complex} = \frac{2.675}{267.5} = 0.01$$

$$\text{Moles of AgCl} = \frac{4.78}{143.5} = 0.033$$

This shows $3Cl^-$ ions in ionic sphere.

39.

Both show *cis* and *trans*-geometrical isomerism. *Cis*-isomer appears in *d* and *l* optical isomers. Hence, both have total 3 isomers each.

40.

^-NCS and ^-SCN are ambident ligands.

41.

$[Co(en)_2(NH_3)_2]^{3+}$ has *cis* and *trans*- structures. The *cis*- structure shows optical isomerism.

42.
43.
44.

Neutral cases of carbonyls slightly increase the bond length of C — O bond by donation in antibonding molecular orbitals of CO molecule.

45.
46.

$NH_3 + H^+ \longrightarrow NH_4^+$

47.

This compound is *cis*-platin anticancer compound.

48.

Cr $(Z = 24)$:[Ar]$3d^3$ has three unpaired electrons even after the effect of strong ligand NH_3.

49.

CO is a strong ligand. 6 electrons of $3d^5\ 4s^1$ form pairs and no unpaired electron is left.

50.

Though NH_3 and CN^- both are strong ligands yet NH_3 cannot vacate two *d*-orbitals from

Ni^{2+} : [Ar]$3d^8$ | ↑↓ | ↑↓ | ↑↓ | ↑ | ↑ |. Here hybridisation is sp^3d^2.

51.

Co^{3+}, $3d^6$ will be | ↑↓ | ↑↓ | ↑↓ | | | by the effect of strong field ligand NH_3.

Hybridisation will be d^2sp^3 showing inner orbital complex. All electrons are paired up, so diamagnetism is shown.

52.

$[Ni(CN)_4]^{4-}$: $x - 4 = -4 \Rightarrow x = \mathbf{0}$

53.

In $\mathbf{[Co(en)_3]}^{3+}$ has all (en) in *cis*- positions and hence, shows optical isomerism.

54.

It is a chelate of five members.

55.

In $[MnCl_4]^{2-}$, Mn^{2+}: [Ar]$3d^5$ has 5 unpaired electrons.

In $[CoCl_4]^{2-}$, Co^{2+}: [Ar]$3d^7$ has 3 unpaired electrons.

In both Cl^- is a weak ligand.

In $[Fe(CN)_6]^{4-}$, CN^- is a strong ligand. Fe^{2+}: [Ar]$3d^6$ will have no unpaired electron.

56.

μ = 2.84 B.M. shows two unpaired electrons in *d*-subshell, *i.e.*, even number of electrons in all | ↑ | ↑ | ↑ | ↑ | | will have at the maximum | ↑↓ | ↑ | ↑ | | | set with two vacant orbitals.

57.

Mn^{2+}, $3d^5$ will have **five** unpaired electrons because H_2O is a weak ligand.

58.

59.

60.

Fac and *mer* isomers are optically inactive.