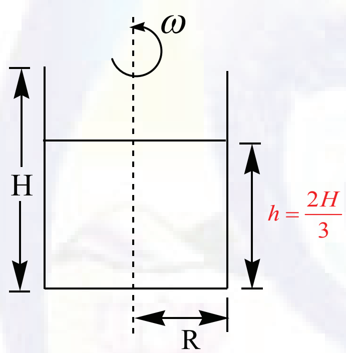
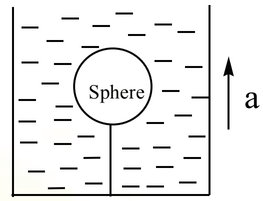
PHYSICS:

31. A cylinder of radius R =1 m and height H= 3 m, two-thirds is filled with water, is rotated about its vertical axis, as shown in figure. The speed of rotation when the water just starts spilling over the rim is $\left[g = 10 m/s^2\right]$



1) $\sqrt{40}\, rad/s$ 2) $\sqrt{30}\, rad/s$
3) $\sqrt{50}\, rad/s$ 4) $\sqrt{10}\, rad/s$

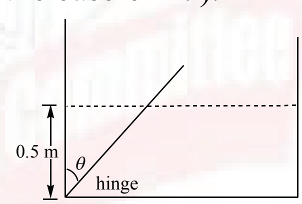
32. A solid sphere of mass $m = 2kg$ and specific gravity s=0.5 is held stationary relative to a tank filled with water as shown. The tank is accelerating vertically upward with acceleration $a = 2ms^{-2}$
The tension in the thread connected between the sphere and the bottom of the tank is $\left[g = 10 m/s^2\right]$



1) 18 N 2) 24 N
3) 22 N 4) 26 N

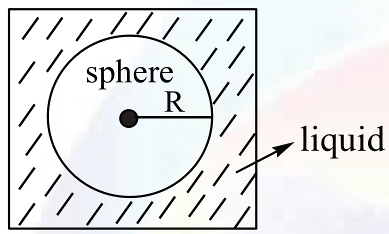
33. A cube of iron of edge 5 cm floats on the surface of mercury, contained in a tank. Water is then poured on top, so that the cube just gets immersed. The depth of cube in water layer is:
(Specific gravities of iron and mercury are 7.8 and 13.6, respectively.)
1) 1 cm 2) 1.8 cm
3) 2 cm 4) 2.2 cm

34. A wooden plank of length 1 m and uniform cross section is hinged at one end to the bottom of a tank as shown in figure. The tank is filled with water up to a height of 0.5 m. The specific gravity of the plank is 0.5. The angle θ that the plank makes with the vertical in the equilibrium position (exclude the case $\theta = 0$).



1) 30^0 2) 60^0
3) 45^0 4) 15^0

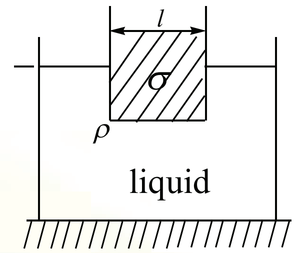
35. A sphere is just immersed in a liquid. The ratio of hydrostatic force acting on top and bottom half of the sphere.



1) $\frac{1}{5}$ 2) $\frac{2}{5}$

3) 5 4) $\frac{3}{5}$

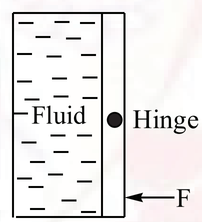
36. A wooden cube of length l and density σ floats in a liquid of density $q(>\sigma)$ filled in a vessel. If the vessel moves with horizontal acceleration a and in steady state, then the net hydrostatic force acting on the cube is



1) $\sigma l^3\sqrt{g^2+a^2}$ 2) $\sigma l^3(g+a)$

3) $\frac{\sigma l^3 g^2}{\sqrt{g^2+a^2}}$ 4) $\sigma l^3 g$

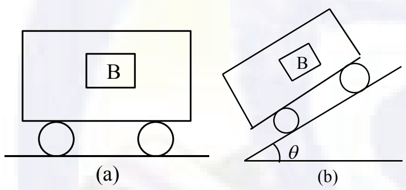
37. A square gate of size $1m\times1m$ is hinged at its midpoint. A fluid of density ρ fills the space to the left of the gate. The force F required to hold the gate stationary is



1) $\frac{\rho g}{3}$ 2) $\frac{\rho g}{2}$

3) $\frac{\rho g}{6}$ 4) $\frac{\rho g}{8}$

38. A body B is capable of remaining stationary inside a liquid at the position shown in figure a. If the whole system is gently placed on smooth inclined plane figure b and is allowed to slide down, then $\left(0<\theta<90^0\right)$



1) The body will move up (relative to liquid)

2) The body will move down (relative to liquid)

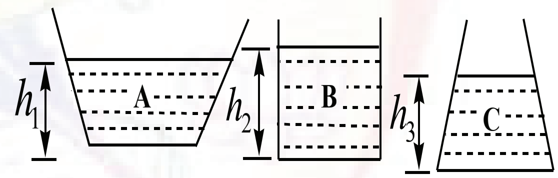
3) The body will remain stationary (relative to liquid)

4) The body will move up for some inclination θ and will move down for another inclination θ.

39. A hemispherical bowl just floats without sinking in a liquid of density $1.2\times10^3 kg/m^3$. If the outer diameter and the density of the bowl are 1 m and $2\times10^4 kg/m^3$, respectively, then the inner diameter of the bowl will be

1) 0.94 m
2) 0.97 m
3) 0.98 m
4) 0.99 m

40. Equal volumes of a liquid are poured in the three vessels A, B and C $\left(h_1<h_2<h_3\right)$. All the vessels have the same base area. Select the correct alternatives.



1) The force on the base will be maximum in vessel A.

2) The force on the base will be maximum in vessel C.

3) Net force exerted by the liquid in all the three vessels is not equal.

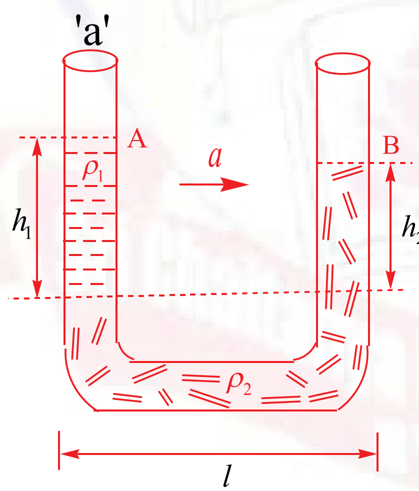
4) Net force exerted by the liquid in vessel A is maximum.

41. An empty balloon weight W_1. If air equal in weight to W is pumped into the balloon, the weight of the balloon becomes W_2. Suppose that the density of air inside and outside the balloon is the same. Then

1) $W_2 = W_1 + W$ 2) $W_2 = \sqrt{W_1 W}$

3) $W_2 = W_1$ 4) $W_2 = W_1 - W$

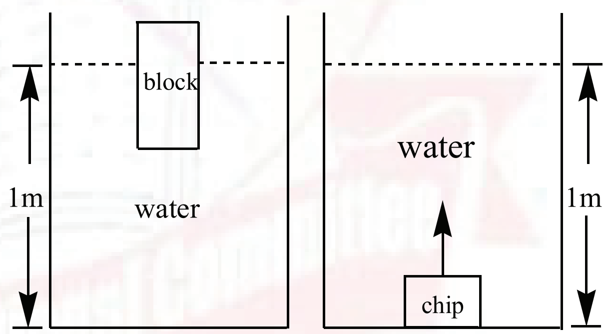
42. A U-tube containing two liquids of specific gravities ρ_1 *and* ρ_2 is given an acceleration 'a' in the horizontal direction is as shown in figure. Then the ratio of $\frac{\rho_1}{\rho_2}$ is



1) $\frac{la + gh_2}{gh_1}$ 2) $\frac{la - gh_2}{gh_1}$

3) $\frac{la + gh_1}{gh_2}$ 4) $\frac{gh_1}{gh_2}$

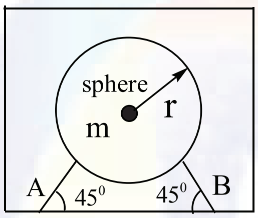
43. A wooden block in the form of a uniform cylinder floats with one-third length above the water surface. A small chip of this block is held at rest at the bottom of a container containing water to a height of 1 m and is then released. The time in which it will rise to the surface of water is $\left(g = 10 m/s^2\right)$



1) 0.84s 2) 0.63 s

3) 0.5 s 4) 1 s

44. A hollow sphere of mass M = 50 kg and radius $r = \left(\frac{3}{40\pi}\right)^{\frac{1}{3}} m$ is immersed in a tank of water (density $\rho_w = 10^3\, kg/m^3$). The sphere is tied to the bottom of a tank by two wires A and B as shown. Tension in wire A is $\left(g = 10m/s^2\right)$



1) $125\sqrt{2}N$ 2) 125 N

3) $250\sqrt{2}N$ 4) 250 N

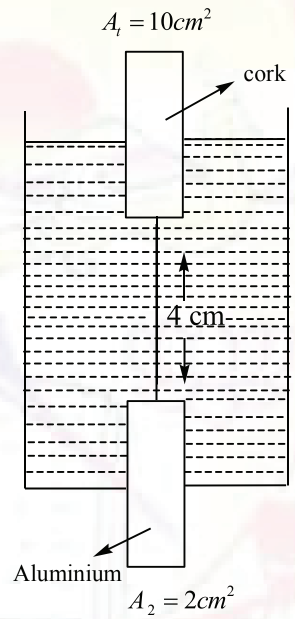
45. A hollow cylindrical container floats in water with half its length immersed. A liquid of specific gravity σ is slowly poured into the container until the levels of the liquid inside the container and of water outside are the same.

It is observed that the container is submerged to two-thirds its length. Then the value of σ is

1) $\frac{1}{2}$ 2) $\frac{1}{3}$

3) $\frac{1}{4}$ 4) $\frac{1}{3}$

46. A cylindrical object of cork of mass 15 gm and CSA A_1 $10cm^2$ floats in a pan of water as shown in figure. An aluminium cylinder of mass 25 gm and CSA A_2 $2cm^2$ is attached 4 cm below the cork and bottom of the pan. Take density of cork $\rho = 0.2gm/cm^3, \rho_{\text{aluminium}} = 2.7gm/cm^3, g = 10m/s^2$.

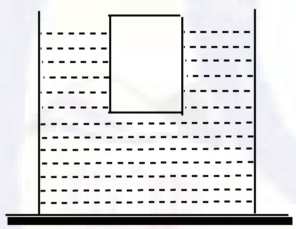


The length of the cork cylinder inside the water in equilibrium is

1) 6 cm 2) 4 cm

3) 8 cm 4) 3 cm

47.A cylindrical block is floating (partially submerged) in a vessel containing water. Initially the platform on which the vessel is mounted (hinged) is at rest, now the platform along with vessel is allowed to fall freely under gravity. As a result of which buoyancy force-



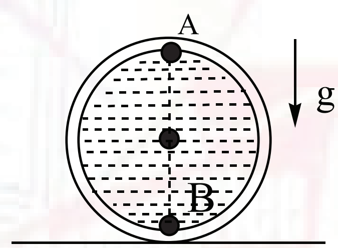
1) Becomes zero

2) decreases

3) increases

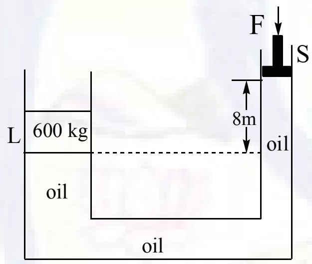
4) information is not Sufficient

48.A non-viscous incompressible liquid of mass m is filled fully inside a thin uniform spherical shell of mass m and radius R performing pure rolling on a rough horizontal surface. There are two points A and B inside the liquid on the vertical diameter separated by 2R as shown in the figure. Pressure difference between B and A is $(P_B - P_A)$. At the given instant velocity of centre of mass of given system is V_0 and kinetic energy of this system is K. There is no slipping of sphere on surface. If the value of $\frac{K}{P_B - P_A}$ is of the form $\frac{A_0 \pi V_0^2 R^2}{9g}$ then, the value of A_0



1) 8
2) 4
3) 9
4) 7

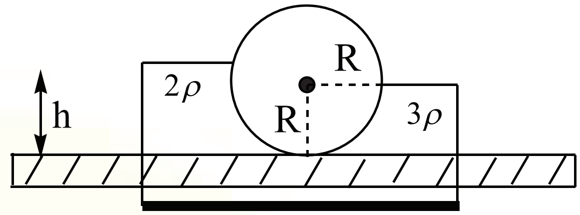
49. For the system shown in figure, the cylinder on the left, at L, has a mass of 600 kg and a cross-sectional area of $800 cm^2$. The piston on the right, at S, has cross-sectional area $25 cm^2$ and negligible weight. If the apparatus is filled with oil $(\rho = 0.78 g/cm^3)$. The force F required to hold the system in equilibrium is



1) 29N 2) 33N

3) 31 N 4) None of these

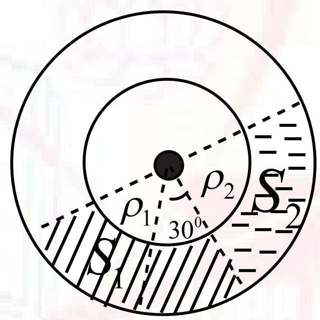
50. In the figure shown, the heavy cylinder (radius R) resting on a smooth surface separates two liquids of densities 2ρ and 3ρ. The height h for the equilibrium of cylinder must be



1) $\frac{3R}{2}$ 2) $R\sqrt{2}$

3) $R\sqrt{\frac{3}{2}}$ 4) None of these

51. A thin uniform circular tube is kept in a vertical plane. Equal volumes of two immiscible liquids whose densities are ρ_1 *and* ρ_2 fill half of the tube as shown. In equilibrium the radius passing through the interface makes an angle of 30^0 with vertical. The ratio of densities (ρ_1/ρ_2) is equal to



1) $\frac{\sqrt{3}-1}{2-\sqrt{3}}$ 2) $\frac{\sqrt{3}+1}{2+\sqrt{3}}$

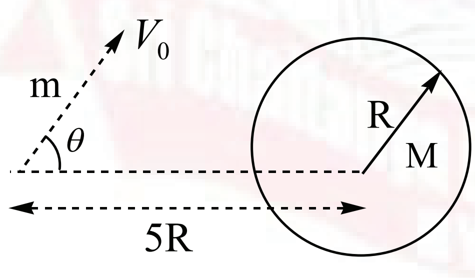
3) $\frac{\sqrt{3}-1}{\sqrt{3}+1}$ 4) $\frac{\sqrt{3}+1}{\sqrt{3}-1}$

52. The escape velocity for a body projected vertically upwards from the surface of the earth is $11.2 km s^{-1}$. If the body is projected in a direction making an angle 45^0 with the vertical, the escape velocity will be

1) $\frac{11.2}{\sqrt{2}} km s^{-1}$ 2) $11.2\times\sqrt{2}\, km s^{-1}$

3) $11.2\times 2 km s^{-1}$ 4) $11.2 km s^{-1}$

53. A spaceship is sent to investigate a planet of mass M and radius R. While hanging motionless in space at a distance 5R from the centre of the planet, the spaceship fires an instrument package of mass m, which is much smaller than the mass of the spaceship. For what angle θ will the package just graze the surface of the planet?



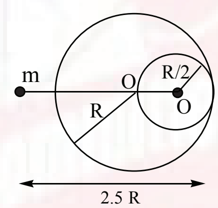
1) $Sin^{-1}\left(\frac{1}{5}\sqrt{1+\frac{8GM}{5V_0^2R}}\right)$

2) $Sin^{-1}\left(\frac{1}{5}\sqrt{1+\frac{8GM}{V_0^2R}}\right)$

3) $Sin^{-1}\left(\frac{1}{5}\sqrt{1+\frac{4GM}{5V_0^2R}}\right)$

4) $Sin^{-1}\left(\frac{1}{5}\sqrt{1+\frac{8GM}{V_0^2R}}\right)$

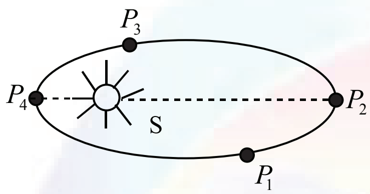
54. A solid sphere of radius R/2 is cut out of a solid sphere of radius R such that the spherical cavity so formed touches the surface on one side and the centre of the sphere on the other side, as shown. The initial mass of the solid sphere was M. If a particle of mass m is placed at a distance 2.5R from the centre of the cavity, then the gravitational attraction on the mass m is



1) $\frac{GMm}{R^2}$ 2) $\frac{GMm}{2R^2}$

3) $\frac{GMm}{8R^2}$ 4) $\frac{23}{100}\frac{GMm}{R^2}$

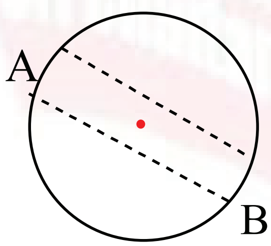
55. Figure shows a planet in an elliptical orbit around the Sun S. The kinetic energy of the planet is maximum at



1) P_1 2) P_2

3) P_3 4) P_4

56. A tunnel has been dug into a solid sphere of non-uniform mass density as shown in the figure. As one moves from A to B through the tunnel through the tunnel the magnitude of gravitational field intensity



1) will continuously decrease

2) will decrease up to the centre of the sphere and then increase

3) may increase or decrease

4) will continuously increase

57. The gravitational field in a region is given by $\vec{E} = \left(3\hat{i} - 4\hat{j}\right) N\,kg^{-1}$.

Find out the work done (in joule) in displacing a particle by 1 m along the line $4y = 3x + 9$.

1) Zero 2) 10J

3) -6J 4) 0.4 J

58. An upward thrust acting on body floating in a liquid

1) does always positive work on the body

2) does always negative work on the body

3) is conservative in nature

4) is non-conservative in nature

59. Distance between centres of two stars is 10a. The masses of these stars are M and 16M and their radii are a and 2a, respectively. A body is fired straight from the surface of the larger star towards the smaller star. The minimum initial speed of the body to reach the surface of the smaller star is

1) $\sqrt{\frac{Gm}{a}}$ 2) $\frac{3}{2}\sqrt{\frac{Gm}{a}}$

3) $\frac{2}{3}\sqrt{\frac{5Gm}{a}}$ 4) $\frac{3}{2}\sqrt{\frac{5Gm}{a}}$

60. The gravitational potential difference between the surface of a planet and a point 20 m above it is 16 J/kg. The work done in moving a 4 kg body by 8 m on a slope of 60^0 from the horizontal (is approximately)

1) 22.16 J 2) 10 J

3) 30 J 4) 50.4 J

Sri Chaitanya IIT Academy., India.

A.P, TELANGANA, KARNATAKA, TAMILNADU, MAHARASHTRA, DELHI, RANCHI

A right Choice for the Real Aspirant

ICON CENTRAL OFFICE, MADHAPUR - HYD

Sec: Jr.Super60		Date: 10-09-16
Time: 07:30AM to10:30AM	WTM-19	Max. Marks: 360

KEY SHEET

CHEMISTRY

1	1	**2**	2	**3**	2	**4**	2	**5**	1	**6**	3
7	4	**8**	3	**9**	2	**10**	1	**11**	1	**12**	4
13	4	**14**	1	**15**	2	**16**	2	**17**	2	**18**	4
19	2	**20**	3	**21**	2	**22**	2	**23**	2	**24**	4
25	4	**26**	3	**27**	3	**28**	1	**29**	4	**30**	4

PHYSICS

31	1	**32**	2	**33**	3	**34**	3	**35**	1	**36**	1
37	3	**38**	3	**39**	3	**40**	2	**41**	3	**42**	1
43	2	**44**	3	**45**	3	**46**	1	**47**	1	**48**	1
49	3	**50**	3	**51**	4	**52**	4	**53**	1	**54**	4
55	4	**56**	3	**57**	1	**58**	3	**59**	4	**60**	1

MATHEMATICS

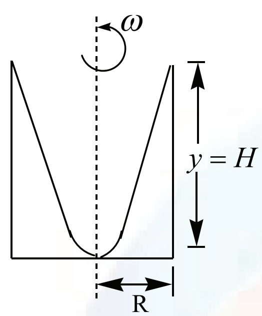
61	2	**62**	1	**63**	1	**64**	1	**65**	2	**66**	4
67	2	**68**	1	**69**	2	**70**	3	**71**	4	**72**	1
73	3	**74**	3	**75**	2	**76**	1	**77**	4	**78**	3
79	3	**80**	2	**81**	3	**82**	4	**83**	1	**84**	3
85	2	**86**	1	**87**	4	**88**	2	**89**	4	**90**	3

PHYSICS

31. We know that $y_{\max} = H = 3m,$

$h = 2/3\ H = 2m$

$R = 1m, g = 10m/s^2$



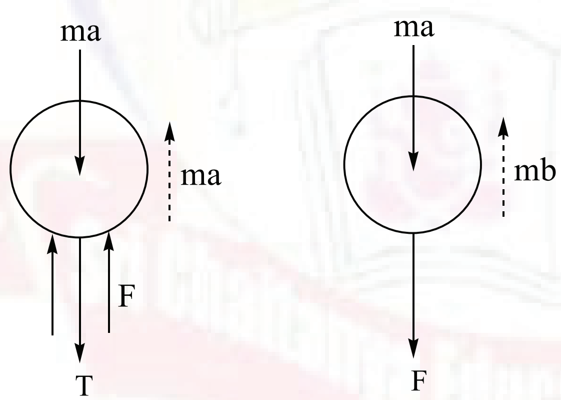
Thus, $\omega = \sqrt{\frac{4g(H-h)}{R^2}} = \sqrt{\frac{4(10)(3-2)}{1^2}} = \sqrt{40}\,rad/s$

32. $g' = g + a = 12ms^{-2}$

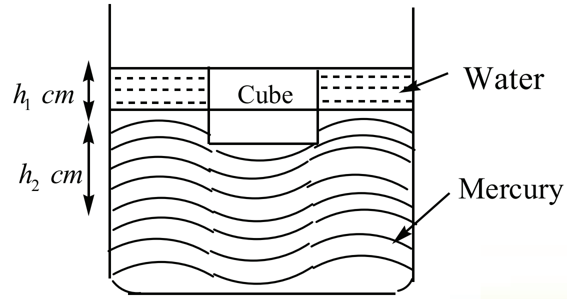
Hence, upthrust exerted by water on the sphere is

$F = V_\rho (g+a) = 48N$

Now considering the free-body diagram of the sphere accelerating with the tank,



$F - mg - T = ma \Rightarrow T = F - mg - ma = 24N$

33. 

$h_2 = (5 - h_1)\,cm$

Weight of water displaced $= (5^2 h_1) g$ dyn and weight of mercury displaced

$5^2(5 - h_1)$ 13.6 g dyn.

Therefore, upthrust offered by water and mercury together is given by

$5^2 h_1 g + 5^2(5 - h_1)13.6\,g$

$= 5^2(68 - 12.6 h_1)\, g\, dyn$

Weight of cube $= 5^3 \times 8.56\, g\;\; dyn$

From the principle of floatation, we have

Upthrust = weight of the floating body

$\therefore 5^2(68 - 12.6 h_1) g = 5^3 \times 8.56\, g$

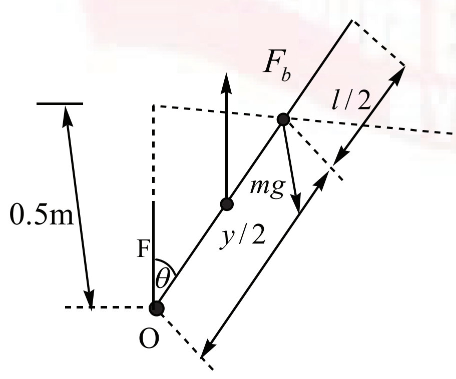
$\Rightarrow 68 - 12.6 h_1 = 41.8 \;\Rightarrow h_1 = 25.2/(12.6) = 2\,cm$

34. Let y be the length of the plank inside water.

$$y = \frac{0.5}{\cos\theta}$$

Let A be the cross sectional area of the plank. Then buoyant force on it is

$F_b = V\rho_w g = (Ay)\rho_w g$



Since plank is in rotational equilibrium, so $\sum \vec{\tau}_0 = 0$

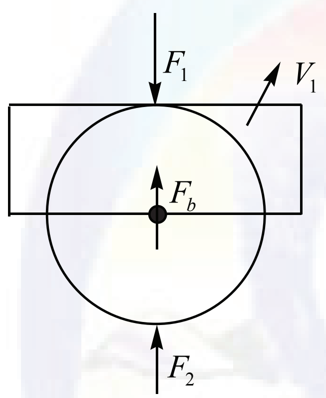
or $mg \times \frac{l}{2}\sin\theta - F_b \times \frac{y}{2}\sin\theta = 0 \; or \; mgl - F_b \times y = 0$

or $\left(Al \times 0.5\right)gl - \left(Ay\right)d_w y = 0 \; or \; 0.5l^2 = y^2$

or $0.5 \times \left(1\right)^2 = \left(\frac{0.5}{\cos\theta}\right)^2 \; or \; \cos^2\theta = \frac{1}{2}$

$\therefore \theta = 45^0$

35. Volume V_1 of the super – incumbent liquid of the upper hemisphere.



$V_1 = \pi R^2.R = \frac{2}{3}\pi R^3 = \frac{\pi R^3}{3}$

Then, the hydrostatic force acting on the upper hemispher

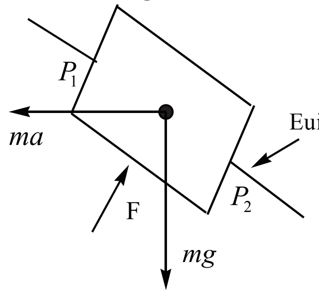
$F_1 \rho V_1 g = \frac{\pi R^2 \rho g}{3}$

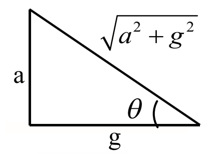
Then , $F_2 - F_1 = F_b \; or \; F_2 = F_b + F_1 = \frac{5}{3}\pi R^3 \rho g$

Then, $\frac{F_1}{F_2} = \frac{1}{5}$

36.

$F = N = mg\cos\theta$



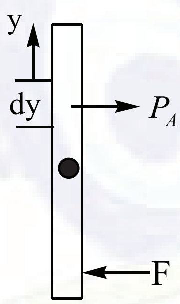


$$F = \sqrt{(ma)^2 + (mg)^2}$$

$$F = m\sqrt{g^2 + a^2}$$

37. At a depth y from the surface of the fluid, the net force acting on the gate element of width dy is

$$dF = (p_0 + \rho gy - p_0) \times 1dy = \rho gydy$$



Torque of this force about the hinge is

$$d\tau = \rho gydy \times \left(\frac{1}{2} - y\right)$$

Net torque experienced by the gate is

$$\tau_{net} = \int d\tau + F \times \frac{1}{2}$$

$$\int_0^1 \rho gydy\left(\frac{1}{2} - y\right) + F \times \frac{1}{2} = 0$$

$$\Rightarrow F = \frac{\rho g}{6}$$

38. Due to acceleration down the plane, both body B and liquid will received the same component of acceleration down the plane.

39. Let d be the inner diameter of the hemispherical bowl. Then, $B = mg$

$$\frac{4}{3}\pi\times\left(\frac{1}{2}\right)^3\times\left(1.2\times10^3\right)g=\frac{4}{3}\pi\left[\left(\frac{1}{2}\right)^3-\left(\frac{d}{2}\right)^3\right]\times\left(2\times10^4\right)g$$

Solving, we get $d=0.98\,m$

40. Height of liquid in vessel C is maximum. Therefore, force on the base of vessel C is maximum $\left[=\left(P_0+h\rho g\right)A\right]$. Net force on all the three vessels = weight of the liquid, which is the same form all the three vessels.

41. Apparent weight of the balloon $=W_2$

Apparent weight = real weight – upthrust

or W_2 = real weight – W

Now, real weight $=W_1+W$

$\therefore W_2=W_1+W-W=W_1$

42. Let A and B be the two free liquid levels in the two limbs. If P_0 be the atmosphere pressure, then starting from point A and reaching point B through the tube, we have

$P_0+h_1\rho_1 g-l\rho_2 a-h_2\rho_2 g=P_0$

$\Rightarrow h_1\rho_1 g=l\rho_2 a+h_2\rho_2 g=\rho_2\left(la+h_2 g\right)$

$$\Rightarrow\frac{\rho_1}{\rho_2}=\frac{la+h_2 g}{h_1 g}$$

43. Since two-thirds of the wooden block is immersed in water, its density $=2\rho/3$, where ρ is the density of water.

Let the volume of the chip be V. Then its weight is $(2/3)V\rho g$.

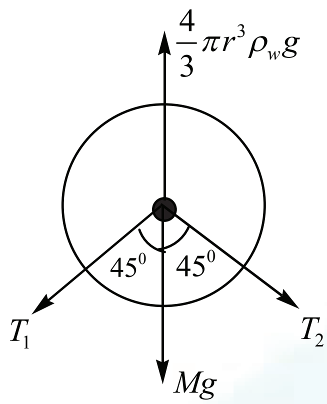
The upthrust acting on it inside the water is $V\rho g(1-2/3)=V\rho g/3$.

Hence, its acceleration a in the upward direction is

$$a=\frac{V\rho g/3}{(2/3)V\rho}=\frac{g}{2}$$

If t is the required time, then $1=0+\frac{1}{2}at^2=\frac{1}{2}\frac{g}{2}t^2$

44. $T_1=T_2, Mg+\sqrt{2}T_1=\frac{4}{3}\pi r^3\rho_w g\;\; T_1=250\sqrt{2}N$



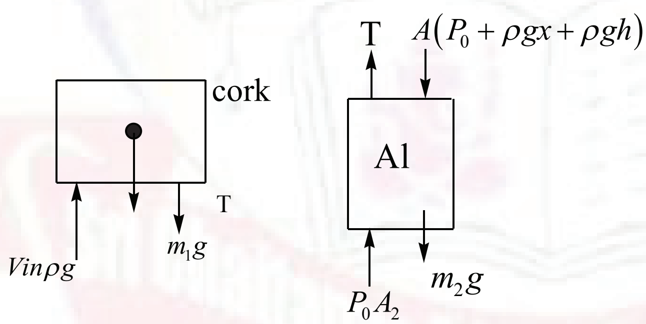
45. Since the container alone floats to half its length in water, its relative density =0.5. Since the levels of the liquid inside and water outside are the same, the volumes of the liquid and of the displaced water are the same. If this volume is V and the volume of the material of container is v, then the total mass of floating body is

$M = \left[V\sigma + v(0.5)\rho\right]$, where ρ is the density of water. By law of floatation,

$M = \left[V\sigma + v(0.5)\rho\right] = V\rho$ giving $V(1-\sigma) = v \times 0.5.$

Let the cross section of the container be A. Then the volume V' of water displaced V by the liquid is $LA\left[\frac{2}{3}-\frac{1}{2}\right] = LA\left[\frac{1}{6}\right]$

46.



Where $m_1 = 15gm, m_2 = 25gm, h = 4cm$

$V_{in} = A_1 x\, cm^3$

For cork cylinder, $T + m_1 g = V_{in}\rho g$

For Aluminium cylinder,

$T + P_0 A_2 = m_2 g + (P_0 + \rho gx + \rho gh)A_2$

Solving above equations, we get x = 6 cm and T= 0.45N

47. As the vessel is falling freely, the pressure at all the points in the liquid is same equal to atmospheric pressure and hence buoyancy force becomes zero.

48. Liquid will be in pure translation as it is incompressible.

So, $P_B - P_A = \rho g \times 2R$

$$\& K = \frac{mv_0^2}{2} + \frac{mv_0^2}{2} + \frac{\left(\frac{2m}{3}R^2\right)}{2} \times \left(\frac{v_0}{R}\right)^2 = \frac{4mv_0^2}{3}$$

$$\text{So, } \frac{K}{P_B - P_A} = \frac{4mv_0^2}{3\rho g \times 2R} = \frac{4 \times \frac{4}{3}\pi R^3 \rho \times v_0^2}{60\rho g R}$$

49. $P_0 A + mg = P_0 S + \frac{F}{S} + sgh$

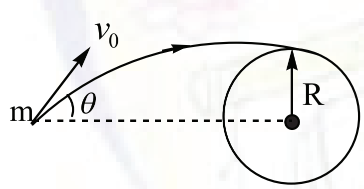
50. The net horizontal force on the cylinder due to liquids is zero.

51. Pressure due to left column = Pressure due to right column

52. Change in energy $= 1/2\left(GMm/R\right) = 1/2Mv_e^2$

So it is independent of angle as gravitational field is conservative in nature.

53. Let the speed of the instrument package be v when it grazes the surface of the planet.



Conserving angular momentum of the package about the centre of the planet

$mv_0 \times 5R\sin\theta = mvR$

$\Rightarrow \quad v = 5v_0 \sin\theta \,| \qquad (i)$

Conserving mechanical energy, we get

$$-\frac{GMm}{5R} + \frac{1}{2}mv_0^2 = -\frac{GMm}{R} + \frac{1}{2}mv^2$$

$$\Rightarrow \frac{1}{2}m\left(v^2 - v_0^2\right) = \frac{4GMm}{5R} \qquad \Rightarrow v^2 - v_0^2 = \frac{8GM}{5R} \qquad (ii)$$

Substituting the value of v from Eq. (i) in Eq. (ii), we have

$$25v_0^2 \sin\theta - v_0^2 = \frac{8GM}{5R}$$

$\Rightarrow \theta = \sin^{-1}\left(\frac{1}{5}\sqrt{1+\frac{8GM}{5v_0^2R}}\right)$

54. Let mass of the cavity $= M'$

Density of the sphere $= M/\left(4/3\pi R^3\right)$

Mass of the cavity cut out $= M' = \frac{4}{3}\pi\frac{R^3}{8}\times\frac{M}{\frac{4}{3}\pi R^3}$

$\therefore\ \frac{M}{8} \Rightarrow F_{net} = F_{Mn} - F_{Mm}$

$= \frac{GMm}{4R^2}\frac{GM'm}{\left(\frac{5}{2}R\right)^2} = \frac{GMm}{4R^2} - \frac{GMm}{50R^2}$

$F_{net} = \frac{23}{100}\frac{GMm}{R^2}$

55. Here, angular momentum is conserved. According to it,

$I_1\omega_1 = I_2\omega_2$

or $MR_1^2\omega_1 = MR_1^2\omega_2 \quad or\ R_1v_1 = R_2v_2$

At point P_4, the value of R is minimum and hence the velocity is maximum or KE is maximum.

56. As the sphere is having non-uniform mass density, so nothing can be predicted about the variation of gravitational field intensity.

57. Slope of displacement vector $m_1 = \frac{3}{4}$

Slope of force vector $m_2 = \frac{-4}{3}$

$m_1m_2 = -1\ w = 0$

58. wo by conservation force in closed path is zero

59. Then, $\frac{GM}{r^2} - \frac{G16M}{\left(10a-r\right)^2} = 0$

$\Rightarrow \left(10a-r\right)^2 = 16r^2$

$\Rightarrow 10a - r = 4r$

$\Rightarrow r = 2a$

Potential at point P,

$$v_P = \frac{-GM}{r} - \frac{G16M}{(10a-r)} = \frac{-GM}{2a} - \frac{2GM}{a} = \frac{-5GM}{2a}$$

Now if the particle projected from the larger planet has enough energy to cross this point, it will reach the smaller planet. For this, the KE imparted to the body must be just enough to raise its total mechanical energy to a value which is equal to PE at point P, i.e.

$$\frac{1}{2}mv^2 - \frac{G(16M)m}{2a} - \frac{GMm}{8a} = mv_P$$

or $$\frac{v^2}{2} - \frac{8GM}{a} - \frac{GM}{8a} = -\frac{5GMm}{2a}$$

or $$v^2 = \frac{45GM}{4a}$$

or $$v_{\min} = \frac{3}{2}\sqrt{\frac{5GM}{a}}$$

60. Here, h = 20 m.

Gravitational potential difference $16\,J\,kg^{-1}$.

The vertical distance through which the body has to be raised is

$8\sin 60^0 = 8\times\left(\sqrt{3}/2\right) = 4\sqrt{3}m$.

Since gravitational potential difference for a distance of 20m is 16J/kg, hence the potential difference for a distance of $4\sqrt{3}m$ for a body of mass 4 kg is

$\left(\frac{16}{20}\times 4\sqrt{3}\right)J\,kg^{-1}$.

Work done in lifting a 4 kg body through a vertical height of $4\sqrt{3}m$ is

$$\left(\frac{16}{20}\times 4\sqrt{3}\right)\times 4 = \frac{64\times 1.732}{5} = 22.16J$$

Final Key

S.NO	SUB	Q.NO	GIVEN KEY	FINALIZED KEY	EXPLANATION
5	PHY	33	3	4	Calculation mistake
6	PHY	41	3	1 or 3	Measured weight or actual weight
7	PHY	49	3	4	Answer does not come to exactly an integer and "NONE OF THESE "option is also therefore valid.