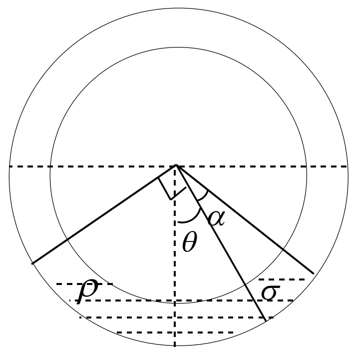
PHYSICS **Max. Marks: 66**

SECTION – I
(SINGLE CORRECT CHOICE TYPE)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE is correct.**

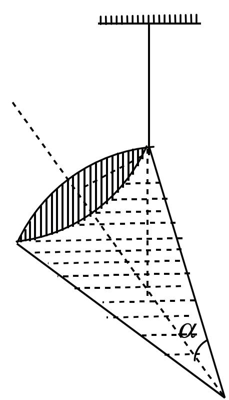
Marking scheme +3 for correct answer , 0 if not attempted and -1 in all other cases.

1. A fine circular tube in a vertical plane contains a column of liquid of density, ρ, which subtends a right angle at the center and a column of density $\sigma = \frac{5}{3}\rho$, subtending an angle of $\alpha = 37^0$ at the center. If the radius through the common surface makes with the vertical an angle θ, then find θ



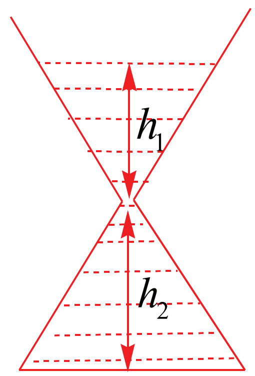
A) $Tan^{-1}(2)$ B) $Tan^{-1}(3)$ C) $Cot^{-1}(2)$ D) $Cot^{-1}(3)$

2. A hollow weightless cone of semi vertex angle $\alpha = 60^0$ is completely filled with liquid and suspended from a point on the rim of its base. Find the ratio of the force of thrust on the base to the weight of the liquid contained by the cone (Assume minimum pressure in cone is zero)



A) $\frac{32}{7}$ B) $\frac{39}{5}$ C) $\frac{36}{7}$ D) $\frac{29}{6}$

3. The shape of the interior of a vessel is a double cone, the ends being open and two portions connected by a minute aperture at the common vertex. It is placed with one circular rim fitting close upon a horizontal plane and is filled with water. If the resultant vertical thrust on the vessel be zero, the length of the axis of the upper portion (h_1) and that of the lower portion (h_2) satisfy



A) $h_1 = h_2$ B) $h_1 = 2h_2$ C) $h_1 = 2.5h_2$ D) $h_1 = 3h_2$

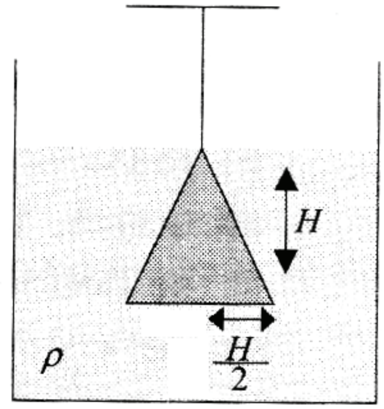
4. A thin circular disc of radius a is immersed into a liquid with its center at a depth of h below the liquid surface and the plane makes an angle $\alpha = 30^0$ with the horizontal. Find the force by one side of liquid on the disc. (Neglect atmosphere)

A) $\frac{\pi\rho g a^2 h}{2}$ B) $\pi\rho g a^2 h$ C) $2\pi\rho g a^2 h$ D) $4\pi\rho g a^2 h$

5. Two closely fitting hemispheres made of sheet metal of small uniform thickness, are hinged together at a point on their rims, and are suspended from the hinge, their rims being greased so that they form a water tight spherical shell. The shell is completely filled with water of weight W through a small hole near the hinge. The minimum weight of the shell so that the contact between the hemispheres does not give away is (Neglect atmosphere)

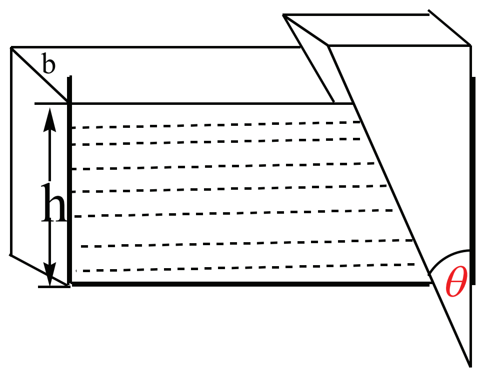
A) W B) 2 W C) 3 W D) 4 W

6. A solid cone of height H and base radius H/2 floats in a liquid of density ρ. It is hanging from the ceiling with the help of a string. The force by the fluid on the curved surface of the cone is (P_0= atmospheric pressure)



A) $\pi H^2\left(\frac{P_0}{4}+\frac{\rho g H}{3}\right)$ B) $\pi H^2\left(\frac{P_0}{4}+\frac{\rho g H}{6}\right)$ C) $\pi H^2\left(\frac{P_0}{4}+\rho g H\right)$ D) $\frac{\pi H^2}{4}(P_0+\rho g H)$

7. A slit is cut at the bottom, along the right bottom edge of a rectangular tank. The slit is closed by a wooden wedge of mass m =1 kg and apex angle $\theta = 45^0$ as shown in figure. The vertical plane surface of the wedge is in contact with the right vertical wall of the container. Coefficient of static friction between these two surfaces is $\mu = 0.2$. To what maximum height, can water be filled in the tank without leakage from the slit? The width of tank is b = 1m and density of water is $\rho = 10^3 kg/m^3$. (Neglect atmosphere)

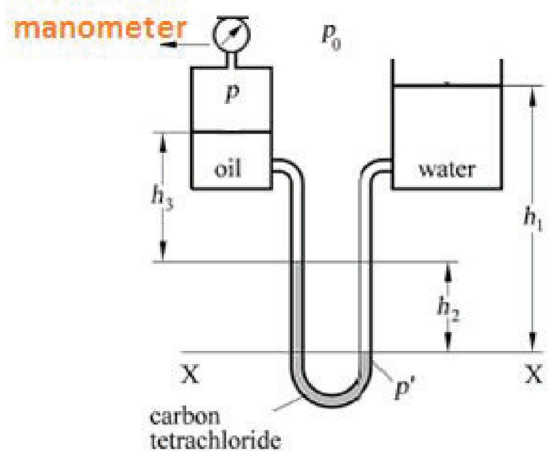


A) 5 cm B) 10 cm C) 50 cm D) 1 m

8. An open water container and a container that is closed to the atmosphere by an open tube manometer are connected by a U-tube, whose lower part is filled with carbon tetrachloride (tet) (CCl_4). The height of the water column (density of water $\rho_w = 1000\ km/m^3$ is $h_1 = 0.4\ m$, the column of oil (density of oil $\rho_{oil} = 950\ kg/m^3$) has the height $h_3 = 0.13m$, and the height h_2 of the CCl_4 column is $h_2 = 0.1m$.

What is the density ρ_{net} of the CCl_4 filling if the manometer reads 1200 N/m^2 (manometer reads Gauge pressure)

(Take $g = 10m/s^2$)



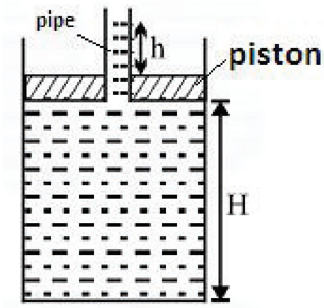
A) $1425kg/m^3$ B) $1485kg/m^3$ C) $1525kg/m^3$ D) $1565kg/m^3$

SECTION - II
(COMPREHENSION TYPE)

This section contains **6 multiple choice questions** relating to three paragraphs with two questions on each paragraph. Each question has 4 choices A), B), C) and D) for its answer, out of which **ONLY ONE is correct.**
Marking scheme +3 for correct answer , 0 if not attempted and -1 in all other cases.

Paragraph for Questions 9 & 10

A piston of mass M=3kg and radius=4cm has a hole into which a thin pipe of radius r=1cm is inserted. The piston can enter a cylinder tightly and without friction, and initially it is at the bottom of the cylinder. 750gm of water is now poured into the pipe so that the piston & pipe are lifted up as shown. (Neglect atmospheric pressure)..



9. Height h of water in the pipe(In meters) is

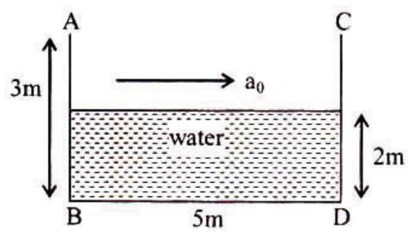
A) $\frac{2}{\pi}$ B) $\frac{3}{\pi}$ C) $\frac{4}{\pi}$ D) $\frac{5}{\pi}$

10. Height H of water in the cylinder (In meters) is

A) $\frac{11}{32\pi}$ B) $\frac{6}{32\pi}$ C) $\frac{5}{32\pi}$ D) $\frac{7}{32\pi}$

Paragraph for Questions 11 & 12

An open rectangular tank with dimensions $5m \times 4m \times 3m$ contains water upto height of 2m as shown in fig. It is accelerated horizontally along the longer side. ($g = 10m/s^2$, Density of water $= 1000kg/m^3$) AB is the rear wall. CD is the front wall



11. Find the maximum acceleration that can be given to the tank without spilling water

A) $2m/s^2$ B) $4m/s^2$ C) $5m/s^2$ D) $6m/s^2$

12. If this acceleration is increased by 20%, as compared to the value in the previous question, what is percentage of water spilled over ?

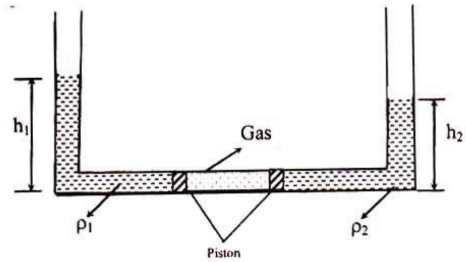
A) 5% B) 10% C) 20% D) 25%

Paragraph for Questions 13 & 14

Figure shows a tube whose two limbs are vertical and one is horizontal. A ideal gas is enclosed between two massless non conducting pistons and liquid of density ρ_1 *and* ρ_2 are filled in vertical limbs to height of h_1 *and* h_2. Now gas is slowly heated

$\rho_1 = 1000\ kg/m^3$, $\rho_2 = 2000\, kg/m^3$, $h_1 = 2m$

Cross-section area of piston A = 10 cm^2



13. Ratio of h_1 *and* h_2 at any instant will be

A) $\frac{1}{2}$ B) $\frac{2}{1}$ C) $\frac{3}{2}$ D) $\frac{3}{4}$

14. If due to heating separation between piston is increased by 3m then displacement of piston on left will be

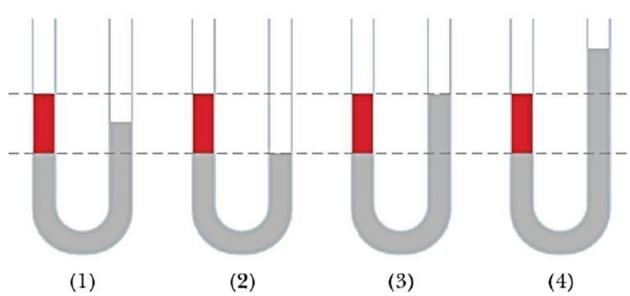
A) 2m B) 1m C) 2.5m D) 1.5m

SECTION – III
(MULTIPLE CORRECT CHOICE TYPE)

This section contains **6 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE is/ are correct.**

Marking scheme +4 for correct answer , 0 if not attempted and 0 in all other cases.

15. Figure shows four situations in which two liquids shown with dark shade and light shade are in a U-tube



A) the liquids cannot be in static equilibrium in situations 2 and 3 for any values of their densities

B) the liquids cannot be in static equilibrium in situation 2 for any values of their densities

C) For static equilibrium to be possible in situation 1 density of liquid shown with dark shade must be greater than that of the other liquid

D) For static equilibrium to be possible in situation 4 density of liquid shown with dark shade must be greater than that of the other liquid

16. Identify the correct statement(s) from the following

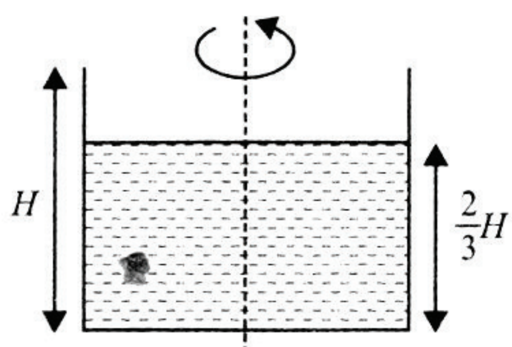
A) An ideal fluid cannot offer any resistance to a shear force (an effort to bring a change in its shape)

B) Any pressure, or additional pressure, applied to the surface or to any other part of an incompressible liquid at rest is transmitted equally to all parts of the liquid

C) In consequence of Pascal's law, a certain mass of liquid can be used as a machine for the purpose of multiplying power due to a force

D) The Elasticity of a fluid is measured by the ratio of a small increase of pressure to the cubical compression produced by it

17. A circular cylinder of radius R and height H is filled with water to a height (2/3)H. It starts rotating about its axis with constantly increasing angular speed. Chose the correct alternatives



A) At all speeds, shape of the free surface is paraboloid.

B) The free surface touches first the brim of the cylinder and then the base of the cylinder.

C) The free surface cannot touch the base without spilling water.

D) The free surface touches the brim as well as the base at the same instant.

18. Mercury is poured into a U-shaped tube of a constant cross-sectional area. When some amount of water is poured into one arm, the level of mercury in the other arm rises by 2 cm. (density of mercury is $13.6\times10^3\ kg/m^3$ and that of alcohol is $0.8\times10^3 kg/m^3$)

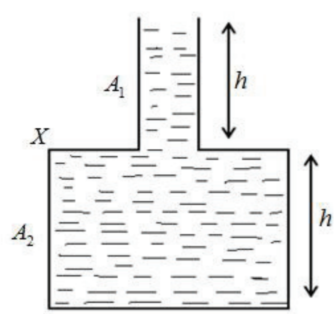
A) The height of the water column is 25.2 cm

B) The height of the water column is 54.4cm

C) If now alcohol is added in other arm then the height of the column of alcohol that must be poured into the second arm to make the level of mercury in it 2 cm higher than in the first arm is 34.0 cm

D) If now alcohol is added in other arm then the height of the column of alcohol that must be poured into the second arm to make the level of mercury in it 2 cm higher than in the first arm is 54.0 cm

19. The vessel shown in figure has two sections of area of cross section A_1,and A_2. A liquid of density ρ fills both the sections, upto height h in each. Neglect the atmospheric pressure ,



A) The pressure at the base of the vessel is 2 ρ gh

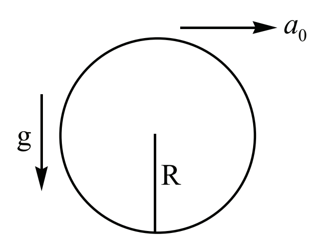
B) The weight of the liquid in vessel is equal to 2 ρ gh

C) The force exerted by the liquid on the base of vessel is 2 ρ gh A_2

D) The walls of the vessel at the level X exert a force ρ gh(A_2 - A_1) downwards on the liquid.

20. A hollow sphere completely filled with water is translating towards right with an acceleration $a_0 = \sqrt{3}\,g$. What are the co-ordinates of the point where the pressure in water is zero?

The origin is at the centre of the sphere, the x-axis is horizontal rightwards and the y-axis is vertical in a direction opposite to g.



A) The maximum pressure inside liquid is at point $\left(\frac{\sqrt{3}R}{2}, \frac{R}{2}\right)$

B) The minimum pressure inside liquid is at point $\left(\frac{\sqrt{3}R}{2}, \frac{R}{2}\right)$

C) The maximum pressure inside liquid is at point $(0, -R)$

D) The minimum pressure inside liquid is at point $\left(-\frac{R}{2}, \frac{\sqrt{3}R}{2}\right)$

Sec: Sri Chaitanya-Jr.Chaina	Jee-Advanced	Date: 29-09-19
Time: 09:00 AM to 12:00 Noon	2012_P2	Max.Marks:198

KEY SHEET

PHYSICS

1	**D**	2	**C**	3	**B**	4	**B**	5	**C**
6	**B**	7	**A**	8	**D**	9	**A**	10	**A**
11	**B**	12	**B**	13	**B**	14	**A**	15	**BD**
16	**ABD**	17	**ABC**	18	**BC**	19	**ACD**	20	**B**

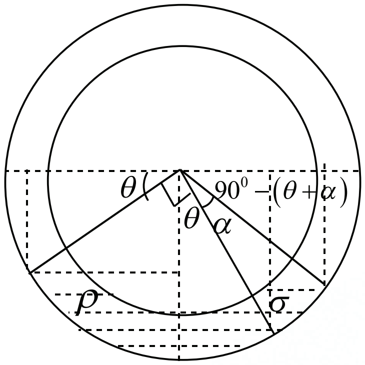
CHEMISTRY

21	**C**	22	**A**	23	**D**	24	**B**	25	**C**
26	**A**	27	**D**	28	**B**	29	**D**	30	**B**
31	**D**	32	**A**	33	**A**	34	**B**	35	**ABD**
36	**ABC**	37	**ABCD**	38	**ABCD**	39	**AC**	40	**ABC**

MATHS

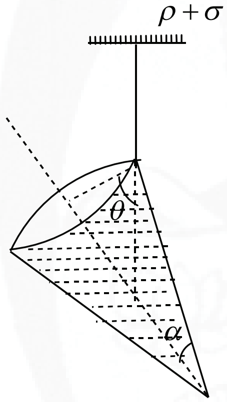
41	**B**	42	**C**	43	**C**	44	**B**	45	**A**
46	**B**	47	**D**	48	**B**	49	**A**	50	**D**
51	**D**	52	**A**	53	**B**	54	**B**	55	**A**
56	**ACD**	57	**BCD**	58	**AC**	59	**BD**	60	**BD**

SOLUTIONS
PHYSICS



1.
$$\rho\left(-R\sin\theta+R\cos\theta\right)=\sigma\left(-R\cos\left(\theta+\alpha\right)+R\cos\left(\theta\right)\right)$$
$$\Rightarrow \rho\left(\cos\theta-\sin\theta\right)=\sigma\left(\cos\theta-\cos\left(\theta+\alpha\right)\right)$$
$$=\sigma\left(\cos\theta-\cos\theta\cos\alpha+\sin\theta\sin\alpha\right)$$
$$\Rightarrow \cos\theta\left(\rho-\sigma+\sigma\cos\alpha\right)=\sin\theta\left(\rho+\sigma\sin\alpha\right)$$
$$\Rightarrow \tan\theta=\frac{\rho-\sigma+\sigma\cos\alpha}{\rho+\sigma\sin\alpha}$$

2.



$$\tan\alpha=\frac{R}{H}$$
$$\therefore \tan\theta=\frac{\left(\frac{H}{4}\right)}{R}=\frac{1}{4}\cot\alpha$$

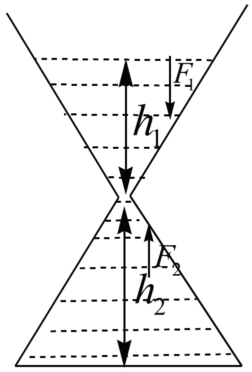
Average gauge pressure over the circular base = gauge pressure at the center of base = $\rho g R\cos\theta$

$\therefore$ Force of thrust on the base = $\rho g R\cos\theta\pi R^2$

$\therefore$ Required ratio $=\dfrac{\pi\rho g R^3\cos\theta}{\rho\frac{1}{3}\pi R^2 H}=\dfrac{3R\cos\theta}{H}$

$$=3\tan\alpha.\cos\theta$$
$$=\frac{3\tan\alpha.4\sin\alpha}{\sqrt{\cos^2\alpha+16\sin^2\alpha}}$$
$$=\frac{12\sin^2\alpha}{\cos\alpha\sqrt{1+15\sin^2\alpha}}$$

3.



Let the force due to liquid on the upper & lower portions of the cone be F_1 *and* F_2 respectively

The resultant vertical thrust on the cone will be zero if F_1 *and* F_2

$$F_1 = \frac{1}{3}\pi r_1^2 h_1 \rho g$$

For the equilibrium of the entire liquid in the upper & lower portions together

$$F_1 + \rho g\left(h_1 + h_2\right)\pi r_2^2 = F_2 + \frac{1}{3}\pi\left(r_1^2 h_1 + r_2^2 h_2\right)g$$

$$\left(h_1 + h_2\right)r_2^2 = \frac{1}{3}\left(r_1^2 h_1 + r_2^2 h_2\right)$$

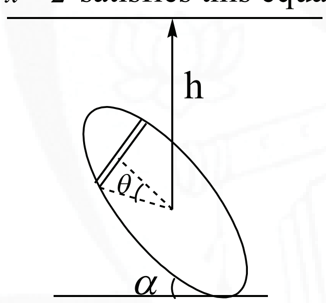
$$\Rightarrow 3h_1 r_2^2 + 2h_2 r_2^2 = r_1^2 h_1$$

$$\Rightarrow 3h_1 h_2^2 + 2h_2^3 = h_1^3$$

$$\Rightarrow 3x + 2 = x^3$$

$x = 2$ satisfies this equation

4.



Et force on the circle, $F_{net} = \int_0^{\pi} \rho g\left(h - R\cos\theta\sin\alpha\right).2R\sin\theta.R\sin\theta d\theta$

$$= 2\rho g R^2 \int_0^{\pi}\left(h\sin^2\theta - R\cos\alpha.\cos\theta\sin^2\theta\right)d\theta$$

$$= 2\rho g R^2\left[h\left(\frac{\theta}{2} - \frac{\cos 2\theta}{4}\right) - R\cos\alpha\frac{\sin^2\theta}{3}\right]_0^{\pi}$$

$$= 2\rho g R^2 h\left(\frac{\pi}{2}\right)$$

Net torque about center $\tau_{net} = \int_0^{\pi}\rho g\left(h - R\cos\theta\sin\alpha\right)2R\sin\theta.R\sin\theta d\theta R\cos\theta$

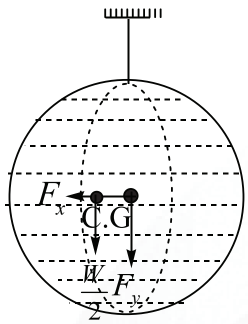
$$= 2\rho g R^3\int_0^{\pi}\left(h\sin^2\theta\cos\theta - R\sin\theta\cos^2\theta.\sin^2\theta\right)d\theta$$

$$= 2\rho g R^3\left[h\frac{\sin^3\theta}{3} - R\sin\alpha\left(\frac{\theta}{8} - \frac{\sin 4\theta}{32}\right)\right]_0^{\pi}$$

$$\frac{1}{4}\rho g R^4 \pi \sin\alpha$$

$\Rightarrow$ Distance of center of pressure from center $= \frac{\tau_{net}}{F_{net}} = \frac{R^2}{4h}\sin\alpha$

5.



Let $F_x \& F_y$ be the components of force on the left hemisphere due to liquid pressure

Considering the equilibrium of liquid in the left hemisphere

$F_x = \rho g R.\pi R^2 \; \& \; F_y = \frac{2}{3}\pi R^3 \rho g$

Net torque due to liquid pressure on the hemisphere about the center is zero

Hence F_x *and* F_y can be taken to be acting from the center

For the hemispheres to not give away, $\frac{W}{2}.\frac{3R}{8} \geq F_x.R \Rightarrow \frac{W}{2}\times\frac{3R}{8} \geq \pi\rho g R^3 \times R = \frac{3}{4}W_L$

$\Rightarrow W \geq 4W_L$

7. Initially $Kx_0 + mg = V_{in}.\rho g$

If the vessel is given a vertical acceleration a upwards and extension of the spring increases by δx then $K(x_0 + \delta x) + m(g+a) = V_{in}^1 \rho(g+a) = (V_{in} - A\delta x)\rho(g+a)$

$\Rightarrow [K + A\rho(g+a)]\delta x = V_{in}\rho a - ma$

And $Kx_0 = V_{in}\rho g - mg$

$\Rightarrow \left[\frac{K + A\rho(g+a)}{K}\right]\frac{\delta x}{x_0} = \frac{a}{g}$

If extension reduces to half $\delta x = \frac{-x_0}{2}$

Substituting this in the above equation & solving for a gives $a = -\frac{(K + A\rho g)}{k + 2A\rho g}g$

$= -\frac{2g}{3}$

9 & 10.

$\pi(4^2\text{H} - 1^2\text{h}) = 750$

$\rho\text{gh} = \frac{\text{mg}}{\pi(4^2 - 1^2)}$

12. The new value of acceleration $= a_0 + 0.2a_0 = 1.2a_0 = 1.2(4m/s^2) = 4.8m/s^2$

Hence inclination of free surface is $Tan^{-1}\dfrac{a}{g} = Tan^{-1}\dfrac{4.8m/s^2}{10m/s^2} = Tan^{-1}0.48$

If water extends over a height h along the wall CD, then

$\theta = Tan^{-1}0.48 = Tan^{-1}\dfrac{3m-h}{5m} \Rightarrow l = h = 0.6m$

$\therefore$ final volume of water remaining in the tank $= \dfrac{1}{2}(3m+0.6m)5m.4m = 36m^3$

Initial volume of water = 5m. 2m. 4m = $40m^3 \Rightarrow \%$ of water remaining $\dfrac{36}{40}\times 100 = 90\%$

$\therefore \%$ of water spilled = 10%

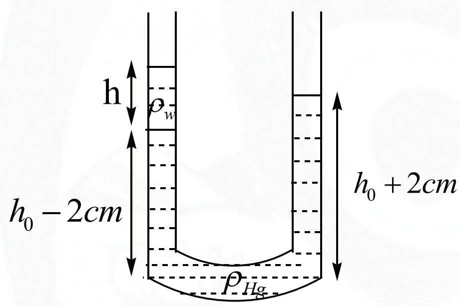
13. $\rho_1 g h_1 = \rho_2 g h_2 \Rightarrow \dfrac{h_1}{h_2} = \dfrac{\rho_2}{\rho_1} = \dfrac{2000kg/m^3}{1000kg/m^3} = 2$

14. If displacements of the distance on the left and right are $\Delta h_1 \& \Delta h_2$ respectively

$\Delta h_1 + \Delta h_2 = 3m \& \Delta h_1 / \Delta h_2 = 2 \Rightarrow \Delta h_1 = 2m$

17. Normal stress will be same in all directions if there is no shear stress in any direction which happens either when the fluid is non viscous or when the fluid is at rest or moving with no relative velocity between its various layers

18.



$\rho_w g h + \rho_{Hg} g(h_0 - 2cm) = \rho_{Hg} g(h_0 + 2cm)$

$\Rightarrow h = \dfrac{\rho_{Hg}(4cm)}{\rho_w}$

20. Conceptual

CHEMISTRY

21. NCERT
22. Rhombohedral or Trigonal
23.

$Z = 4+6+6+12+12 = 40$

$\dfrac{Z}{10} = \dfrac{40}{10} = 4$

24. Fraction of edge unoccupied $= \dfrac{a-2R}{a}$