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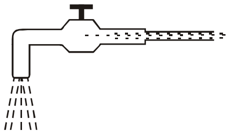
Class: 11
Subject: Physics
Topic: ASK15E11UT05
No. of Questions: 30

Q1. The pressure of water in a water pipe when tap is open and closed are respectively 3×10^5 Nm^{-2} and 3.5×10^5 Nm^{-2}. With open tap, the velocity of water flowing is



(A) $10\ ms^{-1}$
(B) $5\ ms^{-1}$
(C) $20\ ms^{-1}$
(D) $15\ ms^{-1}$

Sol. (A)

Here P = $\frac{1}{2}\rho\upsilon^2 = P_1 - P_2$

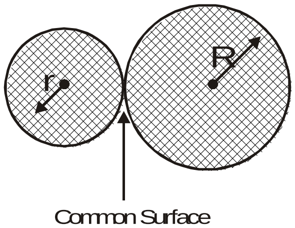
or $v^2 = 2(P_1 - P_2)/\rho$

$= 2\,(3.5 \times 10^5 - 3 \times 10^5)/1000$

$= \frac{2 \times 0.5 \times 10^5}{1000}$

or $\upsilon = \sqrt{\frac{2 \times 0.5 \times 10^5}{1000}} = 10\ ms^{-1}$

Q2. Two soap bubbles of radii R and r come in contact. R is more than r. Radius of curvature of common surface is



(A) $\frac{R-r}{Rr}$

(B) $\frac{Rr}{R-r}$

(C) $\frac{R+r}{Rr}$

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(D) $\frac{Rr}{R+r}$

Sol. (B)

Using excess pressure = $\frac{4S}{R}$, we get

$P_1 - P_{atm} = \frac{4S}{R}$

$P_2 - P_{atm} = \frac{4S}{r}$

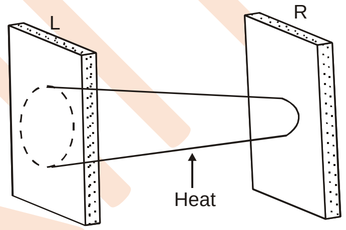
or $P_2 - P_1 = \frac{4S}{r} - \frac{4S}{R}$

or $\frac{4S}{r_{curvature}} = \frac{4S}{R} - \frac{4S}{R}$

or $\frac{1}{r_{curvature}} = \frac{1}{r} - \frac{1}{R} = \frac{R-r}{rR}$

or $r_{curvature} = \frac{rR}{R-r}$

Q3. A conical metallic body is heated at middle. If the body was voiced from its ends then



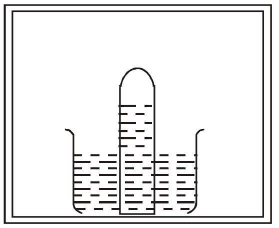
(A) There will be no effect on the body.
(B) Body will contract from middle.
(C) No strain is produced in the body.
(D) Maximum compressive stress will be on the side of body towards R.

Sol. (D)

Stress = $\frac{F}{A}$

Since compressive force is same throughout the body, right side has less area of cross–section, so stress is maximum.

Q4. A barometer kept in an elevator accelerating downward read x cm. The air pressure in the elevator is

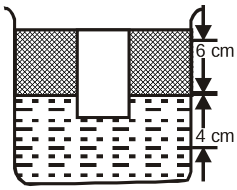


(A) x cm of mercury column
(B) less than x cm of mercury column
(C) greater than x cm mercury column
(D) nil.

Sol. (B)
Net acceleration = (g –a)
$\therefore$ Pressure = $\rho \dfrac{(g-a)x}{\rho}$ cm of mercury
Since $\dfrac{g-a}{g} < 1$
$\therefore$ here pressure in lift is less than x cm of mercury.

Q5. A cubical block of wood 10 cm on a side floats at the interface between oil and water with its lower surface horizontal and 4 cm below the interface. The density of oil is 0.6 g cm^{-1}. The mass of block is
(A) 706 g
(B) 607 g
(C) 760 g
(D) 670 g

Sol. (C)
Volume of block = 10 × 10 × 10 = 1000 cm^3
Volume of block in water = 10 × 10 × 4 = 400 cm^3
Volume of block in oil = 10 × 10 × 6 = 600 cm^3
Weight of block = Weight of oil displaced + Weight of water displaced
or mg = (600 × 0.6)g + (400 × 1) g
or m = 360 + 400 = 760g



Q6. A stone of 0.5 kg mass is attached to one end of a 0.8m long aluminium wire of 0.7 mm diameter and suspended vertically. The stone is now rotated in a horizontal plane at a rate such that wire makes an angle of 85° with the vertical. If Y = 7×10^{10} Nm^{-2}, sin 85° = 0.9962 and cos 85° = 0.872, the increase in length of wire is

(A) 1.67×10^{-3} m
(B) 6.17×10^{-3} m
(C) 1.76×10^{-3} m
(D) 7.16×10^{-3} m

Sol. (A)

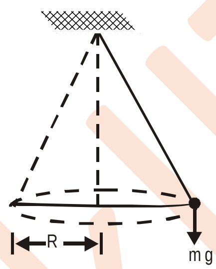
Here $T\cos\theta = mg$ and $T\sin\theta = mR\omega^2$

Using $Y = \frac{T}{A}\frac{l}{\Delta l}$ we get

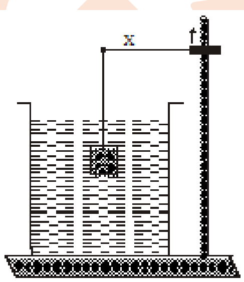
$$\Delta l = \frac{mgl}{\pi r^2 Y\cos\theta}$$

$$= \frac{0.5\times 9.8\times 0.8}{3.14\times\left(0.35\times 10^{-3}\right)^2\times 7\times 10^{10}\times 0.872}$$

$= 1.67 \times 10^{-3}$m



Q7. A metallic plate having space of a square is suspended as shown in figure. The plate is made to dip in water such that level of water is well above that of the plate. The point X is then slowly raised at constant velocity then curve between tension T in string and displacement S of point X is given by



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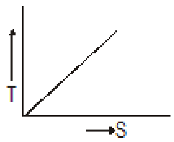
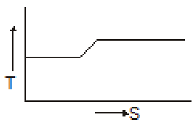
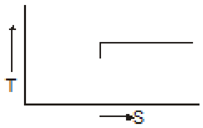
(A)



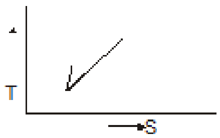
(B)



(C)



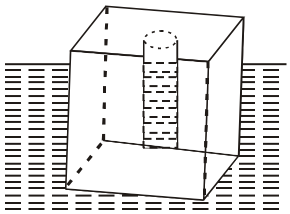
(D)



Sol. (B)

Tension in the string is constant so long as plate remains immersed in liquid. Tension increases linearly as the plate starts coming out of the liquid. When the plate is completely out of the liquid, the tension in string becomes constant.

Q8: A large block of ice of thickness t and density ρ has a large vertical hole along it axis. This block is floating in a lake. The length of rope required to raise a bucket of water through the hole is



(A) $(\rho - l)$ (B) $(1+\rho)\,l$

(C) $\rho\, l$ (D) $l(1-\rho)$

Sol. (D)

Let the block has height h above the surface of water and A be the area of block. Here weight of ice block = weight of liquid displaced

$\rho.A.l.g = (l-h)\,Ag = lAg - hAg$

$-h = (\rho - 1)\,l$ or $h = l\,(1-\rho)$

Which is the least length of rope.

Q9. Find the coefficient of volume expansion for an ideal gas at constant pressure.

(A) $\gamma = \frac{1}{T}$ (B) $g = T$

(C) $g = \frac{1}{T^2}$ (D) $g = \frac{1}{T^3}$

Sol. (A)

For an idea gas PV= nRT

As P is constant, we have

P.dV = nRdT

$$\frac{dV}{dT} = \frac{nR}{P}$$

$$\gamma = \frac{1}{V}\frac{dV}{dT} = \frac{nR}{PV} = \frac{nR}{nRT} = \frac{1}{T}$$

$$\gamma = \frac{1}{T}$$

Q10. What should be the lengths of steel and copper rod so that the length of steel rod is 5cm longer then the copper rod at all the temperatures. Coefficients of linear expansion for copper and steel are 1.7 and 1.1

(A) 2.17, 14.17 cm (B) 9.17, 14.17 cm

(C) 9.17, 18.17 cm (D) 3.17, 5.17 cm

Sol. (B)

It is given that the difference in length of the two rods is always 5 cm. Thus the expansion in both the rods must be same for all temperatures. Thus we can say that at all temperature differences, we have

$$\Delta L_{Cu} = \Delta L_{steel}$$

or $\alpha_{Cu} l_1 \Delta t = \alpha_{st} l_2 \Delta t$ [If l_1 and l_2 are the initial lengths of Cu and steel rods]

or $\alpha_{Cu} l_1 = \alpha_{st} l_2$

or $1.7 l_1 = 1.1 l_2$ .....(1)

It is given that $l_2 - l_1$ = 5cm ....(2)

$$\left(\frac{1.7}{1.1} - 1\right) l_1 = 5\text{cm}$$

or $l_1 = \frac{5 \times 1.1}{0.6} = 9.17\text{cm}$

Now from equation (2) l_2 = 14.17 cm

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Q11. A steel wire of cross-sectional area 0.5 mm^2 is held between two rigid clamps so that it is just taut at 20^oC. Find the tension in the wire at 0^oC. Given that Young's modulus of steel is Y_{st} = 2.1 × 10^{12} dynes / cm^2 and coefficient of linear expansion of steel is $\alpha_{st} = 1.1 \times 10^{-5}$ °C.

(A) 2.31×10^{-4} (B) 2.31×10^{-2}
(C) 9.31×10^{-6} (D) 2.31×10^{-6}

Sol. (D)
We know that due to drop in temperature, then tension increment in a clamped wire is T = YA $\alpha\Delta T$ = 2.1 ×10^{12} × 0.5 × 10^{-2} × 1.1 × 10^{-5} × 20 = 2.31 × 10^{-6}

Q12. Two bodies have the same heat capacity. If they are combined to form a single composite body, show that the equivalent specific heat of this composite body is independent of the masses of the individual bodies.

(A) $\frac{2s_1s_2}{s_2 - s_1}$ (B) $\frac{s_1s_2}{s_2 + s_1}$
(C) $\frac{2s_1s_2}{s_2 + s_1}$ (D) $\frac{s_2}{s_2 + s_1}$

Sol. (C) Let the two bodies have masses m_1, m_2 and specific heats s_1 and s_2 then
$m_1s_1 = m_2s_2$ or $m_1/m_2 = s_2/s_1$
Let s = specific heat of the composite body.
Then $(m_1 + m_2)\, s = m_1s_1 + m_2s_2 = 2m_1s_1$

$$s = \frac{2m_1s_1}{m_1 + m_2} = \frac{2m_1s_1}{m_1 + m_1(s_1/s_2)} = \frac{2s_1s_2}{s_2 + s_1}$$

Q13. 20 gm steam at 100°C is let into a closed calorimeter of water equivalent 10 gm containing 100 gm ice at – 10°C. Find the final temperature of the calorimeter and its contents. Latent heat of steam is 540 cal/gm, latent heat of fusion of ice=80 cal/gm, specific heat of ice = 0.5 cal/°C gm.

(A) 13°C (B) 63°C
(C) 93°C (D) 33°C

Sol. (D)
Heat lost by steam = mL + ms (100 - θ)
where, θ is the equilibrium temperature
Heat lost by steam = 20 × 540 + 20 × 1 (100 - θ)
= 10800 + 2000 - 20θ

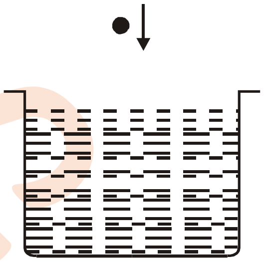
Heat gained by (ice + calorimeter) = 100 × 80 + 100 × 0.5 × 10 + 100 × θ
Now Heat lost = Heat gained

$\therefore$ $10800 + 2000 - 20\,\theta = 8000 + 500 + 110\,\theta$

or $130\theta = 4300$

or $\theta = \dfrac{4300}{130} = 33°C.$

Q14. A ball of radius r and density ρ falls freely under gravity through a distance h before entering water. Velocity of ball does not change even on entering water. If viscosity of water is η, the value of h is given by



(A) $\frac{2}{9}gr^2\left(\frac{1-\rho}{\eta}\right)$ (B) $\frac{2}{81}gr^2\left(\frac{\rho-1}{\eta}\right)$

(C) $\frac{2}{81}r^4\left(\frac{\rho-1}{\eta}\right)^2 g$ (D) $\frac{2g}{9}r^4\left(\frac{\rho-1}{\eta}\right)^2$

Sol. (C)

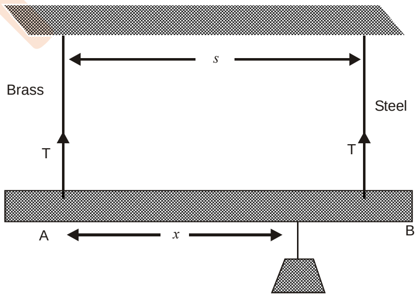
Here velocity of ball = $\sqrt{2gh}$, but this velocity is the same as terminal velocity

Given by $\frac{2}{9}gr^2\left(\frac{\rho-1}{\eta}\right)$

Then $\sqrt{2gh} = \frac{2g}{9}r^2\left(\frac{\rho-1}{\eta}\right)$

or h $= \left[\frac{2}{9}gr^2\left(\frac{\rho-1}{\eta}\right)\right]^2 \times \frac{1}{2g} = \frac{2g}{81}r^4\left(\frac{\rho-1}{\eta}\right)^2$

Q15. A wire of brass and another of steel support a horizontal for as shown



Here s = 1.5 m, $Y_{steel} = 2 \times 10^{11}\ Nm^{-2}$, $Y_{brass} = 1 \times 10^{11}\ Nm^{-2}$, Area of cross sections $a_{steel} = 1 \times 10^{-}$ m^2, $a_{brass} = 2 \times 10^{-5}\ m^2$. Both wires have same length. Then tension produced in both wires ?

(A) if the rod remains horizontal the extensions in the wires have to be different.

(B) tension produced in both wires will be twice for the bar to remain horizontal

(C) tensions produced in both wires is same for the far to remain horizontal.

(D) None of these

Sol. (C)

Elongation of both wires must be same for horizontal position of rod.

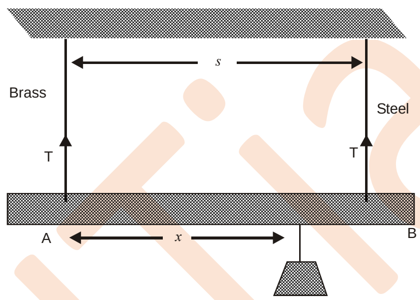
i.e. $$\Delta l = \frac{T_{steel}\, l}{a_{steel} Y_{steel}} = \frac{T_{brass}\, l}{a_{brass} Y_{brass}}$$

$$\therefore \frac{T_{steel}}{T_{brass}} = \frac{A_{steel} Y_{steel}}{A_{brass} Y_{brass}} = \frac{(1\times10^{-5})(2\times10^{11})}{(2\times10^{-5})(1\times10^{11})}$$

i.e. $T_{steel} = T_{brass}$

Hence, tensions produced in both wires is same for the far to remain horizontal.

16: A wire of brass and another of steel support a horizontal for as shown



Here s = 1.5 m, $Y_{steel} = 2 \times 10^{11}$ Nm^{-2}, $Y_{brass} = 1 \times 10^{11}$ Nm^{-2}, Area of cross sections $a_{steel} = 1 \times 10^{-}$ m^2, $a_{brass} = 2 \times 10^{-5}$ m^2. Both wires have same length.Then distance x is

(A) if the rod remains horizontal the extensions in the wires have to be different.

(B) tension produced in both wires is same for the bar to remain horizontal

(C) distance x = 0.75m

(D) tensions produced in both wires is different for the far to remain horizontal.

Sol. (B)

Elongation of both wires must be same for horizontal position of rod.

i.e. $$\Delta l = \frac{T_{steel}\, l}{a_{steel} Y_{steel}} = \frac{T_{brass}\, l}{a_{brass} Y_{brass}}$$

$$\therefore \frac{T_{steel}}{T_{brass}} = \frac{A_{steel} Y_{steel}}{A_{brass} Y_{brass}} = \frac{(1\times10^{-5})(2\times10^{11})}{(2\times10^{-5})(1\times10^{11})}$$

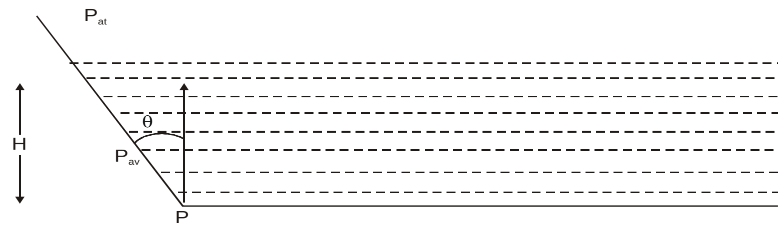
i.e. $T_{steel} = T_{brass}$

Taking moment T_{brass} = × x T_{steel} (s–x)

i.e. x = (s–x) i.e., 2x = s

i.e.2x = s i.e., $x = \frac{s}{2}$ = 0.75m.

Q17. A wall of width ω at an angle θ with the normal is subject to water pressure in a vessel. The height of water in the vessel is H and ρ is the density of water. Then Average pressure on the wall is ?



(A) Average pressure on the wall is $P_{at} + \frac{1}{2}\rho gH$

(B) Average pressure on the wall is $\frac{1}{2}(P_{at} + \rho gH)$

(C) Force exerted on wall is $\frac{1}{2}(P_{at} + \rho gH)\frac{\omega H}{\sin\alpha}$

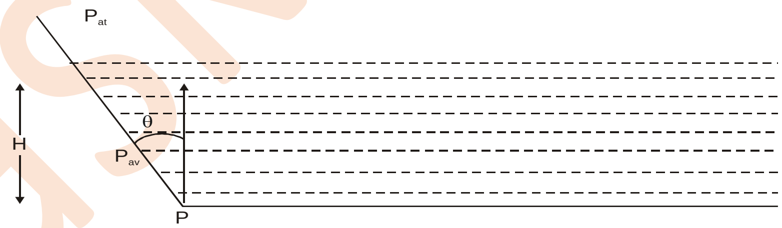
(D) Force exerted on the wall is $\left(P_{at} + \frac{1}{2}\rho gH\right)\frac{\omega H}{\cos\theta}$

Sol. (A) Pressure on bottom = $P_{at} + h\rho g$.

Pressure on top = P_{at} d

Average pressure on bottom = $\frac{P_{at} + (P_{at} + h\rho g)}{2}$

Q18. A wall of width ω at an angle θ with the normal is subject to water pressure in a vessel. The height of water in the vessel is H and ρ is the density of water. Then Force exerted on the wall is ?



(A) Average pressure on the wall is $P_{at} + \frac{1}{2}\rho gH$

(B) Average pressure on the wall is $\frac{1}{2}(P_{at} + \rho gH)$

(C) Force exerted on wall is $\frac{1}{2}(P_{at} + \rho gH)\frac{\omega H}{\sin\alpha}$

(D) Force exerted on the wall is $\left(P_{at} + \frac{1}{2}\rho gH\right)\frac{\omega H}{\cos\theta}$

Sol. (D) Pressure on bottom = $P_{at} + h\rho g$.

Pressure on top = P_{at} d

Average pressure on bottom = $\frac{P_{at} + (P_{at} + h\rho g)}{2}$

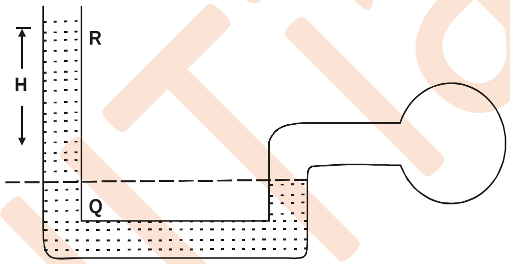
Using Pascal's law, average pressure on the wall $P_{at} + \frac{1}{2}\rho gH$

Area of the wall in contact with water

$= \frac{\omega h}{\cos\theta}$

Force exerted on wall is F = P_{av} A = $\left(P_{at} + \frac{1}{2}\rho gH\right)\frac{\omega H}{\cos\theta}$

Q19. A mercury filled U–tube arrangement is connected to a bulb containing gas. Atmosphere pressure is 1.012×10^5 Pa and H = 0.05 m. Gauge pressure at R is ?

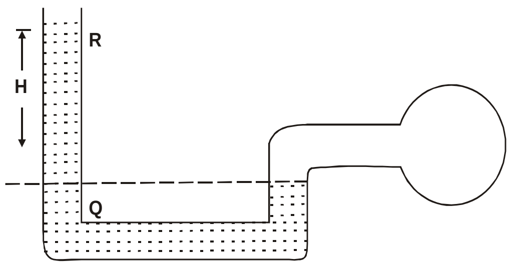


(A) gauge pressure at R is nil
(B) gauge pressure at R is 6.56×10^3 Pa
(C) gauge pressure at R is 1.08×10^5 Pa
(D) pressure at R, Q and inside bulb are same.

Sol. (A) Pressure at R = Atmosphere pressure = 1.013×10^5 Pa

Gauge pressure = nil

Q20. A mercury filled U–tube arrangement is connected to a bulb containing gas. Atmosphere pressure is 1.012×10^5 Pa and H = 0.05 m. Gauge pressure at Q is ?

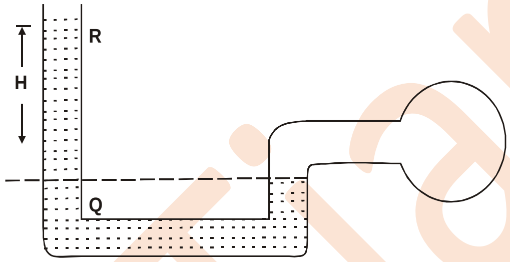


(A) gauge pressure at Q is nil
(B) gauge pressure at Q is 6.56×10^3 Pa

(C) gauge pressure at Q is 1.08×10^5 Pa
(D) pressure at R, Q and inside bulb are same.

Sol. (B)
Pressure at R = Atmosphere pressure = 1.013×10^5 Pa
Gauge pressure = nil
At Q, gauge pressure = ρgH
$= (1.36 \times 10^3)(9.8)(0.05) \qquad = 6.564 \times 10^3$ Pa

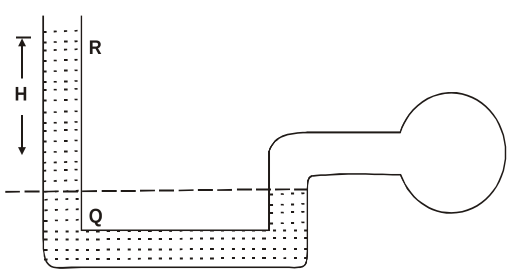
Q21. A mercury filled U–tube arrangement is connected to a bulb containing gas. Atmosphere pressure is 1.012×10^5 Pa and H = 0.05 m. Absolute pressure in bulb is ?



(A) absolute pressure in bulb is nil
(B) absolute pressure in bulb is 6.56×10^3 Pa
(C) absolute pressure in bulb is 1.08×10^5 Pa
(D) pressure at R, Q and inside bulb are same.

Sol. (C)
Pressure at R = Atmosphere pressure = 1.013×10^5 Pa
Gauge pressure = nil
At Q, gauge pressure = ρgH
$= (1.36 \times 10^3)(9.8)(0.05) \qquad = 6.564 \times 10^3$ Pa
Absolute pressure = $P_{at} + \rho gH$
$= (1.013 \times 10^5) + (6.564 \times 10^3) = 1.08 \times 10^5$ Pa
$\therefore$ Pressure in bulb = 1.08×10^5 Pa.

Q22. A mercury filled U–tube arrangement is connected to a bulb containing gas. Atmosphere pressure is 1.012×10^5 Pa and H = 0.05 m. Pressure at R, Q is ?



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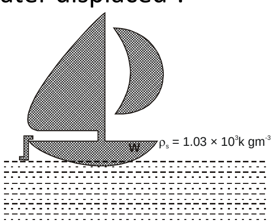
(A) pressure at R, Q is nil
(B) pressure at R, Q is 6.56×10^3 Pa
(C) pressure at R, Q is 1.08×10^5 Pa
(D) pressure at R, Q and inside bulb are same.

Sol. (D)
Pressure at R = Atmosphere pressure = 1.013×10^5 Pa
Gauge pressure = nil
At Q, gauge pressure = ρgH
$= (1.36 \times 10^3)(9.8)(0.05) = 6.564 \times 10^3$ Pa
Absolute pressure = $P_{at} + \rho gH$
$= (1.013 \times 10^5) + (6.564 \times 10^3) = 1.08 \times 10^5$ Pa
$\therefore$ Pressure in bulb = 1.08×10^5 Pa.

Q23. Density of sea water is 1.03×10^3 kg m^{-3}. A ship of weight 10.1×10^6 N floats on it. The ship then enters the fresh water and some cargo is unloaded. Then volume of sea water displaced ?
(A) volume of sea water displaced is 10^3 m^3
(B) volume of sea water displaced 3×10^4 kg
(C) A is incorrect
(D) B is incorrect.



Sol. (A)
Weight of ship = volume of sea water displaced
$\therefore$ volume of sea water displaced, $V = \dfrac{W}{\rho g}$
$= \dfrac{10.1 \times 10^6}{1.03 \times 10^3 \times 9.8} = 1 \times 10^3 m^3$
Mass of volume V of fresh water
$= 1 \times 10^3 \times 1 \times 10^3 = 10^6$ kg
Mass of cargo to be unloaded
$= 1.03 \times 10^6 - 1 \times 10^6 = 3 \times 10^4$ kg

Q24. A body weighs 160 g in air, 130 g in water and 136 g in oil. The specific gravity of oil is
(A) 0.2
(B) 0.6
(C) 0.7
(D) 0.8

Sol. (D)
Specific gravity of oil $= \dfrac{\text{Loss of weight in oil}}{\text{Loss of weight in water}}$

$$= \frac{160-136}{160-130} = \frac{24}{30} = \frac{8}{10} = 0.8$$

Q25. A diver is 10 m below the surface of water. The approximate pressure experienced by the diver is

(A) 10^5 Pa (B) 2×10^5 Pa
(C) 3×10^5 Pa (D) 4×10^5 Pa

Sol. (B)

1 atmosphere = 10^5Pa

Also, p= hρg

= 10×1000×10Pa = 10^5Pa

So, total pressure is nearly 2×10^5Pa

Q26. The room temperature is +20°C when outside temperature is -20°C and room temperature room temperature is + 10°C when outside temperature is -40°C. Find the temperature of the radiator heating the room.

(A) 30°C (B) 60°C
(C) 90°C (D) 45°C

Sol. (B)

Applying Newton's law

In case (1)

$K_1(T-T_{r1})= K_2(T_{r2}-T_{out\ 1})$

And in case (2)

$K_1(T-T_{r2})= K_2(T_{r2}-T_{out\ 2})$

Dividing these equations

$$\frac{T-T_{r1}}{T-T_{r2}} = \frac{T_{r2}-T_{out1}}{T_{r2}-T_{out2}} \qquad \frac{T-20}{T-10} = \frac{20-(-20)}{10-(-40)}$$

or T=60°C

Q27. Some water at 0°C is placed in a large insulated enclosure (vessel). The water vapour formed is pumped out continuously. What fraction of the water will ultimately freeze, if the latent heat vaporization is seven times the latent heat of fusion?

(A) 7/8 (B) 8/7
(C) 3/8 (D) 5/8

Sol. (A)

m = mass of water, f = fraction which freezes

L_1 = latent heat of vaporization

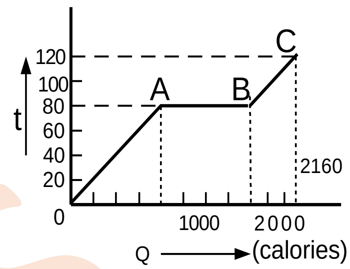
L_2 = latent heat of fusion ∴ $L_1 = 7L_2$

Mass of water frozen = mf

Heat lost by freezing water = m fL_2

Mass of vapour formed = m(1 - f)
Heat gained by vapour = m (1 – f) L_1
mfL_2 = m (1 - f) x $7L_2$
f = 7 – 7f or f = 7/8

Q28. A substance is in the solid form at 0°C. The amount of heat added to this substance and its temperature are plotted in the following graph. If the relative specific heat capacity of the solid substance is 0.5, find from the graph, the mass of the substance is
(Specific heat capacity of water = 1000 cal kg^{-1} K^{-1})



(A) 0.02 kg (B) 2 kg
(C) 0.04 kg (D) 0.05 kg

Sol. (A)
800 calories of heat raise the temperature of the substance from 0°C to 80°C.
$\therefore$ 800 = m (1000 × 0.5) × 80
(Q specific heat = relative sp. heat x sp. heat of water)
or m = 0.02 kg

Q29. A substance is in the solid form at 0°C. The amount of heat added to this substance and its temperature are plotted in the following graph. If the relative specific heat capacity of the solid substance is 0.5, find from the graph, the specific latent heat of the melting process is
(Specific heat capacity of water = 1000 cal kg^{-1} K^{-1})
(A) 6000 cal kg^{-1} (B) 4000 cal kg^{-1}
(C) 1000 cal kg^{-1} (D) 2000 cal kg^{-1}

Sol. (B)
Latent heat = 200 × 4 = 800 cal (Q 1 div reads 200 cal)
= 0.02 × L
$\therefore$ L= 4000 cal kg^{-1}

Q30. A substance is in the solid form at 0°C. The amount of heat added to this substance and its temperature are plotted in the following graph. If the relative specific heat capacity of the solid substance is 0.5, find from the graph, the specific heat of the substance in the liquid state is
(Specific heat capacity of water = 1000 cal kg^{-1} K^{-1})
(A) 300 cal kg^{-1} K^{-1} (B) 500 cal kg^{-1} K^{-1}
(C) 700 cal kg^{-1} K^{-1} (D) 100 cal kg^{-1} K^{-1}

Sol. (C)
In the liquid state temperature rises from 80°C to 120°C, that is,
by 40°C after absorbing (2160 – 1600) cal.

$\therefore \quad 0.02\ s \times 40 = 2160 - 1600$

or $s = 700$ cal kg^{-1} K^{-1}