PRE MID TERM EXAMINATION -2024-25

PHYSICS (042)

Class : XI Duration: 1 Hr
Date : 08/01/2025 Max. Marks: 25

Marking Scheme

Section A

1. (b) Mercury
2. (c) Area of the bottom surface
3. (b) -273.15^{0}C
4. (a) Both Assertion and Reason are true and Reason is correct explanation of Assertion.
5. (c) Assertion is true but Reason is false.

Section B

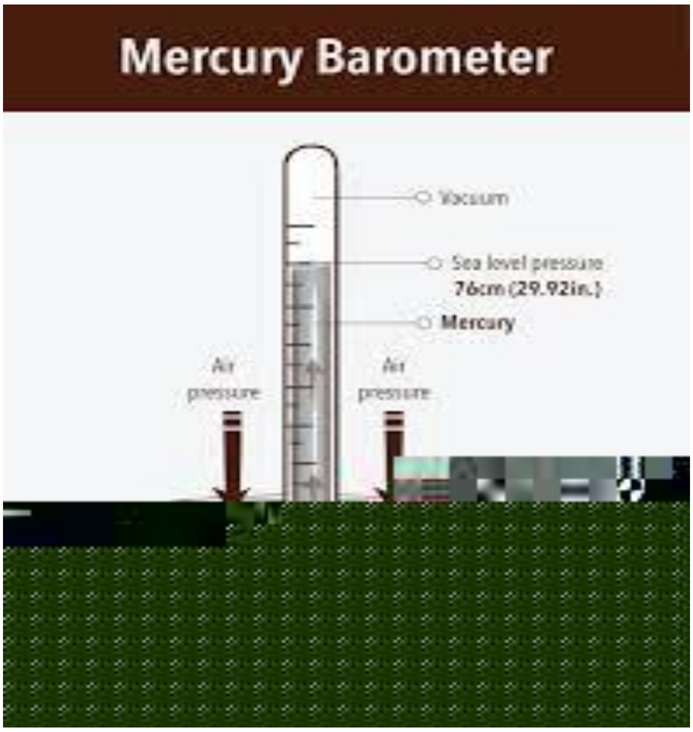
6. In turbulent flow the speed of the fluid at a point is continuously undergoing changes in both magnitude and direction. The flow of wind and rivers is generally turbulent in this sense, even if the currents are gentle. The air or water swirls and eddies while its overall bulk moves along a specific direction. 1+1

7. Given, mass of body, m=40kg;

$g=10ms^{-2}$;

A=2× area of each thigh bone
$=2\times10\ cm^2=20\times10^{-4}m^2$
(weight of the body is supported by two thigh bones)
Force, F= weight of the body =mg=40×10 =400N
Pressure, $P=Force/Area=F/A=400/\ 20\times10^{-4}$
$=2\times10^5Pa$ 2

8. Open-tube manometers have U-shaped tubes and one end is always open. They are used to measure pressure. A mercury barometer is a device that measures atmospheric pressure. The SI unit of pressure is the pascal (Pa), but several other units are commonly used.



9. The molar specific heat capacity of a substance is nothing but the amount of heat you need to provide to raise the temperature of one gram molecule of the substance through one degree centigrade. 1

There are two types of molar specific heats of gases.

1. At constant volume Cv (ii) At constant pressure Cp ½

$C_p - C_v = R$ ½

Section C

2. (a) The weight of Boeing aircraft is balanced by upward force due to the pressure difference.

$\Delta P \times A = 3.3 \times 10^5 \times g$

Where, $g = 9.8 m/s^2$

$\Delta P = 3.3 \times 10^5 \times 9.8 / 500$

$\Delta P = 6.46 \times 10^3 N/m^2$ 1

(b) The pressure difference between the lower and upper surface of the wing is

$\Delta P = (\rho/2)(v_2^2 - v_1^2)$

$v_2 - v_1 = 2\Delta P / \rho (v_2 + v_1)$

$v_{average} = (v_2 + v_1)/2 = 960$ kmph $= 266.67$ m/s

$v_2 - v_1 / v_{average} = \Delta P / \rho \times (v_{average})^2$

$v_2 - v_1 / v_{average} = 0.075$ 2

The speed above the wing needs to be only 8 % higher than that below.

3.

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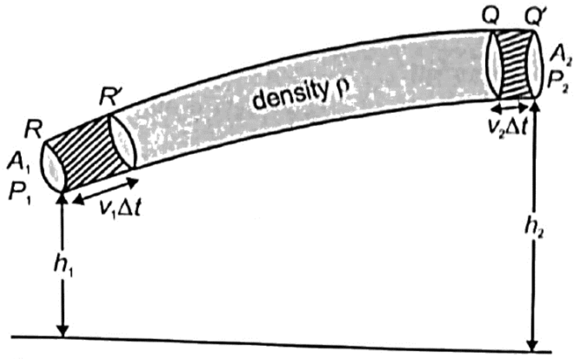
time interval Δt, fluid moves a distance $v_1\Delta t$ from R to R'. In the same time the fluid at the other end moves a distance $v_2\Delta t$ from Q to Q'.



The pressure exerted by the oncoming fluid on this mass m at end R is P_1, and that at Q is P_2.

Thus, the force acting on the fluid inside the pipe at R is $F_1 = P_1A_1$

In time Δt, this force moves the fluid by a distance $v_1\Delta t$.

Hence, the work done by the force on this fluid is

$$W_1 = (F_1)(v_1\Delta t)$$

$$\Rightarrow \quad W_1 = P_1A_1v_1\Delta t$$

During the same interval Δt, the fluid inside the pipe pushes the fluid at Q towards right by a distance $v_2\Delta t$,

Hence, the work done by the fluid inside the pipe

$$W_2 = -P_2A_2v_2\Delta t$$

Negative sign appears because the work is done by the system.

So, the total work done on the fluid is

$$W_1 + W_2 = P_1A_1v_1\Delta t - P_2A_2v_2\Delta t = (P_1 - P_2)\Delta V \qquad \text{...(i)}$$

[By the equation of continuity $A_1v_1\Delta t = A_2v_2\Delta t = \Delta V$]

This work done is related to the change in kinetic energy and the change in potential energy of the fluid by work-energy theorem.

If ρ is the density of the fluid, and $\Delta m = \rho\Delta V$ is the mass passing through the pipe in time Δt, then change in its gravitational potential energy = $\Delta mg(h_2 - h_1)$

$$\Delta U = (\rho\Delta V)g(h_2 - h_1) \qquad \text{...(ii)}$$

Change in kinetic energy = $\frac{1}{2}\Delta m\left(v_2^2 - v_1^2\right)$

$$\Delta K = \frac{1}{2}(\rho\Delta V)\left(v_2^2 - v_1^2\right) \qquad \text{...(iii)}$$

Using equations (i), (ii) and (iii); and applying work-energy theorem,

$$(P_1 - P_2)\Delta V = g(h_2 - h_1)(\rho\Delta V) + \frac{1}{2}(\rho\Delta V)(v_2^2 - v_1^2)$$

$$\Rightarrow \quad P_1 - P_2 = \rho g(h_2 - h_1) + \frac{1}{2}\rho(v_2^2 - v_1^2)$$

$$\Rightarrow \quad \boxed{P_1 + \rho g h_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho v_2^2}$$

In general form $\boxed{P + \rho g h + \frac{1}{2}\rho v^2 = \text{constant}}$

Applications: (i) Dynamic Lift (ii) Torricelli's law 3

4. The surface tension of a liquid is mainly a force that mainly acts to reduce the surface area of a liquid. The directed contracting force which attracts the molecules at the surface of a liquid towards the interior of the liquid is surface tension. The surface tension of liquids depends on the composition of the vapour phase.

The surface tension of liquids have many important roles in daily life and also various industrial processes. There are mainly two types of molecules– interior type and exterior type molecules. Molecules that are on the outside are exterior type molecules and the molecules that are on the inside are interior type molecules. The energy state of the interior molecules is lower than the exterior molecules because the interior molecules are attracted to all the surrounding molecules but the exterior molecules are attracted to only the other surface molecules and to these below the surface. Because of this reason molecules always try to maintain a lower surface area which allows more molecules to have a lower energy state.

In the case of water, the water molecules attract each other because of their opposite charge. Hydrogen is positive and oxygen is negative so they attract each other and stick together. This is the reason there is surface tension and it needs certain energy to break the bonds between the molecules. Water is a liquid which has very high surface tension. Because of this very high surface tension, many things can float on the water whose density is less than water. 1½ $S = Fd/2dl = F/2l$

½ S I unit N/m

½ Dimensional formula $[ML^0T^{-2}]$

½

5. $Q = m \cdot c \cdot \Delta T$ Given:

- Mass of copper block, $m = 2.5kg = 2500g$
- Specific heat of copper, $c = 0.39 J/g°C$
- Initial temperature of copper, $Ti = 500°C$
- Final temperature of copper, $Tf = 0°C$

The change in temperature, $\Delta T = Ti - Tf = 500 - 0 = 500°C$.

Now substituting the values into the formula: $Q = 2500g \cdot 0.39 J/g°C \cdot 500°C$

$= 487500J$

The heat required to melt ice can be calculated using the formula:

$Q = m \cdot L$ Given:

- Latent heat of fusion of ice, $L = 335 J/g$

$m = Q/L = 487500J / 335 J/g$

$m \approx 1455.22g$

$m \approx 1.455kg$

-------------------The End---------------