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Complete PHYSICS

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CLASS 11&12th

CLASS 11th

Fluid Mechanics

01. Pressure

A liquid exerts pressure. To show it, consider a vessel containing a liquid. If it has a small hole near the bottom, the liquid will flow out of it. If the motion of the liquid is stopped by pressing a finger against the hole, the finger will experience an outward force due to the liquid contained in the vessel. Therefore, it can be concluded that the liquid exerts pressure on the walls and base of the containing vessel

Thrust

The total force exerted by a liquid on any surface in contact with it, is called thrust of liquid.

Pressure

The thrust exerted by a liquid (at rest) per unit area of the surface in contact with the liquid is called pressure.

If F is thrust exerted by a liquid on a surface of area A, then pressure is given by

$$p = \frac{F}{A} \qquad ...(i)$$

The unit of pressure is **dyn cm^{-2}** in cgs system and **N m^{-2}** in SI. A pressure of 1 **N m^{-2} is** also called **1 pascal (Pa).**

1 Pa (or **1 N m^{-2}**) = **10 dyn cm^{-2}**

The dimensional formula of pressure is **[M L^{-1}T^{-2}]**.

02. Pascal's Law

It states that *in an enclosed fluid, if an increased pressure is produced in any part of the fluid, then this change of pressure is transmitted undiminished to all the other parts of the fluid.*

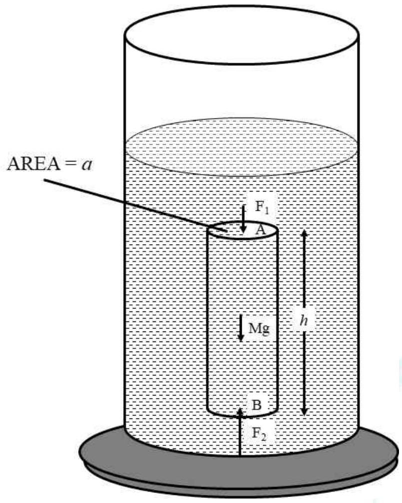
03. Atmosphere and Atmospheric Pressure

The earth is surrounded by a gaseous envelope extending upto a few thousand kilometres. This gaseous envelop is made of 78% nitrogen, 21% oxygen and a small amount of carbon dioxide, water vapour, etc and this gaseous envelope is called ***earth's atmosphere.*** The density of the atmosphere goes on decreasing as one goes up the surface of earth.

*The pressure exerted by the atmosphere is called **atmospheric pressure.***

04. Pressure Exerted by A Liquid (Effect of Gravity)

Consider a liquid of density ρ contained in a vessel as shown in fig. Let us find the pressure difference between two points A and B separated by a vertical distance h.



In order to calculate the pressure difference between points A and B, consider an imaginary cylinder of liquid of cross-sectional area a, such that points A and B lie on its upper and lower circular faces respectively. Obviously, the length of the cylinder will be h and it will contain liquid, whose weight is given by

$$Mg = \text{volume} \times \text{density} \times g$$

or $$Mg = a\ h\ \rho\ g$$

The weight of the liquid of the imaginary cylinder acts vertically downwards.

Let P_1 and P_2 be values of pressure at points A and B respectively.

Now, force on the upper face of the cylinder,

$$F_1 = P_1\ a \qquad \text{(vertically downwards)}$$

Therefore, total force on the upper face of the cylinder

$$= F_1 + Mg \qquad \text{(vertically downwards)}$$

Also, force on the lower face of the cylinder,

$$F_2 = P_2\ a \qquad \text{(vertically upwards)}$$

Since the imaginary cylinder of the liquids is in equilibrium, the net force on it must

$$(F_1 + Mg) - F_2 = 0$$

Substituting for F_1 , F_2 and Mg, we have

or $$(P_1\ a + a\ h\ \rho\ g) - P_2\ a = 0$$

or $$P_2 - P_1 = h\rho\ g \qquad \text{...(i)}$$

05. Archimedes' Principle

It states that *when a body is immersed completely or partly in a liquid, it loses in weight equal to the weight of the liquid displaced by it.*

Let w_1 be weight of a body in air and w_2 be the weight, when completely immersed in a liquid.

Loss in weight of the body inside the liquid = $w_1 - w_2$

when the body is immersed in the liquid, it experiences upthrust. The upthrust is equal to the weight of the liquid displaced by the body. Since the upthrust acts upwards, the weight of the body inside the liquid decreases apparently by an amount equal to the weigh of the displaced liquid. Hence,