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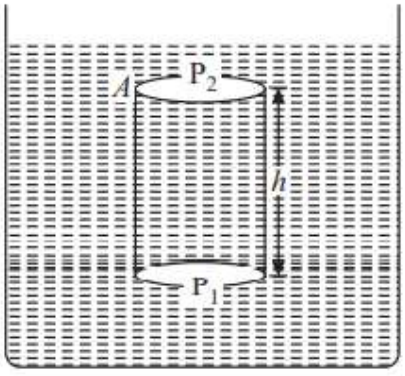
PROPERTIES OF FLUIDS

HYDROSTATIC PRESSURE

- effect of force on unit area is called pressure
- The pressure exerted by a fluid at rest is known as hydrostatic pressure
- The SI Unit of pressure is Nm–2 and is also called Pascal (Pa) in the honour of French scientist Blaise Pascal.

Hydrostatic Pressure at a point in side a liquid



- Pressure does not depend upon shape of the vessel.

Atmospheric Pressure

- The pressure exerted by the atmosphere is known as the atmospheric pressure
- In equi1ibrium, atmospheric pressure equals the pressure exerted by the mercury column.
- Therefore, $P_{atm} = h \rho g = 0.76 \times 13600 \times 9.8$ Nm–2 = 1.01 × 10 5 Nm–2 = 1.01 × 105 Pa

BUOYANCY

- The upward force, which acts on an object when submerged in a fluid, is known as buoyant force

Archimedes principle

- It state that when an object is submerged partially or fully in a fluid, the magnitude of the buoyant force on it is always equal to the weight of the fluid displaced by the object

Floating objects

- One of the forces is due to gravitational force, which pulls it downwards.
- However, the displaced water exerts buoyant force which acts upwards. These forces balance each other in equilibrium state and the object is then said to be floating on water.

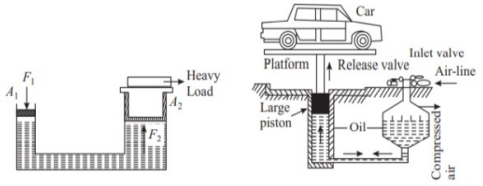
PASCAL'S LAW

- which states that when pressure is applied at any part of an enclosed liquid, it is transmitted undiminished to every point of the liquid as well as to the walls of the container

- This law is also known as the law of transmission of liquid pressure.

Applications of Pascal's Law

- Hydraulic Press/Balance/Jack/Lift



Hydraulic Jack or Car Lifts

Hydraulic Brakes

SURFACE TENSION

- Surface tension is a property of the liquid surface due to which it has the tendency to decrease its surface area.
- The surface tension of a liquid can be defined as the force per unit length in the plane of liquid surface

- The intermolecular forces are of two types: cohesive and adhesive. Cohesive forces characterise attraction between the molecules of the same substance, whereas force of adhesion is the attractive force between the molecules of two different substances.

Surface Energy

Surface tension is equal to the surface energy per unit area.

Applications of Surface Tension

- Mosquitoes sitting on water
- Excess pressure on concave side of a spherical surface
- Spherical drop
- Air Bubble in water
- Soap bubble floating in air
- Detergents and surface tension
- Wax-Duck floating on water

ANGLE OF CONTACT

It is the angle that the tangential plane to the liquid surface makes with the tangential plane to the wall of the container, to the point of contact, as measured from within the liquid, is known as angle of contact.

CAPILLARY ACTION

The phenomenon of rise or depression of liquids in capillary tubes is known as capillary action or capillarity.

Rise of a Liquid in a Capillary Tube

VISCOSITY

Viscosity

- The property of a fluid by virtue of which it opposes the relative motion in its adjacent layers is known as viscosity.
- Dimensions of coefficient of viscosity are [ML–1 T–1

TYPES OF LIQUID FLOW

Streamline Motion

The path followed by fluid particles is called line of flow. If every particle passing through a given point of the path follows the same line of flow as that of preceding particles, the flow is said to be streamlined. A streamline can be represented as the curve or path whose tangent at any point gives the direction of the liquid velocity at that point.

Equation of Continuity

Critical Velocity and Reynolds's Number

When the velocity of flow is less than a certain value, called critical velocity

The flow remains streamlined. But when the velocity of flow exceeds the critical velocity, the flow becomes turbulent

The value of critical velocity of any liquid depends on the z nature of the liquid, i.e. coefficient of viscosity (η) of the liquid; z diameter of the tube (d) through which the liquid flows; and z density of the liquid (ρ).

STOKES' LAW

According to Stokes, the viscous force depends on: z coefficient of viscosity (η) of the medium z radius of the spherical body (r) z velocity of the body (v)

Terminal Velocity

Applications of Stokes' Law

- Parachute
- Velocity of rain drops

BERNOULLI'S PRINCIPLE

Where the velocity of a fluid is high, the pressure is low and where the velocity of the fluid is low, pressure is high.

Energy of a Flowing Fluid

Bernoulli's Equation

The fluid is incompressible, i.e. its density does not change when it passes from a wide bore tube to a narrow bore tube. 2. The fluid is non-viscous or the effect of viscosity is not to be taken into account. 3. The motion of the fluid is streamlined

Applications of Bernoulli's Theorem

- Flow meter or Venturimeter
- Atomizer
- Spray gun
- Bunsen Burner
- Carburettor

1. Does pressure depend on the shape of vessel
   A. Yes
   B. No
   C. May be
   D. None of the above
2. Dimension of Surface Tension is
   A. MT^{-1}
   B. MT^{-2}
   C. $M^{-1}T^{-2}$
   D. MT^{2}
3. Dimension of coefficient of viscocity
   A. MLT^{-2}
   B. MLT^{-2}
   C. $ML^{-1}T^{-1}$
   D. MLT^{-1}
4. What is radius of a drop of rain falling through air with terminal velocity 0.12 $ms^{-1}$and $\eta = 1.8 \times 10^{-5} kgm^{-1}s^{-1}$ $\rho = 1.21\ kgm-3$ and $\sigma = 1.0 \times 10^{3}\ kgm^{-3}$,g =9.8 ms^{-2}
   A. $10^{-5}m$
   B. $10^{-6}m$
   C. $10^{-4}m$
   D. $10^{-3}m$
5. Which of the following works on bernaulli principle
   A. Carbureator
   B. Bunsen Burner
   C. Spray gun
   D. All of the above

Stretch Yourself

1. Explain ,A spinning tennis ball curves during the flight
2. If mercury is poured on a flat glass plate, It break up into small spherical droplet Explain?

3. What is Stokes law? Derive an expression for Stokes law?
4. The average speed of blood artery(d=2 cm) during the resting part of heat cycle is 30 cm s^{-1}.Is the flow laminar or turbulent? Density of blood 1.05 g cm^{-3} and $\eta = 4 \times 10^{-2} poise$

Answer to Check Yoursel

1A) 2 B) 3 C) 4