Question #1.

(a) Define Viscosity? Derive Newton equation of Viscosity.

Viscosity:

Definition:

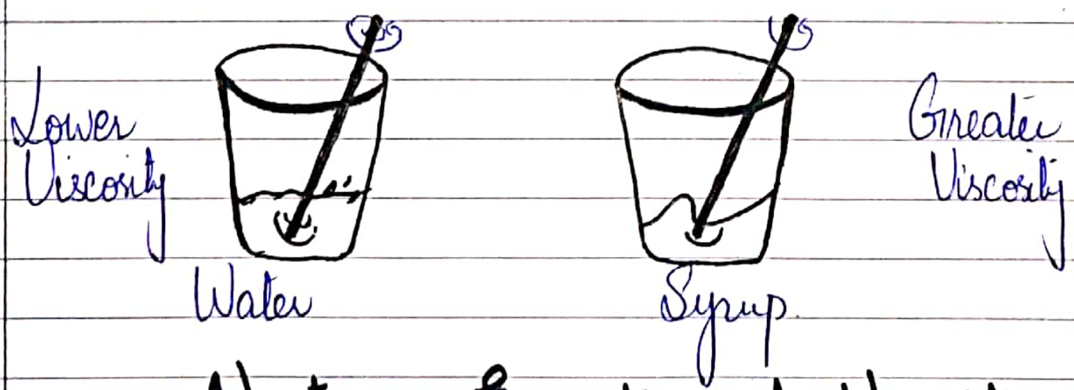
It is the property of a fluid which resists relative motion of its adjacent layers. It is due to cohesion and molecular momentum exchanged between fluid layers.

Unit:

The unit of viscosity is

Example:

Syrup has a greater viscosity than water



Newton's Equation of Viscosity

Statement:

It States that:

"The Shear stress in a flowing fluid is directly proportional to the rate of shear strain."

Mathematical Representation:

$$\tau \propto \frac{du}{dy}$$

$\tau \rightarrow$ Shear stress

Change the sign of proportionality

$$\tau = \mu \frac{du}{dy}$$

Where

μ = Viscosity (dynamic viscosity)

$$\mu = \tau \frac{dy}{du}$$

$\frac{du}{dy}$ = Rate of shear deformation.

Newtonian Fluid:

The fluid which follows "Newton's law of viscosity" is called **Newtonian fluid.**

Question #1:

(b). Define Density, specific weight and specific Volume. Show relation between Density and Specific weight.

Density:

Definition:

Density of a fluid is derived as;

"The ratio of mass of a fluid to the volume of the fluid"

OR

"Mass per unit volume."

Mathematical Form:

$$\rho = m/V = kg/m^3$$

Where

ρ = Rho = density

m = mass

V = Volume.

Specific Weight:

Definition:

Specific weight of a fluid is defined as;

"The ratio of the weight of a fluid to the volume of the fluid."

OR

"Weight of a fluid per unit volume."

Mathematical Form:

$$W = mg/V = \rho g = N/m^3$$

Where

W = Specific weight

mg = weight of the fluid

V = Volume.

Specific Volume:

Specific volume is defined as;

"The ratio of the volume of a fluid to the mass of the fluid."

Or.

"Volume per unit mass of a fluid".

Mathematical Form:

$$\text{Specific Volume} = V/m = 1/\rho$$

Relation between Density & Specific Weight :

As we know that

$$W = w/V$$

and that,

$$w = mg$$

So,

$$W = mg/V \Rightarrow \boxed{W = \rho g}$$

$\because \rho = m/V$
$\Rightarrow \rho =$ density

Question # 1.

(C): If specific volume of gas is $0.72\, m^3/kg$. What is specific weight in N/m^3?

Answer:

Given Data:

Specific volume, $V = 0.72\, m^3/kg$

Required:

Specific Weight $= W = ?$

Solution:

As,

$$V = \frac{1}{\rho}$$

$$\rho = \frac{1}{V}$$

$$\rho = 1/0.72$$

$$\rho = 1.38\, kg/m^3$$

As,

$$W = \rho g$$

$$g = 9.81\, m/s^2$$

$$W = 1.38\, kg/m^3 \times 9.81\, m/s^2$$

$$\boxed{W = 13.54\, N/m^3}$$

Question #2:

(a) Define Pressure? What is absolute and gauge Pressure?

Pressure:

Definition:

Pressure is defined as;

"The force applied perpendicular to the surface of an object per unit area over which that is distributed."

Unit:

The SI unit of Pressure is **Pascal (Pa)**

Gauge Pressure:

Definition:

Gauge Pressure is the pressure relative to atmospheric pressure. Gauge Pressure is Positive for pressures above atmospheric pressure and negative for pressures below it.

Mathematically:

Total Pressure or absolute pressure is thus the sum of gauge pressure and atmospheric pressure.

$$P_{abs} = P_g + P_{atm}$$

Where

P_{abs} = Absolute Pressure

P_g = Gauge Pressure

P_{atm} = Atmospheric Pressure

Absolute Pressure:

Definition:

It is the total pressure at a point in a fluid equaling the sum of gauge pressure and the atmospheric pressure.

Mathematically:

$$P_{abs} = P_g + P_{atm}$$

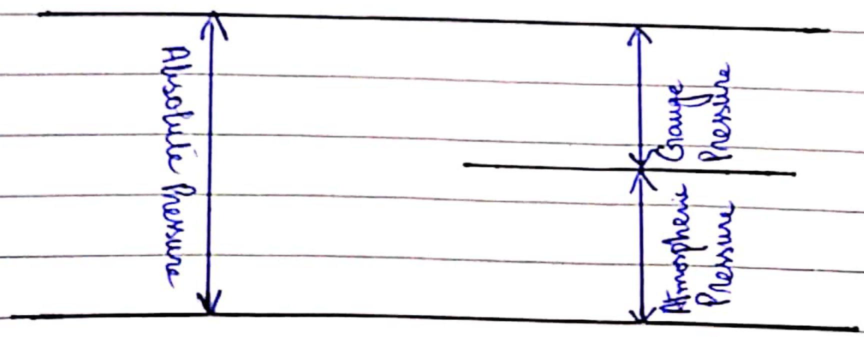
P_{abs} → Absolute Pressure
P_g → Gauge Pressure
P_{atm} → Atmospheric Pressure

Example:

For example,

If your tire gauge reads 39 psi (pounds per square inch) then the absolute pressure is 39 psi + 14.7 psi (P_{atm} in psi) or 53.7 psi (equivalent to 337 kPa)

Diagram



Question # 2.

(b) A water tank having dimensions of 1500mm x 1500mm. Depth of water tank is equal to your student ID number in mm. What is the net pressure on the wall of water tank? Find the location of force application?
If the water tank level drops to the half of the depth, what will be the force and point of application of force?

Given Data:

Length, l = 1500mm = 1.5m
Breadth, b = 1500mm = 1.5m
Depth, h = 7927mm = 7.927m
Per Unit weight of water = $9.81 KN/m^3$

Required Data:

a) = Net Pressure, P = ?
b) = Location of force
c) = If water level drops half of depth find P and location of force

Solution:

a) Net Pressure:

$P = \gamma h$

$P = 9.81 \times 7.927$

$$P = 77.7638 \ KN/m^2$$

b) Force application (centriod)

$$\bar{y} = h/3$$

$$\bar{y} = \frac{7.927}{3}$$

$$\boxed{\bar{y} = 2.642\ m}$$

c). Half Depth:

Pressure at half depth, $P' = \gamma\, h/2$

$$P' = 9.81 \times \frac{7.927}{2}$$

$$P' = 9.81 \times 3.9635$$

$$\boxed{P' = 38.88\ KN/m^2}$$

Centroid:

$$\bar{y}' = \frac{h}{2} \times \frac{1}{3}$$

$$\boxed{\bar{y}' = 1.321\ m}$$