

ID

7904

NAME

Altaf Hussain

SECTION

A

SUBJECT

Fluid Mechanics

TEACHER

Sir Abdul Waheed

# QUESTION No: 1

a) Define Viscosity? Derive Newton equation of viscosity.

^ Answer:-

**VISCOSITY:-**  
**Defn**

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.

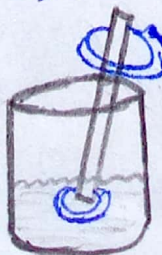
**UNIT:-**

The unit of viscosity is Poise.

**EXAMPLE:-**

Syrup has a greater viscosity than water.

LOWER  
VISCOSITY



WATER



GREATER  
VISCOSITY

SYRUP

# 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  $\mu =$  viscosity (dynamic viscosity)

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

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

## NEWTONIAN FLUID:

The fluid which follows "Newton Law of viscosity" are called "Newtonian fluid".

(3)

# Question No I

Part "B"

Define density 'specific weight' and specific volume. Show relation between specific weight and specific density.

Ans:

## Density :-

Def:

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

## MATHEMATICAL FORM:

$$\rho = \frac{m}{V} = \text{kg/m}^3$$

where  $\rho = \text{Rho} = \text{density}$

$m = \text{mass}$

$V = \text{Volume}$

# SPECIFIC WEIGHT:

## Def:

Specific weight of a fluid is def as "the ratio of the weight of a fluid to the volume of the fluid".

## MATHEMATICAL FORM:

$$W = \frac{mg}{V} = \rho g = \frac{N}{m^3}$$

Where  $W$  = Specific weight

$mg$  = weight of the fluid

$V$  = volume

## SPECIFIC VOLUME:

Specific volume is def as "The ratio of the volume of a fluid to the mass of the fluid".

(5)

**MATHEMATICAL FORM:**

$$\text{Specific volume} = \frac{V}{m} = \frac{1}{\rho}$$

**RELATION BETWEEN DENSITY AND SPECIFIC WEIGHT:**

As we know that

$$w = \frac{W}{V}$$

and that

$$w = mg$$

$$\text{So, } w = \frac{mg}{V} = \boxed{w = \rho g} \quad \rightarrow \rho = \frac{m}{V} \Rightarrow \rho = \text{density}$$

c) If specific volume of gas is  $0.72 \text{ m}^3/\text{kg}$ . What is specific weight in  $\text{N}/\text{m}^3$ ?

### Given data

Specific volume,  $v = 0.72 \text{ m}^3/\text{kg}$

Required Data

Specific weight  $w = ?$

### SOLUTION

$$\text{As, } v = \frac{1}{\rho}$$

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

$$\rho = \frac{1}{0.72}$$

$$\rho = 1.38 \text{ kg}/\text{m}^3$$

$$\text{As, } w = \rho g$$

$$g = 9.81 \text{ m}/\text{s}^2$$

$$w = 1.38 \text{ kg}/\text{m}^3 \times 9.81 \text{ m}/\text{s}^2$$

$w = 13.54 \text{ N}/\text{m}^3$

Question No. #2

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

Answers

**PRESSURE**

Def:

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

UNIT:-

The SI unit of pressure is Pascal (Pa)

**GAUGE PRESSURE:-**

Def:-

Gauge pressure is the pressure relative to atmospheric pressure. Gauge pressure is possible for pressures above atmospheric



and negative for pressure 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 :-**

Def:-

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

# MATHEMATICALLY

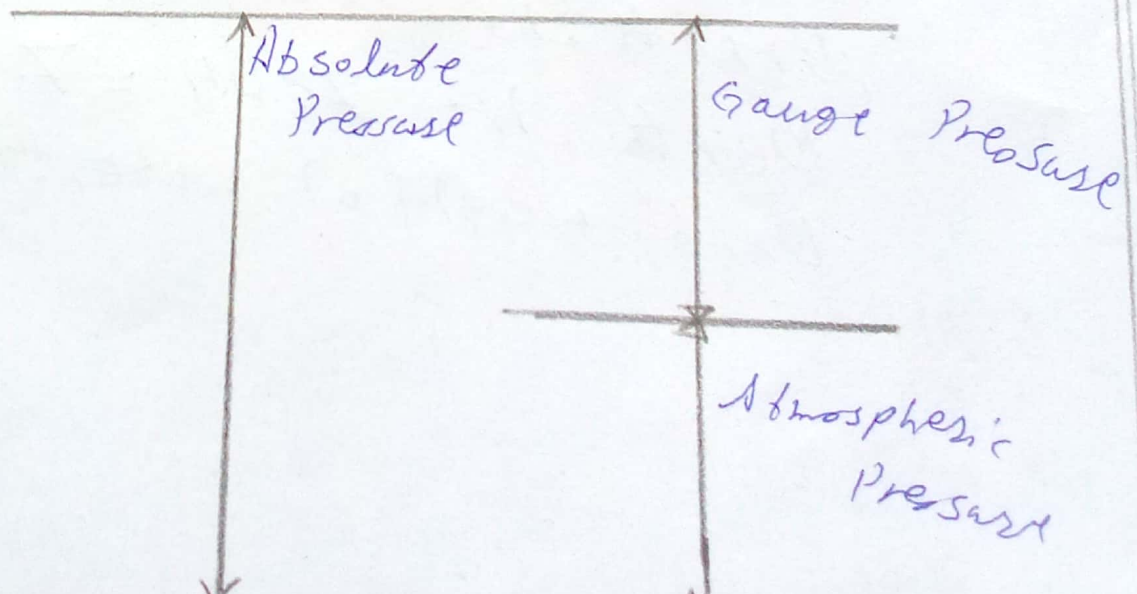
$$P_{abs} = P_g + P_{atm}$$

↓                      ↓                      → atmospheric Pressure  
Absolute Pressure      Gauge Pressure

## EXAMPLE

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

## DIAGRAM



b) A water tank having dimensions of  $1500\text{mm} \times 1500\text{mm}$ . 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:**

$$\text{Length, } l = 1500\text{mm} = 1.5\text{m}$$

$$\text{Breadth, } b = 1500\text{mm} = 1.5\text{m}$$

$$\text{Depth, } h = 7904 = 7.904$$

$$\text{Unit weight of water} = 9.81\text{kN/m}^3$$

## REQUIRED DATA:

- a) net Pressure,  $P = ?$
- b) Location of Force = ?
- c) If water level drops half of depth find Point Location of force.

## SOLUTION:

a) Net Pressure

$$P = \rho h$$

$$P = 9.81 \times 7.904$$

$$P = 77.53 \text{ kN/m}^2$$

b) FORCE APPLICATION (Centroid)

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

$$\bar{y} = \frac{7.904}{3}$$

$$\bar{y} = 2.63 \text{ m}$$

c) HALF DEPTH

Pressure at half depth,  $P' = \rho \frac{h}{2}$

$$P' = 9.81 \times \frac{7.904}{2}$$

$$P' = 38.769 \text{ kN/m}^2$$

CENTROID,

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

$$\bar{y} = 1.317 \text{ m}$$