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Section:

A

Subject:

Fluid Mechanics

Dept:

Civil Engineering

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Q1(a) Define viscosity? Derive newton equation of viscosity.

Answer

Viscosity:

The viscosity of a fluid is a measure of it's resistance to deformation at a given rate. For liquids, it corresponds to the informal concept of "thickness". For example syrup has a higher viscosity than water.

Newton equation of Viscosity:

It states that
"The shear stress in a flowing fluid is directly propotional to the rate of shear strain".

Mathematical expression:

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

τ = Shear Stress

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

Change the sign of propotionality

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

μ = viscosity (Dynamic viscosity)

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

The fluids which follows "Newton's law of viscosity are called "Newtonion fluids".

Q1 (b) Define density, specific weight, and specific volume. Show relation between density and specific weight.

Answer

1. Density:

Density is defined as mass per unit volume of fluid.

Mathematically:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

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

Specific weight:

"Specific weight is the weight possessed by the unit Volume of a fluid". It is denoted by "w"

$$w = \frac{\text{Weight}}{\text{Volume}} = \frac{N}{m^3}$$

Relation between density and Specific weight:

As we know that

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

Here

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

$$w = \rho g \quad \because \frac{m}{V} = \rho$$

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Specific Volume:

Specific Volume is the volume of fluid occupied per unit mass.

It is the reciprocal of density.

$$\text{Specific Volume} = v = \frac{V}{m} = \frac{m^3}{kg}$$

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

Q 1 (c) If specific volume of a gas is $0.72\, m^3/kg$. What is the specific weight in N/m^3

Answer

Given:

Specific volume of gas $= v = 0.72 \frac{m^3}{kg}$

Required:

Specific weight in $N/m^3 = ?$

Solution:

As we know that

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

So density "ρ" $= \frac{1}{V}$

$= \frac{1}{0.72} \Rightarrow 1.389 \, kg/m^3$

Specific weight "w" $= \rho \times g$

$= 1.389 \times 9.8$

$= 13.62 \, N/m^3$

Q2 (a):

Define pressure? What is an absolute and gauge pressure?

Answer

Pressure: Pressure is defined as Force per unit area.

Mathematically:

$$\text{Pressure} = \frac{F}{A}$$

Unit:

The S.I unit of pressure is Pascal.

Gauge Pressure:

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 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:

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

Mathematical form:

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

Q2(b) A water tank having dimensions of 1500mm x 1500mm. Depth of the water tank is equal to your Student ID number in mm. What is the net pressure force on wall of water tank? Find the location of force application? If the water level drops to the half of the depth, what will be the force and point of application of force?

F Solution:-

Length = 1500mm = 1.5m

Breadth = 1500mm = 1.5m

Depth = h = 7911mm = 7.911m

unit weight of water = 9.81 KN/m³

Required:

Net Pressure = ?

Location of force

If water level drop half of depth what will be "P" and location of "F"

i- Pressure:

$P = \gamma h$

$P = 9.81 \times 7.911$

$P = 77.606\ KN/m^3$

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(2) Force Application: (centroid)

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

$$\bar{y} = \frac{7.911}{3}$$

$$\bar{y} = 2.637m$$

(3) Half depth: (Pressure)

$$P = \gamma \times \frac{h}{2}$$

$$P = 9.81 \times \frac{7.911}{2}$$

$$\boxed{P = 38.80 kN/m^3}$$

Centroid:

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

$$\bar{y} = \frac{7.911}{2} \times \frac{1}{3}$$

$$\bar{y} = 1.318m$$