DEPTT : "CIVIL ENGINEERING"

EXAM :

MID TERM

NAME :

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ID :

"7956"

SECTION :

"B"

SEMESTER :

4th

No. OF PAGES :

14

SUBJECT :

FLUID MECHANICS

SUBMITTED TO :

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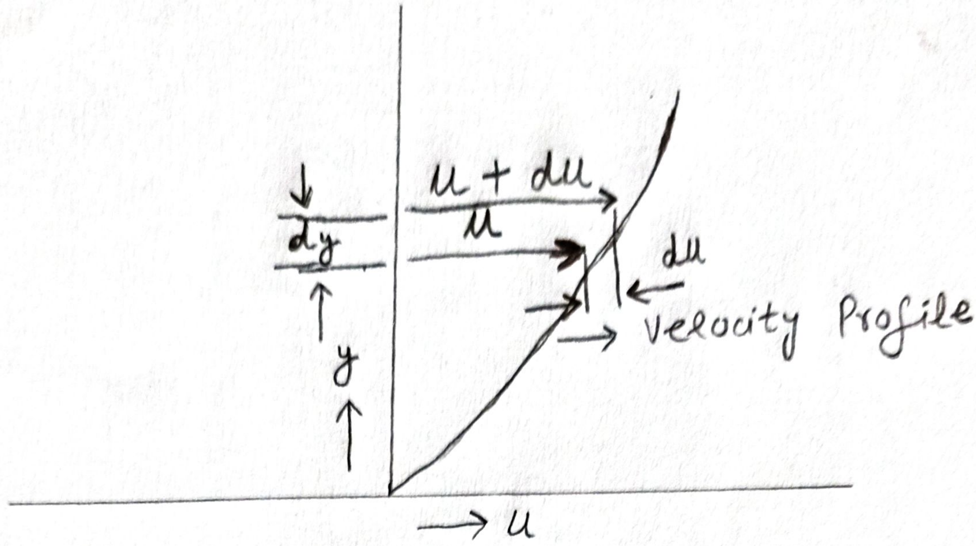
Q:1 a) Define Viscosity? Derive Newton equation of Viscosity.

Answer: Viscosity denotes opposition to flow. Thus, resistance of a fluid (liquid or gas) to a change in shape is known as viscosity. The reciprocal of the viscosity is called the fluidity. Thus, Viscosity can be conceptualized as quantifying the internal frictional force that arises between adjacent layers of fluid that are in relative motion.

The friction forces are from cohesion and momentum it interchanges between molecules in the fluid. With the temperature increase, the viscosity of decreases. This is because cohesion forces decrease. In gases, viscosity increases with increase in temperature because of molecular interchange between layers.

Newton equation of Viscosity:

When two layers of a fluid, a distance 'dy' apart, move one over the other at different velocities, denoted as $u + du$, the viscosity together with relative velocity causes a shear stress acting between the fluid layers.



Velocity Variation near a solid boundary

The top layer causes a shear stress on the adjacent lower layer while the lower layer causes a shear stress on the adjacent top layer. This shear stress is proportional to the rate of change of velocity with respect to y. It is denoted by symbol τ called Tau.

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

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

In this equation μ (called mu) is the constant of proportionality and is known as the co-efficient of dynamic viscosity or viscosity. $\frac{du}{dy}$ represents the rate of shear strain or rate of shear deformation or velocity gradient.

From the equation, we have $\mu = \dfrac{\tau}{\left(\dfrac{du}{dy}\right)}$

Thus viscosity is also defined as

"the shear stress required to produce unit rate of shear strain."

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

Answer: . **Density:** A material's density is defined as its mass per unit volume. Or, density is the ratio between mass and volume or mass per unit volume. It is a measure of how much "stuff" an object has in a unit volume (cubic meter or cubic centimeter). Density is essentially a measurement of how tightly matter is crammed together.

Density Formula: Density is usually represented by Greek letter "ρ" or simply "D". To determine the density of an object, measure its mass (m) and divide it by its volume (v) :

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

The SI unit of density is kilogram per cubic meter (kg/m^3). It is also frequently represented in the cgs unit of grams per cubic centimeter (g/cm^3)

Specific weight : Specific weight of a fluid is the ratio between the weight of a fluid to its volume. Thus weight per unit volume of a fluid is called specific weight and it is denoted by the symbol w.

Thus mathematically,

$$w = \frac{\text{Weight of fluid}}{\text{Volume of fluid}}$$

$$= \frac{(\text{Mass of fluid}) \times \text{Acceleration due to gravity}}{\text{Volume of fluid}}$$

$$= \frac{\text{Mass of fluid} \times g}{\text{Volume of fluid}}$$

$$= \rho \times g \qquad \left(\text{as } \frac{\text{mass of fluid}}{\text{Volume of fluid}} = \rho\right.$$

$$\boxed{w = \rho g}$$

The value of specific weight or weight density (w) for water is 9.81×1000 Newton/m^3 in SI units.

Specific Volume: Specific volume of a fluid is defined as the volume of a fluid occupied by a unit mass or volume per unit mass of a fluid is called specific volume.

Mathematically, it is expressed as

$$\text{Specific Volume} = \frac{\text{Volume of fluid}}{\text{Mass of fluid}}$$

$$= \frac{1}{\text{mass of fluid}}$$

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

The specific volume is the reciprocal of mass density. It is expressed as m^3/kg. It is commonly applied to gases.

Relation b/w density and specific weight

As $w = mg$ where $\gamma = \frac{w}{V}$

Thus $\gamma = \frac{mg}{V}$, As we have

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

So

$$\gamma = \rho \times g$$ or

$$\rho = \frac{\gamma}{g}$$

Q1:(c) If specific volume of a gas is 0.72 m^3/kg. what is specific weight in N/m^3 ?

Answer:

Given Data: Specific Volume of gas = v

$v = 0.72\ kg/m^3$

Required: Specific weight in N/m^3 = ?

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

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

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

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

Now

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

$= 1.38 \times 9.81$

$\boxed{= 13.537\ N/m^3}$

$\boxed{w = 13.537\ N/m}$ Answer

Q2: a) Define Pressure? What is an absolute and guage pressure?

Answer: Pressure is defined as the force divided by the area perpendicular to the force over which the force is applied. Thus, a given force can have a significantly different effect depending on the area over which the force is exerted.

The basic formula for pressure is:

$$P = F/A$$

Unit of Pressure $= 1\ N/m^2,\ 1\ kg/m \cdot s^2$

Dimension $= M L^{-1} T^{-2}$

SI Unit $=$ Pascal

1 Pascal $= 1\ N/m^2$

To find the pressure at a specific depth in a liquid without speaking of any object being submerged (general formula for objects being submerged in liquid for any depth):

$P = \rho g h$

ρ = density of the fluid causing the pressure

h = depth in the fluid

g = magnitude of the accelaration of the gravity = $9.8\ m/sec^2$

Gases too exert pressure on the wall of the container containing them. A gas consists of molecules and every molecule has some kinetic energy. These molecules when colliding with the walls of a container apply pressure on it.

Gauge Pressure: It is denoted as P_{guage}.
Gauge pressure is the pressure measured relative to atmospheric pressure. Gauge pressure is positive for pressures above atmospheric pressure, zero at atmospheric pressure, and negative for pressures below atmospheric pressure.

For the case of finding the pressure at a depth 'h' in a non-moving liquid exposed to the air near the surface of the

Earth, the gauge pressure is:

$$P_{guage} = \rho g h$$

Absolute Pressure: The total pressure is commonly referred to as the absolute pressure $P_{absolute}$. Absolute pressure is the sum of guage pressure and atmospheric pressure.

Absolute pressure measures the pressure relative to a compelete vacuum. So absolute pressure is positive for all pressures above a compelete vacuum, zero for a compelete vacuum, and never negative.

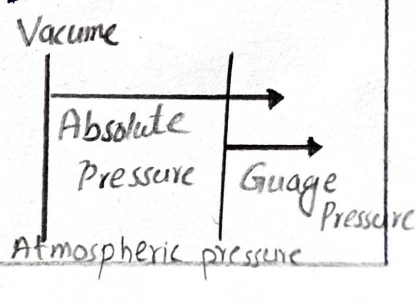
$$P_{absolute} = P_{gauge} + P_{atm}$$

$$P_{gauge} = \rho g h$$

So

$$P_{absolute} = \rho g h + P_{atm}$$

$$P_{absolute} = \rho g h + 1.01 \times 10^{5}\ Pa$$



Q:2(b) **Given Data :**

Length = l = 1500mm = 1.5 m

Breadth = b = 1500 mm = 1.5 m

Depth = h = 7956mm = 7.956 m

Gravity = g = 9.81 m/sec^2

Density of water, D = 1000 kg/m^3

Required data:

i) Net Pressure, P = ?

ii) Location of force

iii) H water level drop half of depth find P and location of force.

Solution:

Net Pressure:

As $P = Dgh$

$$P = 1000 \frac{kg}{m^3} \times 9.81 \, m/sec^2 \times 7.956$$

$$P = 78048.36$$

$$\boxed{P = 78.048 \text{ KPa}}$$

$$\boxed{P = 78.048 \text{ KPa}}$$
Answer

Pressure per unit width :

$$P_1 = \frac{P}{\text{width}}$$

$$P_1 = \frac{78.048}{1.5}$$

$$\boxed{P_1 = 52.032 \text{ KN/m}}$$

<u>Location of force</u> :-

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

$$y' = \frac{7.956}{3}$$

$$\boxed{\bar{y} = 2.652 \text{ m}}$$

Resultant force :

Always act at $1/3\,h$ from base

resultant force $= \frac{1}{2}\, b\, h$

$= \frac{1}{2}\,(52.032)\,(7.956)$

$$\boxed{F = 206.98\ KN}$$

Water level half of depth :

$$\boxed{h = \frac{7.956}{2} = 3.978\,m}$$

Net Pressure :

$P = D\,g\,h$

$P = 1000\ Kg/m^3 \times 9.81 \times 3.978$

$P = 39024.18$

$\Rightarrow \boxed{39.024\ KPa}$

Pressure per unit width :

$$P_2 = \frac{P}{\text{width}}$$

$$P_2 = \frac{39.024}{1.5}$$

$$\Rightarrow \boxed{P_2 = 26.016 \text{ KN/m}}$$

Resultant Force :

$$F = \frac{1}{2} bh$$

$$F = \frac{1}{2}(39.024)(3.978)$$

$$\boxed{F = 77.61 \text{ KN}}$$

Location of force :

$$\bar{y} = h/2$$

$$y' = \frac{3.978}{2}$$

$$\boxed{\bar{y} = 1.989 \text{ m}}$$