



### Unit system and dimensional homogeneity

**Question 1:**

The Specific weight of water is  $1000 \text{ kg/m}^3$ . Using this given value, find the specific mass of water in SI units ( $g=9.81 \text{ m/s}^2$ ).

**Question 2:**

Write the dimensions of the physical quantities and units in SI system of the parameters given below.

Dimension	Unit	SI
Force		
Tensor		
Velocity		
Acceleration		
Moment		
Specific mass		
Specific Weight		
Kinematic viscosity		
Dynamic viscosity		
Work		
Power		

**Question 3:**

Let's have an oil with a volume  $V=200 \text{ lt}$  and weighs  $G=1785 \text{ N}$ . Determine the mass, specific weight and specific mass of the oil.

**Question 4:**

Find the specific masses and kinematic viscosities of the fluids with specific weights and dynamic viscosities given below.

$$\gamma_{Ether} = 7063 \text{ N / m}^3$$

$$\gamma_{Mercury} = 132886 \text{ N / m}^3$$

$$\gamma_{Glycerin} = 12360 \text{ N / m}^3$$

$$\mu_{Ether} = 228.6 \text{ N s / m}^2$$

$$\mu_{Mercury} = 1560 \text{ N s / m}^2$$

$$\mu_{Glycerin} = 799515 \text{ N s / m}^2$$

**Question 5:**

Since the standard acceleration of gravity is known as  $g=9.81 \text{ m/s}^2$ , find the following parameters of an object weighing  $9810 \text{ N}$ .

- a) Mass
- b) Weight of the object on the moon ( $g_{moon}=1.62 \text{ m/s}^2$ )
- c) The acceleration when a horizontal force of  $3924 \text{ N}$  is applied both on the earth and the moon.



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### Question 6:

The volume of glycerin with 1200 kg mass is  $0.952 \text{ m}^3$ . Find the weight, specific mass and specific weight of the glycerin.

### Question 7:

The equation of drag force acting on a very slowly moving spherical particle in a fluid is given as  $F=3.\pi.\mu.D.V$ . In the equation,  $\mu$  is the dynamic viscosity with a dimension  $[F T L^{-2}]$ , and D and V are the diameter and the velocity of the particle respectively.

- What is the dimension of the  $(3\pi)$  constant multiplier?
- Is this equation dimensionally homogeneous?

### Question 8:

Based on experiments done by Henry DARCY (1803-1858), the following equation was proposed for

determining head loss of friction.  $h_k = f \frac{L}{D} \frac{v^2}{2g}$ , where

- $h_k$ : Energy loss  
L: Pipe length  
D: Pipe diameter  
f: Darcy-Weisbach friction coefficient  
V: Cross-sectional average velocity of the fluid  
g: Acceleration of gravity

Show that DARCY Equation is fulfilled in terms of dimensional homogeneity.

### Question 9:

The equation of the discharge of flow over a spillway is given in British unit system as follows:

$$Q = 3.09 B H^{3/2}$$

,where H is the height of water above the spillway crest  $[L]=\text{ft}$ , B is width of the spillway  $[L]=\text{ft}$ , Q is discharge over the spillway  $[L^3/s]=\text{ft}^3/\text{s}$

- Is the quantity 3.09 dimensionally homogeneous?
- Can we use this equation with other unit systems? (Note:  $1 \text{ ft}=0.3048 \text{ m}$ ).