Unit Systems & Dimensional Homogeneity

Exercise 1: The specific weight of water, in the MK_fS unit system, is given as γ=1000 kg_f/m^3.

- Find out the specific mass value of the water in the MK_fS unit system.
- Determine the specific weight and the specific mass of water in the SI unit system.

Exercise 2: Determine the dimensions and units of the quantities given below, both in the MK_fS and SI unit systems. Force, moment, tension, power, work, velocity, acceleration, specific weight, specific mass, dynamic viscosity, kinematic viscosity.

Exercise 3: The weight of oil, occupying a volume of 200 liters, is determined as 182 kg_f. Compute the mass, specific weight and the specific mass of the oil.

Exercise 4: Compute the specific mass and kinematic viscosity of the fluids with the given characteristics.

γ_{ether} =720 kg_f/m^3 μ_{ether} =23.3 $kg_f\ s/m^2$

$\gamma_{mercury}$ =13546 kg_f/m^3 $\mu_{mercury}$=159 $kg_f\ s/m^2$

$\gamma_{glycerine}$=1260 kg_f/m^3 $\mu_{glycerine}$=81500 $kg_f\ s/m^2$

Exercise 5: The weight of a body is given as 1000 kg_f.

- Determine the mass of this body.
- Determine the weight of this body on the moon, if the standard gravitational acceleration of the moon is g_{moon}=1.62 m/s^2.
- Compute for both cases, i.e. on the earth and on the moon, the acceleration that the body encounters when a horizontal force of 400 kg_f acts on the body.

Exercise 6: The volume of glycerin with a mass of 1200 kg is measured as 0.952 m^3. Determine the weight, specific mass and the specific weight of the glycerin. Convert these values (which you have computed in the SI unit system) to the MK_fS unit system.

Exercise 7: A spherical particle, moving very slowly in a flow field, is subjected to a force given by the equation

$$F = 3\pi\mu DV$$

where μ is the dynamic viscosity of the fluid, D is the diameter and V is the velocity of the particle.

- Determine the dimension of the constant multiplier 3π.
- Determine if this equation is a dimensionally homogenous equation or not.

Exercise 8: Henry Darcy (1803–1858) found that the head (energy) loss in a pipe flow may be given by the equation

$$h = f\frac{L}{D}\frac{V^2}{2g}$$

where h_k is the head loss, L is pipe length, D is the diameter of the pipe, f is the Darcy-Weisbach friction coefficient, V is the cross-sectional average velocity, and g is the gravitational acceleration. Determine if Darcy's equation is a dimensionally homogenous equation or not.

Exercise 9: In the British Unit System, the flow rate (discharge) through a spillway is given by the equation

$$Q = 3.09BH^{3/2}.$$

where H [L]=ft is the water height over the spillway, B [L]=ft is the width of the spillway, and Q $[L^3T^{-1}]=ft^3/s$ is the flow rate.

- Does the coefficient 3.09 have a dimension?
- Can we use this equation in a unit system other than the British Unit System?

  1ft=0.3048 m; 1 inch=0.0254 m