Answer on Question #80665, Physics / Other

A body mass 2kg and volume $5x10^{-4}m^3$ is hung from a balance graduated in Newton's. What would the balance read when the body is in air, fully immersed in water, fully immersed in paraffin?

Solution:

Given:

$m = 2\ \text{kg}$,

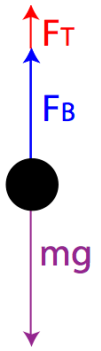
$V = 5 \times 10^{-4}\ \text{m}^3$,

$\rho_{water} = 1000\ \text{kg/m}^3$,

$\rho_{paraffin} = 800\ \text{kg/m}^3$,

$F_T = ?$

First, draw a free body diagram (FBD) of the situation, realizing that you have the force of gravity (mg) pulling down, the buoyant force upward, and the force of tension in the balance upward.



You can write balance equation using Newton's 2nd Law in the y-direction as:

$$F_{net} = F_T + F_B - mg = 0$$

Finally, you can use this equation to solve for the force of tension in the balance.

$$F_T = mg - F_B$$

(i) In air

$$F_B = 0$$

So,

$$F_T = mg = Weight = (2\ kg)(9.8\ m/s^2) = 19.6\ N$$

(ii) in water

The buoyancy force is

$$F_B = \rho_{fluid} V g$$

where ρ_{fluid} is density of fluid.

So, for water

$$F_T = mg - \rho_{water} V g = (m - \rho_{water} V) g$$

$$F_T = (2 - 1000 \times 5 \times 10^{-4}) \times 9.8 = 14.7\ N$$

(ii) in paraffin

$$F_T = \left(m - \rho_{paraffin} V\right) g$$

$$F_T = (2 - 800 \times 5 \times 10^{-4}) \times 9.8 = 15.68\ N$$

Answer: (i) in air $19.6\ N$; (ii) in water $14.7\ N$; (iii) in paraffin $15.68\ N$.