Answer on Question #72418, Physics / Other

A tank contains water on top of mercury. A cube of Fe, 60 mm along each edge, is a sitting upright in equilibrium in the liquids. Find how much of it is in each liquid.

The rho Fe= 7.7×10^3 kg/m^3 & rho Hg= 13.6×10^3 kg/m^3.

Solution:

Suppose x_1 is depth in water and x_2 in mercury

$$x_1 + x_2 = h = 60\ mm$$

The equilibrium equation is

Weight = total buoyant force for each medium,

$$W = B = B_w + B_{Hg}$$

where weight is

$$W = mg = \rho_{Fe} V g = \rho_{Fe} A h g,$$

where area A is h^2.

The buoyant forces are:

in water

$$B_w = \rho_w (A x_1) g$$

in mercury

$$B_{Hg} = \rho_{Hg} (A x_2) g$$

Substituting

$$\rho_{Fe} A h g = \rho_w (A x_1) g + \rho_{Hg} (A x_2) g$$

after cancelling terms, we will get

$$\rho_{Fe} h = \rho_w x_1 + \rho_{Hg} x_2$$

solve for x_1 and x_2 using first equation

$$\rho_{Fe} h = \rho_w (h - x_2) + \rho_{Hg} x_2$$

So, depth in mercury is

$$x_2 = \frac{\rho_{Fe} h - \rho_w h}{\rho_{Hg} - \rho_w} = \frac{\rho_{Fe} - \rho_w}{\rho_{Hg} - \rho_w} h = \frac{7700 - 1000}{13600 - 1000} \times 60\ mm = 31.9\ mm$$

Thus, depth in water

$$x_1 = 60 - 31.9 = 28.1\ mm$$

Answer: in water $x_1 = 28.1\ mm$; in mercury $x_2 = 31.9\ mm$.