Answer on Question #58254, Physics / Molecular Physics | Thermodynamics

A .48kg piece of wood floats on water but is found to sink in alcohol (sg=.79). What is the sg of the wood?

Solution:

Well, obviously it is between .79 and 1.

You need to know it's apparent weight or mass in alcohol M_a.

The apparent weight of the wood in alcohol is

$$W_a = M_a g = Mg - F_b$$

Solving for the buoyant force

$$F_b = Mg - M_a g = (M - M_a)g$$

According to Archimedes principle

$$F_b = \rho_a V_{df} g$$

Combining (3) and (2), we get

$$\rho_a V_{df} g = (M - M_a)g$$
$$\rho_a V_{df} = (M - M_a)$$
$$V_{df} = (M - M_a)/\rho_a$$

By definition specific gravity is the density of the substance divided by the density of water so that can write

$$sg_a = \frac{\rho_a}{\rho_w}$$
$$or$$
$$\rho_a = Sg_a * \rho_w$$

Substituting, we get

$$V_{df} = \frac{M - M_a}{[\, sg_a \rho_w \,]}$$

Now, since the block of wood sinks in alcohol, it must be totally immersed in the liquid, so that the volume of displaced fluid V_{df} must be equal to the volume of the block of wood V_{bw} ($V_{bw} = V_{df}$).

It follows that

$$M = \rho_{bw} * V_w = \rho_{bw} * V_{df} = \rho_{bw} * \frac{M - M_a}{[\, sg_a * \rho_w \,]}$$

$$M = sg_w * \frac{M - M_a}{sg_a}$$

since by definition of specific gravity $SG_w = \frac{\rho_{bw}}{\rho_w}$.

Finally, from (7)

$$\boldsymbol{sg_w = \frac{M \cdot sg_a}{M - M_a}}$$