Answer on Question 51619, Physics, Other

Question:

1) A block of wood floats in water with one-third of its volume submerged. Determine the density of the wood if the density of water is $1000\, kg/m^3$.

2) The volume of a metal sphere increases by $9.0 \cdot 10^{-5} m^3$ when its temperature is raised by 80°C. If the original volume is $2 \cdot 10^{-2} m^3$, find the coefficient of linear expansion of the sphere.

Solution:

1) According to the Archimedes' Principle the buoyant force that act on an object submerged in water is equal to the weight of water displaced by the object. Thus, we can write:

$$m_{wood} g = m_{water} g,$$

$$\rho_{wood} V_{wood} g = \rho_{water} V_{water\ displaced} g,$$

$$\frac{\rho_{wood}}{\rho_{water}} = \frac{V_{water\ displaced}}{V_{wood}}.$$

Since the block of wood floats in water with one-third of its volume submerged, we can write:

$$V_{water\ displaced} = \frac{1}{3} V_{wood}.$$

So, we can obtain the density of the wood:

$$\rho_{wood} = \rho_{water} \cdot \left(\frac{\frac{1}{3} V_{wood}}{V_{wood}} \right) = \frac{1}{3} \rho_{water} = \frac{1}{3} \cdot 1000 \frac{kg}{m^3} = 3.33 \cdot 10^2 \frac{kg}{m^3}$$

Answer:

$$\rho_{wood} = 3.33 \cdot 10^2 \frac{kg}{m^3}$$

2) Because the volumes expands three times as much as length do, we can use for the case of the thermal expansion of a metal sphere the next formula:

$$\Delta V = 3\alpha V_0 \Delta T,$$

where, ΔV is the change in volume of the metal sphere due to the thermal expansion, V_0 is the original volume of the sphere, ΔT is the change in temperature, 3α is the coefficient of the volume expansion of the metal sphere, we must divide it by 3 in order to obtain the coefficient of linear expansion of the sphere.

Thus, we can obtain the coefficient of linear expansion of the sphere:

$$\alpha = \frac{1}{3} \cdot \frac{\Delta V}{V_0 \Delta T} = \frac{1}{3} \cdot \frac{(2 \cdot 10^{-2} m^3 - 9.0 \cdot 10^{-5} m^3)}{80°\mathrm{C} \cdot 2 \cdot 10^{-2} m^3} = 4.1 \cdot 10^{-3} \frac{1}{°\mathrm{C}}$$

Answer:

$\alpha = 4.1 \cdot 10^{-3} \frac{1}{°\mathrm{C}}$.