

Question#18921

A lead block is suspended from the underside of a 0.4 kg block of wood of density of 720 kg per meter cube. If the upper surface of the wood is just level with water. What is the mass of the lead block. Density of lead is 11340 kg per meter cube.

Solution:

According to the Archimedes' principle the buoyant force is equal to the sum of weights lead block and block of wood:

$$F_{buoyant} = m_{wood}g + m_{lead}g = g(m_{wood} + m_{lead})$$

$$F_{buoyant} = g\rho_{water}(V_{wood} + V_{lead})$$

$$m_{wood} + m_{lead} = \rho_{water}V_{wood} + \rho_{water}V_{lead}$$

$$V_{lead} = \frac{m_{lead}}{\rho_{lead}}$$

$$V_{wood} = \frac{m_{wood}}{\rho_{wood}}$$

$$m_{wood} + m_{lead} = \rho_{water} \frac{m_{wood}}{\rho_{wood}} + \rho_{water} \frac{m_{lead}}{\rho_{lead}}$$

$$m_{lead} \left(1 - \frac{\rho_{water}}{\rho_{lead}}\right) = \rho_{water} \frac{m_{wood}}{\rho_{wood}} - m_{wood} = m_{wood} \left(\frac{\rho_{water}}{\rho_{wood}} - 1\right)$$

$$m_{lead} = \frac{m_{wood} \left(\frac{\rho_{water}}{\rho_{wood}} - 1\right)}{1 - \frac{\rho_{water}}{\rho_{lead}}}$$

$$m_{lead} = \frac{0.4 \left(\frac{1000}{720} - 1\right)}{1 - \frac{1000}{11340}} = 0.1706 \text{ kg}$$

**Answer: 0.1706 kg**