Problem 1.60

Biological tissues are typically made up of 98% water. Given that the density of water is 1.0×10^3 kg/m^3, estimate the mass of (a) the heart of an adult human; (b) a cell with a diameter of 0.5 μm; (c) a honey bee.

Solution

In order to obtain the mass of each object (mostly made of water), multiply the density of water by the rough volume of each.

Part (a)

The human heart is roughly the size of a fist. Assume its volume is $(2 \text{ in})^3 = 8 \text{ in}^3$.

$$m = \rho V = 1.0 \times 10^3 \, \frac{\text{kg}}{\text{m}^3} \times 8 \, \text{in}^3 \times \left(\frac{2.54 \text{ cm}}{1 \text{ in}} \right)^3 \times \left(\frac{1 \text{ m}}{100 \text{ cm}} \right)^3 \approx 0.1 \text{ kg} = 100 \text{ g}$$

Part (b)

The radius of this cell is 0.25 μm.

$$m = \rho V = 1.0 \times 10^3 \, \frac{\text{kg}}{\text{m}^3} \times \frac{4}{3}\pi(0.25 \, \mu\text{m})^3 \times \left(\frac{1 \text{ m}}{10^6 \, \mu\text{m}} \right)^3 \approx 6.5 \times 10^{-17} \text{ kg}$$

Part (c)

Estimate the honeybee's volume as 1 cm^3.

$$m = \rho V = 1.0 \times 10^3 \, \frac{\text{kg}}{\text{m}^3} \times 1 \, \text{cm}^3 \times \left(\frac{1 \text{ m}}{100 \text{ cm}} \right)^3 = 0.001 \text{ kg} = 1 \text{ g}$$