Exercise 1.56

(**a**) The speed of light in a vacuum is 2.998×10^8 m/s. Calculate its speed in miles per hour. (**b**) The Sears Tower in Chicago is 1454 ft tall. Calculate its height in meters. (**c**) The Vehicle Assembly Building at the Kennedy Space Center in Florida has a volume of 3,666,500 m^3. Convert this volume to liters and express the result in standard exponential notation. (**d**) An individual suffering from a high cholesterol level in her blood has 242 mg of cholesterol per 100 mL of blood. If the total blood volume of the individual is 5.2 L, how many grams of total blood cholesterol does the individual's body contain?

Solution

Part (a)

Convert from meters per second to miles per hour using dimensional analysis.

$$2.998 \times 10^8 \ \frac{\cancel{m}}{\cancel{s}} \times \frac{1.0936 \ \cancel{\text{yd}}}{1 \ \cancel{m}} \times \frac{3 \ \cancel{ft}}{1 \ \cancel{\text{yd}}} \times \frac{1 \text{ mi}}{5280 \ \cancel{ft}} \times \frac{60 \ \cancel{s}}{1 \ \cancel{\text{min}}} \times \frac{60 \ \cancel{\text{min}}}{1 \text{ hr}} \approx 6.706 \times 10^8 \ \frac{\text{mi}}{\text{hr}}$$

Part (b)

Convert from feet to meters using dimensional analysis.

$$1454 \ \cancel{ft} \times \frac{12 \ \cancel{\text{in}}}{1 \ \cancel{ft}} \times \frac{2.54 \ \cancel{\text{cm}}}{1 \ \cancel{\text{in}}} \times \frac{1 \text{ m}}{100 \ \cancel{\text{cm}}} \approx 443.2 \text{ m}$$

Part (c)

Convert from cubic meters to liters using dimensional analysis.

$$3{,}666{,}500 \ \cancel{m^3} \times \left(\frac{100 \ \cancel{\text{cm}}}{1 \ \cancel{m}} \right)^3 \times \frac{1 \ \cancel{\text{mL}}}{1 \ \cancel{\text{cm}^3}} \times \frac{1 \text{ L}}{1000 \ \cancel{\text{mL}}} = 3{,}666{,}500{,}000 \text{ L}$$

If the uncertainty is in the hundreds place (3,666,5$\color{red}{0}$0), then the answer is

$$3.6665 \times 10^9 \text{ L};$$

if the uncertainty is in the tens place (3,666,50$\color{red}{0}$), then the answer is

$$3.66650 \times 10^9 \text{ L};$$

and if the uncertainty is in the ones place (3,666,500), then the answer is

$$3.666500 \times 10^9 \text{ L}.$$

Part (d)

Multiply the cholesterol density by the amount of blood to get the mass of cholesterol present.

$$\text{Mass of cholesterol} = \text{Density of cholesterol} \times \text{Volume of blood}$$

$$= \left(242 \ \frac{\text{mg cholesterol}}{\text{mL blood}}\right) \times (5.2 \text{ L blood})$$

$$= \left(242 \ \frac{\cancel{\text{mg cholesterol}}}{\cancel{\text{mL blood}}} \times \frac{1 \text{ g cholesterol}}{1000 \ \cancel{\text{mg cholesterol}}}\right) \times \left(5.2 \ \cancel{\text{L blood}} \times \frac{1000 \ \cancel{\text{mL blood}}}{1 \ \cancel{\text{L blood}}}\right)$$

$$= (0.242 \text{ g cholesterol}) \times (5200)$$

$$\approx 1.26 \times 10^3 \text{ g cholesterol}$$