

## Density Problems

KEY

Density is the ratio of the mass of an object to its volume. It is calculated simply by dividing mass by volume for any sample.

$$\text{Density} = \text{mass} / \text{volume}$$

$$D = m / V$$

This formula can also be rearranged to solve for either mass or volume.

When mass is measured in grams (g) and volume in cubic centimeters ( $\text{cm}^3$ ), density has units of  $\text{g}/\text{cm}^3$ . This is the most commonly expressed unit for density, but there are others. Be sure to check what you are given and what you are asked!

Solve the following problems using the concept of density.

1. Determine the volume that 32.5 grams of carbon tetrachloride will occupy if it has a density of  $1.60 \text{ g}/\text{cm}^3$ .

$$D = \frac{m}{V} \quad m = DV \quad V = \frac{m}{D}$$
$$V = \frac{32.5 \text{ g}}{1.60 \text{ g}/\text{cm}^3} = \boxed{20.3 \text{ cm}^3}$$

2. The density of ethanol is  $0.789 \text{ g}/\text{cm}^3$  at  $20^\circ\text{C}$ . What is the mass of  $150 \text{ cm}^3$  of this alcohol?

$$m = DV = (0.789 \text{ g}/\text{cm}^3)(150 \text{ cm}^3) = \boxed{120 \text{ g}}$$

3. A block of lead measures  $20.00 \text{ mm} \times 30.00 \text{ mm} \times 45.00 \text{ mm}$ . Calculate the mass of this block if the density of lead is  $11.34 \text{ g}/\text{cm}^3$ .

$$V = 2 \text{ cm} \times 3 \text{ cm} \times 4.5 \text{ cm} = 27.00 \text{ cm}^3$$
$$m = DV = (11.34 \text{ g}/\text{cm}^3)(27.00 \text{ cm}^3) = \boxed{306.2 \text{ g}}$$

4. A cubic box holds 1000 g of water. (The density of water is  $1.00 \text{ g}/\text{mL}$ )

- a. what is the volume of the box in mL?

$$1000 \text{ mL}$$

- b. in  $\text{cm}^3$

$$1000 \text{ cm}^3$$

- c. What is the length of one side in centimeters?

$$10 \text{ cm}$$

- d. in meters

$$1 \text{ m}$$

5. The density of mercury is  $13.36 \text{ g}/\text{mL}$ .

- a. What is the mass of  $8.20 \text{ mL}$  of Hg?

$$m = DV = (13.36 \text{ g}/\text{mL})(8.20 \text{ mL}) = \boxed{109 \text{ g}}$$

- b. What volume would  $120.0 \text{ g}$  of Hg occupy?

$$V = \frac{m}{D} = \frac{120.0 \text{ g}}{13.36 \text{ g}/\text{mL}} = \boxed{8.982 \text{ mL}}$$

6. A graduated cylinder is filled with water to the  $20.0 \text{ mL}$  graduated mark. Five pennies are added to the cylinder and the water level rises to  $21.8 \text{ mL}$ . If the mass of five pennies is  $15.10 \text{ grams}$ , what is the average density of the pennies?

$$D = \frac{m}{V} = \frac{15.10 \text{ g}}{1.8 \text{ mL}} = \boxed{8.4 \text{ g}/\text{mL}}$$