**Density Calculations**

There are physical characteristics of a substance that help identify the substance. One of these characteristics is density. Density (whose symbol is the lowercase letter d) is defined as mass per unit volume. Density is calculated by dividing the mass of an object by its volume. This is shown in equation form, as follows:

Density = mass ÷ volume

We can calculate the density of a solid, liquid, or gas. The density of a gas will be dealt with in a later unit, because its density is very sensitive to temperature and pressure. Although the density of liquids and solids do change with temperature and pressure changes, the amount is fairly small. We will ignore these small amounts and act as if all our density problems are at the same temperature and pressure. Note the difference in units in the formulas of the density of a solid and liquid. The unit for cubic centimeters is cm3 and for milliliters is mL.

solids: d = grams ÷ cubic centimeters

liquids: d = grams ÷ milliliters

**Practice Problems**

1) A block of aluminum occupies a volume of 15.0 mL and weighs 40.5 g. What is its density?

2) Mercury metal is poured into a graduated cylinder that holds exactly 22.5 mL. The mercury used to fill the cylinder weighs 306.0 g. From this information, calculate the density of mercury.

3) What is the weight of the ethyl alcohol that exactly fills a 200.0 mL container? The density of ethyl alcohol is 0.789 g/mL.

4) A rectangular block of copper metal weighs 1896 g. The dimensions of the block are 8.4 cm by 5.5 cm by 4.6 cm. From this data, what is the density of copper?

5) A flask that weighs 345.8 g is filled with 225 mL of carbon tetrachloride. The weight of the flask and carbon tetrachloride is found to be 703.55 g. From this information, calculate the density of carbon tetrachloride.

6) Calculate the density of sulfuric acid if 35.4 mL of the acid weighs 65.14 g.

7) Find the mass of 250.0 mL of benzene. The density of benzene is 0.8765 g/mL.

8) A block of lead has dimensions of 4.50 cm by 5.20 cm by 6.00 cm. The block weighs 1587 g. From this information, calculate the density of lead.

9) 28.5 g of iron shot is added to a graduated cylinder containing 45.50 mL of water. The water level rises to the 49.10 mL mark, From this information, calculate the density of iron.

10) What volume of silver metal will weigh exactly 2500.0 g. The density of silver is 10.5 g/cm3.

Answers to practice problems:

1)       d = 40.5 g / 15.0 mL                 d = 2.70 g/mL

2)       d = 306.0 g / 22.5 mL               d = 13.6 g/mL

3)       d = g / mL       g = (d) (mL)               g = (0.789 g/mL) (200.0 mL) = 158 g

4)       (8.4 cm) (5.5 cm) (4.6 cm) = 212.52 cm3     d = 1896 g / 212.52 cm3 = 8.9 g/cm3

Significant figures in the answer are dictated by the length measurements of two sig figs.

5)  mass of CCl4 = 703.55 g - 345.8 g = 357.75 g        d = 357.75 g / 225 mL = 1.59 g/mL

6)  d = 65.14 g / 35.4 mL         d = 1.84 g/mL

7)  d = g / mL     g = (d) (mL)            g = (0.8765 g/mL) (250.0 mL) = 219.1 g

8)  (4.50 cm) (5.20 cm) (6.00 cm) = 140.4 cm3    d = 1587 g / 140.4 cm3 = 11.3 g/cm3

9)    vol of iron shot = 49.10 mL - 45.50 mL = 3.60 mL

d = 28.5 g / 3.60 mL

d = 7.92 g/mL

10)  d = g / cm3         cm3 = g / d            cm3 = 2500.0 g / 10.5 g/cm3 = 238 cm3