CHM 1010 **GAGE**

Problems Based on Scientific Method and Measurements I -- Answers

1. Determine the number of significant figures in each of the following measurements.
   a. 6006 mm 4 b. 0.056700 g 5 c. 7.800×10^{-3} min 4
   d. 0.000064 kg 2 e. 7.09×10^{4} mcg 3 f. 0.1040 mL 4

2. How many kg are in 3.56×10^{4} mcg?

$$3.56 \times 10^{4}\text{mcg} \times \frac{1\text{ g}}{10^{6}\text{ mcg}} \times \frac{1\text{ kg}}{10^{3}\text{ g}} = 3.56 \times 10^{-5}\text{ kg}$$

3. How many mg of silver are in 0.023 ounces of silver? 16 oz = 1 lb, 454 g = 1 lb

$$0.023\text{ oz} \times \frac{1\text{ lb}}{16\text{ oz}} \times \frac{454\text{ g}}{1\text{ lb}} \times \frac{10^{3}\text{mg}}{1\text{ g}} = 650\text{ mg or } 6.5 \times 10^{2}\text{ mg (2 sf)}$$

4. Decide if each of the following statements represents a fact, law, theory, hypothesis or belief. Explain your selection.

   a. The average velocity of any molecule is inversely related to its mass.

Law – generalized statement of a relationship but no explanation for the relationship.

   b. The pressure of a gas increases with temperature because gaseous particles moving with a higher velocity make more frequent collisions resulting in greater force exertion.

Theory – states a generalized relationship with a behavioral explanation for the observations.

   c. Chlorine is a highly reactive element.

Fact – statement of a specific observation

5. If you travel at a posted speed limit of 65 mi/hr, how fast are you traveling in km/hr? in m/s?
   1.61 km = 1 mi

$$65\ \frac{\text{mi}}{\text{hr}} \times \frac{1.61\text{ km}}{1\text{ mi}} = 1\bar{0}0 \text{ or } 1.0 \times 10^{2}\ \frac{\text{km}}{\text{hr}}$$

$$\frac{65\text{ mi}}{\text{hr}} \times \frac{1.61\text{ km}}{1\text{ mi}} \times \frac{1000\text{ m}}{1\text{ km}} \times \frac{1\text{ hr}}{3600\text{ s}} = 29\ \frac{\text{m}}{\text{s}}$$

6. How many grams of dry air are in a room that is 21.0 ft x 17.5 ft x 8.0 ft.? The average density of dry air is 1.168g/L. 30.48 cm = 1 ft

$$21.0\ \text{ft} \times \frac{30.48\ \text{cm}}{1\ \text{ft}} = 640.\ \text{cm} \qquad 17.5\ \text{ft} = 533\ \text{cm} \qquad 8.0\ \text{ft} = 240\ \text{cm}$$

$$640\ \text{cm} \times 533\ \text{cm} \times 240\ \text{cm} = 8.2 \times 10^{7}\ \text{cm}^3 \qquad 8.2 \times 10^{7}\ \text{cm}^3 \times \frac{1\ \text{L}}{1000\ \text{cm}^3} = 8.2 \times 10^{4}\ \text{L}$$

$$D = \frac{M}{V} \quad \text{so} \quad M = D \times V \qquad 1.168\ \frac{\text{g}}{\text{L}} \times 8.2 \times 10^{4}\ \text{L} = 9.6 \times 10^{4}\ g$$

7. In the manufacture of polyethylene, 3.2 lb of initiator are used for 5.0 tons of product. How many grams of initiator would be needed to produce 3.98×10^{6} kg of polyethylene? 454 g = 1 lb, 2.20 lb = 1 kg

$$3.98 \times 10^{6}\ \text{kg poly} \times \frac{2.20\ \text{lb poly}}{1\ \text{kg poly}} \times \frac{1\ \text{ton poly}}{2000\ \text{lb}} \times \frac{3.2\ \text{lb init}}{5.0\ \text{ton poly}} \times \frac{454\ \text{g init}}{1\ \text{lb init}} = 1.3 \times 10^{6}\ \text{g init}$$

8. The length of a test tube was determined by three students and their results are shown below. The actual length is 211 mm.

Student 1	Student 2	Student 3
210 mm	215 mm	201 mm
211 mm	230 mm	202 mm
210 mm	201 mm	202 mm
211 mm	245 mm	201 mm
209 mm	222 mm	201 mm

Which student(s) is precise? Which student(s) is accurate? Explain your selection.
Students 1 and 3 are precise because they are able to reproduce the same value. Student 1 is also accurate because the measured values are close to the actual value.

9. The density of a sample of hydrochloric acid is 1.19 g/mL. What is the mass in grams of a 0.45 L sample of the acid?

$$D = \frac{M}{V} \quad \text{so} \quad M = D \times V \qquad M = 1.19\ \frac{\text{g}}{\text{mL}} \times 450\ \text{mL} = 5.4 \times 10^{2}\ \text{g}$$

10. An irregular sample of metal weighing 109.2 grams was placed in a graduated cylinder containing 21.0 mL of water. The volume registered in the cylinder after the metal was added was 33.2 mL. What is the density of the metal?

$$D = \frac{M}{V} \qquad M = 109.2\ \text{g},\ V = 33.2\ \text{mL} - 21.0\ \text{mL} = 12.2\ \text{mL} \qquad D = \frac{109.2\ \text{g}}{12.2\ \text{mL}} = 8.95\ \text{g/mL}$$

11. One baked potato provides an average of 31.0 mg of Vitamin C. If 5.0 lb of potatoes contain 15 potatoes, how many mg of Vitamin C are available per pound of potatoes?

$$1\ \text{lb pot} \times \frac{15\ \text{pot}}{5.0\ \text{lb pot}} \times \frac{31.0\ \text{mg Vit C}}{1\ \text{pot}} = 93\ \text{mg Vit C}$$