CHEM 101

Chapter 1 Problems

1.8 Which of the following properties are intensive and which are extensive?

(a) Length, extensive.

(b) volume, extensive.

(c) temperature, intensive

(d) mass, extensive

1.12 Does each of the following describe a physical change or a chemical change? (a) The helium gas inside a balloon tends to leak out after a few hours. (b) A flashlight beam slowly gets dimmer and finally goes out. (c) Frozen orange juice is reconstituted by adding water to it. (d) The growth of plants depends on the sun's energy in a process called photosynthesis. (e) A spoonful of table salt dissolves in a bowl of soup.

(a) Physical change. The helium isn't changed in any way by leaking out of the balloon.

(b) Chemical change in the battery.

(c) Physical change. The orange juice concentrate can be regenerated by evaporation of the water.

(d) Chemical change. Photosynthesis changes water, carbon dioxide, etc., into complex organic matter.

(e) Physical change. The salt can be recovered unchanged by evaporation.

1.16 Classify each of the following as an element, a compound, a homogeneous mixture, or a heterogeneous mixture: (a) seawater, (b) helium gas, (c) sodium chloride (table salt), (d) a bottle of soft drink, (e) a milkshake, (f) air in a bottle, (g) concrete.

(a)	homogeneous mixture	(b)	element	(c)	compound
(d)	homogeneous mixture	(e)	heterogeneous mixture	(f)	homogeneous mixture
(g)	heterogeneous mixture				

1.17 Name the SI base units that are important in chemistry. Give the SI units for expressing the following: (a) length, (b) volume, (c) mass, (d) time, (e) energy, (f) temperature

a) meter (m)

b) cubic meter (m^3)

c) kilogram (kg)

d) second (s)

e) joule (J)

f) Kelvin (k)

1.22 The density of ethanol, a colorless liquid that is commonly known as grain alcohol, is 0.798 g/mL. Calculate the mass of 17.4 mL of the liquid.

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\textbf{mass} = \text{density} \times \text{volume}$$

$$\textbf{mass of ethanol} = \frac{0.798\ \text{g}}{1\ \cancel{\text{mL}}} \times 17.4\ \cancel{\text{mL}} = \textbf{13.9 g}$$

1.23 Convert the following temperatures to degrees Celsius or Fahrenheit:

(a) 95°F, the temperature on a hot summer day

(b) 12°F, the temperature on a cold winter day

(c) a 102°F fever

(d) a furnace operating at 1852°F

(e) -273.15°C (theoretically the lowest attainable temperature).

$$?\ ^\circ C = (^\circ F - 32^\circ F) \times \frac{5^\circ C}{9^\circ F}$$

(a) $$?\ ^\circ C = (95 - 32)\cancel{^\circ F} \times \frac{5^\circ C}{9\cancel{^\circ F}} = \mathbf{35^\circ C}$$

(b) $$?\ ^\circ C = (12 - 32)\cancel{^\circ F} \times \frac{5^\circ C}{9\cancel{^\circ F}} = \mathbf{-11^\circ C}$$

(c) $$?\ ^\circ C = (102 - 32)\cancel{^\circ F} \times \frac{5^\circ C}{9\cancel{^\circ F}} = \mathbf{39^\circ C}$$

(d) $$?\ ^\circ C = (1852 - 32)\cancel{^\circ F} \times \frac{5^\circ C}{9\cancel{^\circ F}} = \mathbf{1011^\circ C}$$

(e) $$?\ ^\circ F = \left(^\circ C \times \frac{9^\circ F}{5^\circ C}\right) + 32^\circ F$$

$$?\ ^\circ F = \left(-273.15\cancel{^\circ C} \times \frac{9^\circ F}{5\cancel{^\circ C}}\right) + 32^\circ F = \mathbf{-459.67^\circ F}$$

1.25 Convert the following temperatures to kelvin:
(a) 113°C, the melting point of sulfur,

(b) 37°C, the normal body temperature,

(c) 357°C, the boiling point of mercury

$$K = (°C + 273°C)\frac{1\,K}{1°C}$$

(a) $\mathbf{K} = 113°C + 273°C = \mathbf{386\,K}$

(b) $\mathbf{K} = 37°C + 273°C = \mathbf{3.10 \times 10^{2}\,K}$

(c) $\mathbf{K} = 357°C + 273°C = \mathbf{6.30 \times 10^{2}\,K}$

1.26 Convert the following temperatures to degrees Celsius:
(a) 77 K, the boiling point of liquid nitrogen.
(b) 4.2 K, the boiling point of liquid helium.
(c) 601 K, the melting point of lead.

(a) $$\text{K} = (°\text{C} + 273°\text{C})\frac{1\text{ K}}{1°\text{C}}$$

$$°\text{C} = \text{K} - 273 = 77\text{ K} - 273 = \mathbf{-196°C}$$

(b) $$°\text{C} = 4.2\text{ K} - 273 = \mathbf{-269°C}$$

(c) $$°\text{C} = 601\text{ K} - 273 = \mathbf{328°C}$$

1.40 Carry out the following conversion:
(a) 242 lb to milligrams.

Solution: The sequence of conversions is

$$\text{lb} \rightarrow \text{grams} \rightarrow \text{mg}$$

Using the following conversion factors,

$$\frac{453.6 \text{ g}}{1 \text{ lb}} \qquad \frac{1 \text{ mg}}{1 \times 10^{-3} \text{ g}}$$

we obtain the answer in one step:

$$? \textbf{ mg} = 242 \cancel{\text{lb}} \times \frac{453.6 \cancel{\text{g}}}{1 \cancel{\text{lb}}} \times \frac{1 \text{ mg}}{1 \times 10^{-3} \cancel{\text{g}}} = \mathbf{1.10 \times 10^{8} \text{ mg}}$$

1.40 Carry out the following conversion:

C) 7.2 m^3 to liters.

Using the following conversion factors,

$$\left(\frac{1\ \text{cm}}{1\times10^{-2}\ \text{m}}\right)^3 \qquad\qquad \frac{1\ \text{L}}{1000\ \text{cm}^3}$$

the answer is obtained in one step:

$$?\ \mathbf{L} = 7.2\ \cancel{\text{m}^3} \times \left(\frac{1\ \cancel{\text{cm}}}{1\times10^{-2}\ \cancel{\text{m}}}\right)^3 \times \frac{1\ \text{L}}{1000\ \cancel{\text{cm}^3}} = \mathbf{7.2\times10^3\ L}$$

1.41 The average speed of helium at 25°C is 1255 m/s.
Convert this speed to miles per hour (mph)

$$\frac{1255\ \cancel{m}}{1\ \cancel{s}} \times \frac{1\ mi}{1609\ \cancel{m}} \times \frac{3600\ \cancel{s}}{1\ h} = \mathbf{2808\ mi/h}$$

1.42 How many seconds are there in a solar year (365.24 days)?

$$? \text{ s} = 365.24\ \cancel{day} \times \frac{24\ \cancel{h}}{1\ \cancel{day}} \times \frac{60\ \cancel{min}}{1\ \cancel{h}} \times \frac{60\ s}{1\ \cancel{min}} = \mathbf{3.1557 \times 10^7\ s}$$

1.44 A slow jogger runs a mile in 13 min. Calculate the speed in (a) in/s, (b) m/min, (c) km/h. (1 mi = 1609 m; 1 in = 2.54 cm.)

$$\textbf{(a)}\quad \textbf{? in/s} = \frac{1\ \cancel{\text{mi}}}{13\ \cancel{\text{min}}} \times \frac{5280\ \cancel{\text{ft}}}{1\ \cancel{\text{mi}}} \times \frac{12\ \text{in}}{1\ \cancel{\text{ft}}} \times \frac{1\ \cancel{\text{min}}}{60\ \text{s}} = \textbf{81 in/s}$$

$$\textbf{(b)}\quad \textbf{? m/min} = \frac{1\ \cancel{\text{mi}}}{13\ \text{min}} \times \frac{1609\ \text{m}}{1\ \cancel{\text{mi}}} = \mathbf{1.2 \times 10^2\ m/min}$$

$$\textbf{(c)}\quad \textbf{? km/h} = \frac{1\ \cancel{\text{mi}}}{13\ \cancel{\text{min}}} \times \frac{1609\ \cancel{\text{m}}}{1\ \cancel{\text{mi}}} \times \frac{1\ \text{km}}{1000\ \cancel{\text{m}}} \times \frac{60\ \cancel{\text{min}}}{1\ \text{h}} = \textbf{7.4 km/h}$$

1.55 In 2008, about 95.0 billion lb of sulfuric acid were produced in the United States. Convert this quantity to tons.

$$(95.0 \times 10^9\ \cancel{\text{lb}}\ \text{of sulfuric acid}) \times \frac{1\ \text{ton}}{2.0 \times 10^3\ \cancel{\text{lb}}} = \mathbf{4.75 \times 10^7\ tons\ of\ sulfuric\ acid}$$

1.56 In determining the density of a rectangular metal bar,
a student made the following measurements: length, 8.53 cm; width, 2.4 cm; height, 1.0 cm; mass, 52.7064 g.
Calculate the density of the metal

$$\text{Volume of rectangular bar} = \text{length} \times \text{width} \times \text{height}$$

$$\mathbf{density} = \frac{m}{V} = \frac{52.7064\ \text{g}}{(8.53\ \text{cm})(2.4\ \text{cm})(1.0\ \text{cm})} = \mathbf{2.6\ g/cm^3}$$

1.57 Calculate the mass of each of the following:

(a) A sphere of gold with a radius of 10.0 cm [the volume of a sphere with a radius r is $V = 4/3\ \pi r^3$; the density of gold = 19.3 g/cm^3],

(b) A cube of platinum of edge length 0.040 mm (the density of platinum = 21.4 g/cm^3),

$$\text{mass} = \text{density} \times \text{volume}$$

(a) $$\textbf{mass} = (19.3\ \text{g}/\cancel{\text{cm}^3}) \times \left[\frac{4}{3}\pi(10.0\ \cancel{\text{cm}})^3\right] = \mathbf{8.08 \times 10^4\ g}$$

(b) $$\textbf{mass} = (21.4\ \text{g}/\cancel{\text{cm}^3}) \times \left(0.040\ \cancel{\text{mm}} \times \frac{1\ \cancel{\text{cm}}}{10\ \cancel{\text{mm}}}\right)^3 = \mathbf{1.4 \times 10^{-6}\ g}$$

1.76 Osmium (Os) is the densest element known (density = 22.57 g/cm3). Calculate the mass in pounds and in kilograms of an Os sphere 15 cm in diameter (about the size of a grapefruit).

$$\text{Volume of sphere} = \frac{4}{3}\pi r^3$$

$$\text{Volume} = \frac{4}{3}\pi\left(\frac{15\text{ cm}}{2}\right)^3 = 1.77 \times 10^3\text{ cm}^3$$

$$\text{mass} = \text{volume} \times \text{density} = (1.77 \times 10^3\ \cancel{\text{cm}^3}) \times \frac{22.57\ \cancel{\text{g}}\text{ Os}}{1\ \cancel{\text{cm}^3}} \times \frac{1\text{ kg}}{1000\ \cancel{\text{g}}} = \mathbf{4.0 \times 10^1\ kg\ Os}$$

$$4.0 \times 10^1\ \cancel{\text{kg}}\text{ Os} \times \frac{2.205\text{ lb}}{1\ \cancel{\text{kg}}} = \mathbf{88\ lb\ Os}$$