AP Chemistry Summer Study Session

Unit Conversions

Common English-Metric Equivalents		
Length	**Mass**	**Volume**
1 meter = 1.094 yards	453.6 grams = 1 pound	1 liter = 1.06 quarts
2.54 centimeters = 1 inch	28.35 grams = 1 ounce	29.57 milliliters = 1 fluid ounce
1.609 kilometers = 1 mile	1 kilogram = 2.205 pounds	3.785 liters = 1 gallon

1. The circumference of the earth is 25,000 miles at the equator. What is the circumference in kilometers? In meters?

2. A rectangular solid measures 1.0 m by 5.6 cm by 2.1 dm. Express its volume in cubic centimeters.

3. A marathon is 26 miles and 385 yards. What is this distance in kilometers? In meters?

4. For a pharmacist dispensing pills or capsules, it is often easier to weigh the medication to be dispensed than to count the individual pills. A single antibiotic capsule used to treat an infection is 0.65 g.
   (a) If a pharmacist weighs out 15.6 g of capsules, then how many capsules have been dispensed?
   (b) If a pharmacist needs to dispense 20 capsules to fill a prescription, then what mass of capsules should he weigh?

5. Would a car traveling at a constant speed of 65 km/h violate a 45 mi/h speed limit?

Density

6. A material will float on the surface of a liquid if the material has a density less than that of the liquid. Given that the density of water is approximately 1.0 g/mL, will a block of material having a volume of 1.2×10^4 in^3 and weighing 350 lb float or sink when placed in a reservoir of water? (1 mL = 1 cm^3)

7. Diamonds are measured in carats, and 1 carat = 0.200 g. The density of diamond is 3.51 g/cm^3.
   (a) What is the volume of a 5.0-carat diamond?
   (b) What is the mass in carats of diamond measuring 2.8 mL?

8. A sample containing 33.42 g of metal pellets is poured into a graduated cylinder initially containing 12.7 mL of water, causing the water level in the cylinder to rise to 21.6 mL. Calculate the density of the metal.

Moles and Molar Mass

9. Diamond is a natural form of pure carbon.
    (a) How many moles of carbon are in a 1.00-carat diamond (1.00 carat = 0.200 g)?
    (b) How many atoms of carbon are in a 1.50-carat diamond?

10. What amount (moles) is represented by each of these samples?
    (a) 150.0 g Fe_2O_3
    (b) 10.0 mg NO_2
    (c) 1.5×10^{16} molecules of BF_3

11. Ascorbic acid, or vitamin C ($C_6H_8O_6$), is an essential vitamin. It cannot be stored by the body and must be present in the diet.
    (a) What is the molar mass of ascorbic acid?
    (b) Vitamin C tablets are taken as dietary supplement. If a typical tablet contains 500.0 mg vitamin C, calculate each of the following for one 500.0 mg tablet.
        (i) Moles of vitamin C
        (ii) Molecules of vitamin C

12. A student is asked to use 0.21 moles of $CuSO_4(s)$ in a reaction. However, there is no instrument in the laboratory that directly measures the amount (i.e. moles) of a substance. The student notices that graduated cylinders, thermometers, and balances are available for student use.
    (a) Which one of the available lab equipment should the student choose to measure the required amount of 0.21 moles of $CuSO_4(s)$? Explain your reasoning.
    (b) Briefly describe the steps the student should take to obtain the 0.21 moles of $CuSO_4(s)$ needed for lab. You can assume the student has access to scoopulas, beakers, etc.

Stoichiometry

13. Ammonia is produced from the reaction of nitrogen and hydrogen according to the following balanced equation:

$$N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$$

    (a) How many moles of H_2 are required to react with 3.0 moles of N_2?
    (b) If 2.0 moles of N_2 react, then how many moles of NH_3 will be produced?
    (c) What mass of NH_3 will be produced if 2.0 moles of N_2 react?

14. Milk of magnesia is often used as an antacid to treat stomach aches, in other words, it neutralizes excess hydrochloric acid secreted by the stomach. Milk of magnesia contains magnesium hydroxide which reacts with hydrochloric acid according to the following equation:

$$Mg(OH)_2(s) + 2\ HCl(aq) \rightarrow 2\ H_2O(l) + MgCl_2(aq)$$

(a) How many grams of $Mg(OH)_2$ are needed to neutralize 0.555 grams of HCl?
(b) How many grams of $MgCl_2$ will be produced when the reaction in part (a) is complete?

15. Methanol (CH_3OH), also called methyl alcohol, is used as a fuel in race cars and is a potential replacement for gasoline. Methanol can be manufactured by combining gaseous carbon monoxide and hydrogen according to the balanced equation:

$$2\ H_2(g) + CO(g) \rightarrow CH_3OH(l)$$

(a) If 3.21 grams of CO(g) and 2.98 grams of H_2 are mixed together and allowed to react to completion, then how many moles of CH_3OH should be produced?
(b) How many grams of CH_3OH should be produced from the reaction described in part (a)?
(c) A student mixes the quantities of CO(g) and H_2(g) described in part (a) together and produces 3.52 g CH_3OH. Calculate the student's percent yield.

16. Over the years, the thermite reaction has been used for welding railroads rails, in incendiary bombs, and to ignite solid-fuel rocket motors. The reaction is

$$Fe_2O_3(s) + 2\ Al(s) \rightarrow 2\ Fe(l) + Al_2O_3(s)$$

(a) What masses of iron(III) oxide and aluminum must be used to produce 15.0 g iron?
(b) What is the maximum mass of aluminum oxide that could be produced?
(c) Consider the same reaction between iron(III) oxide and aluminum. If 79.85 grams of iron(III) oxide and 13.49 gram of aluminum are mixed and allowed to react to completion, then what mass of aluminum oxide is produced?