Gaseous Stoichiometry

1. Diborane, B_2H_6, is a highly explosive compound formed by the reaction

    $$3NaBH_4 \text{ (s)} + 4BF_3 \text{ (g)} \rightarrow 2B_2H_6 \text{ (g)} + 3NaBF_4 \text{ (s)}$$

    a. What mass of sodium borohydride, $NaBH_4$, is required to form 1.00L of B_2H_6 at 0° C and 1.00 atm?
    b. What volume of BF_3 at $20.^\circ$ C and 742 mmHg is required to produce 6.00 g $NaBF_4$?

2. Calcium reacts with water, yielding hydrogen gas and calcium hydroxide. How many grams of water are required to produce 7.00 L of dry hydrogen at 1.05 atm and $30.^\circ$C? (you will need to write and balance the reaction)

3. Hydrogen cyanide, HCN, is a poisonous gas that was used in the gas chambers of Hitler's concentration camps. It can be formed by the reaction

    $$NaCN \text{ (s)} + H^+ \text{ (aq)} \rightarrow HCN \text{ (g)} + Na^+ \text{ (aq)}$$
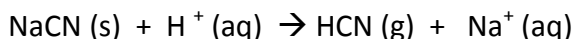
    What mass of NaCN is required to make 8.53 L of HCN at 22° C and 751 mmHg?

4. A gaseous mixture contains 5.78 g of methane, 2.15 g of neon, and 6.80 g of sulfur dioxide. What pressure is exerted by the mixture inside a 75.0L cylinder at 85° C? Which gas contributes the greatest pressure?

5. To prepare a sample of hydrogen gas a student reacts zinc with hydrochloric acid. The overall net reaction is Zn (s) $2H^+$ (aq) $\rightarrow$ Zn^{+2} (aq) + H_2 (g)

    The hydrogen gas is collected over water at 24° C and the total pressure is 758 mmHg (vapor pressure of H_2O = 22.4 mmHg).
    a. What is the partial pressure of the hydrogen?
    b. How many grams of hydrogen are there in a 2.00 L sample of wet gas?

6. Helium (0.56g) and hydrogen are mixed in a 1.0 L flask at room temperature (298 K). The partial pressure of He is 150mmHg and that of H_2 is 25 mmHg. How many grams of H_2 are present?

7. What is the total pressure in atmospheres of a gas mixture that contains 1.0 g of H_2 and 8.0 g of Ar in a 3.0L container at 27° C. What are the partial pressures of the two gases?

8. The hydrocarbon benzene (C_6H_6) burns to give CO_2 and water vapor.

$$2\ C_6H_6\ (g)\ +\ 15\ O_2\ (g)\ \rightarrow\ 12\ CO_2\ (g)\ +\ 6\ H_2O\ (g)$$
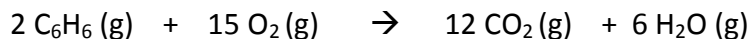
a) If a 0.095g sample of C_6H_6 burns completely in O_2, what is the pressure of water vapor in a 4.75 L flask at $30.0\,^\circ C$?

b) If the O_2 gas needed for combustion is contained in a 4.75L flask at $22\,^\circ C$ what is its pressure?

9. Potassium superoxide reacts with CO_2 to give oxygen gas.

$$4\ KO_2\ (s)\ +\ 2\ CO_2\ (g)\ \rightarrow\ 2\ K_2CO_3\ (s)\ +\ 3\ O_2\ (g)$$

a) If you combine 16.0 g of KO_2 with the CO_2 in a 4.00L tank, in which the gas pressure is 1.24 atm at $23\,^\circ C$, which reactant is consumed completely?

b) If the O_2 gas is captured from the reaction, what is its pressure in a 2.50L flask at $25\,^\circ C$?

10. A sample of gas collected over water at $42\,^\circ C$ occupies a volume of 1.00L. The wet gas has a pressure of 0.986 atm. The gas is dried and the dry gas occupies 1.04 L with a pressure of 1.00 atm at $90.\,^\circ C$. What is the vapor pressure of the water at $42\,^\circ C$?

11. Compare and Contrast a real gas and an ideal gas. Explain how to make a real gas behave more like an ideal gas. (details are needed just like when explaining a "good collision")

12. In each of the pair of gases below, tell which effuses faster and why:
    a) CO_2 and F_2 b) O_2 and N_2 c) C_2H_4 and B_2H_6

13. Argon gas is ten times as dense as helium gas at the same temperature and pressure. Which gas effuses faster? How much faster?