Problem Set 4: Stoichiometric Calculations and Limiting Reactants

HCHE 111L: Introduction to Elementary Inorganic Chemistry

Due Date: Friday September 22nd, 2017

Problem 1

Sodium Hydroxide reacts with carbon dioxide as follows:

$$2\,\mathrm{NaOH\,(s)} + \mathrm{CO_2} \longrightarrow \mathrm{Na_2CO_3\,(s)} + \mathrm{H_2O\,(l)}$$

Which reactant is the limiting reactant when 1.70 mol NaOH and 1.00 mol CO_2 are allowed to react? How many moles of Na_2CO_3 can be produced? How many moles of the excess reactant remain after the completion of the reaction?

Problem 2

Detonation of nitroglycerin ($C_3H_5N_3O_9$) proceeds as follows:

$$4\,\mathrm{C_3H_5N_3O_9\,(l)} \longrightarrow 12\,\mathrm{CO_2\,(g)} + 6\,\mathrm{N_2\,(g)} + 10\,\mathrm{H_2O\,(g)}$$

a) If a sample containing 3.00 mL of nitroglycerin (density = 1.592 g/mL) is detonated how many total moles of gas are produced?

b) How many grams of N_2 are produced in the detonation?

Problem 3

Hydrofluoric acid, HF(aq), cannot be stored in glass bottles because compounds called silicates in the glass are attacked by the HF(aq). Sodium silicate (Na_2SiO_3), for example, reacts as follows:

$$\mathrm{Na_2SiO_3\,(s)} + 8\,\mathrm{HF}(aq) \longrightarrow \mathrm{H_2SiO_3\,(aq)} + 2\,\mathrm{NaF}(aq) + 3\,\mathrm{H_2O}(l)$$

a) How many moles of HF are needed to react with 0.300 mol of Na_2SiO_3?

b) How many grams of NaF form when 0.500 mol of HF reacts with excess Na_2SiO_3?

c) How many grams of Na_2SiO_3 can react with 0.800 g of HF?

Problem 4

Automotive air bags inflate when sodium azide (NaN_3) rapidly decomposes to its component elements:

$$2\,NaN_3(s) \longrightarrow Na(s) + 3\,N_2(g)$$

a) How many moles of N_2 are produced by the decomposition of 2.50 mol of NaN_3?

b) How many grams of NaN_3 are required to form 6.00 g of nitrogen gas?

c) How many grams of NaN_3 are required to produce 10.0 ft^3 of nitrogen gas if the gas has a density of 1.25 g/L?

Problem 5

The fizz produced when an Alka-Seltzer tablet is dissolved in water is due to the reaction between sodium bicarbonate ($NaHCO_3$) and citric acid ($H_3C_6H_5O_7$):

$$3\,NaHCO_3(aq) + H_3C_6H_5O_7(aq) \longrightarrow 3\,CO_2(g) + 3\,H_2O(l) + Na_3C_6H_5O_7$$

consider an experiment where 1.00 g of sodium bicarbonate and 1.00 g of citric acid are allowed to react.

a) Which is the limiting reactant?

b) How many grams of carbon dioxide form?

c) How many grams of the excess reactant remain after the limiting reactant is consumed?

Problem 6

The CO_2 exhaled by astronauts must be "scrubbed" (removed) from the spacecraft atmosphere. One way to do this is with solid LiOH:

$$CO_2(g) + 2\,LiOH(s) \longrightarrow Li_2CO_3(s) + H_2O(l)$$

the CO_2 output of an astronaut is about 1.0 kg/day. What is the minimum mass of LiOH required for a six-day space shuttle flight?