Name:_____ Date:_____ Hr:_____

# Stoichiometry 3.5 Limiting Reactant Worksheet

A 24.5g sample of sodium chloride reacts with 41.3g of fluorine gas according to the following chemical equation:

L.R. excess
24.5g 41.3g

$$2\,NaCl_{(s)} + F_{2(g)} \rightarrow 2\,NaF_{(s)} + Cl_{2(g)}$$

a. What is the limiting reactant?

$\frac{24.5\,g\ NaCl}{1} \times \frac{1\,mol\ NaCl}{58.443\,g\ NaCl} \times \frac{1\,mol\ F_2}{2\,mol\ NaCl} \times \frac{37.996\,g\ F_2}{1\,mol\ F_2} =$ Need 7.96g $F_2$ — NaCl L.R.

b. How many liters of chlorine gas are produced?

$\frac{24.5\,g\ NaCl}{1} \times \frac{1\,mol\ NaCl}{58.443\,g\ NaCl} \times \frac{1\,mol\ Cl_2}{2\,mol\ NaCl} \times \frac{70.906\,g\ Cl_2}{1\,mol\ Cl_2}$ (wrong) $= 14.86\,g\ Cl_2$

$\times \frac{22.4\,L\ Cl_2}{1\,mol\ Cl_2} =$ 4.70L $Cl_2$

2) A 84.1g sample of phosphorus reacts with 85.0g of oxygen gas according to the following chemical equation:

Excess L.R.
84.1g 85.0g

$$4\,P + 5\,O_2 \rightarrow 2\,P_2O_5$$

a. Find the limiting reagent.

$\frac{84.1\,g\ P}{1} \times \frac{1\,mol\ P}{30.974\,g\ P} \times \frac{5\,mol\ O_2}{4\,mol\ P} \times \frac{31.998\,g\ O_2}{1\,mol\ O_2} =$ Need 108.6g $O_2$ — $O_2$ is L.R.

b. How many grams of $P_2O_5$ are produced in theory?

$\frac{85.0\,g\ O_2}{1} \times \frac{1\,mol\ O_2}{31.998\,g\ O_2} \times \frac{2\,mol\ P_2O_5}{5\,mol\ O_2} \times \frac{141.943\,g\ P_2O_5}{1\,mol\ P_2O_5} =$ 150.8g $P_2O_5$

c. If only 123 g of $P_2O_5$ are produced, what is the percent yield?

$\frac{123\,g\ P_2O_5}{150.8\,g\ P_2O_5} \times 100 =$ 81.6%

3) Most nitrogen exists in a gaseous state. Plants require a soluble form of nitrogen so they can absorb it from the ground. Ammonia is a good fertilizer, as the mass percent of nitrogen in ammonia is very high. The following reaction is used to convert gaseous nitrogen into ammonia, which can be used as fertilizer.

L.R. excess
186.3g 289.8g

$$N_2 + 3\,H_2 \rightarrow 2\,NH_3$$

If 186.3 grams of nitrogen react with 289.8 grams of hydrogen:

a) Which reactant is limiting?

$\frac{186.3\,g\ N_2}{1} \times \frac{1\,mol\ N_2}{28.02\,g\ N_2} \times \frac{3\,mol\ H_2}{1\,mol\ N_2} \times \frac{2.0158\,g\ H_2}{1\,mol\ H_2} =$ Need 40.21g $H_2$ — $N_2$ L.R.

b) What is the theoretical yield of ammonia?

$$\frac{186.3\ g\ N_2}{1} \times \frac{1\ mol\ N_2}{28.02\ g\ N_2} \times \frac{2\ mol\ NH_3}{1\ mol\ N_2} \times \frac{17.03\ g\ NH_3}{1\ mol\ NH_3} = \boxed{226.5\ g\ NH_3}$$

c) If this reaction is known to have a 73.8% yield, what mass of ammonia could you expect to produce?

$$\frac{A}{T} = 0.738 \qquad \frac{A}{T} = .738 \qquad A = .738(226.5)$$

$$(226.5\ g)$$

$$\boxed{A = 167\ g\ NH_3}$$

4) A 5.75g sample of silicone dioxide reacts with 5.50g of sodium hydroxide according to the following equation:

L.R.

$$\underset{5.75g}{SiO_2} + 2\underset{5.50g}{NaOH} \rightarrow Na_2SiO_3 + H_2O$$

a) How many grams of $Na_2SiO_3$ are produced?

Need

$$\frac{5.75\ g\ SiO_2}{1} \times \frac{1\ mol\ SiO_2}{60.084\ g\ SiO_2} \times \frac{2\ mol\ NaOH}{1\ mol\ SiO_2} \times \frac{39.997\ g\ NaOH}{1\ mol\ NaOH} = 7.65\ g\ NaOH$$

$$\frac{5.50\ g\ NaOH}{1} \times \frac{1\ mol\ NaOH}{39.997\ g\ NaOH} \times \frac{1\ mol\ Na_2SiO_3}{2\ mol\ NaOH} \times \frac{122.062\ g\ Na_2SiO_3}{1\ mol\ Na_2SiO_3} = \boxed{8.39\ g\ Na_2SiO_3}$$

b) What is the percent yield if only 7.24g $Na_2SiO_3$ are produced?

$$\frac{7.24\ g\ Na_2SiO_3}{8.39\ g\ Na_2SiO_3} \times 100 = \boxed{86.3\%\ yield}$$

5) In a synthesis reaction between phosphorus and liquid bromine, 5.78g of phosphorus and 27.9g of liquid bromine were poured in a beaker. After the reaction was complete, what were the COMPLETE contents inside the beaker (think hard about everything)? If 22.3 grams of $PBr_3$ were actually produced, what was the percent yield of $PBr_3$?

L.R.

$$\underset{5.78g}{2P} + \underset{27.9g}{3Br_2} \rightarrow 2PBr_3$$

Need

$$\frac{5.78\ g\ P}{1} \times \frac{1\ mol\ P}{30.974\ g\ P} \times \frac{3\ mol\ Br_2}{2\ mol\ P} \times \frac{159.808\ g\ Br_2}{1\ mol\ Br_2} = 44.73\ g\ Br_2$$

$$\frac{27.9\ g\ Br_2}{1} \times \frac{1\ mol\ Br_2}{159.808\ g\ Br_2} \times \frac{2\ mol\ PBr_3}{3\ mol\ Br_2} \times \frac{270.688\ g\ PBr_3}{1\ mol\ PBr_3} = \boxed{31.51\ g\ PBr_3}$$

$$\frac{27.9\ g\ Br_2}{1} \times \frac{1\ mol\ Br_2}{159.808\ g\ Br_2} \times \frac{2\ mol\ P}{3\ mol\ Br_2} \times \frac{30.974\ g\ P}{1\ mol\ P} = \boxed{3.61\ g\ P}$$

$$\frac{22.3\ g\ PBr_3}{31.51\ g} = \boxed{70.8\%\ yield}$$

$31.51\ g\ PBr_3$

$3.61\ g\ P$