Limiting Reagent Worksheet

1) *Copper (II) chloride reacts with sodium nitrate.*

a) Write the balanced equation for the reaction given above:

$$CuCl_2 + 2NaNO_3 \rightarrow Cu(NO_3)_2 + 2NaCl$$

b) If 15.0 grams of copper (II) chloride react with 20.0 grams of sodium nitrate, how much sodium chloride can be formed?

$$15.0g\ CuCl_2 \times \frac{1mol\ CuCl_2}{134.5g} \times \frac{2mol\ NaCl}{1mol\ CuCl_2} = .223mol\ NaCl \times \frac{58.5g}{1mol\ NaCl} = 13.0g\ NaCl$$

$$20.0g\ NaNO_3 \times \frac{1mol\ NaNO_3}{85.0g} \times \frac{2mol\ NaCl}{2mol\ NaNO_3} = .235mol\ NaCl$$

c) What is the limiting reagent for the reaction in #2? $CuCl_2$

d) How many grams of copper(II) nitrate is formed?

$$15.0g\ CuCl_2 \times \frac{1mol\ CuCl_2}{134.5g} \times \frac{1mol\ Cu(NO_3)_2}{1mol\ CuCl_2} \times \frac{187.5g}{1mol\ Cu(NO_3)_2} = 20.9g\ Cu(NO_3)_2$$

e) How much of the excess reagent is left over in this reaction?

$$15.0g\ CuCl_2 \times \frac{1mol\ CuCl_2}{134.5g} \times \frac{2mol\ NaNO_3}{1mol\ CuCl_2} \times \frac{85.0g}{1mol} = 18.95g \rightarrow 19.0g\ \underline{\text{used}}$$

20.0g have − 19.0g used = 1.0g left over $NaNO_3$

f) If 11.3 grams of sodium chloride are formed in the reaction described in problem #2, what is the percent yield of this reaction?

$$\frac{11.3}{13.0} \times 100 = 86.9\%\ \text{yield}$$

2) *Lead (II) nitrate reacts with sodium iodide.*

a) Write the balanced equation:

$$Pb(NO_3)_2 + 2NaI \rightarrow PbI_2 + 2NaNO_3$$

b) If I start with 25.0 grams of lead (II) nitrate and 15.0 grams of sodium iodide, how many grams of sodium nitrate can be formed?

$$25.0g\ Pb(NO_3)_2 \times \frac{1mol\ Pb(NO_3)_2}{331.2g} \times \frac{2mol\ NaNO_3}{1mol\ Pb(NO_3)_2} = .151mol\ NaNO_3$$

$$15.0g\ NaI \times \frac{1mol\ NaI}{149.9g} \times \frac{2mol\ NaNO_3}{2mol\ NaI} = .100mol\ NaNO_3 \times \frac{85.0g}{1mol\ NaNO_3} =$$

$$8.51g\ NaNO_3$$

c) What is the limiting reagent in the reaction described in problem 2? NaI

d) How many grams of lead(II) iodide is formed?

$$15.0g\ NaI \times \frac{1mol\ NaI}{149.9g} \times \frac{1mol\ PbI_2}{2mol\ NaI} \times \frac{461.0g}{1mol\ PbI_2} = 23.1g\ PbI_2$$

e) How much of the nonlimiting reagent will be left over from the reaction in problem #2?

$$15.0g\ NaI \times \frac{1mol\ NaI}{149.9g} \times \frac{1mol\ Pb(NO_3)_2}{2mol\ NaI} \times \frac{331.2g}{1mol\ Pb(NO_3)_2} = 16.6g \text{ used}$$

$25.0g$ have $- 16.6g$ used $= 8.4g\ Pb(NO_3)_2$ remains left over

f) If 6.00 grams of sodium nitrate are formed in the reaction described in problem #2, what is the percent yield of this reaction?

$$\frac{6.00}{8.51} \times 100 = 70.5\%\ yield$$

3) *1000. grams of sodium chloride is combined with 2000. grams of barium phosphate.*

a) Write the balanced equation:

$$6NaCl + Ba_3(PO_4)_2 \longrightarrow 2Na_3PO_4 + 3BaCl_2$$

b). What is the limiting reactant?

$$1000g\ NaCl \times \frac{1mol\ NaCl}{58.5g} \times \frac{2mol\ Na_3PO_4}{6mol\ NaCl} = 5.70$$

$$2000g\ Ba_3(PO_4)_2 \times \frac{1mol\ Ba_3(PO_4)_2}{601.9} \times \frac{2mol\ Na_3PO_4}{1mol\ Ba_3(PO_4)_2} = 6.65$$

NaCl is the limiting reactant

c) How many grams of excess reactant are left?

$$1000g\ NaCl \times \frac{1mol\ NaCl}{58.5g} \times \frac{1mol\ Ba_3(PO_4)_2}{6mol\ NaCl} \times \frac{601.9g}{1mol} = 1715g\ Ba_3(PO_4)_2\ \underline{\text{used}}$$

2000.g have − 1715g used = 285g $Ba_3(PO_4)_2$ left over

4) *A chemist combines 5.00g of sodium with 150.0g of 15.0% by mass solution of magnesium chloride.*

Write a balanced equation for the reaction.

$$2Na + MgCl_2 \longrightarrow 2NaCl + Mg$$

a) Determine the mass of magnesium produced.

$$5.00g\ Na \times \frac{1mol\ Na}{23.0g} \times \frac{1mol\ Mg}{2mol\ Na} = .109\ mol\ Mg \times \frac{24.3g}{1mol\ Mg} = 2.65g\ Mg$$

$$(150 \times .15)g\ MgCl_2 \times \frac{1mol\ MgCl_2}{95.3g} \times \frac{1mol\ Mg}{1mol\ MgCl_2} = .236$$

b) Determine the number of grams of excess reactant.

$$5.00g\ Na \times \frac{1mol\ Na}{23.0g} \times \frac{1mol\ MgCl_2}{2mol\ Na} \times \frac{95.3g}{1mol\ MgCl_2} = 10.4g\ MgCl_2\ \text{used}$$

$(150 \times .15) = 22.5g\ MgCl_2$ in solution

22.5g have − 10.4g used = 12.1g of $MgCl_2$ remains

5) *4000. grams of heptane is combusted with 7000. grams of oxygen.*

$$C_7H_{16} + 11\,O_2 \rightarrow 7\,CO_2 + 8\,H_2O$$

a) What is the limiting reactant?

$4000g\ C_7H_{16} \times \frac{1\,mol\ C_7H_{16}}{100.2g} \times \frac{7\,mol\ CO_2}{1\,mol\ C_7H_{16}} = 279\ mol\ CO_2$

$\rightarrow 7000g\ O_2 \times \frac{1\,mol\ O_2}{32.0g} \times \frac{7\,mol\ CO_2}{11\,mol\ O_2} = 139\,mol\ CO_2$

O_2 is limiting

b) How many grams of carbon dioxide is produced?

$139\,mol\ CO_2 \times \frac{44.0g}{1\,mol} = 6125g\ CO_2$

c) How many grams of excess reactant are left?

$7000g\ O_2 \times \frac{1\,mol\ O_2}{32.0g} \times \frac{1\,mol\ C_7H_{16}}{11\,mol\ O_2} \times \frac{100.2g}{1\,mol\ C_7H_{16}} = 1992g\ C_7H_{16}$ used

$4000.g - 1992g = 2008g\ C_7H_{16}$ left over

(4000.g have; 1992g used)

6) *10.0g of zinc reacts with 10.0g of hydrochloric acid. The excess of this reaction is then reacted with 100.0g of silver nitrate. How many grams of silver are recovered?* → 100g must be in excess! ☺

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

$10g\ Zn \times \frac{1\,mol}{65.4g} \times \frac{1\,mol\ ZnCl_2}{1\,mol\ Zn} = .153$

limiting → $10g\ HCl \times \frac{1\,mol}{36.5g} \times \frac{1\,mol\ ZnCl_2}{2\,mol\ HCl} = .137$

$10g\ HCl \times \frac{1\,mol\ HCl}{36.5g} \times \frac{1\,mol\ Zn}{2\,mol\ HCl} \times \frac{65.4g}{1\,mol} = 8.96g$ used

$10 - 8.96 = 1.04g$ left over

$Zn + 2AgNO_3 \rightarrow Zn(NO_3)_2 + 2Ag$

$1.0g\ Zn \times \frac{1\,mol\ Zn}{65.4g\ Zn} \times \frac{2\,mol\ Ag}{1\,mol\ Zn} \times \frac{107.9g}{1\,mol\ Ag} =$

$3.43g\ Ag$

7) *12.5 g of copper are reacted with an excess of chlorine gas. If the percent yield is 90.2%, how many grams of copper (II) chloride are obtained?*

$Cu + Cl_2 \rightarrow CuCl_2$

$12.5g\ Cu \times \frac{1\,mol\ Cu}{63.5g} \times \frac{1\,mol\ CuCl_2}{1\,mol\ Cu} \times \frac{134.5g}{1\,mol\ CuCl_2} = 26.5g$ (theoretical)

$26.5 \times .902 = 23.9g$ actually made

8) *In the reaction of Zn with HCl, 140.15 g of $ZnCl_2$ was formed. If the percent yield is 87.2%, how many grams of zinc were originally used?*

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

$160.72g\ ZnCl_2 \times \frac{1\,mol\ ZnCl_2}{136.4g} \times \frac{1\,mol\ Zn}{1\,mol\ ZnCl_2} \times \frac{65.4g}{1\,mol\ Zn} = 77.061g\ Zn$

$\frac{act}{th} \times 100 = \%$

$\frac{140.15}{x} \times 100 = 87.2$

Theor. = 160.72