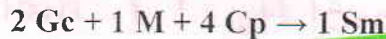


Worksheet 8.3 Limiting Reagent and Excess Reagent

Notes:

Balanced Reaction to make S'mores is given below.

SUBSTANCE



- (a) If you have 12 graham crackers and 12 chocolate pieces, how many S'mores can you **THEORETICALLY** make? (Calculate how many S'mores can be formed from 12 Gc and 12 Cp.)

$$12 \text{ Gc} \left| \frac{1 \text{ Sm}}{2 \text{ Gc}} = 6 \text{ Sm} \right. \quad 12 \text{ Cp} \left| \frac{1 \text{ Sm}}{4 \text{ Cp}} = 3 \text{ Sm} \right.$$

- (b) A reactant that is left over is said to be in **excess** and those that are used up limit the amount of product that can be made and are thus called **limiting reactants**. The maximum number of S'mores you could make is called the **theoretical yield**. Identify the limiting reagent and excess reagent.

Limiting Reagent: 12 chocolate pieces

Excess Reagent: 12 Graham crackers

- (c) Calculate the amount of excess reagent remaining.

$$12 \text{ Cp} \left| \frac{2 \text{ Gc}}{4 \text{ Cp}} = \frac{12(2)}{4} = 6 \text{ Gc USED} \right.$$

$$12 \text{ Gc AVAILABLE} - 6 \text{ Gc USED} = 6 \text{ Gc LEFTOVER}$$

For each problem:

- (a) Calculate the **theoretical yield** of GRAMS of product formed from each given reactant.
 (b) Determine the **limiting reagent and excess reagent**
 (c) Calculate the **GRAMS** of excess reagent remaining



$$3.6 \text{ mol Al} \left| \frac{2 \text{ mol AlCl}_3}{2 \text{ mol Al}} \right| \frac{133.5 \text{ g AlCl}_3}{1 \text{ mol AlCl}_3} = 481 \text{ g AlCl}_3$$

$$5.3 \text{ mol Cl}_2 \left| \frac{2 \text{ mol AlCl}_3}{3 \text{ mol Cl}_2} \right| \frac{133.5 \text{ g AlCl}_3}{1 \text{ mol AlCl}_3} = 472 \text{ g AlCl}_3$$

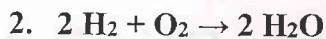
1b. Limiting Reagent:

Excess Reagent:

1c.

$$3.6 \text{ mol Al} \left| \frac{27 \text{ g Al}}{1 \text{ mol Al}} = 97.2 \text{ g Al AVAILABLE} \right.$$

$$5.30 \text{ mol Cl}_2 \left| \frac{2 \text{ mol Al}}{3 \text{ mol Cl}_2} \right| \frac{27 \text{ g Al}}{1 \text{ mol Al}} = 95.4 \text{ g Al USED}$$



6.4 mol H_2 & 108.8g O_2

2a. $6.40 \text{ mol H}_2 \left| \frac{2 \text{ mol H}_2\text{O}}{2 \text{ mol H}_2} \right| \frac{18 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 115 \text{ g H}_2\text{O}$

$108.8 \text{ g O}_2 \left| \frac{1 \text{ mol O}_2}{32 \text{ g O}_2} \right| \frac{2 \text{ mol H}_2\text{O}}{1 \text{ mol O}_2} \left| \frac{18 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 122.4 \text{ g H}_2\text{O}$

2b. Limiting Reagent: 6.40 mol H_2

Excess Reagent: 108.8 g O_2

2c. 108.8g O_2 AVAILABLE

$6.40 \text{ mol H}_2 \left| \frac{1 \text{ mol O}_2}{2 \text{ mol H}_2} \right| \frac{18 \text{ g O}_2}{1 \text{ mol O}_2} = 57.6 \text{ g O}_2 \text{ USED}$

$108.8 \text{ g O}_2 \text{ AVAILABLE} - 57.6 \text{ g O}_2 \text{ USED} = 51.2 \text{ g O}_2 \text{ LEFT OVER}$



68.13 g P_2O_5 & 1.52 mol H_2O

3a. $68.13 \text{ g P}_2\text{O}_5 \left| \frac{1 \text{ mol P}_2\text{O}_5}{142 \text{ g P}_2\text{O}_5} \right| \frac{4 \text{ mol H}_3\text{PO}_4}{2 \text{ mol P}_2\text{O}_5} \left| \frac{98 \text{ g H}_3\text{PO}_4}{1 \text{ mol H}_3\text{PO}_4} = 94.04 \text{ g H}_3\text{PO}_4$

$1.52 \text{ mol H}_2\text{O} \left| \frac{4 \text{ mol H}_3\text{PO}_4}{6 \text{ mol H}_2\text{O}} \right| \frac{98 \text{ g H}_3\text{PO}_4}{1 \text{ mol H}_3\text{PO}_4} = 99.3 \text{ g H}_3\text{PO}_4$

3b. Limiting Reagent: 68.13 g P_2O_5

Excess Reagent: 1.52 mol H_2O

3c. $1.52 \text{ mol H}_2\text{O} \left| \frac{18 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 27.4 \text{ g H}_2\text{O AVAILABLE}$

$68.13 \text{ g P}_2\text{O}_5 \left| \frac{1 \text{ mol P}_2\text{O}_5}{142 \text{ g P}_2\text{O}_5} \right| \frac{6 \text{ mol H}_2\text{O}}{2 \text{ mol P}_2\text{O}_5} \left| \frac{18 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 25.91 \text{ g H}_2\text{O USED}$

$27.4 \text{ g H}_2\text{O AVAILABLE} - 25.91 \text{ g H}_2\text{O USED} = 1.49 \approx 1.5 \text{ g H}_2\text{O LEFT OVER}$



4a. $449.07 \text{ g P} \left| \frac{1 \text{ mol P}}{31 \text{ g P}} \right| \frac{2 \text{ mol P}_2\text{O}_5}{4 \text{ mol P}} \left| \frac{142 \text{ g P}_2\text{O}_5}{1 \text{ mol P}_2\text{O}_5} \right| = 1028.5 \text{ g P}_2\text{O}_5$

$114 \text{ g O}_2 \left| \frac{1 \text{ mol O}_2}{32 \text{ g O}_2} \right| \frac{2 \text{ mol P}_2\text{O}_5}{5 \text{ mol O}_2} \left| \frac{142 \text{ g P}_2\text{O}_5}{1 \text{ mol P}_2\text{O}_5} \right| = 202 \text{ g P}_2\text{O}_5$

4b. Limiting Reagent: 114 g O₂

Excess Reagent: 449.07 g P

4c. 449.07 g P AVAILABLE

$114 \text{ g O}_2 \left| \frac{1 \text{ mol O}_2}{32 \text{ g O}_2} \right| \frac{4 \text{ mol P}}{5 \text{ mol O}_2} \left| \frac{31 \text{ g P}}{1 \text{ mol P}} \right| = 88.4 \text{ g P USED}$

$449.07 \text{ g P AVAILABLE} - 88.4 \text{ g P USED} = 360.7 \text{ g P LEFT OVER}$



$28 \text{ g N}_2 + 25 \text{ g H}_2$

5a.

$28 \text{ g N}_2 \left| \frac{1 \text{ mol N}_2}{28 \text{ g N}_2} \right| \frac{2 \text{ mol NH}_3}{1 \text{ mol N}_2} \left| \frac{17 \text{ g NH}_3}{1 \text{ mol NH}_3} \right| = 34 \text{ g NH}_3$

$25 \text{ g H}_2 \left| \frac{1 \text{ mol H}_2}{2 \text{ g H}_2} \right| \frac{2 \text{ mol NH}_3}{3 \text{ mol H}_2} \left| \frac{17 \text{ g NH}_3}{1 \text{ mol NH}_3} \right| = 140 \text{ g NH}_3$

5b. Limiting Reagent: 28 g N₂

Excess Reagent: 25 g H₂

5c.

25 g H₂ AVAILABLE

$28 \text{ g N}_2 \left| \frac{1 \text{ mol N}_2}{28 \text{ g N}_2} \right| \frac{3 \text{ mol H}_2}{1 \text{ mol N}_2} \left| \frac{2 \text{ g H}_2}{1 \text{ mol H}_2} \right| = 6 \text{ g H}_2 \text{ USED}$

$25 \text{ g H}_2 \text{ AVAILABLE} - 6 \text{ g H}_2 \text{ USED} = 19 \text{ g LEFT OVER}$

You CAN CHOOSE



$50.0\text{ g Mg} + 75.0\text{ g HCl}$

6a. $50.0\text{ g Mg} \left| \frac{1\text{ mol Mg}}{24\text{ g Mg}} \right| \frac{1\text{ mol H}_2}{1\text{ mol Mg}} \left| \frac{2\text{ g H}_2}{1\text{ mol H}_2} \right| = 4.17\text{ g H}_2$

$75.0\text{ g HCl} \left| \frac{1\text{ mol HCl}}{36.5\text{ g HCl}} \right| \frac{1\text{ mol H}_2}{2\text{ mol HCl}} \left| \frac{2\text{ g H}_2}{1\text{ mol H}_2} \right| = 2.05\text{ g H}_2$

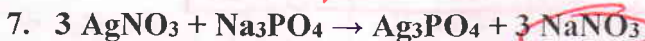
6b. Limiting Reagent: 75.0 g HCl Excess Reagent: 50.0 g Mg

6c. $50.0\text{ g Mg AVAILABLE}$

$75.0\text{ g HCl} \left| \frac{1\text{ mol HCl}}{36.5\text{ g HCl}} \right| \frac{1\text{ mol Mg}}{2\text{ mol HCl}} \left| \frac{24\text{ g Mg}}{1\text{ mol Mg}} \right| = 24.7\text{ g Mg USED}$

$50.0\text{ g Mg AVAILABLE} - 24.7\text{ g Mg USED} = 25.3\text{ g Mg LEFT}$

You CAN CHOOSE



$200.\text{ g AgNO}_3 + 200.\text{ g Na}_3\text{PO}_4$

7a.

$200.\text{ g AgNO}_3 \left| \frac{1\text{ mol AgNO}_3}{170\text{ g AgNO}_3} \right| \frac{3\text{ mol NaNO}_3}{3\text{ mol AgNO}_3} \left| \frac{85\text{ g NaNO}_3}{1\text{ mol NaNO}_3} \right| = 100.\text{ g NaNO}_3$

$200.\text{ g Na}_3\text{PO}_4 \left| \frac{1\text{ mol Na}_3\text{PO}_4}{164\text{ g Na}_3\text{PO}_4} \right| \frac{3\text{ mol NaNO}_3}{1\text{ mol Na}_3\text{PO}_4} \left| \frac{85\text{ g NaNO}_3}{1\text{ mol NaNO}_3} \right| = 311\text{ g NaNO}_3$

7b. Limiting Reagent: $200.\text{ g AgNO}_3$ Excess Reagent: $200.\text{ g Na}_3\text{PO}_4$

7c. $200.\text{ g Na}_3\text{PO}_4 AVAILABLE$

$200.\text{ g AgNO}_3 \left| \frac{1\text{ mol AgNO}_3}{170\text{ g AgNO}_3} \right| \frac{1\text{ mol Na}_3\text{PO}_4}{3\text{ mol AgNO}_3} \left| \frac{164\text{ g Na}_3\text{PO}_4}{1\text{ mol Na}_3\text{PO}_4} \right| = 64.3\text{ g Na}_3\text{PO}_4 USED$

$200.\text{ g Na}_3\text{PO}_4 AVAILABLE - 64.3\text{ g Na}_3\text{PO}_4 USED = 135.7\text{ g Na}_3\text{PO}_4 LEFT OVER$