Name_____ Date____/____/____ Period____

Worksheet 8.3 Limiting Reagent and Excess Reagent

Notes:

Balanced Reaction to make S'mores is given below. SUBSTANCE

2 Gc + 1 M + 4 Cp → 1 Sm

(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.

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

$6\ Sm \left| \frac{4\ Cp}{1\ Sm} \right. = 24\ Cp$

(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.

START W/ LIMITING

Limiting Reagent: 12 chocolate pieces Excess Regent: 12 Graham crackers

(c) Calculate the amount of excess reagent remaining. 12 Gc AVAILABLE

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

12 Gc AVAILABLE − 6 Gc USED = 6 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

1. **2 Al + 3 Cl_2 → 2 $AlCl_3$** (B) **3.6 mol Al** (A) **& 5.3 mol Cl_2** (A)

1a.

$27+3(35.5)$

U — MOL A — MOL B — U

G — G

$3.6\ mol\ Al \left| \frac{2\ mol\ AlCl_3}{2\ mol\ Al} \right. \left| \frac{133.5\ g\ AlCl_3}{1\ mol\ AlCl_3} \right. = 481\ g\ AlCl_3$

$5.3\ mol\ Cl_2 \left| \frac{2\ mol\ AlCl_3}{3\ mol\ Cl_2} \right. \left| \frac{133.5\ g\ AlCl_3}{1\ mol\ AlCl_3} \right. = 472\ g\ AlCl_3$

1b. Limiting Reagent: 5.30 mol Cl_2 Excess Reagent: 3.6 mol Al

1c.

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

$5.30\ mol\ Cl_2 \left| \frac{2\ mol\ Al}{3\ mol\ Cl_2} \right. \left| \frac{27\ g\ Al}{1\ mol\ Al} \right. = 95.4\ g\ Al$ USED

2. $2\ H_2 + O_2 \rightarrow 2\ H_2O$ **6.40 mol H_2 & 108.8g O_2**

2a. $6.40\ mol\ H_2 \left| \frac{2\ mol\ H_2O}{2\ mol\ H_2} \right| \frac{18\ g\ H_2O}{1\ mol\ H_2O} = 115\ g\ H_2O$

$108.8\ g\ O_2 \left| \frac{1\ mol\ O_2}{32\ g\ O_2} \right| \frac{2\ mol\ H_2O}{1\ mol\ O_2} \left| \frac{18\ g\ H_2O}{1\ mol\ H_2O} \right| = 122.4\ g\ H_2O$

2b. Limiting Reagent: $6.40\ mol\ H_2$ Excess Reagent: $108.8\ g\ O_2$

2c. $108.8\ g\ O_2$ AVAILABLE

$6.40\ mol\ H_2 \left| \frac{1\ mol\ O_2}{2\ mol\ H_2} \right| \frac{18\ g\ O_2}{1\ mol\ O_2} = 57.6\ g\ O_2$ USED

$108.8\ g\ O_2$ AVAILABLE $- 57.6\ g\ O_2$ USED $= 51.2\ g\ O_2$ LEFT OVER

3. $2\ P_2O_5 + 6\ H_2O \rightarrow 4\ H_3PO_4$ **68.13 g P_2O_5 & 1.52 mol H_2O**

3a. $68.13\ g\ P_2O_5 \left| \frac{1\ mol\ P_2O_5}{142\ g\ P_2O_5} \right| \frac{4\ mol\ H_3PO_4}{2\ mol\ P_2O_5} \left| \frac{98\ g\ H_3PO_4}{1\ mol\ H_3PO_4} \right| = 94.04\ g\ H_3PO_4$

$1.52\ mol\ H_2O \left| \frac{4\ mol\ H_3PO_4}{6\ mol\ H_2O} \right| \frac{98\ g\ H_3PO_4}{1\ mol\ H_3PO_4} = 99.3\ g\ H_3PO_4$

3b. Limiting Reagent: $68.13\ g\ P_2O_5$ Excess Reagent: $1.52\ mol\ H_2O$

3c. $1.52\ mol\ H_2O \left| \frac{18\ g\ H_2O}{1\ mol\ H_2O} \right| = 27.4\ g\ H_2O$ AVAILABLE

$68.13\ g\ P_2O_5 \left| \frac{1\ mol\ P_2O_5}{142\ g\ P_2O_5} \right| \frac{6\ mol\ H_2O}{2\ mol\ P_2O_5} \left| \frac{18\ g\ H_2O}{1\ mol\ H_2O} \right| = 25.91\ g\ H_2O$ USED

$27.4\ g\ H_2O$ AVAILABLE $- 25.91\ g\ H_2O$ USED $= 1.49$

$\approx 1.5\ g\ H_2O$ LEFT OVER

4. $4\ P + 5\ O_2 \rightarrow 2\ P_2O_5$ P 449.07 g & 114 g O_2

4a. $449.07\ g\ P \left| \frac{1\ mol\ P}{31\ g\ P} \right| \frac{2\ mol\ P_2O_5}{4\ mol\ P} \left| \frac{142\ g\ P_2O_5}{1\ mol\ P_2O_5} \right. = 1028.5\ g\ P_2O_5$

$114\ g\ O_2 \left| \frac{1\ mol\ O_2}{32\ g\ O_2} \right| \frac{2\ mol\ P_2O_5}{5\ mol\ O_2} \left| \frac{142\ g\ P_2O_5}{1\ mol\ P_2O_5} \right. = 202\ g\ P_2O_5$

4b. Limiting Reagent: $114\ g\ O_2$ Excess Reagent: $449.07\ g\ P$

4c. $449.07\ g\ P$ AVAILABLE

$114\ g\ O_2 \left| \frac{1\ mol\ O_2}{32\ g\ O_2} \right| \frac{4\ mol\ P}{5\ mol\ O_2} \left| \frac{31\ g\ P}{1\ mol\ P} \right. = 88.4\ g\ P$ USED

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

5. $N_2 + 3\ H_2 \rightarrow 2\ NH_3$

$28\ g\ N_2 + 25\ g\ H_2$

5a.

$28\ g\ N_2 \left| \frac{1\ mol\ N_2}{28\ g\ N_2} \right| \frac{2\ mol\ NH_3}{1\ mol\ N_2} \left| \frac{17\ g\ NH_3}{1\ mol\ NH_3} \right. = 34\ g\ NH_3$

$25\ g\ H_2 \left| \frac{1\ mol\ H_2}{2\ g\ H_2} \right| \frac{2\ mol\ NH_3}{3\ mol\ H_2} \left| \frac{17\ g\ NH_3}{1\ mol\ NH_3} \right. = 140\ g\ NH_3$

5b. Limiting Reagent: $28\ g\ N_2$ Excess Reagent: $25\ g\ H_2$

5c. $25\ g\ H_2$ AVAILABLE

$28\ g\ N_2 \left| \frac{1\ mol\ N_2}{28\ g\ N_2} \right| \frac{3\ mol\ H_2}{1\ mol\ N_2} \left| \frac{2\ g\ H_2}{1\ mol\ H_2} \right. = 6\ g\ H_2$ USED

$25\ g\ H_2$ AVAILABLE $- 6\ g\ H_2$ USED $= 19\ g$ LEFT OVER

YOU CAN CHOOSE

6. $Mg + 2\,HCl \rightarrow MgCl_2 + H_2$ — 50.0 g Mg + 75.0 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 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 g Mg AVAILABLE − 24.7 g Mg USED = 25.3 g Mg LEFT

YOU CAN CHOOSE

7. $3\,AgNO_3 + Na_3PO_4 \rightarrow Ag_3PO_4 + 3\,NaNO_3$ — 200. g $AgNO_3$ + 200. g Na_3PO_4

7a.

$200.\text{ g }AgNO_3\left|\frac{1\text{ mol }AgNO_3}{170\text{ g }AgNO_3}\right|\frac{3\text{ mol }NaNO_3}{3\text{ mol }AgNO_3}\left|\frac{85\text{ g }NaNO_3}{1\text{ mol }NaNO_3}\right| = 100.\text{ g }NaNO_3$

$200.\text{ g }Na_3PO_4\left|\frac{1\text{ mol }Na_3PO_4}{164\text{ g }Na_3PO_4}\right|\frac{3\text{ mol }NaNO_3}{1\text{ mol }Na_3PO_4}\left|\frac{85\text{ g }NaNO_3}{1\text{ mol }NaNO_3}\right| = 311\text{ g }NaNO_3$

7b. Limiting Reagent: 200 g $AgNO_3$ Excess Reagent: 200. g Na_3PO_4

7c. 200. g Na_3PO_4 AVAILABLE

$200.\text{ g }AgNO_3\left|\frac{1\text{ mol }AgNO_3}{170\text{ g }AgNO_3}\right|\frac{1\text{ mol }Na_3PO_4}{3\text{ mol }AgNO_3}\left|\frac{164\text{ g }Na_3PO_4}{1\text{ mol }Na_3PO_4}\right| = 64.3\text{ g}$ USED Na_3PO_4

200. g Na_3PO_4 AVAILABLE − 64.3 g USED = 135.7 g Na_3PO_4 LEFT OVER