CW: Limiting & Excess Reactants

Define -

Limiting reactant - find these in video notes

Excess reactant -

Question 1)

Balance:

$$\underline{2}\ HCl + \underline{\quad}\ Ba(OH)_2 \rightarrow \underline{\quad}\ BaCl_2 + \underline{2}\ H_2O$$

If 2.0 mol of HCl reacts with 2.5mol of $Ba(OH)_2$ ....

1. How many moles of each product can be made?

   $BaCl_2$ = _____ H_2O = _____

	$2\ HCl$	+ $Ba(OH)_2$	→ $BaCl_2$	+ H_2O
	2.0 mol	2.5 mol	0	0
C	$-2x$	$-x$	$+x$	$+2x$
E	0 mol	1.5 mol	1.0 mol	2.0 mol

$2.0 - 2x = 0$, $x = 1.0$ mol

$2.5 - x = 0$, $x = 2.5$

2. Which is the limiting reactant?

   HCl

3. Which is the excess reactant?

   $Ba(OH)_2$

4. Which reactant do you use to determine the amount of product? LR

5. How many grams of water are ACTUALLY produced?

$$2.0\ mol\ H_2O \left| \frac{18.016\ g\ H_2O}{1\ mol\ H_2O} \right. = 36.032\ g\ H_2O$$

= 36g H_2O

6. How many grams of $BaCl_2$ are ACTUALLY produced?

$$1.0\ mol\ BaCl_2 \left| \frac{208.28\ g\ BaCl_2}{1\ mol\ BaCl_2} \right. = 208.28\ g\ BaCl_2$$

210g $BaCl_2$

estion #2)

$$\underline{2}\ HCl + \underline{\quad}\ Ba(OH)_2 \rightarrow \underline{\quad}\ BaCl_2 + \underline{2}\ H_2O$$

f 4.0 mol of HCl reacts with 4.5mol of $Ba(OH)_2$ ....

1. Which is the limiting reactant?

	$2\,HCl$	+	$Ba(OH)_2$	→	$BaCl_2$	+	$2\,H_2O$
I	4.0 mol		4.5 mol		0		0
C	$+2x$		$-x$		$+x$		$+2x$
E	0 mol		2.5 mol		2.0 mol		4.0 mol

$4.0 - 2x = 0$

$x = 2.0$

$4.5 - x = 0$

$x = 4.5$

2. Which is the excess reactant?

$Ba(OH)_2$

3. Which reactant do you use to determine the amount of product?

HCl (limiting reactant)

4. How many grams of water are produced?

$$4.0\,\text{mol}\ H_2O \left| \frac{18.016\ g\ H_2O}{1\ \text{mol}\ H_2O} \right. = 72\ g\ H_2O$$

5. How many grams of $BaCl_2$ are produced?

$$2.0\,\text{mol}\ BaCl_2 \left| \frac{208.28\ g\ BaCl_2}{1\ \text{mol}\ BaCl_2} \right. = 416.56 \rightarrow 420\ g\ BaCl_2$$

Question 3)

Given: $2Mg + O_2 \dashrightarrow 2MgO$ If 1.00 g Mg reacts with 0.500 L O_2 at STP, how many g MgO will be produced? (Remember to identify the limiting reactant.)

LR →

	$2\,Mg$	+	O_2	→	$2\,MgO$
I	0.0411 mol		0.0223 mol		0
C	$-2x$		$-x$		$+2x$
E	0 mol		0.0017 mol		0.0412 mol

$$1.00\,g\ Mg \left| \frac{1\ \text{mol}}{24.31\ g} \right. = 0.0411\,\text{mol}$$

$$0.500\,L\ O_2 \left| \frac{1\ \text{mol}\ O_2}{22.4\ L\ O_2} \right. = 0.0223\,\text{mol}$$

$0.0411 - 2x = 0$

$x = 0.0206$

$0.0223 - x = 0$

$x = 0.0223$

$$0.0412\,\text{mol}\ MgO \left| \frac{40.31\ g\ MgO}{1\ \text{mol}\ MgO} \right. = 1.66\,g\ MgO$$

Question 4) If 10.0 g NO reacts with 7.0 g O_2, how many g NO_2 are produced? (Write a balanced equation & Identify your limiting reactant!!

$$2NO + O_2 \rightarrow 2NO_2$$

	$2NO$	$+ O_2$	$\rightarrow 2NO_2$
I	0.333 mol	0.219	0
C	$-2x$	$-x$	$+2x$
E	0	0.0520	0.334

$10.0\text{ g NO} \left| \frac{1\text{ mol NO}}{30.01\text{ g NO}} \right. = 0.333\text{ mol NO}$

$7.0\text{ g } O_2 \left| \frac{1\text{ mol } O_2}{32.00\text{ g } O_2} \right. = 0.219\text{ mol } O_2$

$0.333 - 2x = 0$

$x = .167$

$0.219 - x = 0$

$x = 0.219$

$0.334\text{ mol } NO_2 \left| \frac{46.01\text{ g}}{1\text{ mol}} \right. = 15.4\text{ g } NO_2$

Question 5) Given: Sodium reacts with water to produce sodium hydroxide and hydrogen gas.

a) If 90.0 grams Na is dropped into 80.0 g H_2O, how many liters of $H_2(g)$ will be produced at STP by the given reaction?

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

	$2Na$	$+ 2H_2O$	$\rightarrow 2NaOH$	$+ H_2$
I	3.91 mol	4.44 mol	0	0
C	$-2x$	$-2x$	$+2x$	$+x$
E	0	0.520	3.92	1.96

$90.0\text{ g Na} \left| \frac{1\text{ mol Na}}{22.99\text{ g Na}} \right. = 3.91\text{ mol}$

$80.0\text{ g } H_2O \left| \frac{1\text{ mol } H_2O}{18.016\text{ g } H_2O} \right. = 4.441\text{ mol}$

$3.91 - 2x = 0$

$x = 1.96$

$4.44 - 2x = 0$

$x = 2.22$

$1.96\text{ mol } H_2 \left| \frac{22.4\text{ L } H_2}{1\text{ mol } H_2} \right. = 43.9\text{ L } H_2$

b) How much of the excess reactant is left over?

$0.520\text{ mol } H_2O$

Percent, Actual, and Theoretical Yield

1) $LiOH + KCl \rightarrow LiCl + KOH$

a) I began this reaction with 20 grams of lithium hydroxide. What is my theoretical yield of lithium chloride?

$$\frac{20\text{ g LiOH}}{23.949\text{ g LiOH}} \left| \frac{1\text{ mol LiOH}}{1\text{ mol LiOH}} \right| \frac{1\text{ mol LiCl}}{1\text{ mol LiCl}} \left| \frac{42.391\text{ g LiCl}}{1\text{ mol LiCl}} \right| = 40\text{ g LiCl}$$

b) I actually produced 6 grams of lithium chloride. What is my percent yield?

$$\frac{6\text{ g}}{40\text{ g}} \times 100 = 15\% \rightarrow 20\%$$

2) $C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$

a) If I start with 5 grams of C_3H_8, what is my theoretical yield of water?

$$\frac{5\text{ g } C_3H_8}{44.094\text{ g } C_3H_8} \left| \frac{1\text{ mol } C_3H_8}{1\text{ mol } C_3H_8} \right| \frac{4\text{ mol } H_2O}{1\text{ mol } H_2O} \left| \frac{18.016\text{ g } H_2O}{1\text{ mol } H_2O} \right| = 8\text{ g } H_2O$$

b) I got a percent yield of 75% How many grams of water did I make?

$$75\% = 100 \times \frac{x}{8} \rightarrow 8 \times .75 = \frac{x}{8} \times 8$$

$$6\text{g} = x$$

3) $Be + 2\ HCl \rightarrow BeCl_2 + H_2$

My theoretical yield of beryllium chloride was 10.7 grams. If my actual yield was 4.5 grams, what was my percent yield?

$$\frac{4.5\text{g}}{10.7\text{g}} \times 100 = 42\ \%$$

4) $2\ NaCl + CaO \rightarrow CaCl_2 + Na_2O$

What is my theoretical yield of sodium oxide if I start with 20 grams of calcium oxide?

$$\frac{20\text{g CaO}}{56.08\text{ g CaO}} \left| \frac{1\text{ mol CaO}}{1\text{ mol CaO}} \right| \frac{1\text{ mol } Na_2O}{1\text{ mol } Na_2O} \left| \frac{61.48\text{ g } Na_2O}{1\text{ mol } Na_2O} \right| = 22\text{ g } Na_2O \rightarrow 20\text{g } Na_2O$$

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5) $FeBr_2 + 2\ KCl \rightarrow FeCl_2 + 2\ KBr$

a) What is my theoretical yield of iron (II) chloride if I start with 34 grams of iron (II) bromide?

$$\frac{34\text{ g } FeBr_2}{} \left| \frac{1\text{ mol } FeBr_2}{215.65\text{ g } FeBr_2} \right| \frac{1\text{ mol } FeCl_2}{1\text{ mol } FeBr_2} \left| \frac{126.75\text{ g } FeCl_2}{1\text{ mol } FeCl_2} \right. = 20\text{ g } FeCl_2$$

b) What is my percent yield of iron (II) chloride if my actual yield is 4 grams?

$$\frac{4\text{ g}}{20\text{ g}} \times 100 = 20\ \%$$

6) $TiS + H_2O \rightarrow H_2S + TiO$

What is my percent yield of titanium (II) oxide if I start with 20 grams of titanium (II) sulfide and my actual yield of titanium (II) oxide is ~~22~~ 12 grams?

$$\frac{20\text{g } TiS}{} \left| \frac{1\text{ mol } TiS}{79.95\text{ g } TiS} \right| \frac{1\text{ mol } TiO}{1\text{ mol } TiS} \left| \frac{63.88\text{ g } TiO}{1\text{ mol } TiO} \right.$$

$$= 15.9 \rightarrow 20\text{ g}$$

$$\frac{12}{20} \times 100 = 60\ \%$$

7) $U + 3\ Br_2 \rightarrow UBr_6$

What is my actual yield of uranium hexabromide if I start with 100 grams of uranium and get a percent yield of 83% ?

$$\frac{100\text{g } U}{} \left| \frac{1\text{ mol } U}{238.04\text{g } U} \right| \frac{1\text{ mol } UBr_3}{1\text{ mol } U} \left| \frac{477.74\text{ g } UBr_3}{1\text{ mol } UBr_3} \right. = 200\text{g } UBr_3$$

$$83\ \% = 100 \times \frac{X}{200}$$

$$X = 166\text{ g}$$

8) $H_2SO_4 \rightarrow H_2O + SO_3$

If I start with 89 grams of sulfuric acid and produce 7.1 grams of water, what is my percent yield?

$$\frac{89\text{g } H_2SO_4}{} \left| \frac{1\text{ mol } H_2SO_4}{98.086\text{ g } H_2SO_4} \right| \frac{1\text{ mol } H_2O}{1\text{ mol } H_2SO_4} \left| \frac{18.016\text{ g } H_2O}{1\text{ mol } H_2O} \right.$$

$$= 16\text{g } H_2O$$

$$\frac{7.1}{16} \times 100 = 44\ \%$$

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