Stoichiometry Worksheet 2:

Percent Yield

For each of the problems:

a. Write the balanced chemical equation

b. Identify the given (with units) and what you want to find (with units)

c. Show set up with units. Check sig figs, give final answer with units and label.

- 1. Using the Hoffman apparatus for electrolysis, a chemist decomposes 36 g of water into its gaseous elements. How many grams of hydrogen gas should she get (theoretical yield)?

Equation:	2 H_2O	→	O_2	+ 2H_2
Before:				
Change:				
After:				

Change grams to moles!

Only moles go in the BCA table!

- 36 g x $\frac{1 \text{ mole } H_20}{18.02 \text{ g}}$ =2.0 mole

- 1. Using the Hoffman apparatus for electrolysis, a chemist decomposes 36 g of water into its gaseous elements. How many grams of hydrogen gas should she get (theoretical yield)?

Equation:	$2\ H_2O$	→	O_2	$+\ 2H_2$
Before:	2.0		0	0
Change:				
After:				

Calculate the change!

$$2.0\,mol\ \ H_2O \times \frac{2\,mol\ \ H_2}{2\,mol\ \ H_2O} = 2\,mol\ \ H_2$$

$$2.0\,mol\ \ H_2O \times \frac{1\,mol\ \ O_2}{2\,mol\ \ H_2O} = 1\,mol\ \ 0_2$$

Equation:	2 H_2O	→	O_2	+ 2H_2
Before:	2.0		0	0
Change:				
After:				

- 1. Using the Hoffman apparatus for electrolysis, a chemist decomposes 36 g of water into its gaseous elements. How many grams of hydrogen gas should she get (theoretical yield)?

Equation:	2 H_2O	→	O_2	+ 2H_2
Before:	2.0		0	0
Change:	-2.0		1.0	2.0
After:	0		1.0	2.0

Change moles to grams!

- $2.0 \text{ mole} \times \frac{2.02 \text{ g}}{1 \text{ mole } H_2} = 4.0 \text{ g } H_2$

- 2. Recall that liquid sodium reacts with chlorine gas to produce sodium chloride. You want to produce 581 g of sodium chloride. How many grams of sodium are needed?

Equation:	2 Na +	Cl_2	→	2 NaCl
Before:				
Change:				
After:				

Change grams to moles!

- 581 g of NaCl x $\frac{\text{1 mole } H_20}{58.44 \text{ g}}$ =9.94 mole

Na :	22.99
Cl:	+35.45
NaCl:	58.44g

- 2. Recall that liquid sodium reacts with chlorine gas to produce sodium chloride. You want to produce 581 g of sodium chloride. How many grams of sodium are needed?

Equation:	2 Na +	Cl_2	→	2 NaCl
Before:	?	XS		0
Change:				9.94
After:				9.94

$$9.94\,mol\,NaCl \times \frac{1\,mol\,Cl_2}{2\,mol\,NaCl} = 4.97\,mol\,Cl_2$$

$$9.94\,mol\,NaCl \times \frac{2\,mol\,Na}{2\,mol\,NaCl} = 9.94\,mol\,Na$$

Equation:	2 Na +	Cl_2	→	2 NaCl
Before:	9.94	XS		0
Change:	-9.94	-4.97		9.94
After:	0	XS		9.94

Change moles to grams!

- 9.94 mole Na x $\frac{22.99 \text{ g}}{1 \text{ mole Na}}$ =228 g Na

- 3. You eat 180.0 g of glucose (90 M&Ms). If glucose, $C_6H_{12}O_6$, reacts with oxygen gas to produce carbon dioxide and water, how many grams of oxygen will you have to breathe in to burn the glucose?

Equation: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

Before:

Change:

After:

Change grams to moles!

- 180.0 g of $C_6H_{12}O_6$ x $\frac{\text{1 mole } H_20}{180.18 \text{ g}}$ =0.9990 mole

6C : 6(12.01)

12H: 12(1.01)

6O: +6(16.00)

180.18g

- 3. You eat 180.0 g of glucose (90 M&Ms). If glucose, $C_6H_{12}O_6$, reacts with oxygen gas to produce carbon dioxide and water, how many grams of oxygen will you have to breathe in to burn the glucose?

Equation:	$C_6H_{12}O_6$	$+ 6O_2$	$\rightarrow$	$6CO_2$	$+ 6H_2O$
Before:	0.9990	XS		0	0
Change:					
After:					

$$.9990mol \times \frac{6molO_2}{1mol} = 5.994molO_2$$

$$.9990mol \times \frac{6molCO_2}{1mol} = 5.994molCO_2$$

$$.9990mol \times \frac{6molH_2O}{1mol} = 5.994molH_2O$$

Equation:	$C_6H_{12}O_6$	$+ 6O_2$	$\rightarrow$ $6CO_2$	$+ 6H_2O$
Before:	0.9990	XS	0	0
Change:	-0.9990	-5.994	5.994	5.994
After:	0	XS	5.994	5.994

Change moles to grams!

- $5.994 \text{ mole } O_2 \times \frac{32.00 \text{ g}}{1 \text{ mole } O_2} = 191.8 \text{ g } O_2$

4. Suppose 4.61 g of zinc was allowed to react with hydrochloric acid to produce zinc chloride and hydrogen gas. How much zinc chloride should you get?

Suppose that you actually recovered 8.56 g of zinc chloride. What is your percent yield?

Equation:	Zn +	2 HCl	$\rightarrow$	$ZnCl_2$	+ H_2
Before:					
Change:					
After:					

Change grams to moles!

- 4.61 g of Zn x $\frac{1 \text{ mole Zn}}{65.38 \text{ g}}$ =0.0705 mole

4. Suppose 4.61 g of zinc was allowed to react with hydrochloric acid to produce zinc chloride and hydrogen gas. How much zinc chloride should you get?

Suppose that you actually recovered 8.56 g of zinc chloride. What is your percent yield?

Equation:	Zn +	2 HCl	$\rightarrow$ $ZnCl_2$	+ H_2
Before:	0.0705	XS	0	0
Change:	- 0.0705	-0.141	0.0705	0.0705
After:	0	XS	0.0705	0.0705

Change moles to grams!

- 0.0705 mole $ZnCl_2$ x $\frac{136.28\ g}{1\ mole\ ZnCl_2}$ =9.61 g $ZnCl_2$

4. Suppose 4.61 g of zinc was allowed to react with hydrochloric acid to produce zinc chloride and hydrogen gas. How much zinc chloride should you get?

Suppose that you actually recovered 8.56 g of zinc chloride. What is your percent yield?

Equation:	Zn +	$2\ HCl$	$\rightarrow$ $ZnCl_2$	+ H_2
Before:	0.0705	XS	0	0
Change:	- 0.0705	-0.141	0.0705	0.0705
After:	0	XS	0.0705	0.0705

Find %Yield!

- $0.0705 \text{ mole } ZnCl_2 \times \frac{136.28 \text{ g}}{1 \text{ mole } ZnCl_2} = 9.61 \text{ g } ZnCl_2$

$$\%Yield = \frac{\text{ACTUAL}}{\text{THEORETICAL}} \times 100$$

$$= \frac{8.56 \text{ g}}{9.61 \text{ g}} \times 100 = 89.1\% \text{ yield}$$

- 5. Determine the mass of carbon dioxide that should be produced in the reaction between 3.74 g of carbon and excess O_2. What is the % yield if 11.34 g of CO_2 is recovered?

Equation:	C	+ O_2	→	CO_2
Before:	0.311	XS		0
Change:	- 0.311	- 0.311		0.311
After:	0	XS		0.311

Calculations

$$3.74 gC \times \frac{1 molC}{12.01 g} = 0.311 molC$$

$$0.311 molC \times \frac{1 molCO_2}{1 molC} = 0.311 molCO_2$$

$$0.311 molCO_2 \times \frac{44.01 gCO_2}{1 molCO_2} = 13.7 gCO_2$$

$$\frac{11.34\ g\ CO_2}{13.7\ g\ CO_2} \times 100\% = 82.8\ \%\ yield$$

- 6. In the reaction between excess K(s) and 4.28 g of O_2(g), potassium oxide is formed . What mass would you *expect* to form (theoretical yield)? If 17.36 g of K_2O is *actually* produced, what is the percent yield?

Equation:	4K +	O_2	→	$2K_2O$
Before:				
Change:				
After:				

- 6. In the reaction between excess K(s) and 4.28 g of O_2(g), potassium oxide is formed . What mass would you *expect* to form (theoretical yield)? If 17.36 g of K_2O is *actually* produced, what is the percent yield?

Equation:	4K +	O_2	→	$2K_2O$
Before:	XS	0.134		0
Change:	-0.536	-0.134		0.266
After:	XS	0		0.266

Calculations

$$4.28\ g\ O_2 \times \frac{1\ mol\ O_2}{32.00\ g\ O_2} = 0.134\ mol\ O_2$$

$$0.134\ mol\ O_2 \times \frac{2\ mol\ K_2O}{1\ mol\ O_2} = 0.268\ mol\ K_2O$$

$$0.268\ mol\ K_2O \times \frac{94.20\ g\ K_2O}{1\ mol\ K_2O} = 25.2\ g\ K_2O$$

$$\frac{17.36\ g\ K_2O}{25.2\ g\ K_2O} \times 100\% = 68.9\ \%\ yield$$

- 7. Determine the mass of carbon dioxide one could expect to form (and the percent yield) for the reaction between excess CH_4 and 11.6 g of O_2 if 5.38 g of carbon dioxide gas is produced along with some water vapor.

Equation:	CH_4 +	$2O_2$	$\rightarrow$ CO_2	+ $2H_2O$
Before:	XS	0.363	0	0
Change:				
After:				0.363

- 7. Determine the mass of carbon dioxide one could expect to form (and the percent yield) for the reaction between excess CH_4 and 11.6 g of O_2 if 5.38 g of carbon dioxide gas is produced along with some water vapor.

Equation:	CH_4 +	$2O_2$	$\rightarrow$ CO_2	+ $2H_2O$
Before:	XS	0.363	0	0
Change:	- 0.181	- 0.363	0.181	0.363
After:	XS	0	0.181	0.363

Calculations

$$11.6gO_2 \times \frac{1molO_2}{32.00gO_2} = 0.363molO_2$$

$$0.363molO_2 \times \frac{1molCO_2}{2molO_2} = 0.181molCO_2$$

$$0.181molCO_2 \times \frac{44.01gCO_2}{1molCO_2} = 7.98gCO_2$$

$$\frac{5.38\ g\ CO_2}{7.98\ g\ CO_2} \times 100\% = 67.4\ \%\ yield$$

- 8. Determine the mass of water vapor you would expect to form (and the percent yield) in the reaction between 15.8 g of NH_3 and excess oxygen to produce water and nitric oxide (NO). The mass of water actually formed is 21.8 g.

Equation:	$4NH_3$ +	$5O_2$	$\rightarrow$	$6H_2O$	+ 4NO
Before:	0.928	XS		0	0
Change:					
After:					

- 8. Determine the mass of water vapor you would expect to form (and the percent yield) in the reaction between 15.8 g of NH_3 and excess oxygen to produce water and nitric oxide (NO). The mass of water actually formed is 21.8 g.

Equation:	$4NH_3$ +	$5O_2$	→ $6H_2O$	+ 4NO
Before:	0.928	XS	0	0
Change:	- 0.928	-1.16	1.39	0.928
After:	0	XS	1.39	0.928

Calculations

$$15.8 g NH_3 \times \frac{1 mol NH_3}{17.04 g NH_3} = 0.928 mol NH_3$$

$$0.928 mol NH_3 \times \frac{6 mol H_2O}{4 mol NH_3} = 1.39 mol H_2O$$

$$1.39 mol H_2O \times \frac{18.02 g H_2O}{1 mol H_2O} = 25.1 g H_2O$$

$$\frac{21.8\ g\ H_2O}{25.1\ g\ H_2O} \times 100\% = 86.9\ \%\ yield$$