AP Chemistry Worksheet 9: *Limiting Reactants & Theoretical Yield*

Zumdahl textbook chapter 3

For each problem below, write the equation and show your work. Always use units and box in your final answer.

1. A manufacturer of bicycles has 50 wheels, 30 frames, and 24 seats.
    a. How many bicycles can be manufactured using these parts?

    b. How many parts of each kind are left over?

    c. Which part is like a limiting reactant in that it limits the production of bicycles?

2. The fizz produced when an Alka-Seltzer tablet is dissolved in water is due to the reaction between sodium bicarbonate, $NaHCO_3$, and citric acid, $H_3C_6H_5O_7$.

1
23
1
12
48
84

$$3\ NaHCO_3\ (aq)\ +\ H_3C_6H_5O_7\ (aq)\ \text{-->}\ 3\ CO_2\ (g)\ +\ 3\ H_2O(l)\ +\ Na_3C_6H_5O_7\ (aq)$$

In a certain experiment 1.[illegible] g of sodium bicarbonate and 1.00 g of citric acid are allowed to react.

a. Which reactant is the limiting reactant? [illegible] Show your work to support your answer.

$3NaHCO_3$ +	$H_3C_6H_5O_7$ →	$3CO_2$ +	$3H_2O$ +	$Na_3C_6H_5O_7$
.0114 mol	.00521 mol	0	0	0
− .0114	~~.00521~~ − .0038 mol	+ .0115	+ .0115	+ .00380 mol
0	.00141 mol	.0115	.0115 mol	.00380

1
889 =

3
2
5
2
92

b. How many grams of carbon dioxide form?

.0115 mol × 40g/mol = .46g CO_2

c. How much of the limiting reactant is left when the reaction is complete?

~~.00141 mol~~ NONE

d. How much of the excess reactant remains after the reaction is complete?

.00141 mol $H_3C_6H_5O_7$

3. When hydrogen sulfide gas is bubbled into a solution of sodium hydroxide, the reaction forms sodium sulfide and water. How many grams of sodium sulfide are formed if 2.50 g of hydrogen sulfide is bubbled into a solution containing 1.85 g of sodium hydroxide, assuming that the limiting reagent is completely consumed?

H_2S

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4. Solutions of sulfuric acid and lead (II) acetate react to form solid lead (II) sulfate and a solution of acetic acid. If 10.0 g of sulfuric acid and 10.0 g of lead (II) acetate are mixed, calculate the number of grams of sulfuric acid, lead (II) acetate, lead (II) sulfate, and acetic acid present in the mixture after the reaction is complete.

$$\frac{10.0\text{ g } H_2SO_4}{98.0 \text{ g/mo}} = \frac{10.0\text{g } Pb(C_2H_3O_2)_2}{325.29 \text{ g/mol}}$$

.102 mol H_2SO_4 .0307 mol $Pb(C_2H_3O_2)_2$

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$$C_6H_6 + Br_2 \longrightarrow C_6H_5Br + HBr$$

4 [illegible] benzene, C_6H_6, with bromine, Br_2, to prepare bromobenzene, C_6H_5Br, and [illegible]

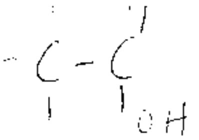
a. [illegible] theoretical yield of bromobenzene in this react[illegible] g of benz[illegible]

$$30g\ C_6H_6 \times \frac{1 mol}{78g} = .385 mol\ C_6H_6$$

$$65.0g\ Br_2 \times \frac{1 mol}{160.8} = .407 mol\ Br_2$$

b. If the actual yield of bromobenzene was 56.7 g, what was the percent yield?

#5



C_6H_6 +	Br_2 →	C_6H_5Br	+ HBr
.385mol	.407mol	0	0
-.385mol	-.385mol	+.385mol	+.385mol
0	.022 mol	.385 mol	.385 mol

a)

$$.385 \text{ mol} \times \frac{157g\ C_6H_5Br}{mol} = 60.445g$$

$\boxed{60.4g\ C_6H_5Br}$

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b) $\frac{56.7g}{60.4} \times 100 = \boxed{93.9\%}$

4)

H_2SO_4 +	$Pb(C_2H_3O_2)_2$ →	$PbSO_4$	+ 2CH_3COOH
.102mol	.0307mol	0	0
-.0307	-.0307	+.0307	+.0614
.0713 Mol	0	.0307mol	.0615 mol

↓ none left in solution

.0614mol CH_3COOH × $\frac{60.1g}{mol}$ = [illegible]

$.0713 \text{mol } H_2SO_4 \times \frac{98.0g}{mol} = 6.99g\ H_2SO_4$

.0307mol $PbSO_4$ × $\frac{303.26g}{mol}$ = 9.31g $PbSO_4$

3) $H_2S + 2NaOH \rightarrow Na_2S + \overset{HOH}{2H_2O}$

.0735mol	.0463	0	0
-.02315m	-.0463	+.02315	+.0463
.0504 mole H_2S Excess	0	.02315 mol	.0463 mol

$2.50g\ H_2S \times \frac{1 mol}{34g} = .0735 mol\ H_2S$

$1.85g\ NaOH \times \frac{1 mol}{40g} = .0463 mol\ NaOH$

$.02315 mol \times \frac{78.8g}{1 mol} = \boxed{1.80g\ Na_2S}$ produced