Lab # 14

A Swell Acetylsalicylic Acid Synthesis Pre-Lab Worksheet

Name: ______________________

____

Class/Period ____________

DETERMINING THE LIMITING REAGENT AND THEORETICAL YIELDS FOR ASPIRIN SYNTHESIS REACTION

Formulas to remember:

One mole of a substance = formula mass in grams.
Formula mass of a substance = total atomic masses of all atoms in the chemical formula. Example:

Salicylic acid: $C_7H_6O_3$

Element	Atomic mass	x	# of atoms	=	
Carbon (C)	12 u	x	7	=	84 u
Hydrogen (H)	1 u	x	6	=	6 u
Oxygen (O)	16 u	x	3	=	48 u
					138 u

Molar mass (gram formula mass) for $C_7H_6O_3$ = 138 g = mass of 1 mole

Fill in the following information to determine the limiting reagent in this reaction. In the space below the name of each reagent, show your calculations for determining the reagent's molar mass and number of moles used.

Reagent	Molar Mass (in g)	Mass used in lab	Moles = $\frac{\text{mass in g}}{\text{molar mass}}$
Salicylic acid $C_7H_6O_3$	____________	3 g	____________
Acetic anhydride $C_4H_6O_3$	____________	6 mL* = ____ g *Convert to g m = v x d Density of acetic anhydride = 1.08 g/mL	____________

The reagent with the smaller number of moles is the limiting reagent. In other words, in the reaction between 3 g of salicylic acid and 6 mL of acetic anhydride, the limiting reagent, or the reagent that is completely used up, is:

______________________________.

Insert the number of moles of limiting reagent (calculated on the previous page) into the value for **Moles**, below. Use the following equation to calculate the theoretical yield for each of the products.

Theoretical yield = (moles of limiting reagent) x (molar mass of product)

Reagent	**Molar Mass (in g)**	**Moles**	**Theoretical yield (in g)**
Acetylsalicylic acid $C_9H_8O_4$ (aspirin)	________________	________________	______________________
Acetic acid $C_2H_4O_2$	________________	________________	______________________

Thus, in the reaction between 3 g of salicylic acid and 6 mL of acetic anhydride, the theoretical yield for acetyl-salicylic acid is: ______________g and the theoretical yield for acetic acid is: ______________g.

A Swell Acetylsalicylic Acid Synthesis Lab Worksheet

Group members:

____

____

____

Class/Period ____________

DATA/RESULTS

Mass of filter paper alone: ________________

Mass of filter paper plus solid (aspirin): ________________

Mass of aspirin (actual yield from this reaction): ________________

Observed melting point of aspirin from this experiment: ________________

CALCULATIONS — COMPARING MELTING POINTS

Use the following formulas and values to determine the percent error between the observed melting point of the aspirin you produced versus the accepted (literature) melting point for pure aspirin.

$$\% \text{ error} = \left(\frac{\text{accepted value - observed value}}{\text{accepted value}} \right) \times 100$$

Accepted (literature) melting point for pure aspirin: 135° C

Observed melting point of aspirin from this experiment: ________________

Percent error between the observed melting point of the aspirin you produced versus the accepted (literature) melting point for pure aspirin: ________________ %
NOTE: Show your work for determining the percent error in the space below.

If the melting point for the aspirin you synthesized was lower than the accepted melting point for pure aspirin (135° C), you can infer that your aspirin has some impurities. What might have caused these impurities? What might some of these impurities be?

CALCULATIONS — ACTUAL YIELD VS. THEORETICAL YIELD OF ASPIRIN

Use your data and the formulas below to determine the percent yield of aspirin from this experiment.

Theoretical yield of aspirin: ____________ moles = ____________ g

Actual yield of aspirin from this lab: ____________ moles = ____________ g

NOTE: $\text{Moles} = \frac{\text{mass in g}}{\text{molar mass}}$

$$\% \text{ yield} = \left(\frac{\text{actual yield}}{\text{theoretical yield}} \right) \times 100$$

Percent yield of aspirin from this experiment (show your calculations in the space below): ____________ %

* Questions continued on other side

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Additional Post Lab Questions

1. Why is it necessary to use glycerol rather than water for the melting point heat bath?

2. Even if your results were "perfect", list potential causes for the following. Between the two answers combined, include a minimum of three different reasons. Think of procedural causes, rather than "errors in calculation".
   a. Product mass greater than the maximum calculated?

   b. Product mass less than expected?

Additional Stoichiometry Practice!!

3. A reaction between methane and sulfur produces carbon disulfide (CS2), a liquid often used in the production of cellophane. The balanced equation is:

   $$2\,CH_4 + S_8 \longrightarrow 2\,CS_2 + 4\,H_2S$$

   a. Calculate the moles CS_2 produced when 1.5mol S_8 is used.

   b. How many moles H_2S produced?

4. Titanium is a transition metal used in many alloys because it is extremely strong and lightweight. Titanium tetrachloride ($TiCl_4$) is extracted from titanium oxide using chlorine and coke (carbon).

   $$TiO_2(s) + 2Cl_2(g) \longrightarrow TiCl_4\,(s) + CO_2(g)$$

   If you begin with 1.25 mol TiO_2 , what mass of Cl_2 gas is needed? (Show your work)

5. One in a series of reactions that inflate air bags in automobiles is the decomposition of sodium azide (NaN_3).

   $$2\,NaN_3\,(s) \longrightarrow 2\,Na(s) + 3\,N_2(g)$$

   Determine the mass of N_2 produced if 100.0g NaN_3 is decomposed. (Show your work)