CHM 2210 Lab Quiz (10 pts, due next lab period)

Background Reading

PubChem (for properties of organic compounds)
APA Style (for citing references)
CRC Handbook of Chemistry and Physics (see chapter on properties of organic compounds)
McMurry, J., Organic Chemistry, Section 21-5 (see Conversion of Acid Anhydrides to Esters)
Ebbing D. and Gammon S., General Chemistry, 10th Ed.,
Section 3.8 (Limiting Reactant and Yields), including Examples 3.15 and 3.16
Zanger M. and McKee J.R., Small Scale Syntheses, pp 9-11 (Yield Calculations),
pg 10-1 (Lab Notebook), and pp 545-9 (Appx II: Physical Properties)
Zubrick, J.W., The Organic Chemistry Lab Survival Manual,
Chapter 2, including Figures 2.4, 2.5, and 2.9 (Lab Reports)

Reaction Summary

An actual yield of 1.86 g of aspirin ($C_9H_8O_4$), along with a side-product of acetic acid (CH_3CO_2H), is obtained by heating 2.00 g of salicylic acid ($C_7H_6O_3$) with 4.00 g of acetic anhydride ($C_4H_6O_3$).

Assignment

This exercise is essentially a mini-report for a hypothetical lab. It will have four sections: Substances, Reactions, Data, and References. Provide a heading (or caption) for each section of the exercise.

For your Substances section, create a table containing the following information for all four substances: names, formulas (skeletal and empirical), molecular weights, and the moles and masses involved. Note that the actual yield quantity of acetic acid can be calculated using stoichiometry. Also, include the boiling points of the liquids and the melting points of the solids.

For your Reaction section, write the net chemical equation for the overall reaction.
Use skeletal formulas and include all stoichiometric coefficients (even where it is 1).

For your Data section, determine the limiting reagent and the theoretical yield (See pg 4 of link). Show all of your calculations. Include conversions to moles as well as the mole/mole ratios. Next, determine the (actual) percentage yield from the amount of aspirin obtained. Show that you get the same result whether you use masses or moles as the basis for your calculation.

Include a References section as well. Write your references in proper format, using the APA style resource in the background reading above. Include all page numbers in your references.

Sample Substances Table

Name	Formula	Mlclr Weight (g/mol)	MP of Solids (^oC)	BP of Liquids (^oC)	Mass (g) used or created	Moles used or created
Ethanol (EtOH)	CH_3CH_2OH	46.1		78.3	20.0	0.464
Phosphorus Tribromide	PBr_3	270.7		173.2	30.0	0.111
1-Bromoethane (EtBr)	CH_3CH_2Br	109.0		38.0	27.3	0.250
Phosphorous Acid	$HPO(OH)_2$	82.0	73.6		6.8	0. 083

Sample Yield Calculations

Start with the balanced equation: $\mathbf{3}CH_3CH_2OH_{(L)} + PBr_{3(L)} \rightarrow \mathbf{3}CH_3CH_2Br_{(L)} + HPO(OH)_{2(S)}$

Convert masses of reactants into moles: $(20.0\text{ g EtOH})\left(\frac{1\text{ mol}}{46.1\text{ g}}\right) = 0.464\text{ mol}$

$(30.0\text{ g } PBr_3)\left(\frac{1\text{mol}}{270.7\text{g}}\right) = 0.111\text{ mol}$

Convert moles of reactants into theoretical moles of products:

$(0.464\text{ mol EtOH})\left(\frac{3\text{ mol EtBr}}{3\text{ mol EtOH}}\right) = 0.464\text{ mol EtBr}$

$(0.111\text{ mol EtOH})\left(\frac{3\text{ mol EtBr}}{1\text{ mol PBr3}}\right) = 0.333\text{ mol EtBr}$

The lower of the two values for product moles (0.333) is your theoretical yield.

Convert your theoretical yield from moles to grams: $(0.333\text{ mol EtBr})\left(\frac{109.0\text{ g}}{1\text{ mol}}\right) = 36.3\text{ g EtBr}$

Convert your actual yield from grams to moles: $(27.3\text{ g EtBr})\left(\frac{1\text{ mol}}{109.0\text{ g}}\right) = 0.250\text{ mol EtBr}$

Determine your actual yield % using both mass and moles: $\left(\frac{27.3\text{ g}}{36.3\text{ g}}\right) \times 100\% = 75.2\ \%$

$\left(\frac{0.250\text{ mol}}{0.333\text{ mol}}\right) \times 100\% = 75.2\ \%$