Name:

Friday Worksheet Analytical chemistry and organic 7

 Aspirin can be made by reacting salicylic acid with acetic acid in the presence of an acid catalyst. The reaction between the phenol group (a hydroxyl group bonded directly to an aromatic reaction) and the acetic acid, however, is slow and has a relatively low yield. When acetic anhydride is used, in place of acetic acid, the reaction is much faster and has a higher yield.



- a) Identify substance "A". Acetic acid
- b) i. In the space below write the reaction between salicylic acid and acetic acid in the presence of an acid catalyst.



ii. What type of reaction is this? Circle the correct response
Acid/Base
Redox
Condensation
Hydrolysis
Explain. A small molecule is given off when salicylic acid and acetic anhydride form a chemical bond.

iii. What functional groups are present in aspirin? Carboxy group (COOH), hydroxyl (OH) and a carbon to carbon double bond (C=C) iv. Calculate the percentage yield for the above reaction if the amount of salicylic acid used was 1.99 g and 2.17g of aspirin was obtained.

Molar mass of aspirin 180.16 g/mol molar mass of salicylic acid is 138.12 g/mol Step 1 convert to mol

salicylic acid

=> n_{salicylic acid} = 1.99 / 138.12 = 0.01440

Step 2 calculate the theoretical yield of aspirin

=> the equation shows that for every mol of salicylic acid that reacts one mol of aspiring forms. Hence 0.01440 mol of aspiring forms.

Step 3 calculate the mass of aspirin that should form => 0.01440 X 180.16 = 2.60 g Step 4 calculate the percentage yield.

=> (2.17 / 2.60) X 100 = 83.5%

c) A student was asked to work out the purity of a sample of aspiring derived from the reaction above. Given a sample of the dried aspirin the student decided to dissolve the sample and titrate the resultant solution with NaOH using phenolphthalein as an indicator. Will this method work? Explain

The aspirin, been an acid, will also react with the NaOH

d) A student weighed 2.10 g of salicylic acid. What volume of acetic anhydride Is needed to completely react with this amount of salicylic acid if the density of acetic anhydride is 1.082 g/mL. Molar mass of acetic anhydride is 102.1 g/mol Step 1 convert to mol salicylic acid => n_{salicylic acid} = 2.10 / 138.12 = 0.0152 Step 2 calculate the number of mol of acetic anhydride => 0.0152 Step 3 calculate the mass of acetic anhydride => 0.0152 X 102.1 = 1.55 g

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Step 4 calculate the volume of acetic anhydride
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=> V = mass/density = 1.55 / 1.082 = 1.43 mL
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e) A bottle of aspirin was opened by a chemist after several years of been stored on the shelf. The chemist noticed a strong smell of vinegar.

i. In the space below write a balanced equation for the reaction that most likely occurred.



ii. What type of reaction took place? hydrolysis

- f) A chemist analysed aspirin tablets for quality control. The initial step of the analysis was the standardisation of a NaOH solution. Three 25.00 mL samples of a 0.1014 mol L⁻¹ solution of standardised HCl were titrated with the NaOH solution. The average volume required to reach the endpoint was 25.50 mL.
 - i. Calculate the concentration of the NaOH solution in mol/Litre.

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Step 1 Write the equation
NaOH(aq) + HCl)aq) => H<sub>2</sub>O(l) + NaCl(aq)
Step 2 calculate the amount, in mol, of HCl in each flask.
=> n_{HCl} = C X V = 0.104 M X 0.025 L = 0.00260
Step 3 calculate the mol of NaOH
According to the equation HCl and NaOH react in a1:1 ratio.
=> mol of NaOH = 0.00260
Step 4 concentration of NaOH
=> C = n/V => 0.00260 / 0.0255 = 0.102M
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ii. What is a standard solution? A solution whose concentration is accurately known

iii. Why is NaOH not used as a primary standard?Because it reacts with the atmosphere and it is difficult to calculate the mass of pure NaOH in the sample.

- iv. The next step involved the following
 - a) 100 tablets were crushed and placed in 250 mL volumetric flask
 - b) The flask was made up to the mark with distilled water.
 - c) A 20.0 mL aliquot was taken and placed in a conical flask and titrated with the standardised NaOH solution.
 - d) This was repeated several times and an average titre of 2.13 mL was obtained.

Calculate the amount, in mg, of aspirin in each tablet.

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Step 1 Calculate the amount of NaOH needed to
react with the 20.0 mL aliquot. Aspirin and
NaOH react in a 1:1 ratio according to the
equation on the right.
=> n_{NaOH} = 0.102 X 0.00213 = 0.00218
=> n_{aspirin} = 0.00218
Step 2 calculate the amount of mol of aspirin in the 250 mL volumetric flask.
=> (250/20) X 0.00218 = 0.02725 mol
Step 3 find the amount in grams of aspirin in the volumetric flask
=> 0.02725 X 180.16 = 4.91 g
Step 4 calculate the amount of aspirin in mg in each tablet
=> since 100 tablets were dissolved 4.91 /100 = 0.0491 g per tablet
or 49.1 mg per tablet
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