

**Friday Worksheet**  
**Analytical chemistry revision 1**

**Name:** .....

- 1) An organic compound "C" is formed by the reaction of two organic compounds "A" and "B", using  $\text{H}_2\text{SO}_4$  as a catalyst. It was analysed and found to contain the following percentage composition by mass, 62.1% carbon, 10.3% hydrogen and 27.6% oxygen. An 8.81 g sample of compound "A" was placed in a 250 mL volumetric flask and made up to the mark with distilled water. A 20.0 mL aliquot was taken and titrated against a 1.00 M NaOH solution. The average titre for this titration was 8.00 mL.

- a) Calculate the empirical formula of compound "C".

62.1% carbon, 10.3% hydrogen and 27.6% oxygen

step 1 convert to mol

=>  $62.1/12 \text{ C} : 10.3/1 \text{ H} : 27.6/16 \text{ O}$

=> 5.175 : 10.3 : 1.725

Step 2 simplest ratio

$5.175/1.725 :$

3 : 6 : 1

$\text{C}_3\text{H}_6\text{O}$

Calculate the molecular formula of compound "C" given that its molar mass is 116 g/mol

Step 1 Calculate the ratio formula mass / empirical mass =  $116 / 58 = 2$

Step 2 calculate the molecular formula

=>  $\text{C}_3\text{H}_6\text{O} \times 2 = \text{C}_6\text{H}_{12}\text{O}_2$

- b) Compound "A" is known to be a monoprotic acid. Calculate the molar mass of the acid and identify it.

The monoprotic acid reacts with the NaOH in a 1:1 ratio.

Step 1 Calculate the mol of NaOH that reacted with the acid in the 20 mL aliquot. This will be the mol of acid present in the 20.0 mL aliquot.

=>  $n = C \times V = 1.00 \times 0.00800 = 0.008 \text{ mol}$

Step 2 Find the mol of acid in the 250 mL volumetric flask.

=>  $(250/20) \times 0.008 = 0.1 \text{ mol}$

Step 3 Find the formula mass(Fm) of the acid.

=>  $\text{Fm} = \text{mass} / \text{mol} = 8.81 / 0.1 = 88.1 \text{ g/mol}$

Step 4 Identify the organic acid

=> butanoic acid is the only organic acid with a molar mass of 88.1 g/mol

- c) The  $^1\text{H}$  NMR,  $^{13}\text{C}$  NMR and the IR spectra of the compound "C" are shown below.

- i. Draw the structural formula of compound "C"

Knowing the molecular formula of compound "C" and the fact that one of the reactants is an organic acid (butanoic acid) formed with with a  $\text{H}_2\text{SO}_4$  catalyst points to a possible ester molecule.

=> the IR spectrum confirms that there is no hydroxyl (OH) group present but there is a C=O and a C-O group present.

=> The  $^{13}\text{C}$  NMR confirms that there are 6 carbon environments.

ii. Name compound "C"

Ethyl butanoate

e) Name compound "B"

Ethanol

