KIHS – Chemistry Department – Unified Exam (2) Grade: 12 (LS)	ثانوية الكيان الدولية	Name: ---------- Date: 29-4-22 Duration: 75 min

Exercise 1 (10 points) **Sulfamic acid**

The main constituent of a scale product is sulfamic acid. it is sold commercially as small white crystals. The aim of this exercise is to determine the percentage purity of sulfamic acid in the scale product by pH-metric titration.

Sulfamic acid is a strong acid of formula NH_2SO_3H. It is represented by HA in this exercise.

$K_W = 10^{-14}$ at 25^0C **Molar mass of sulfamic acid = 97 g.mol^{-1}**

1- <u>Experimental procedure</u>

<u>Step 1</u>: 2.425g of the scale product are dissolved in distilled water. A solution (S) of volume 500 ml is thus obtained.

<u>Step 2</u>: A volume V_a = 10 ml of solution (S) is transferred into a beaker, and a volume V' = 40 ml of distilled water is then added.

<u>Step 3</u>: Titration is carried out by using sodium hydroxide solution ($Na^+ + OH^-$) of concentration $C_b = 4 \times 10^{-2}$ mol.L^{-1}. Equivalence is reached when 11.2 ml of the basic solution is added.

1.1. Indicate the titrant and the analyte.

1.2. Name the glassware needed to:

a) Transfer V_a into the beaker b) Add the basic solution.

1.3. Specify whether the addition of distilled water to the beaker before titration, affects the volume of the basic solution added at equivalence or not?

2- <u>Make Use of the titration Results</u>

2.1. Write the equation of the titration reaction.

2.2. Determine the concentration C_a of the sulfamic acid in the scale product.

2.3. Deduce the percentage purity of sulfamic acid in the scale product.

2.4. Show by calculation the value of pH of the resulting solution in each of the following cases.

Case 1: At the end of the titration, the content of the burette is let to run into the beaker.

The pH of the resulting solution in the beaker tends to 12.6.

Case 2: The pH of the solution in the beaker after the addition of water and before titration is equal to 2.04.

2.5. Draw the profile of the curve pH = f(b) that passes through two remarkable points V_b = 0 ml and V_{bE} = 11.2 ml. **Scale: 1 cm for 2 units of pH, 1cm for 2 ml**

Exercise 2 (20 points) **Organic Compounds**

Given the following set of compounds

(A): $CH_3 – (CH_2)_2 – CH_2OH$ (B): $CH_3 – CH_2 – CH_2 – CHO$ (C): $CH_3 – CH_2 – CO – CH_3$

(D): $(CH_3)_3COH$ (E): $CH_3 – CH_2 – CH(OH) – CH_3$ (F): $CH_3 – CH_2 – CH_2 – COOH$

1- **Naming, isomers and functional group**

1.1. Give the name of the family of each of the compounds (B), (C) and (F).

1.2. Give the name of each of the compounds (C), (D) and (E)

1.3. Rewrite on your answer sheet compounds (C) and (E), and circle the functional group of each compound.

1.4. Specify the type of isomerism between the compounds: (B) and (C) ; (A) and (E).

1.5. Draw an isomer (G) of the compound (F). Give its name.

2- Preparation of some organic compounds.

Write the equations of the following reactions (Using the condensed structural formulas)

2.1. Preparation of compound (F) starting from compound (A).

2.2. Compound (C) is converted into compound (E).

2.3. Balance the following half reaction.

$CH_3 – CH_2 – CH_2 – CHO \longrightarrow CH_3 – CH_2 – CH_2 – COOH$

3- **Identification of some organic compounds**

3.1. Predict a test that indicates the presence of compound (B) and (C).

3.2. How can you distinguish between compounds (B) and (C)?

3.3. Choose from the given compounds, a compound that can't undergo mild oxidation.

3- **Esterification Reaction**

The equilibrium constant K_C for the esterification reaction is 4.12 if the alcohol is primary and 2.25 if the alcohol is secondary. Molar masses in $g.mol^{-1}$: C = 12 H = 1 O = 16

Document-1

An equimolar mixture of 0.5 mol compound (F) and alcohol (either A or E) is heated.

At equilibrium, 0.3 mol of an ester (H) is formed.

4.1. Show that the molecular formula of the ester (H) is $C_8H_{16}O_2$.

4.2. Determine the equilibrium constant K_C of the given reaction.

4.2. Based on document-1, identify the alcohol used in this esterification reaction.

4.4. Write the equation of the esterification reaction.

4.5. Choose the correct answer. Justify.

Starting with non-equimolar mixture of the reactants, the value of K_C:

a) changes b) remains the same