Exercise 1   **Synthesis of an ester**

It is required to prepare an ester from some chemical compounds available in the laboratory. These compounds are the following: an alcohol A, ethanoic acid, concentrated sulfuric acid and a dehydrating agent P_2O_5.

Given: - Molar mass of alcohol A, M (A) = 88 g.mol^{-1}.   - Density of alcohol A, d = 0.80 g.mL^{-1}.

1- Identification of the Alcohol (A)
(A) is a non cyclic saturated monoalcool.
   1.1- Determine the molecular formula of A.
   1.2- In acid medium and in the presence of excess oxidizing agent, alcohol A is transformed into an organic compound which reacts with D.N.P.H and does not react with Fehling's solution .
      1.2.1- Record your observation in the above two tests.
      1.2.2- Specify the class of the alcohol A.
      1.2.3- Write the possible condensed structural formulas of alcohol A.
      1.2.4- Give the name of the alcohol A, knowing that its carbon chain is branched.

2- Esterification Reactions
Use the condensed structural formulas of the organic compounds to write the equations of the chemical reactions.
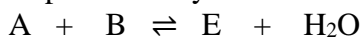An ester is prepared starting with ethanoic acid and the alcohol A.

   2.1- Write the equation of the reaction between A and ethanoic acid.
   2.2- This reaction is slow. Indicate two ways to increase its rate.

3- Yield of an Esterification Reaction
A mixture of 0.5 mol of ethanoic acid and a volume V = 39.6 mL of alcohol A is heated in the presence of a few drops of concentrated sulfuric acid.
When the composition of the reacting system becomes non-variable, the remaining acid is titrated and its number of moles is equal to 0.25 mol.

The reaction in this mixture is represented by the following equation:
$$A + B \rightleftharpoons E + H_2O$$
Where B represents ethanoic acid.
   3.1- Calculate the initial number of moles of the alcohol (A).
   3.2- Determine the yield of this reaction.

Exercise 2   **The pheromones**

Pheromones are organic substances (esters, ketones, alcohols…) very fragrant emitted by most animals (ants, bees …) and act as messengers among the individuals of the same species.
Given, in the table below, the chemical formulas and the names of some pheromones:

Pheromone	Chemical formula or systematic name
A	CH$_3$ – C – O – CH$_3$ ‖ O
B	3-methylbutyl ethanoate

C	CH$_3$ – CH$_2$ – CH$_2$ – CH – CH – CH$_2$ – CH$_3$
	                          │ │
	                        CH$_3$ OH

D	3-Hexanone

3-hexanone is a liquid compound at room temperature.

1- preliminary study

1.1- Name the common functional group of pheromones A and B.

1.2- Write the condensed structural formula of the organic compound that can react with methanol to produce pheromone A.

1.3- The compound (pheromone) C is subjected to mild oxidation by the reaction with an oxidizing agent. Write the condensed structural formula of the organic compound obtained and give its name.

2- Preparation of the pheromone B

Given:

- Molar mass in g.mol^{-1}: M (acetic acid) = 60 and M (pheromone B) = 130
- Density of acetic acid : d = 1.04 g / mL.
- Starting from initial equimolar mixture of carboxylic acid and alcohol, the percentage yield at equilibrium is:67% if the alcohol is primary and 60% if the alcohol is

In order to prepare the pheromone B, one proceeds as follows:

- A volume V_1 of isoamyl alcohol (equivalent to 0.20 mol of this alcohol) is mixed with a volume V_2 = 30 mL of acetic acid.
- This mixture is heated for 45 min.
- The pheromone B is extracted from the reacting medium and it is purified and weighed. The mass is found to be m = 17.42 g.

2.1- Write, using the condensed structural formulas of the organic compounds, the equation of the reaction that took place.

2.2- Deduce from the experimental procedure, described above, one of the characteristics of this reaction.

2.3- Calculate the initial number of moles of acetic acid.

2.4- Determine the yield of this reaction.

2.5- Verify, whether the heating duration (45 min) was sufficient to reach the equilibrium.

2.6- Suggest two experimental ways that help to increase the yield of this reaction.

Exercise 3   **Identification of certain Organic Compounds**

The mild oxidation of an alcohol (A) leads to the formation of a monocarboxylic acid (B) with a saturated open carbon chain.

The aim of this exercise is to identify (A) and (B) and to study their esterification reaction.

Given:

- M(H) = 1 g.mol^{-1} ; M(C) = 12 g.mol^{-1} ; M(O) = 16 g.mol^{-1}
- The yield of the esterification of an equimolar mixture of carboxylic acid and a primary alcohol is 67 %.

1- Identification of (A) and (B)

The percentage by mass of oxygen in the acid (B) is 36.36 %

1.1- Show that the molecular formula of (B) is $C_4H_8O_2$. Deduce the molecular formula of (A).

1.2- Knowing that the carbon chain of (A) is branched, identify (A) and (B),

2- Esterification of Alcohol (A)

A mixture of 1 mol of (A) and 2 mol of (B) is heated in the presence of few drops of concentrated sulfuric acid. After a certain time, a homogeneous equilibrium is established with a constant $K_C = 4$.

2.1- Write the equation of this reaction. Give the systematic name of the organic compound (C) formed.
2.2- Determine the number of moles of (C) formed at equilibrium. Deduce the yield of this esterification.
2.3- This yield exceeds 67 %. Explain, if each one of the three following proposals justifies this fact:
    2.3.1- Heating the reacting medium.
    2.3.2- Presence of few drops of sulfuric acid in the reacting medium.
    2.3.3- Using an initial mixture of reactants which is not equimolar.

Exercise 4   **Preparation of an Ester**

Consider a compound (A) of formula C_xH_yO.

In all the equations of the reactions suggested in this exercise, represent the organic compounds by their condensed structural formulas.

    Given:
        - Molar mass in $g.mol^{-1}$: $M(H) = 1$; $M(C) = 12$ and $M(O) = 16$.

1- Identification of the Compound (A)

A quantitative analysis carried out on the compound (A) gave the following mass percentages: carbon = 66.67 % and hydrogen = 11.11 %.

1.1- Show that x = 4 and y = 8.
1.2- Write the possible condensed structural formulas of (A) knowing that its carbon chain is   saturated and non cyclic.
1.3- (A) is subjected to the following tests:
Deduce the chemical family of (A) and give its name, knowing that its carbon chain is not branched.

Test	Result of the test
(A) + 2,4-D.N.P.H	Yellow precipitate
(A) + Fehling's solution	Brick-red precipitate

2- Preparation of the Ester (E)

An equimolar mixture of the two compounds (X) and (Y), (X) is an alcohol yielding (A) by catalytic oxidation and (Y) obtained by continuous heating of (X), react until having a constant quantity of ester. This quantity is equal to 0.4 mol. The equation of the corresponding reaction is:

$$X + Y \rightleftharpoons E + H_2O$$
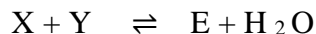
2.1- Write the condensed structural formula of the ester E. Give its name.
2.2- Show that the initial quantity of X (or Y) is n = 0.6 mol, knowing that the equilibrium constant associated to the above equation is Kc = 4.0.