In Depth

22. Propanal and propanone

Measurements are made in a combustion bomb to compare the combustion characteristics of alcohol, aldehyde, ketone and alkane that contain 3-carbon atoms. Propanal shows the highest flame velocities while acetone gives the lowest. The experimental observations are then interpreted by the effects of distinctive molecular structures. Propanal generates a hydrogen atom that improves oxidation, leading to higher flame velocities. However, acetone forms the methyl radical (CH_3) which does not improve the oxidation and has lower flame velocities accordingly.

1. **Molecular formula and condensed structural formulas**

The mass of carbon in a carbonyl compound (A) is 2.25 times greater than the mass of oxygen.

1.1. Show that the molecular formula of (A) is C_3H_6O

1.2. Write the possible condensed structural formulas of the possible isomers of (A) knowing that the carbon chain is saturated and not cyclic.

1.3. Indicate, based on the condensed formulas, the aldehyde and the ketone. Justify

1.4. Based on the text, specify among the isomers of (A) that which burns with a lower flame.

1.5. Identify compound (A) knowing that when heated moderately with Fehling's solution, it gives a brick red precipitate.

2. **Comparative study between aldehyde and ketone**

Aldehydes and ketones have common chemical properties and different chemical properties.

2.1. Explain to what are due the common properties and the distinctive properties.

2.2. Give a test that permit to recognize the carbonyl group.

23. Butanal

Butanal is a colorless, flammable liquid with a pungent odor. It is miscible with many organic solvents.

Quantitative organic analysis of a compound (A) of formula C_xH_yO gave the following result :

- % by mass is of carbon 66.67 %
- % by mass of hydrogen is 11.11 %.

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

I. **Identification of Compound (A)**

1.1. Show that the molecular formula of (A) is C_4H_8O

1.2. Write the possible condensed structural formulas of the possible isomers of (A) and give their names knowing that the carbon chain is saturated and not cyclic.

1.3. The following tests are carried out :
(A) + 2, 4-D.N.P.H ⟶ yellow-orange precipitate
(A) + Fehling solution ⟶ brick red precipitate.
1.3.1. Deduce the family of (A).
1.3.2. Identify (A), knowing that its carbon chain is branched.

2. **Some chemical properties of (A)**
A certain quantity of (A) is divided into two parts. The first part is treated with an acidified solution of potassium permanganate. The organic compound formed is denoted (B). The second part is heated in the presence of a hydrogenation catalyst. The organic compound formed is denoted (C).
2.1. Write the equation of the first reaction.Identify the functional group of (B).
2.2. Write the equation of the second reaction. Name (C).

24. Identification of organic compounds

An oxygen-containing compound is an organic pure compound whose molecule contains at least one oxygen atom.

Four flasks are labeled 1 to 4, each containing one of the following organic compounds (**Document 1**) :

* 2-methyl-2-propanol
* 2-pentanol
* butanone
* butanal.

Document 1

1. Write the condensed structural formula of each of the above organic compounds (**Document 1**).
2. A series of chemical tests are carried out to identify each compound, the test is considered (+) if a reaction occurs and (-) if no reaction occurs, the results are shown in **document 2** :

Test	Flask (1)	Flask (2)	Flask (3)	Flask (4)
Dichromate	-	+	-	+
D.N.P.H	-	+	+	-
Fehling	-	+	-	-

Document 2

Identify the contents of each flask.

25. Aldehydes and ketones

There are four saturated and non-cyclic organic compounds, numbered from 1 to 4, whose molecular formulas are given in **document 1** :

(1) C_3H_6O	(2) C_4H_8O	(3) C_3H_6O	(4) $C_5H_{10}O$

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

Document 1

1. **Some chemical properties**

Referring to **document 1** :

1.1. Indicate the name of the common functional group for these organic compounds.

1.2. Two chemical tests show the presence of this functional group.

1.2.1. What are these 2 tests?

1.2.2. Indicate what is observed in each test.

1.3. One of the 4 compounds is identified without chemical tests. Give its condensed structural formula and its name. Justify

1.4. Compounds 2 and 3 give a positive test with the Fehling solution while compound 4 gives a negative test.

1.4.1. Describe how the test was performed with compounds 2 and 3.

1.4.2. Specify the chemical organic family of compounds 2, 3 and 4.

1.4.3. Write the possible condensed structural formulas of compounds 2, 3 and 4.

1.4.4. Name compounds 2 and 4, knowing that both are branched-chain.

2. **Some chemical reactions**

2.1. The catalytic hydrogenation of compounds 3 and 4 leads to two alcohols :

2.1.1. Indicate the class of each alcohol obtained.

2.1.2. Write the equation of the reaction in each case.

2.1.3. Name the products obtained in each case.

26. Mild oxidation of an alcohol and an aldehyde

A flask containing an alcohol (A) is found in the organic laboratory and contains the following information :

- Molar mass of the alcohol A, $M_{(A)} = 74\ g.mol^{-1}$.
- Density of alcohol A, $\rho = 0.80\ g.mL^{-1}$.

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

Document 1

1. Identification of alcohol (A)

(A) is a non-cyclic saturated monoalcohol.

1.1. Determine, by referring to **document 1**, the molecular formula of (A).

1.2. Write the condensed structural formulas of the possible alcohol isomers of (A).

1.3. Mild oxidation of the alcohol (A) is carried out and it is converted into an organic compound (B).

(B) reacts with D.N.P.H and reacts with Tollens reagent.

1.3.1. Note what is observed in the two tests performed above.

1.3.2. Specify the nature of the compound (B).

1.3.3. Write the two possible condensed structural formulas of (B). Name them.

1.4. Deduce the class of alcohol (A).

1.5. Name the 2 possible alcohols of (A).

1.6. Identify the alcohol (A), knowing that its carbon chain is branched.

2. Oxidation reaction of the alcohol (A)

The limited mild oxidation of (A) into (B) is carried out by an acidified solution of $K_2Cr_2O_7$

2.1. Write the equation of the reaction between (A) and the dichromate ions leading to compound (B).

2.2. Determine the volume of the alcohol (A) necessary to reduce 20 mL of an acidified solution of $K_2Cr_2O_7$ of concentration 1 $mol.L^{-1}$.

3. Continuous mild oxidation

The oxygen gas constitutes 20 % by volume of the air contained in the atmosphere.
The molar volume of a gas under the conditions of the experiment is $V_m = 24\ L.mol^{-1}$.

Document 2

Compound (B) is separated by a suitable technique of fractional distillation. It is then treated with an excess of oxygen of air in order to obtain compound (C).

3.1. Specify the nature of the compound (C).

3.2. Write the equation of the oxidation reaction leading from (B) to (C).

3.3. Referring to **document 2** :

3.3.1. Determine the volume of oxygen required to oxidize 0.06 mol of (B).

3.3.2. Deduce the volume of air required for this reaction.

27. Identification of organic compounds

The objective of this exercise is to conduct studies and chemical tests on some organic compounds.

A	B	C	D	E
Saturated and non-cyclic alcohol. % by mass of O = 26.67 %	2-methyl-2-propanol	CH_3COOH	Propanal	Propanone

Molar masses in $g.mol^{-1}$: $M_C = 12$; $M_H = 1$; $M_O = 16$.

Document 1

1. **Identification of the organic compound (A)**

1.1. Referring to **document 1** :

1.1.1. Give the general molecular formula of the compound (A)

1.1.2. Determine the molecular formula of (A).

1.1.3. Write the possible condensed structural formulas of (A).

2. **Distinctive properties of organic compounds**

2.1. Write the condensed structural formulas of compounds (B), (D) and (E).

2.2. Indicate the family to which each of the compounds (B), (D) and (E) belong.

2.3. Which type of isomerism represents compounds (D) and (E).

2.4. The five compounds of **document 1** are represented in a random order from 1 to 5. The chemical tests given in **document 2** are then carried out in order to identify each compound.

Compound	**Test 1** with DNPH	**Test 2** A few drops of acidified $KMnO_4$	**Test 3** Schiff's Reagent	**Test 4** BBT (yellow-6-green-7.6-bleu)
1	Yellow-orange precipitate	Purple color discoloration	Pink color	Negative
2	Negative	Purple color discoloration	Negative	Negative
3	Yellow-orange precipitate	Persistent purple color	Negative	Negative
4	Negative	Negative	Negative	Yellow color
5	Negative	Negative	Negative	Negative

Document 2

Referring to the chemical tests obtained in **document 2.** Match the compounds (A), (B), (C), (D) and (E) to compounds 1, 2, 3, 4 and 5.

2.5. Catalytic dehydrogenation of the 2 isomers of compound (A) leads to compounds (D) and (E) :

2.5.1. Write the equation of each reaction.

2.5.2. Give the condensed structural formula of a functional isomer of (A).

2.6. Write the equation of the oxidation reaction of compound 1 with acidified permanganate ions.