IN DEPTH

27. Propanol

Propanol is a very useful alcohol in the food industry. Indeed, its properties allow it to serve as an organic solvent but also to participate in the manufacture of alcoholic beverages or flavors. It is colorless and has a specific odor. It is completely soluble in water.

1. **Formula and isomerism of propanol**

1.1. Give the molecular formula of propanol.

1.2. Write the condensed structural formulas and names of the possible isomers of propanol.

1.3. Specify the class of each isomer.

2. **Mild oxidation**

The mild oxidation,considered complete, is carried out for a mass m = 29.6 g of a mixture (M) of the preceding isomers of propanol. Two organic compounds are obtained, one having a pH < 7.

2.1. Identify the organic compound with pH < 7.

2.2. Write the equation of the mild oxidation of these two alcohols by oxygen gas.

2.3. An aqueous solution of volume equal to 2 L is prepared with the identified organic compound denoted HA. The solution has a pH = 3. Determine the number of mole of HA formed during the mild oxidation.

Take $pK_a = 5$.

2.4. Deduce the percentage composition of the mixture (M).

2.5. Pick out from the text the physical properties of propanol.

Given : The molar atomic masses in $g.mol^{-1}$: C = 12 ; H = 1 and O = 16

28. Identification of an alcohol

The word alcohol was borrowed, via medieval Latin scholar alkohol and the Romanesque languages of the Iberian Peninsula (Castilian or Catalan alcohol, lusitanian álcool), to the Arabic mediterranean al-kohol.

Quantitative organic analysis of a compound (A) consisting of C, H and O gave the following percentages by mass : C = 64.86 % ; H = 13.51 %.

1. **Determination of the molecular formula of A**

1.1. Compound (A) contains a single oxygen atom. Determine its molecular formula.

Given : The molar atomic masses in $g.mol^{-1}$: C = 12 ; H = 1 and O = 16

1.2. Choose from the following general molecular formulas, the appropriate one for (A).

a. $C_nH_{2n}O$; b. $C_nH_{2n}O_2$; c. $C_nH_{2n+2}O$

1.3. Specify the possible functional groups of (A).

The isomers of (A)

2.1. The functional group of (A) is polyatomic. Indicate to which family of organic compounds does (A) belong.

2.2. Write the possible condensed structural formulas of (A) and give their names.

2.3. Choose by justifying among the isomers of (A) :

2.3.1. Those whose continuous mild oxidation leads to a carboxylic acid.

2.3.2. Those or the one whose mild oxidation leads to a ketone.

Identification of (A)

(A) is a tertiary alcohol having the minimum number of carbon atoms.

Deduce, from the condensed structural formulas of the isomers, that which corresponds to (A).

38. The pentanol

The amyl alcohol, or pentanol, is an organic compound of the class of alcohols of formula $C_5H_{11}OH$.

The mass of carbon is 5 times that of hydrogen in a saturated monoalcohol (A)

1. Isomerism of (A)

1.1. Show that the molecular formula of (A) is $C_5H_{10}O$.

1.2. Write the condensed structural formulas and names of the possible alcohol isomers of (A) (limited to linear carbon chain alcohols).

1.3. Choose from the following types of isomers, which is more suitable for the preceding isomers of (A) :

a. Positional isomers ; **b.** Skeletal isomers (chain) ; **c.** Functional isomers.

2. Mild oxidation of (A)

A mass m = 0.80 g of (A) is mildly oxidized by an acidified solution of potassium dichromate of concentration 0.50 $mol.L^{-1}$ and the product obtained is immediately removed by distillation. An organic compound (B) is obtained.

2.1. Identify the organic compound (B), knowing that (A) is a primary alcohol.

2.2. Write the equation of the mild oxidation of A into B by the acidified solution of potassium dichromate.

Given : $E(Cr_2O_7^{2-} / Cr^{3+}) > E(A / B)$

2.3. Determine the minimum volume of the dichromate solution used to oxidize m = 0.80 g of (A).

3. Esterification of (A)

0.02 mol of (A) and 0.92 g of methanoic acid (HCOOH) are introduced into a sealed tube which is placed in an oven. After 20 minutes, the remaining methanoic acid is titrated with a sodium hydroxide solution of concentration 1.0 $mol.L^{-1}$. The equivalence is obtained after the addition of 12 mL of the sodium hydroxide solution.

3.1. Write the equation of the reaction between methanoic acid and alcohol (A).
3.2. Determine the percentage of alcohol that has reacted with methanoic acid after 20 minutes.

Given : The molar atomic masses ($g.mol^{-1}$) : H = 1 ; O = 16 ; C = 12

III. Identification of 3 alcohols

In a laboratory of organic chemistry there are 3 bottles, numbered 1, 2 and 3, with labels almost erased. It can also be seen that each bottle contains a single organic product and that this product is a saturated and non-cyclic alcohol composed of 4 carbon atoms.

Chemical tests are carried out on samples taken from each bottle to identify each alcohol.

Test 1 : A few drops of an acidified solution of potassium permanganate $KMnO_4$ of purple color are added to samples taken from bottles 1, 2 and 3. The drops immediately are decolorized in the two samples taken from bottles 1 and 2, while the purple color persists in the sample taken from the bottle 3.

Document 1

Test 2 : On another sample taken from bottle 1, a large excess of the acidified solution of $KMnO_4$ is added, a product is obtained which gives a yellow color with BBT. Whereas if the same work is repeated with the sample of the bottle 2, nothing happens.

Document 2

BBT (yellow – 6.0 - green – 7.8 - blue)

Document 3

1. Referring to **document 1**. Specify the class of alcohol in bottle 3.
2. Deduce its condensed structural formula and its name.
3. Verify if the class of the 2 alcohols found in bottles 1 and 2 can be determined from **document 1** only.
4. Based on the 2 tests of **document 1 and 2** on one hand and on **document 3** on the other hand. Specify the class of the two alcohols in bottles 1 and 2.
5. Identify the alcohol in the bottle 2.
6. Write the possible condensed structural formulas of the alcohols in bottle 1.
7. Identify the alcohol in bottle 1, knowing that its carbon chain is branched.
8. Write the equation of the oxidation reaction of the alcohol of the bottle 1 with the solution of acidified potassium permanganate.

1. Linear alcohol

Quantitative elemental analysis of a saturated, non-cyclic monoalcohol (A) with a linear carbon chain showed that the mass percentage of oxygen in the alcohol was 18.18 %.
Molar mass in $g.mol^{-1}$: $M_{(H)} = 1$; $M_{(C)} = 12$ and $M_{(O)} = 16$.

Document 1

1. **Determination of the molecular formula of (A)**
   - 1.1. Show with reference to **document 1** that the molecular formula of (A) is $C_5H_{12}O$.
   - 1.2. Write the possible condensed structural formulas of the alcohol isomers of (A) and indicate the class of each.
   - 1.3. Give the condensed structural formula of a functional isomer of (A).
2. **Identification of (A)**

The catalytic dehydrogenation of (A), in the presence of the copper powder, results in the formation of an organic compound (B).
(B) does not react with an acidified solution of potassium dichromate $K_2Cr_2O_7$.

Document 2

- 2.1. Referring to **document 2**, specify the class of alcohol (A).
- 2.2. Give the possible names of (A).
- 2.3. Identify (A) knowing that it is a symmetrical alcohol.
- 2.4. Write the equation of the catalytic dehydrogenation of (A).

3. **Some reactions of (A)**
   - 3.1. Write, using the condensed structural formulas of organic compounds, the equations of the following reactions :
     - 3.1.1. Reaction of (A) with an acidified solution of potassium dichromate $K_2Cr_2O_7$.
     - 3.1.2. Reaction of (A) with ethanoic acid.
   - 3.2. A primary alcohol (A') is a skeletal isomer of the alcohol (A). (A') has 3 carbon atoms in its main chain :
     - 3.2.1. Identify the alcohol (A').
     - 3.2.2. Write the equation of the continuous mild oxidation reaction of (A') with the oxygen of the air.

2. Identification of alcohol

An organic compound (A) of formula C_xH_yO is available.
In all the equations of the reactions required in this exercise, represent the organic compounds by their general formulas using R- to represent the hydrocarbon chain.

- Molar masses in $g.mol^{-1}$: $M_{(H)} = 1$; $M_{(C)} = 12$ and $M_{(O)} = 16$.
- Density of (A), $\rho = 0.79\ g.mL^{-1}$.

Document 1

1. Identification of the chemical family of (A)

1.1. Cite four possible organic families that can represent(A).

1.2. The partial mild oxidation of (A) with an acidified potassium permanganate solution $KMnO_4$ leads to a compound (B), which in turn and in the presence of an excess of oxidant forms a product (C). (C),when dissolved in water gives a pH significantly less than 7.

1.2.1. Deduce the organic family of compounds (A), (B) and (C).

1.2.2. Give the general molecular formula of compounds (A), (B) and (C).

1.2.3. Write the equation of the oxidation of (A) into (C) using the general formulas of the two compounds.

2. Identification of Compound (A)

A volume $V_A = 15$ mL of compound (A) is dissolved in distilled water to obtain a solution of volume equal to 1 L.

A sample of volume $V' = 10$ mL of this solution is taken and titrated with an acidified solution of potassium permanganate $KMnO_4$ with a concentration $C = 0.1$ mol.L^{-1}, according to the reaction in part **1.2.3**. The pink-purplish color persists for a poured volume $V_E = 20.6$ mL of the titrant solution.

2.1. Determine the concentration C_A of the alcohol (A).

2.2. Deduce the molar mass of (A).

2.3. Calculate the mass percentage of the oxygen element in the alcohol (A).

2.4. Quantitative elemental analysis of compound (A) shows that it contains 52.17 % by mass of carbon.

2.4.1. Calculate the mass percentage of the hydrogen element in (A).

2.4.2. Determine the molecular formula of (A).

2.4.3. Identify compound (A).