IN DEPTH

27. Organic formulas

The complete combustion of 3.795 mg of a liquid A containing C, H, and O gave 9.708 mg of CO_2 and 3.969 mg of H_2O.

1. Determine the empirical formula of A.
2. Knowing that the molar mass of A is 88 $g.mol^{-1}$. Deduce the molecular formula of A.
3. Knowing that A belongs to the carbonyl compounds. Write two possible condensed structural formulas of A of your choice.

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

28. Identification of a functional group

Quantitative organic analysis of compound A formed of C, H and O gave the following mass percentages : C = 60 % and H = 13.3 %.

1. Determine the molecular formula of A, knowing that its molar mass is 60 $g.mol^{-1}$.

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

2. The following two condensed structural formulas of A are given :

CH_3-CH_2-CH_2-OH and CH_3-CH_2-O-CH_3

2.1. Verify if these two formulas correspond to two possible isomers of A.

2.2. Identify A knowing that it belongs to the family of ethers.

29. The purple

The purple is extracted from the murex, a marine shell. The percentage by mass of the purple is the following (**Document 1**) :

C : 45.7 %
H : 1.90 %
O : 7.60 %
Br : 38.1 %
N : 6.7 %.

Document 1

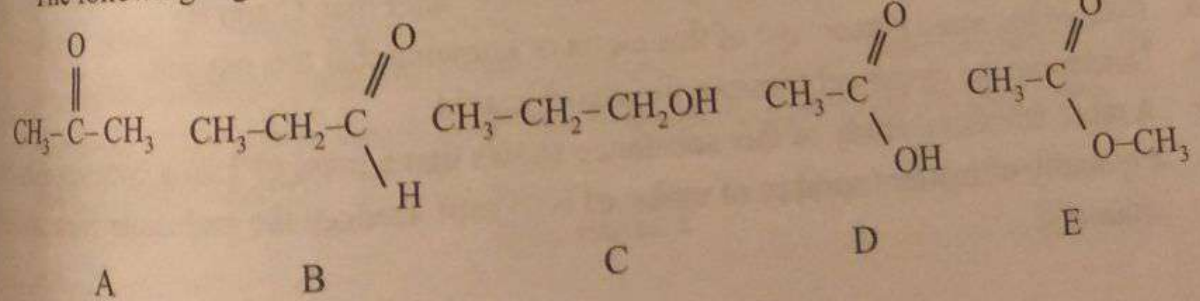
1. Verify if the purple contains another element than those mentioned above.
2. Determine the empirical formula of purple.

Given : Molar masses in $g.mol^{-1}$: C = 12 ; H = 1 ; O = 16 ; N = 14 ; Br = 80.

3. Knowing that the purple contains 2 atoms of Br. Deduce its molecular formula.

30. Functional Groups

The following organic molecules are given : A, B, C, D and E.



A B C D E

Mind map | Method sheet | Exercises | Correction

1. Circle the functional group and name the family of each of the preceding molecules.
2. Specify the isomeric molecules.
3. Which of the D or E molecules has the largest mass percentage of oxygen? Justify.
4. Indicate the molecules whose number of hydrogen atoms is double than that of carbon.

31. Monochlorinated Alkanes

The % by mass of the chlorine in a monochlorinated alkane A, obtained by a substitution reaction between the chlorine and the alkane, is equal to 33.33.

1. Show that the molecular formula of (A) is $C_5H_{11}C\ell$
2. Write the possible condensed structural formulas of the isomers of A which have no alkyl group as a branch.
3. Write the condensed structural formula of A which has 2 methyl groups as branches.

Given : Molar mass in $g.mol^{-1}$: $C = 12$; $H = 1$; $C\ell = 35.5$.

32. Identification of a hydrocarbon

A volume V of a gaseous hydrocarbon C_xH_y gives, after complete combustion, the same volume V' of CO_2 (g) and H_2O (g).

1. Write the equation of the reaction of the complete combustion of this hydrocarbon in terms of x and y.
2. Show that $y = 2x$
3. Determine the molecular formula for this hydrocarbon, given that $V' = 5V$.
4. Identify the family to which this hydrocarbon belongs.

Take the molar volume V_m.

33. Elemental analysis of vitamin C

Ascorbic acid or vitamin C, is very common in foods like fruits and some vegetables. This nutrient is widely known for its anti-influenza effect and for reducing fatigue.

The combustion of 1.94 g of this organic substance gives 2.9084 g of the gas which disturbs lime water and 0.795 g of H_2O.

$M_C = 12\ g.mol^{-1}$; $M_O = 16\ gmol^{-1}$; $M_H = 1\ g.mol^{-1}$

Document 1

1. Identify the gas that disturbs the lime water.
2. Determine, by referring to **document 1**, the percentage by mass of carbon and hydrogen in this substance.
3. Verify if there is a 3rd element in this substance other than C and H.
4. Deduce the mass percentage of this element knowing that it is oxygen.
5. Determine the empirical formula for ascorbic acid.
6. A more advanced study of this substance shows that a mass of 1.76 g corresponds to a quantity of matter (number of mole) of 0.01 mol. Deduce the molecular formula of vitamin C.

34. Paracetamol

Paracetamol is the active ingredient of a drug called "Panadol". Paracetamol is an antipyretic analgesic used to relieve pain and reduce fever.

The combustion of a sample of 1.208 g of this product gives 0.648 g of water and 2.816 g of CO_2.

$M_C = 12\ g.mol^{-1}$; $M_O = 16\ g.mol^{-1}$ $M_H = 1\ g.mol^{-1}$

Document 1

The analysis of another sample of this compound, of mass $m' = 3$ g, shows that it leads to the formation of 477.2 mL of ammonia gas NH_3.

$V_m = 24\ L.mol^{-1}$

$M_N = 14\ g.mol^{-1}$

Document 2

1. By referring to **document 1**, determine the percentage by mass of carbon, and hydrogen in this compound.
2. By referring to **document 2**, determine the percentage by mass of the nitrogen element in this compound.
3. Deduce the mass percentage of the oxygen element in this compound.
4. A mass of 75.5 mg of paracetamol corresponds to 5×10^{-4} mol.
   - **4.1.** Calculate the molar mass of Paracetamol.
   - **4.2.** Determine its molecular formula.

35. Acyl chloride

The qualitative analysis of an organic compound (S) shows that it consists of the elements C, H, O and an unknown halogen X.

Quantitative analysis of this compound yields the following results :

A sample of (S) of mass m = 255 mg produced 465.5 mg of carbon dioxide and 171.4 mg of water.

$M_C = 12\ g.mol^{-1}$; $M_O = 16\ g.mol^{-1}$; $M_H = 1\ g.mol^{-1}$

Document 1

A second sample of (S) is treated with molten sodium, the halogen X takes its ionic form X^-. After dissolving the mixture in distilled water and adding an excess of an $AgNO_3$ solution, a white precipitate is formed which blackens in the sun light. Quantitative analysis of this halogen X shows that its percentage by mass in (S) is 29.46 %.

Document 2

The precipitate AgBr gives a cream color.
The precipitate AgCℓ gives a white color which blackens in the sun light.
The AgI precipitate gives a yellow color.

Document 3

1. By referring to **documents 2 and 3**. Identify the halogen X that exists in this substance (S).
2. Determine, by referring to **documents 1 and 2**, the percentage by mass of the elements C, H and O in substance (S).
3. The compound (S) contains a single oxygen atom :
   - **3.1.** Determine the molecular formula of (S).
   - **3.2.** Write the linear condensed structural formula of (S) where (S) is an acyl chloride.
   - **3.3.** Write the condensed structural formula of a branched isomer of (S).