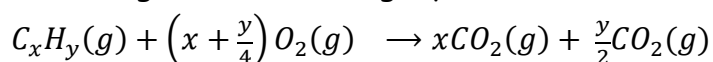


STRUCTURE DETERMINATION OF ORGANIC COMPOUNDS THROUGH CALCULATIONS

A. Trial questions on Eudiometry (combustion of gaseous hydrocarbon and other organic compounds)

- 30cm³ of a gaseous hydrocarbon, **Z**, was exploded with 200cm³ of oxygen, which was in excess. The residual gas volume was found to be 155cm³ on cooling to room temperature. The volume of the residual gas reduced to 35cm³ on treatment with concentrated potassium hydroxide solution.
 - Write the general equation for the reaction between **Z** and oxygen.
 - Calculate the molecular formula of **Z** and hence write its structural formula.
- W** is an organic compound of the C_nH_{2n}O series. 40cm³ of the gaseous **W** were mixed with 180cm³ of oxygen, the mixture was exploded and the residual gaseous product at room temperature bubbled through concentrated potassium hydroxide solution. The final volume of the gas was found to be 20cm³. Determine the molecular formula of **W** and write all the possible isomers of **W** (Indicate their **IUPAC** names)
- When 20cm³ of a hydrocarbon, **T**, was exploded in 200cm³ of oxygen (excess), it burnt completely with a sooty flame. The volume of the residual gas after cooling to room temperature was 160cm³. On addition of aqueous potassium hydroxide to the residual gas, there was a contraction in volume of 140cm³. Determine the molecular formula of **T** and hence write its structural formula.
- When 142cm³ of a hydrocarbon, **Q**, of molecular mass 58 was exploded with excess oxygen and cooled to room temperature, the volume of the residual was 694cm³. After addition of concentrated potassium hydroxide, the volume decreased to 126cm³.
 - Determine the molecular formula of **Q**
 - Write down all the possible isomers of **Q** indicating their **IUPAC** names.
- A hydrocarbon, **R**, with molecular formula C_xH_y, reacted with oxygen according to the following equation;



When 20cm^3 of **R** was exploded with 205cm^3 of an excess amount of oxygen, it burnt completely. The volume of the residual gas after cooling to room temperature was 185cm^3 . When aqueous potassium hydroxide was added, the volume of the gas that finally remained was 125cm^3 . Calculate the molecular formula of **R** and hence write its structural formula.

6. 10cm^3 of a hydrocarbon, **W**, (C_xH_y) was exploded with 95cm^3 of oxygen. On cooling to room temperature, the residual gases occupied 70cm^3 . When the residual gases were passed through potassium hydroxide solution, the volume reduced to 30cm^3 .
- Write the equation for the reaction between **W** and oxygen.
 - Determine the molecular formula of **W**.
 - Identify the homologous series to which **W** belongs and write all the possible isomers of **W**.
7. 20cm^3 of a gaseous hydrocarbon, **M**, with general formula, C_nH_{2n-2} , were exploded with 100cm^3 of oxygen and cooled to room temperature. When the residual gas mixture was bubbled through concentrated potassium hydroxide solution, the final volume was found to be 20cm^3 .
- Write the equation for the reaction between **M** and oxygen.
 - Calculate the value of n and hence deduce the molecular formula of **M**.
 - Write the structural formula of **M**.
8. When 20cm^3 of a hydrocarbon, **Q**, was exploded in 200cm^3 of oxygen (excess), it completely burnt with a sooty flame. The volume of the residual gas after cooling to room temperature was 160cm^3 . On addition of aqueous potassium hydroxide to the residual gas, the final volume of gas was 20cm^3 .
- Calculate the molecular formula of **Q**.
 - Write the structural formula of **Q**.
9. When 30cm^3 of an organic compound **R** of formula $C_nH_{3n}O$ was burnt in pure and excess oxygen and cooled to room temperature, 240cm^3 of the residual gas formed. On addition of concentrated potassium hydroxide solution, the volume reduced to 180cm^3 .
- (i) Write the equation for the combustion of **R**.
(ii) Determine the molecular formula of **R**.

- (b) (i) Write down the structural formulae of the possible isomers of **R** and give their IUPAC names.
(ii) **R** reacts with sodium metal to give effervescence of a colourless gas. Identify **R**.
- (c) Discuss the reactions of **R** with sulphuric acid. Indicate the equations and mechanisms of reaction where possible.
10. (a) 20cm^3 of an organic compound **X** of formula C_nH_{2n+2} was exploded in oxygen. After cooling to room temperature, the residual gas occupied 200cm^3 . On addition of caustic potash, the contraction in volume was 20cm^3 .
- Write an equation for the combustion of **X**.
 - Determine the molecular formula of **X**.
- (b) **X** reacts with limited chlorine to form an organic compound **Q**.
- Identify **R** and give its IUPAC name.
 - State any other condition necessary for **X** to react with chlorine to form **Q**.
 - Outline the mechanism for the reaction between **X** and chlorine.
- (c) Discuss the reactions of **Q** and sodium hydroxide.
- (d) Write equations to show how **Q** can be converted to propene.
11. 20cm^3 of an organic compound **M** of formula C_nH_{2n} was exploded in excess oxygen and after cooling to room temperature, the residual gas occupied 200cm^3 . On addition of caustic potash, there was a contraction in volume to 20cm^3 .
- (a) (i) Write an equation for the combustion of compound **M**.
(ii) Determine the molecular formula of **M**
- (b) (i) Write down all the possible structural isomers of **M** and give their IUPAC names.
(ii) Ozonolysis of **M** give a single product. Identify **M**.
- (c) Write equations of reaction between **M** and
- Bromine water.
 - Hydrogen bromide.
 - Concentrated sulphuric acid in the presence of water.
- For each case indicate a mechanism of reaction.

12. 10cm^3 of an organic compound **Z** of formula C_nH_{2n-2} was exploded in excess oxygen. After cooling to room temperature, the volume of the condensed vapour was found to be 30cm^3 .
- Determine the molecular formula of **Z**.
 - Z** decolourises bromine water but has no effect on acidified potassium manganate(VII). Write down all the structural isomers of **Z** and give their IUPAC names.
 - Name a reagent that can be used to distinguish between the isomers you have named in (b) above and for each case state what is observed.
 - Write an equation of reaction for what takes place in (c)(i) above.
 - Explain your observations in (c)(i) above.
 - Discuss the reactions of **Z** with;
 - Hydrogen chloride gas.
 - Hydrogen gas.
13. 25cm^3 of an organic compound **W** of formula $C_nH_{2n}O$ was exploded with 250cm^3 of oxygen and after cooling, the residual gas occupied a volume of 170cm^3 . On addition of potassium hydroxide solution, there was a contraction in volume of 20cm^3 .
- Determine the molecular formula of **W**.
 - X** and **Y** are the two isomers of **W** and form a yellow precipitate with Brady's reagent. **X** further forms a silver mirror with ammoniacal silver nitrate solution whereas **Y** does not.
 - Name **X** and **Y**.
 - Write an equation for the reaction between **X** and ammoniacal silver nitrate solution.
 - Discuss the reactions of **X** and ;
 - Phenylhydrazine.
 - Sodium sulphite.
 - Name the reagent that can be used to distinguish between **X** from Benzaldehyde and for each case state what is observed.
 - Write equations to show how **Y** can be obtained from propene.
14. 20cm^3 of an organic compound **G** of formula $C_xH_yO_z$ was exploded in excess oxygen. After cooling to room temperature, the condensed water vapour

occupied a volume of 60cm^3 . On addition of caustic potash, there was a contraction in volume of 80cm^3 . In vapour form, **G** has a vapour density of 59.

(a) Determine the molecular formula of **G**.

(b) (i) Write down the structural formula of **G** and give its IUPAC name.

(ii) **G** reacts with a solution of sodium carbonate to give off effervescence of a colourless gas. Name the functional group in **G**.

(c) Write equations to show how **G** can be obtained from cyclobutanol.

(d) In an experiment to determine the percentage purity of magnesium metal (Atomic number=24), 0.6g of impure magnesium metal was dissolved in 50cm^3 of 0.5M solution of **G** and the resultant solution diluted to 250cm^3 . 22.10cm^3 of the resultant solution was required to neutralize 25cm^3 of 0.095M sodium hydroxide solution.

Determine.

(i) The number of moles of sodium hydroxide used.

(ii) Excess moles of solution **G** in 250cm^3 .

(iii) Moles of solution **G** that reacted with magnesium metal.

(iv) Percentage purity of magnesium metal.

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B. Trial questions involving use of the ideal gas equation in determination of molecular formula.

1. A compound, **G**, contains 54.5% carbon, 9.09% hydrogen and the rest being oxygen.

(a) Calculate the empirical formula of **G**

(b) 0.54g of **G** occupies 150.9cm^3 at a temperature of 19°C and a 740mmHg pressure. Determine the molecular formula of **G** and write the structure formula of **G** if it gives bubbles with magnesium powder.

2. 3.4g of an organic compound **Q** on complete combustion produced 5.04dm^3 of carbon dioxide and 2.70g of water at stp. An aqueous solution of **Q** containing 2.8gdm^{-3} has an osmotic pressure of 380mmHg at 25°C . Determine the molecular formula of **Q**.

3. An organic compound, **E**, contains 54.55% carbon, 9.09% hydrogen and the rest being oxygen. The density of **E** at 50°C and 2.0atmosphere pressure is 3.3185gdm^{-3} . Determine the molecular formula of **E**.

C. Trial questions involving use of vapour density measurements in determination of molecular formula.

1. An organic compound, **L**, has a density of 2.49gdm^{-3} at room temperature. 1.5g of compound **L** when completely burnt in air, formed 2.2g of carbon dioxide and 0.9g of water. Determine the molecular formula of **L**.
2. An organic compound **D** contains 66.7% carbon, 11.1% hydrogen and the rest being oxygen. If the vapour density of **D** is 36. Determine its molecular formula.

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D. Trial questions involving use of the data from steam distillation in determination of molecular formula

1. A compound **Y** contains carbon, hydrogen and nitrogen only. On complete combustion, 2.325g of **Y** yielded 6.6g of carbon dioxide and 295.5cm^3 of nitrogen gas measured at 15°C and at 760mmHg.
- (a) Calculate the empirical formula of **Y**.
- (b) When compound **Y** was steam distilled at 97°C and 755mmHg, the distillate contained 45.49% by mass of **Y**. (The saturated vapour pressure of water at this temperature is 650mmHg). Determine the molecular formula of **Y**.

2.

E.