

ADVANCED LEVEL CHEMISTRY PROBLEMS

ORGANIC CHEMISTRY REVISION QUESTIONS

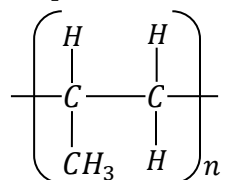
1. The complete combustion of 2.7g of a hydrocarbon **A** gave 2.7g of water. It takes a given volume of nitrogen 10.16 seconds to effuse through a narrow opening while the same volume of A under the same conditions takes 14.11 seconds.
- (a). Determine the
- (i). Empirical formula of **A**. (02 marks)
 - (ii). Molecular formula of **A**. (02 marks)
- (b). When A is reacted with mercury(II) sulphate in the presence of dilute sulphuric acid at 60°C, it forms a compound **B** which forms a yellow precipitate with Brady's reagent.
- (i). Name the functional group in **A**. (01 mark)
 - (ii). Name a reagent that can be used to identify the functional group in **A**, state what would be observed and write equation for the reaction that would take place. (03 marks)
 - (iii). Write the structural formulae and names of all the possible isomers of **A**. (02 marks)
- (c). Name a reagent that can be used to distinguish between the isomers of **A** in (b) and in each state what would be observed and write equation for the reaction that would take place if each isomer is treated with the reagent named. (03 marks)
- (d). **A** reacts with sodium in the presence of liquid ammonia.
- (i). Identify **A**. ($\frac{1}{2}$ mark)
 - (ii). Write equation and outline a mechanism for the reaction between **A** and hydrogen bromide. ($3\frac{1}{2}$ marks)
- (e). Write equations to show how **B** can be converted to 2,3-dibromobutane. (03 marks)
- 2 (a). The boiling point of 2-chlorobutane and 2-iodobutane are 68°C and 119°C respectively. When treated separately with sodium hydroxide followed by acidified silver nitrate solution, 2-chlorobutane forms a white precipitate after 15 minutes while 2-iodobutane forms a yellow precipitate almost immediately. Explain why;
- (i). The boiling point of 2-chlorobutane is lower than that of 2-iodobutane. (02 marks)
 - (ii). The formation of the precipitate in 2-chlorobutane takes a longer time than in 2-iodobutane. (03 marks)

- (b). Write
- (i). Equation for the reaction of 1-chlorobutane with aqueous sodium hydroxide. (01 mark)
 - (ii). The mechanism for the reaction in (b) (i). (01 mark)
- (c). The reaction in (b) (i) is exothermic. Sketch a labelled potential energy versus reaction coordinate diagram for the reaction. (2½ marks)
- (d). Write equation for the reaction showing the conversion of benzene to chlorobenzene. Outline a mechanism for the reaction. (04 marks)
- (e). Write equations to show how 2-bromobutane can be converted to butanone. Indicate the conditions for the reactions. (2½ marks)
- (f). (i) Name one reagent that can be used to confirm the formation of butanone. (01 mark)
- (ii). State what would be observed if butanone was present. (01 mark)
 - (iii). Write equation for the reaction of butanone and the reagent you have named in (f) (i). (01 mark)
 - (iv). A solution containing iodine and sodium hydroxide was added to butanone. State what was observed. (01 mark)
3. A hydrocarbon **D** contains 92.31% carbon. When vaporised at 72°C and 786mmHg, 1.17g of **D** occupies 410.57cm³.
- (a). Determine the
- (i). Empirical formula of **D**. (1½ marks)
 - (ii). Molecular formula of **D**. (02 marks)
- (b). **D** burns with a yellow sooty flame. Identify **D** (0½ mark)
- (c). Write equations, indicating the conditions for the reactions to show how **D** reacts with each of the following. Write the IUPAC name for the major organic product.
- (i). Propene (1½ marks)
 - (ii). Ethanoyl chloride (1½ marks)
 - (iii). Bromoethane. (1½ marks)
- (d). Write mechanisms for each reaction taking place in (c) above. (7½ marks)
- (e). Would you expect **D** to undergo electrophilic addition or electrophilic substitution reaction? Explain your answer. (02 marks)
- (f). Write equations to show how **D** can be made from 1,1-dichloroethane. (02 marks)

- 4 (a). A compound **Q** contains 64.9% carbon, 13.5% hydrogen and the rest being oxygen. 1.85g of **Q** in the vapour form occupied 969.8cm³ at 200°C.
- Calculate the empirical formula of **Q**. (02 marks)
 - Determine the molecular formula of **Q**. (2½ marks)
(The molar gas constant, $R = 8.31JK^{-1}mol^{-1}$)
- (b). **Q** reacts with sodium with effervescence but has no effect on sodium carbonate. Write the names and the structures of all possible isomers of **Q**. (04 marks)
- (c). When treated with anhydrous zinc chloride in the presence of concentrated hydrochloric acid, **Q** formed two layers after about 8 minutes. Identity **Q**. (01 mark)
- (d). **Q** reacted with acidified chromium trioxide to give a compound **R**. Write equation for the reaction:
- leading to the formation of **R**. (01 mark)
 - between **R** and acidified 2,4-dinitrophenylhydrazine and outline a mechanism for the reaction. (5½ marks)
 - Write equation to show how **Q** can be prepared from an alkene and outline a mechanism for the reaction. (04 marks)
- 5 (a). Benzene undergoes electrophilic substitution reactions while cyclohexene undergoes electrophilic addition reactions.
- Distinguish between electrophilic substitution and electrophilic addition reaction. (02 marks)
 - Explain why benzene undergoes electrophilic substitution while cyclohexene undergoes electrophilic addition reactions. (04 marks)
- (b). Describe the reactions of bromine with
- Benzene. (05 marks)
 - Cyclohexene. (06 marks)
(Your answers should include equations and mechanisms for the reaction where applicable)
- (c). Write equations to show how benzene can be converted to cyclohexene. (03 marks)
- 6 (a) (i). Write equation for the reaction in which 2-chloropropane can be obtained from propene. (1½ marks)
- (ii). Outline a mechanism for the reaction leading to the formation of 2-chloropropane in (a) (i) above. (2½ marks)

- (iii). Write equation to show how 2-chloropropane can be converted to propyne.
[your answer should include reagents and conditions]. (05 marks)
- (b). (i) Name one reagent that can be used to differentiate between propyne and but-2-yne. (01 marks)
- (ii). State what would be observed if propyne and but-2-yne were separately treated with the reagent you have named in (b) (i). (02 marks)
- (iii). Write equation to illustrate your answer. (01 mark)
- (c). Write
- (i). Equation(s) to show how 2-methylpropanoic acid can be prepared from 2-chloropropane (03 marks)
- (ii). The mechanism for the reaction between 2-methylpropanoic acid with methanol in the presence of concentrated sulphuric acid. (04 marks)

- 7 (a). Propanone and propanal both undergo nucleophilic addition reactions.
- (i). What is a nucleophilic addition reaction? (01 mark)
- (ii). Explain why carbonyl compounds can undergo nucleophilic addition reactions. (02 marks)
- (a). Name
- (i). The functional group in propanone and propanal. (01 mark)
- (ii). A reagent used to identify the functional group in propanone and propanal. State what would be observed and write equation for the reaction that takes place. (03 marks)
- (b). Name a reagent that can be used to distinguish between propanone and propanal. State what is observed and write equation for the reaction. (03 marks)
- (c). Propanal was added to saturated solution of sodium hydrogen sulphite.
- (i). State what was observed. (01 mark)
- (ii). Outline an acceptable mechanism for the reaction. (02 marks)
- (d). Propanal can be converted to a compound Y with a structure



- (i). Name Y. (01 mark)
- (ii). Write equations to show how propanal can be converted to Y. (03 marks)
- (iii). State one use of Y. (01 mark)
- (e). Propanone was warmed with a mixture of iodine and sodium hydroxide solution.

- (i). State what was observed. (01 mark)
- (ii). Write equation for the reaction. (01 mark)
- 8 (a). An organic compound **P** contains 35.04% Carbon, 6.56% hydrogen and 58.40% bromine. Calculate the empirical formula of **P**. ($H = 1$, $C = 12$; $Br = 79.9$). (02 marks)
- (b). The vapour pressure of **P** was found to be 68
- (i). Determine the molecular formula of **P**. (02 marks)
- (ii). Write the names and structural formulae of all the possible isomers of **P**. (04 marks)
- (c). When **P** was reacted with sodium hydroxide, a compound, **Q** was formed. When a solution of anhydrous zinc chloride in concentrated hydrochloric acid was added to **Q**, it turned cloudy within 10 minutes.
- (i). Identify **Q**. (01 mark)
- (ii). State the condition(s) for the reaction to take place and write the mechanism for the reaction between **P** and sodium hydroxide. (03 marks)
- (d). Explain the difference in the reactivity of **P** and bromobenzene with sodium hydroxide. (05 marks)
- (e). Write equation(s) to show how **P** can be synthesized from butan-1-ol. (03 marks)
- 9 (a). The acids $HCOOH$, CH_3COOH and CH_3CH_2COOH are organic acids.
- (i). Arrange the acids in order of increasing acid strength. (01 mark)
- (ii). Explain your answer in (a) above. (05 marks)
- (b). Describe the reaction between CH_3COOH and ethanol. [Your answer should include an equation and a mechanism for the reaction]. (5½ marks)
- (c). Write equations to show how CH_3CH_2COOH can be converted to propyne Include the conditions for the reactions in each case. (04 marks)
- (d). Name a reagent that can be used to distinguish between $HCOOH$ and CH_3COOH . State what would be observed when the reagent you have named is treated separately with the reagent you have named. (03 marks)
- (e). Write equation for the reaction that takes place in (d). (1½ marks)

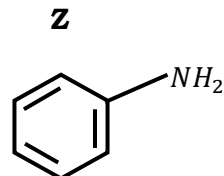
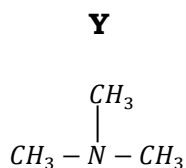
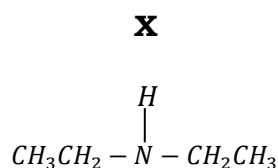
- 10 (a). Discuss the reactions of ethanol with sulphuric acid. In each case, outline a mechanism for the reaction that takes place. (13 marks)
- (b). Write equations to show how the following compounds can be synthesised from ethanol.
- (i). Propanone. (04 marks)
- (ii). Ethyne. (03 marks)
- 11 (a). A gaseous hydrocarbon **X** consists of 11.11% by mass hydrogen and has a vapour density of 27. Calculate the
- (i). Empirical formula of **X**. (02 marks)
- (ii). Molecular formula of **X**. (02 marks)
- (iii). Write the structural formulae and the IUPAC names of all the possible isomers of **X**. (04 marks)
- (b). 1 mole **X** reacts completely with one mole of hydrogen gas in the presence of platinum catalyst. Identify **X**. (01 mark)
- (c). When **X** was warmed with a dilute sulphuric acid, a substance **Y** was formed which was oxidized to compound **Z** by hot acidified potassium dichromate(VI). Outline a mechanism for the reaction between
- (i). **X** and warm dilute sulphuric acid. (03 marks)
- (ii). **Z** and acidified solution of hydroxylamine. (04 marks)
- (iii). **Z** and a solution of potassium cyanide in dilute sulphuric acid. (04 marks)
12. Explain the following observations;
- (a). Diethylamine is a stronger base than aminobenzene. (05 marks)
- (b). Bromine water reacts with propene to form 1-bromopropan-2-ol as the major product instead of 1,2-dibromopropane. (05 marks)
- (c). Ethanoic acid is a weaker acid than dichloroethanoic acid. (05 marks)
- (d). When 2-methylpropene is reacted with hydrogen bromide, the major product is 2-bromo-2-methylpropane rather than 1-bromo-2-methylpropane. (05 marks)

13. Write names or structural formulae of one pair of compounds with the same functional groups that can be distinguished using the following reagents. In each case, state what would be observed if each member of a pair was separately treated with the reagent and write an equation for the reaction that would take place.
- (a). Ammoniacal silver nitrate solution. (04 marks)
 - (b). Bromine water. (04 marks)
 - (c). Acidified potassium dichromate(VI). (04 marks)
 - (d). Iodine solution and sodium hydroxide solution. (04 marks)
 - (e). 2,4 dinitrophenylhydrazine. (04 marks)
14. When 0.10g of an organic compound **X** containing carbon, hydrogen and oxygen only was completely burnt in excess oxygen, 0.227g of carbon dioxide and 0.093g of water were produced. When 0.368g of **X** were vaporised at 37°C and 760mmHg, it occupied a volume of 161.4cm³. calculate
- (a). Calculate the
 - (i). Empirical formula of **X**. (02 marks)
 - (ii). Molecular formula of **X**. (02 marks)
 - (b). Write the structural formulae and the IUPAC names of the possible isomers of **X**. (03 marks)
 - (c). **X** does not react with ammoniacal silver nitrate solution. Identify **X**. (01 mark)
 - (d). Write equations to show how **X** can be
 - (i). Synthesised from ethanol. (03 marks)
 - (ii). 1-bromopropane (03 marks)
 - (e). Outline a mechanism for a reaction between **X** and
 - (i). A solution of hydrazine in concentrated sulphuric acid. (04 marks)
 - (ii). An aqueous solution of hydrogen cyanide. (02 marks)
- 15 (a). Explain why benzene undergoes electrophilic substitution whereas cyclohexene undergoes electrophilic addition reaction. In each case, write an equation to illustrate your answer. (04 marks)
- (b). Write equation
- (i). To show how methylbenzene can be converted to benzene. (03 marks)
 - (ii). For the reaction between methylbenzene and chlorine in the presence of sunlight. Outline a mechanism for the reaction. (04 marks)

- (c). Write the mechanism for the reaction between benzene and
- (i). A mixture of concentrated nitric acid and sulphuric acid. (03 marks)
 - (ii). Propene in the presence of phosphoric acid. (03 marks)
 - (iii). Ethanoyl chloride in the presence of iron(III) chloride. (03 marks)
16. Explain what is meant by each of the following terms. [your answers should include acceptable mechanism for the reaction]
- (a). Nucleophilic addition reaction. (04 marks)
 - (b). Nucleophilic substitution unimolecular reaction. (04 marks)
 - (c). Nucleophilic substitution bimolecular reaction. (04 marks)
 - (d). Electrophilic substitution reaction (04 marks)
 - (e). Electrophilic addition reaction. (04 marks)
17. Write names or structural formulae of one pair of compounds with the same functional groups that can be distinguished using the following reagents. In each case, state what would be observed if each member of a pair was separately treated with the reagent and write an equation for the reaction that would take place.
- (a). Sodium carbonate solution. (04 marks)
 - (b). Neutral iron(III) chloride solution. (04 marks)
 - (c). Hot sodium hydroxide solution, dilute nitric acid and silver nitrate solution. (04 marks)
 - (d). Sodium nitrite and concentrated hydrochloric acid at 0°C. (04 marks)
 - (e). A solution of anhydrous zinc chloride and concentrated. (04 marks)
18. Explain the following observations
- (a). Methanoic acid is a stronger acid than ethanoic acid. (04 marks)
 - (b). Alkenes undergo electrophilic addition reactions while carbonyl compounds undergo nucleophilic addition reaction. (05 marks)
 - (c). The boiling point of ethanol is much higher than that of methoxymethane although both have the same molecular mass. (03 marks)
 - (d). The boiling point of pentane and 2,2-dimethylpropane are 36°C and 10°C respectively yet the two compounds have the same molecular mass. (04 marks)
 - (e). Ethanamide is a weaker base than ethylamine. (04 marks)

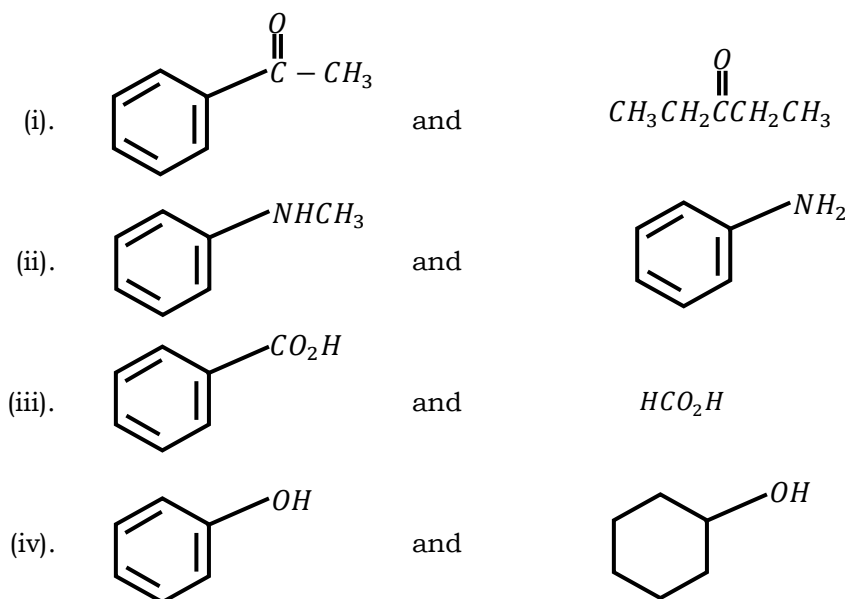
- 19 (a). Explain the following observations.
- The enthalpy of hydrogenation of cyclohexene is 121kJmol^{-1} while that of benzene is 209kJmol^{-1} . (03 marks)
 - Although benzene has a carbon to carbon double bond, it undergoes electrophilic substitution reaction rather than electrophilic addition reactions. (03 marks)
- (b). Describe the reactions of benzene with each of the following. [include the condition and mechanism for the reactions]
- Sulphuric acid. (03 marks)
 - Chlorine. (04 marks)
 - ethanoyl bromide. (03 marks)
- (c). Write equations to show how benzene can be
- Converted to benzoyl chloride (02 marks)
 - Obtained from ethanol. (02 marks)
- 20 (a). When a given mass of an aliphatic non-cyclic amine **Z** was burnt in excess oxygen, 2.64g of carbon dioxide and 1.62g of water were produced while 269.51cm^3 of nitrogen were collected at 68°C and 789mmHg. The vapour density of **Z** at s.t.p. is 2.634gdm^{-3} . Calculate the
- Empirical formula of **Z**. (03 marks)
 - Molecular formula of **Z**. (02 marks)
- (b). Write the structural formulae and IUPAC names of the isomers of **Z**. (04 marks)
- (c). Name a reagent that can be used to distinguish between the isomers in (b) and in each case, state what would be observed and write the equations for the reactions that took place. (07 marks)
- (d). Write equations to show how benzene can be converted to phenylmethanamine. (04 marks)

21. The structural formulae of amines **X**, **Y** and **Z** are shown below.



- (a). (i) Describe the reaction of the amines with nitrous acid. [Your answer should include observations and equations] (08 marks)
- (ii). The basicity of the amines is in order $X > Y > Z$. Explain. (05 marks)
- (b). (i) Write equation(s) to show how **Z** can be prepared from nitrobenzene. [Include reagents and conditions]. (03 marks)
- (ii). **Z** can be used in the manufacture of azo-dyes. Describe the steps you would follow in preparing azo-dye starting from **Z**. [your answer should include observations and equations]. (04 marks)
- 22 (a). Describe the reactions of bromoethane with potassium hydroxide. (07 marks)
- (b). (i) Briefly describe a test that can be carried to distinguish between bromoethane and bromobenzene. (03 marks)
- (ii). Account for the difference in the reactivity of bromoethane and bromobenzene. (05 marks)
- (c). write equation to show how
- (i). Bromoethane can be prepared from ethanol. (01 mark)
- (ii). Bromobenzene can be prepared from benzene. (01 mark)
- (d). Write the mechanism for the reaction in (c) (ii). (03 marks)

23. For each of the following pairs of compounds



Name one reagent which;

- (a). When reacted with each member of the pair will show similar observation. (08 marks)
- (b). Can be used to distinguish between the members of each pair. In each case, state what would be observed when each member of the pair is reacted with the reagent you have named. (12 marks)
- 24 (a). 1.86g of compound **X** contains carbon, hydrogen, and nitrogen only. **X** on combustion liberated 5.28g of carbon dioxide gas and 224cm³ of nitrogen at s.t.p.
- (i). Determine the empirical formula of **X**. (03 marks)
- (ii). When steam distilled at 98°C and 760 mmHg pressure, the distillate contained 25.8g of water and 7.4g of **X**. determine the molecular formula of **X**. [the vapour pressure of water at 98°C is 720 mmHg] (03 marks)
- (b). **X** burns with a yellow sooty flame. Identify **X**. (01 mark)
- (c). **X** was added to bromine water
- (i). State what was observed. (01 mark)
- (ii). Write the equation for the reaction. (01 mark)
- (iii). Write the name of the major organic product formed. (01 mark)
- (d). **X** was reacted with sodium nitrite and dilute hydrochloric acid at 5°C.
- (i). Name the major organic product formed. (01 mark)
- (ii). Write equation for the reaction that took place. (01 mark)
- (e). State one industrial use of the product in (d). (01 mark)
- (f). State what would be observed and write equation for the reaction that would take place if the product in (d) was separately treated with an alkaline solution of
- (i). Phenol. (02 marks)
- (ii). 2-naphthol. (02 marks)
- (g). Write equations to show how **X** can be converted to cyclohexanol. (03 marks)
- 25 (a). An organic compound **P** contains 68.85% carbon, 4.92% hydrogen and the rest being oxygen. When vaporised at 199.2kPa and 92°C, 1.83g of P occupied a volume of 228.4cm³. Determine the
- (i). Empirical formula of **P**. (02 marks)
- (ii). Molecular formula of **P**. (02 marks)

- (b). **P** burns with a yellow sooty flame. Write the structural formula and name of **P**.
(01 mark)
- (c). (i) Name the functional group in **P**. (01 mark)
- (ii). Name a reagent that can be used to confirm for the presence of the functional group in **P** you have named. (01 mark)
- (iii). State what is observed when the reagent you have named in (c) (ii) is treated with **P**. (01 mark)
- (iv). Write equation for the reaction that takes place in (c) (iii) above. (01 mark)
- (c). Describe the reaction of **P** with methanol. (04 marks)
- (d). State what is observed and write equation for the reaction that takes place when neutral iron(III) chloride solution is added to a warm solution of **P**. (02 marks)
- (e). Write equations to show how **P** can be
- (i). Obtained from aniline. (2½ marks)
- (ii). Converted to chlorocyclohexane. (2½ marks)
- 26 (a). A compound **X**, vapour density 58, contains 62.07% carbon, 10.34% hydrogen and the rest being oxygen. **X** burns with a non-sooty flame.
- (i). Calculate the empirical formula of **X**. (02 marks)
- (ii). Determine the molecular formula of **X**. (02 marks)
- (b). Hydrolysis of **X** yielded compounds **Y**, $C_4H_{10}O$ and **Z**, $C_2H_4O_2$. Both **Y** and **Z** react with metallic sodium. **Z** reacts with sodium carbonate but **Y** does not.
- (i). Identify **Z** (01 mark)
- (ii). Write the IUPAC names and the structural formulae of all the possible isomers of **Y**. (04 marks)
- (iii). Name a reagent that can be used to distinguish between the isomers in (b) (ii) and state what would be observed if the reagent is reacted separately with each of the isomers. (04 marks)
- (c). When **Y** was warmed with acidified potassium dichromate, there was no observable change.
- (i). Identify **Y**. (01 mark)
- (ii). Write the structural formula of **X**. (01 mark)
- (d). Write
- (i). An equation and outline a mechanism for the reaction between **Y** and hot concentrated phosphoric acid. (04 marks)
- (ii). The IUPAC name of the product in (d)(i). (01 mark)

- 27 (a). Write equations to show how the following compounds can be prepared.
- (i). Phenylamine from benzene. (02 marks)
 - (ii). Ethylamine from ethanol. (02 marks)
- (b). Which one of phenylamine and ethylamine is a stronger base? Explain (03 marks)
- (c). State what would be observed and write equations for the reactions that take place for each of the compounds, phenylamine and ethylamine reacting with
- (i). Ethanoyl chloride. (03 marks)
 - (ii). Acidified solution of sodium nitrite at 5°C. (03 marks)
- (d). Write mechanism for the reaction of ethanoyl chloride and ethylamine (03 marks)
- (e). Phenylamine can be converted to benzene diazonium chloride. Write equation for the conversions of the diazonium salt to
- (i). Iodobenzene. (02 marks)
 - (ii). Benzoic acid. (03 marks)

28. Explain the following types of organic reactions. [include an example and a mechanism for the reaction]

- (a). Elimination unimolecular reaction. (05 marks)
- (b). Elimination bimolecular reaction. (05 marks)
- (c). Electrophilic substitution reaction. (05 marks)
- (d). Electrophilic addition reaction. (05 marks)

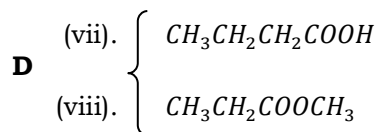
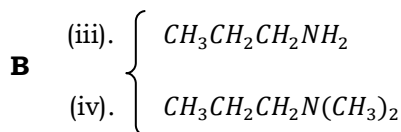
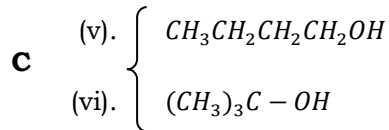
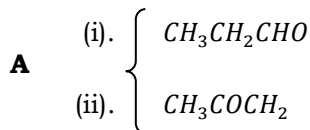
29. Name one reagent that can be used to distinguish between each of the following pairs of compounds and in each case, state what would be observed when the reagent you have named is used.

- (i). $CH_3CH_2COCH_2CH_3$ and $CHCOCH_2CH_2CH_3$
- (ii). C_6H_5CHO and $C_6H_5CH_2COCH_3$
- (iii). $CH_3C \equiv CCH_3$ and $CH_3CH_2C \equiv CH$
- (iv). CH_3OH and CH_3CH_2OH
- (v). $(CH_3)_3C - OH$ and $CH_3CH_2CH_2CH_2OH$

(vi). C_6H_5Cl and $CH_3CH_2CH_2CH_2Cl$

(vii). $C_6H_5NH_2$ and $C_6H_5CH_2NH_2$

30.



(a). For each of the pairs of compounds above, give the IUPAC name for each member of the pair, and name the class of organic compounds to which it belongs.

(08 marks)

(b). For each pair of the compounds, give one test to distinguish between them. In each case, describe the observations expected and name the products. (12 marks)

31 (a). What is meant by the term structural isomerism? (01 mark)

(b). Describe the three types of structural isomerism giving suitable examples in each case. (09 marks)

(c). A compound has structural formula $C_3H_6Cl_2$. Write down the structural formulae and names of the possible isomers of the compound. (04 marks)

(d). Describe the reaction of one of the isomers of $C_3H_6Cl_2$ with sodium hydroxide and write the mechanism for the reaction. (06 marks)

32. Discuss the reaction of

(a). Amines with nitrous acid. (07 marks)

(b). Ethanol with sulphuric acid. (07 marks)

(c). Methylbenzene with chlorine. (06 marks)

[Your answers should include equations and mechanisms for the reactions where applicable]

33. For each of the following compounds, name one reagent that can be used to
- Test for the functional group. (08 marks)
 - Distinguish between each group of the pair. (12 marks)
- In each case, give the relevant observations made when the reagents named in (a) and (b) are used.
- $(CH_3)_3C-OH$ and $CH_3CH_2CH_2CH_2OH$
 - CH_3COCH_3 and CH_3CH_2CHO
 - CH_3CHO and CH_3CH_2CHO
 - $C_6H_5CH_2OH$ and C_6H_5OH
34. (a). Compound **X** has a molecular formula C_3H_8O . Write the structural formulae and IUPAC names of all the possible isomers of **X**. (03 marks)
- (b). X reacted with iodine and aqueous sodium hydroxide solution to form a yellow precipitate.
- Identify **X**. (01 mark)
 - Write equation for the reaction between **X** and iodine in the presence of sodium hydroxide solution. (02 marks)
 - State what would be observed and write equation for the reaction that would take place when **X** is reacted with hot acidified potassium dichromate(VI) solution and name the main organic product. (04 marks)
- (c). When X was heated with excess concentrated sulphuric acid, a gas **Y** which decolourises bromine water was evolved. Write equation for the reaction between
- X** and sulphuric acid and suggest a mechanism for the reaction (04 marks)
 - Y** and bromine water and name the product. (02 marks)
- (d). Y was used to manufacture hydroxybenzene. Write equation and indicate conditions for the reaction (04 marks)

- 35 (a). Propene and propanone both undergo addition reactions.
- Write the structural formulae of propene and propanone. (02 mark)
 - Name one substance that forms an addition compound with
 - Propene. (01 mark)
 - Propanone (01 mark)
 - Name the two addition compounds formed in (a) (ii). (02 mark)
- (b). 1-bromopropane undergoes substitution reaction more readily than bromobenzene. Explain. (03 marks)
- (c). Benzene is nitrated using a mixture of nitric acid and sulphuric acid.
- State the conditions for the reaction. (01 mark)
 - What is the role of sulphuric acid. (01 marks)
 - Write a mechanism for the reaction that takes place. (03 mark)
 - Name the product of the reaction. (01 mark)
- (d). Write equations to show how
- Benzene can be converted bromobenzene. (01 mark)
 - Benzene can be converted to benzoic acid. (02 marks)
 - Propene can be prepared from propanone. (02 marks)
- 36 (a). Both ethanol and phenol contain a common functional group.
- Name the functional group and write its formula. (01 mark)
 - Name a reagent that can be used to identify the functional group and state what would be observed. (02 marks)
 - Name one reagent that can be used to distinguish between the two compounds. (01 mark)
 - State what would be observed if each of the compounds is treated with the reagent you have named. (02 marks)
- (b). An aqueous solution of phenol is acidic to litmus whereas that of ethanol is neutral. Explain the observation. (03 marks)
- (c). Phenol and ethanol can react with ethanoyl chloride.
- Write equation for the reaction of each compound with ethanoyl chloride and name the organic product in each case. (03 marks)
 - Outline the mechanism for the reaction between phenol and ethanoyl chloride. (02 marks)
- (d). Write equation, state the condition and indicate mechanism for a reaction in which ethanol reacts differently from phenol. (06 marks)

37. Phenylamine and cyclohexanamine contain the same functional group.
- Name the functional group in the compounds. (01 mark)
 - Name one reagent that can be used to distinguish between the compounds. (01 mark)
 - State what would be observed when the reagent you have named is treated with each of the compounds. (02 marks)
 - Write equations for the reactions that take place in (b) (ii). (02 marks)
 - Which of the two compounds is a stronger base? Explain. (04 marks)
 - Write equations to show how phenylamine
 - Reacts with chlorine water. State what is observed and name the organic product formed. (03 marks)
 - Can be converted to phenylhydrazine. (02 marks)
 - Reacts with benzene diazonium chloride. (02 marks)
 - Outline a mechanism for the reaction between cyclohexanamine and ethanoyl bromide. (03 marks)
38. The molecular formula of a given compound, M, is C_3H_9N .
- Write the structural formulae and the IUPAC names of any three isomers of M. (03 marks)
 - Discuss the reactions of the isomers with nitrous acid. [Your answer should include observations and equations where applicable]. (06 marks)
 - Arrange the isomers in order of their increasing
 - Basic strength. Explain your answer. (04 marks)
 - Boiling points. Explain your answer. (04 marks)
 - Write equations to show how benzoic acid can be converted phenylamine. (03 marks)
39. Benzaldehyde and ethanal contain the same functional groups.
- Name the functional group. (01 mark)
 - Name a reagent that be used to confirm for the presence of this functional group in the compounds. (01 mark)
 - State what is observed and write equation for the reaction that takes place when the reagent you have named is treated with each of the compounds. (04 marks)

- (d). Name a reagent that can be used to distinguish between the two compounds. In each case, state what would be observed and write equation for the reaction that takes place. (04 marks)
- (e). State what would be observed outline a mechanism for the reaction between ethanal and a saturated solution of sodium hydrogensulphite. (04 marks)
- (f). Outline a mechanism for the reaction between acidified solution of hydrazine and benzaldehyde. (04 marks)
- (g). Write equations to show how benzaldehyde can be prepared from ethanal. (02 marks)
- 40 (a). A colourless liquid **Y** containing 50.00% carbon, 5.56% hydrogen and the rest being oxygen burns with a blue non-sooty flame. The vapour density of **Y** is $3.0 \times 10^{-3} \text{ g cm}^{-3}$ at room temperature. Determine the
- (i). Empirical formula of **Y**. (1 ½ marks)
- (ii). Molecular formula of **Y**. (02 marks)
- [1 mole of gas occupies 24 dm³ at room temperature and pressure].
- (b). **Y** decolourises cold acidified potassium manganate(VII) solution. Write the structural formula and IUPAC name of **Y**. (02 marks)
- (c). Write a mechanism for the reaction between **Y** and each of the following substances and in each case, give the IUPAC name of the products.
- (i). Hydrogen chloride (02 marks)
- (ii). Methanol in the presence of concentrated sulphuric acid. (04 marks)
- (d). Write equations to show how **Y** can be
- (i). Converted to ethane. (03 marks)
- (ii). Obtained from ethanal. (03 marks)
- (e). Write equation and name the product for the reaction between **Y** and
- (i). Bromine in carbon tetrachloride. (1 ½ marks)
- (ii). Sodium hydrogen carbonate. (1 ½ marks)

- 41 (a). An organic compound **G** contains 25.40% carbon, 3.17% hydrogen, 37.57% chlorine and the rest being oxygen. The vapour density of **G** is 47.25.
- Calculate the empirical formula of **G**. (1½ marks)
 - Determine the molecular formula of **G**. (1½ marks)
- (b). Write the structural formulae and the IUPAC names of all the possible isomers of compound **G**. (03 marks)
- (c). (i) Name a reagent that would react with all the isomers to give the same observation. (01 mark)
- (ii). State what would be observed when the reagent you have named is treated with the isomers. (01 mark)
- (c). **G** reacts with sodium hydrogencarbonate with effervescence. Write equation for the reaction. (01 mark)
- (d). Write equation and outline the mechanism for the reaction between **G** and
- Potassium cyanide. (2½ marks)
 - Silver methanoate. (2½ marks)
- (e). Write equations to show how **G** can be
- Converted to ethyne. (03 marks)
 - Obtained from methanal. (03 marks)
- 42 (a). A bromoalkane, **Q**, with general formula $C_nH_{2n+1}Br$, contains 58.39% bromine.
- Determine the molecular formula of **Q**. (03 marks)
 - Write the structural formula and the IUPAC names of the possible isomers of **Q**. (04 marks)
- (b). **Q** was reacted with hot sodium hydroxide solution to and the resulting mixture was added a solution of anhydrous zinc chloride and concentrated hydrochloric acid and a turbid solution was formed after 8 minutes.
- Identify **Q**, (01 mark)
 - Write a mechanism for the reaction that took place between **Q** and hot sodium hydroxide. (1½ marks)
 - Write equation for the reaction leading to the formation of the turbid solution. (1½ mark)
- (c). Write equations, indicating the conditions and outline mechanisms for the reaction between **Q** and
- Phenol. (02 marks)
 - Silver ethanoate (02 marks)

- (d). Write equations to show how Q can be
- (i). Converted to 2-methylbutan-1-amine. (02 marks)
 - (ii). But-2-yne (03 marks)
- 43 (a). A hydrocarbon, Z consists of 85.71% carbon. In a given experiment, 32g of bromine required 11.2 g of Z for complete decolourisation. Determine the
- (i). Empirical formula of Z. (02 marks)
 - (ii). Molecular formula of Z. (02 marks)
- [bromine reacts with Z in a ratio of 1;1]
- (b). Write the structural formulae and IUPAC names of the isomers of Z. (03 marks)
- (c). Ozonolysis of Z produced a single product. Identify Z.
- (i). Identify Z. (01 marks)
 - (ii). Write equation for the ozonolysis of Z. include the conditions for the reactions. (02 marks)
- (d). Outline a mechanism for the reaction between Z and
- (i). Bromine. (2½ marks)
 - (ii). Warm dilute sulphuric acid. (03 marks)
 - (iii). Benzene in the presence of an acid. (03 marks)
- (e). Write equations to show how Z can be obtained from an alkyl halide. (1½ marks)
- 44 (a). 6.85g of a bromoalkane, **J**, was reacted with excess sodium hydroxide solution. The resulting solution was neutralised with excess nitric acid and diluted to 250cm³. 25cm³ of this solution required 12.5cm³ of 0.4M silver nitrate solution for complete precipitation of silver bromide. Calculate
- (i). The relative formula mass of **J**. (04 marks)
 - (ii). The molecular formula of **J**. (02 marks)
 - (iii). Write the structural formulae and IUPAC names of all the possible isomers of **J**. (04 marks)
- (b). **J** undergoes nucleophilic substitution bimolecular reaction when reacted with warm sodium hydroxide solution.
- (i). Identify **J**. (01 mark)
 - (ii). Write the equation for the reaction between **J** and warm sodium hydroxide solution (02 marks)

- (iii). Write the rate equation for the reaction between **J** and warm sodium hydroxide solution. (01 mark)
- (iv). Draw a well labelled potential energy diagram for the reaction, given that the reaction is endothermic. (04 marks)
- (c). Outline a mechanism for the reaction between **J** and hot sodium methoxide. (02 marks)
- 45 (a). A hydrocarbon **T** contains 88.89% carbon. When vaporised, 1.35g of **T** occupied 672cm³ at 54.6°C.
- (i). Calculate the empirical formula of **T**. (02 marks)
- (ii). Determine the molecular formula of **T**. (02 marks)
- [One mole of gas occupies 22.4 dm³ at s.t.p.]
- (b). When **T** was warmed with a mixture of dilute sulphuric acid mercury(II) sulphate, compound **U** was formed. **U** reacts with Brady's reagent to give a yellow precipitate.
- (i). Write the structural formulae and the IUPAC names of the possible isomers of **T**. (02 marks)
- (ii). Name a reagent that can be used to distinguish between the isomers you have written in (b) (i), and state what would be observed if the reagent you have named is treated with each of the isomers (03 mark)
- (iii). Write equation for the any reaction that takes place in (b) (ii). (02 marks)
- (c). (i) Identify **U**. (01 mark)
- (ii). Write equation for the reaction between **U** and Brady's reagent that leads to the formation of a yellow precipitate. (02 marks)
- (d). **T** reacts with sodium amide. Write equations to show how **T** can be
- (i). Prepared from 1,2-dichloropropane. (03 marks)
- (ii). Converted to 2,2-dibromopentane. (03 marks)
- 46 (a). An organic compound, **L**, contains 61.02% carbon, 15.25% hydrogen and the rest being nitrogen. The vapour density of **L** 2.634g l⁻¹ at s.t.p.
- (i). Calculate the empirical formula of **L**. (02 marks)
- (ii). Deduce the molecular formula of **L**. (02 marks)
- (b). **L** reacts with a solution of sodium nitrite and cold dilute hydrochloric acid to form bubbles of a colourless gas and compound **M**.

- (i). Name the colourless gas. (01 mark)
 - (ii). Write the structural formulae and IUPAC names of the possible isomers of L. (02 marks)
 - (c). When a solution of anhydrous zinc chloride was added to M, a cloudy solution was formed after 9 minutes.
 - (i). Identify L and M. (02 marks)
 - (ii). Write equation for the reaction leading to the formation of M. (02 marks)
 - (d). Write an equation and outline a mechanism for the reaction between
 - (i). L and ethanoyl chloride (03 marks)
 - (ii). M and cold concentrated sulphuric acid. (03 marks)
 - (e). Write equations to show how L can be prepared from M. (02 marks)
- 47 (a). An organic compound **V** contains 66.41% carbon, 5.53% hydrogen and the rest being chlorine. When 2.53g of **V** were vaporised at 785mmHg and 92°C, it occupied a volume of 580cm³.
- (i). Calculate the empirical formula of **V**. (02 marks)
 - (ii). Determine the molecular formula of **V**. (02 marks)
 - (b). **V** burns with a yellow sooty flame. Write the structural formulae of all the possible isomers of **V**. (04 marks)
 - (c). **V** reacts with aqueous sodium hydroxide.
 - (i). Identify the isomer. (01 marks)
 - (ii). Write equation and outline a mechanism for the reaction between the isomer. (03 marks)
 - (iii). Describe a test that can be carried out to differentiate **V** from the rest of the any one isomer in (b). (03 marks)
 - (d). Write equations to show how **V** can be
 - (i). Converted to cyclohexylethanoic acid (03 marks)
 - (ii). Prepared from phenylmethanal. (02 marks)

- 48 (a). On organic compound **M** contains 78.51% carbon, 8.41% hydrogen and the rest being nitrogen. When vaporised, 4.28g of **M** occupied 886.4cm³ at 114kNm⁻² and 31°C. Determine the
- (i). Empirical formula of **M**. (02 marks)
 - (ii). Molecular formula of **M**. (02 marks)
- [Molar gas constant, R= 8.31Jmol⁻¹K⁻¹]
- (b). **M** burns with a yellow sooty flame. Write the structural isomers of all the possible isomers of **M**. (04 marks)
- (c). Name a reagent that can be used to distinguish between the isomers you have written in (b). (01 mark)
- (d). State what would be observed when the reagent is treated with each of the isomers you have written. (03 marks)
- (e). Write equations for the reaction that take place in (d). (03 marks)
- (f). Identify the isomer that is the
- (i). Strongest base. Explain your answer. (02½ marks)
 - (ii). Weakest base. Explain your answer. (02½ marks)
- 49 (a). An organic compound **R** contains 79.25% carbon, 5.66% hydrogen and the rest being oxygen. When vaporised, at 78°C, 1.59g of **R** occupied 432cm³. Determine
- (i). The empirical formula of **R**. (02 marks)
 - (ii). The molecular formula of **R**. (02 marks)
- [Molar gas constant, R= 8.31Jmol⁻¹K⁻¹]
- (b). **R** burns with a yellow sooty flame. Write the structural formula and name of **R**. (02 marks)
- (c). State what would be observed and write equations for the reaction that would take place when the following are added to **R**.
- (i). A solution of 2,4-dinitrophenylhydrazine in concentrated sulphuric acid. (2½ marks)
 - (ii). Ammoniacal silver nitrate solution. (2½ marks)
- (d). Outline a mechanism for the reaction that takes place in (c) (i). (05 marks)
- (e). Write equations to show how **R** can be converted to aniline. (04 marks)

FAILURE TO PREPARE IS PREPARING TO FAIL