

SUBJECT: S5 CHEMISTRY PAPER I (THEORY)

COMBINATIONS:

- **MATHS -CHEMISTRY- BIOLOGY (MCB)**
- **PHYSICS-CHEMISTRY-BIOLOGY (PCB)**
- **PHYSICS-CHEMISTRY- MATHS (PCM)**

SECTION A: Answer all questions of this section/ 70 marks

1. State whether each of the following statements is **True(T)or False(F)**
(5marks)

- (a) A functional group determines the chemical behavior of an organic compound.
- (b) Halogen alkanes contain a halogen atom attached to a carbon chain.
- (c) A peptide bond is formed between an amino group and a carboxyl group of two amino acids.
- (d) The general formula of aliphatic alkanes is C_nH_{2n}
- (e) Stereoisomerism involves different spatial arrangements of atoms.

2. Circle the letter corresponding to the correct answer. **(10 marks)**

(i) Why do members of a homologous series show similar chemical properties?

- A. They have the same molecular mass
- B. They contain the same functional group
- C. They have the same boiling point
- D. They are all hydrocarbons

(ii) Which condition is necessary for an alkene to show cis-trans isomerism?

- A. Each carbon of the double bond has two identical groups
- B. Each carbon of the double bond has two different groups
- C. The alkene is cyclic
- D. The alkene is branched

(iii) . Why does alcoholic KOH favor elimination rather than substitution?

- A. Alcohol increases polarity
- B. High temperature and strong base
- C. Presence of water
- D. Low molecular mass

(iv) Primary alkyl halides favor SN2 reactions because they:

- A. Form stable carbocation's
- B. Have less steric hindrance
- C. Are more polar
- D. Contain weak bonds

(v) . Amino acids exist as zwitterions because they contain:

- A. Only acidic groups
- B. Only basic groups
- C. Both acidic and basic groups
- D. Only non-polar groups

(vi) Peptide bonds are classified as:

- A. Ester bonds
- B. Ionic bonds
- C. Amide bonds
- D. Hydrogen bonds

(vii) The isoelectric point of an amino acid is the pH at which it:

- A. Is fully ionized
- B. Has maximum solubility
- C. Has no net charge
- D. reacts with acids.

(viii) Primary and secondary amines have higher boiling points than tertiary amines because they:

- A. Are more polar
- B. Have higher molecular mass
- C. Can form hydrogen bonds
- D. Are more basic

(ix) Why does C-I bond break more easily than C-Cl bond?

- A. Iodine is smaller
- B. Iodine is more electronegative

- C. C-I bond is weaker
- D. Chlorine is heavier

(x) Why are alkanes insoluble in water?

- A. They are heavy molecules
- B. They are non-polar
- C. They contain carbon
- D. They form hydrogen bonds

3) Match each reaction in list A with its corresponding in list B in alkene reaction. (4 MARKS)

List A

1. Reaction with HBr
2. Reaction with Br₂
3. Reaction with cold KMnO₄
4. Hydrogenation

List B

- A. Vicinal dihalide
- B. Halogen alkane
- C. Alkane
- D. Diol

4) Match each Types of Alkyl Halides in list A with its

corresponding in list B. (4 MARKS)

List A

1. Primary alkyl halide
2. Secondary alkyl halide
3. Tertiary alkyl halide
4. Methyl halide

List B

- A. Carbon attached to three carbons
- B. Carbon attached to one carbon
- C. Carbon attached to two carbons
- D. No carbon attached

5) Fill in the blanks using the given words :(**10 MARKS**)

covalent, catenation, saturated, decarboxylation, van der Waals, free radical, Markovnikov's, ozonolysis, alcohol, SN1,

- i. Organic compounds generally have low melting points because they contain _____ bonds.
- ii. The property by which carbon atoms form long chains is known as _____.
- iii. A hydrocarbon that contains only single bonds is called a _____ hydrocarbon
- iv. Preparation of methane from sodium ethanoate involves the _____ reaction.

- v. Branched alkanes have lower boiling points due to weaker _____ forces.
- vi. Halogenation of alkanes in sunlight occurs through a _____ mechanism.
- vii. Addition of HBr to an unsymmetrical alkene follows _____ rule.
- viii. The reaction used to determine the position of a double bond is _____.
- ix. Hydrolysis of alkyl halides with aqueous NaOH gives an _____ as the major product.
- x. Tertiary alkyl halides mainly undergo substitution by the _____ mechanism.

6) An organic compound contains 40% carbon, 6.7% hydrogen, and 53.3% oxygen by mass. What is the empirical formula of the compound?(2MARKS)

- A. CH_2O
B. $\text{C}_2\text{H}_4\text{O}_2$
C. $\text{C}_3\text{H}_6\text{O}_3$
D. CHO

7) The empirical formula of a compound is CH_2O . If its molecular mass is 180 g mol^{-1} , what is its molecular formula? (2MARKS)

- A. $\text{C}_2\text{H}_4\text{O}_2$
B. $\text{C}_3\text{H}_6\text{O}_3$
C. $\text{C}_3\text{H}_{12}\text{O}_6$
D. $\text{C}_5\text{H}_{10}\text{O}_5$

8) An organic compound has a vapour density of 22. What is its molecular mass? (2MARKS)

- A. 22
B. 44
C. 11
D. 88

9) Which fraction of petroleum mainly contains hydrocarbons with 14–18 carbon atoms? (1MARKS)

- A. Petrol
B. Kerosene
C. Diesel oil
D. Lubricating oil

10) Which of the following hydrocarbons has the lowest boiling point? (2MARKS)

- A. n-butane
B. isobutane
C. n-pentane
D. isopentane

11) How many structural isomers are possible for C_5H_{12} ? (2MARKS)

A. 2
B. 3

C. 4
D. 5

12) An alkene decolourises bromine water and has a molecular formula C_6H_{12}

How many moles of hydrogen are required to completely hydrogenate 1 mole of this alkene? (2MARKS)

A. 1 mole
B. 2 moles

C. 3 moles
D. 6 moles

13) During the dehydration of 2-butanol, the major product formed is: (2MARKS)

A. But-1-ene
B. But-2-ene

C. 2-methylpropene
D. Ethene

14) Which of the following alkyl halides will react fastest with aqueous NaOH? (2MARKS)

A. CH_3Cl
B. CH_3CH_2Cl

C. $(CH_3)_3CCl$
D. $CH_3CH_2CH_2Cl$

15) For an amino acid with $pK_{a1} = 2.4$ and $pK_{a2} = 9.6$, what is its isoelectric point (pI)? (2MARKS)

A. 3.6
B. 6.0

C. 7.2
D. 12.0

16) An alkene gives ethanal and propanone on ozonolysis. Which alkene is it? (2MARKS)

17) Which order shows increasing boiling point? (2MARKS)

A. neopentane < isopentane < n-pentane
B. n-pentane < isopentane < neopentane
C. isopentane < neopentane < n-pentane

18) Cracking of 1 mole of decane gives 1 mole of ethene. What is the formula of the other product? (2MARKS)

A. C_6H_{14}
B. C_7H_{16}

C. C_8H_{18}
D. C_9H_{20}

19) A hydrocarbon has general formula C_nH_{2n} and molar mass 56 g mol^{-1} . What is the compound? (2MARKS)

- A. Ethene
- B. Propene

- C. Butene
- D. Pentene

20) What is the percentage of carbon in ethanol (C_2H_6O)? (2MARKS)

- A. 40.0%
- B. 46.0%
- C. 52.2%
- D. 60.0%

21) Calculate the pI of an amino acid with $pK_{a1} = 2.2$ and $pK_{a2} = 9.8$. (2MARKS)

- A. 4.0
- B. 6.0
- C. 7.2
- D. 12.0

22) Which reaction sequence can be used to distinguish terminal and internal alkynes? (2MARKS)

- A. Bromine water test
- B. Combustion reaction
- C. Ammoniacal silver nitrate test
- D. Hydrogenation with nickel

23) Which pair represents functional isomers? (2MARKS)

- B. Propan-1-ol and propan-2-ol
- C. Ethanol and dimethyl ether
- D. Butane and isobutane

24) Which pair of reagents can be used together to confirm the presence of an alkene? (2MARKS)

- A. Lime water and NaOH
- B. Bromine water and acidified $KMnO_4$
- C. Tollens' reagent and Fehling's solution
- D. Sodium metal and water

25) Which molecular formula can represent both an alcohol and an ether? (2MARKS)

- A. C_2H_4O
- B. C_2H_6O
- C. C_3H_6O
- D. C_4H_6O

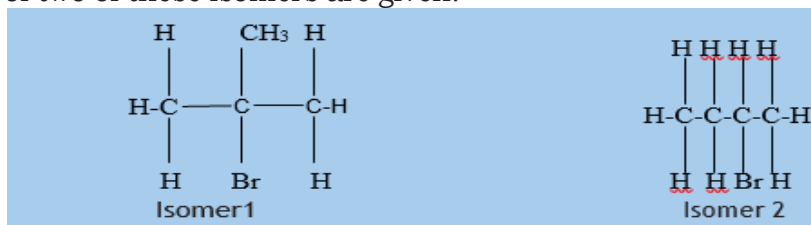
SECTION B: ANSWER ALL QUESTIONS/60 MARKS

26. Describe a chemical test you would use to distinguish between the pairs of compounds below. In each case give a reagent, conditions and the expected

observations:

- a) Propane and propene **(2marks)**
- b) Butan-2-ol and 2-methylpropan-2-ol **(2marks)**
- c) Methyl ethanoate and propanoic acid **(2marks)**
- d) CH_3COCH_3 and CH_3CHO **(2marks)**
- e) Propanoyl Chloride and 1-chloropropane **(2marks)**

27. a) There are four structural isomers of molecular formula $\text{C}_4\text{H}_9\text{Br}$. The formulae of two of these isomers are given.



- i. Draw the remaining two structural isomers. **(2MARKS)**
- ii. Give the name of isomer 2 **(1MARKS)**
- b) All four structural isomers of $\text{C}_4\text{H}_9\text{Br}$ undergo similar reactions with ammonia
 - i) Give the name of the mechanism involved in these reactions. **(1MARKS)**
 - ii) Draw the structural formula of the product formed by the reaction of isomer 2 with ammonia. **(1MARKS)**
 - iii) Select the isomer of molecular formula $\text{C}_4\text{H}_9\text{Br}$ that would be most reactive with ammonia. State the structural feature of your chosen isomer that makes it the most reactive of the four isomers. **(1MARKS)**
 - iv) The elimination of HBr from Isomer 1 produces two structural isomers, compounds A and B.
 - a) Give the reagents and conditions required for this elimination reaction. **(1MARKS)**
 - b) Give the structural formulae of the two isomers, A and B formed by elimination of HBr from isomer 1. **(1MARKS)**
- c) Ethene, C_2H_4 , reacts with bromine to give 1,2-dibromoethane.
 - i. Give the name of the mechanism involved. **(1MARKS)**
 - ii. Show the mechanism for this reaction. **(1MARKS)**

28) An aliphatic aldehyde **A** has the formula **RCHO** .

- a. A reacts with 2,4-dinitrophenylhydrazine. Explain what happens and name the type of reaction. **(2MARKS)**
Say how the product of reaction could be used to identify **A**
- b. When **A** is treated with warm, acidified **$\text{K}_2\text{Cr}_2\text{O}_7$** solution, B is formed. Give the structural formula of B. **(2MARKS)**
- c. When **A** is treated with lithium tetrahydridoaluminate (reducing agent) in ethoxyethane solution
C is formed. Give the structural formula of **C**. **(1MARKS)**

- d. **A** is warmed gently with ammoniacal silver nitrate. Explain what happens, and say what is observed. **(2MARKS)**
- e. **B** and **C** react to form **D**. Write the structural formula of **D**. **(1MARKS)**
- f. From the compounds **A, B, C, and D**, which would you predict to possess:
- Highest boiling point. (1marks)
 - Lowest boiling point. (1marks)

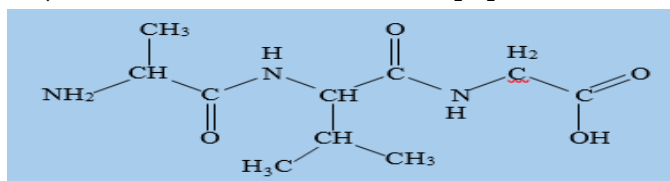
29: The table below shows the first, second, and third ionization energies in KJ/mol of six successive elements in the periodic table of elements.

Elements	1 st I.E	2 nd I.E	3 rd I.E
A	1060	1900	2920
B	1000	2260	3390
C	1260	2300	3850
D	1520	2660	3950
E	418	3070	4600
F	590	1150	4940

N.B: Elements are not in the same period.

- a) For a given element, **M**, write equation to show 1st, 2nd, and 3rd ionization energies. **/3marks**
- b) From the above table, identify the letter corresponding to an alkaline earth metal (Group II). Explain your answer. **/2marks**
- c) Which element is most likely to be a noble gas? Explain your answer. **/2marks**
- d) Suggest the formula of a compound formed between elements **F** and **C**. Explain your answer. **/2marks**
- e) Suggest from the above table which elements are metals. **/1mark**

30) The structure of a certain tripeptide is shown here:



- Draw the displayed formulae of the three amino acids that make up the tripeptide. **(3MARKS)**
 - Which of these amino acids has two chiral carbon atoms? **(2MARKS)**
- b. This tripeptide can be split up into the three amino acids by refluxing with aqueous hydrochloric acid.

i. Which bond is broken in this reaction? **(2MARKS)**

ii. The reaction can be described as hydrolysis. Explain why, using a diagram. **(3MARKS)**

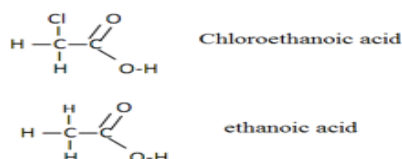
30)a) Two different organic molecules react to form an amide bond in the resultant molecule.

(i) Write the structural formula of the resultant molecule showing the location of the

amide bond. **(1 mark)**

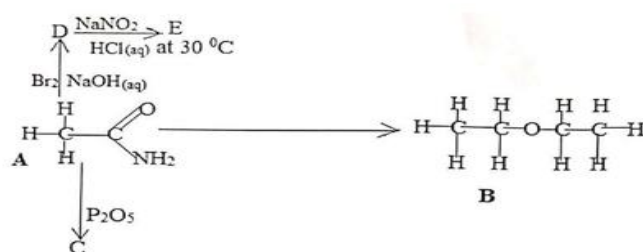
(ii) Explain the reason why the amide bonds are strong. **(2 marks)**

b) Study the diagrams given below and answer the questions that follow:



Explain why chloroethanoic acid is a stronger acid than ethanoic acid. **2 marks)**

b) Study the diagram below and answer the questions that follow:



i) Write the semi-developed molecular formula of organic substance: C, D and E. **(2 marks)**

ii) Write different chemical equations of reactions (not more than 5 equations) that can be used to illustrate the conversion of 2 moles of organic substance A into 1 mole of substance B. Include reagents and conditions. **(3 mark)**

Good Luck!

