

2915/104

ORGANIC AND INORGANIC CHEMISTRY I

June/July 2019

Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ANALYTICAL CHEMISTRY

MODULE I

ORGANIC AND INORGANIC CHEMISTRY I

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:

Answer booklet;

Scientific calculator (battery operated).

This paper consists of TWO sections; A and B.

Answer ALL the questions in section A and any THREE questions from section B.

Each question in section A carries 4 marks while each question in section B carries 20 marks.

Maximum marks for each part of the question are indicated.

Candidates should answer the questions in English.

This paper consists of 7 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

SECTION A (40 marks)

Answer **ALL** the questions in this section.

1. (a) Write the structural formula for each of the following compounds:
- (i) isopentane; (1 mark)
- (ii) cyclopentene. (1 mark)
- (b) Give the IUPAC names of the following compounds:
- (i)
$$\begin{array}{c} \text{CH}_3\text{CH}_2 - \text{CH} \text{CH}_2\text{CH}_2\text{CH}_3 \\ | \\ \text{CH} = \text{CH}_2 \end{array}$$
 (1 mark)
- (ii) $\text{CH}_3\text{CHOHCH}_2\text{CHOHCH}_2\text{CH}_3$ (1 mark)
2. (a) Define the term isomerism. (1 mark)
- (b) List **three** types of isomerism exhibited by hydrocarbons. (3 marks)
3. Write the equations to show the products formed if the following haloalkanes undergo dehydrohalogenation:
- (a) 2-bromo-2-methylbutane; (2 marks)
- (b) 3-chlorohexane. (2 marks)
4. (a) Explain why propanol has a higher boiling point than the corresponding hydrocarbon. (2 marks)
- (b) Explain why propanol is soluble in water. (2 marks)
5. Outline the mechanism for the acid-catalysed esterification of CH_3COOH with $\text{CH}_3\text{CH}_2\text{OH}$. (4 marks)
6. Write the electronic configuration using s.p.d.f notation of atoms with the following atomic numbers:
- (a) 10; (1 mark)
- (b) 17; (1 mark)
- (c) 20; (1 mark)
- (d) 32. (1 mark)

7. Identify the types of bonding expected to occur between elements with the following electronic configuration:
- (a) $1S^2 2S^2$ and $1S^2 2S^2 2P^4$; (1 mark)
 - (b) $1S^2 2S^2 2P^5$ and $1S^2 2S^2 2P^6 3S^1$; (1 mark)
 - (c) $1S^2 2S^2 2P^5 2P^6 3S^2 3P^5$ and $1S^2 2S^2$; (1 mark)
 - (d) $1S^2 2S^2 2P^2$ and $1S^2 2S^2 2P^5$. (1 mark)
8. Explain why aluminium is a good conductor of electricity while diamond is a non-conductor. (4 marks)
9. Explain why the first ionization energy of rubidium is less than the first ionization energy of potassium. ($K = 19, Rb = 37$). (4 marks)
10. List **four** uses of sodium metal. (4 marks)

SECTION B (60 marks)

*Answer any **THREE** questions from this section.*

11. (a) Draw dot-and-cross diagrams to illustrate the type of bonding in the following molecules:
- (i) Methane, CH_4 ; (1 mark)
 - (ii) Hydrogen, H_2 ; (1 mark)
 - (iii) Hydrogen sulphide, H_2S ; (1 mark)
 - (iv) Hydrogen iodide, HI . (1 mark)
- (b) Name the block and group of the periodic table that each of the following elements belong:
- (i) P, $1S^2 2S^1$; (2 marks)
 - (ii) Q, $1S^2 2S^2 2P^5$; (2 marks)
 - (iii) R, $1S^2 2S^2 2P^6 3S^2 3P^6 4S^2 3d^{10} 4P^4$. (2 marks)

- (c) Explain why carboxylic acids have higher boiling points than carbonyl compounds of comparable molecular weight. (4 marks)
- (d) (i) Starting with tert-butylalcohol, demonstrate how trimethylacetic acid can be synthesized via grignard method. (5 marks)
- (ii) Give **one** advantage of grignard synthesis of carboxylic acids. (1 mark)
12. (a) (i) State the aufbau principle. (1 mark)
- (ii) Explain the aufbau principle. (3 marks)
- (b) Write the equations for the following reactions:
- (i) potassium with water; ($1\frac{1}{2}$ marks)
- (ii) action of heat of Lithium nitrate; ($1\frac{1}{2}$ marks)
- (iii) action of heat on Potassium nitrate; ($1\frac{1}{2}$ marks)
- (iv) sodium sulphate solution and barium chloride solution; ($1\frac{1}{2}$ marks)
- (c) On heating with concentrated sulphuric acid, butan-2-ol is converted into a mixture of alkenes.
- (i) Name the type of reaction that takes place. (1 mark)
- (ii) Give the structural formulae of the alkenes formed. (2 marks)
- (iii) Name the alkenes in (c) (ii) above. (2 marks)
- (d) Give the name and structural formula of the organic compound produced when pentan-1-ol is heated with acidified potassium dichromate (VI). (2 marks)
- (e) When 2-methylpropan-2-ol is heated with a carboxylic acid in the presence of a catalyst, an ester is formed.
- (i) Name the type of reaction that takes place. (1 mark)
- (ii) Draw the general structural formula of the ester. (1 mark)
- (iii) Name a suitable catalyst that can be used in the reaction. (1 mark)

13. (a) (i) Draw all the possible structural isomers of the compound with molecular formula $C_5H_{11}Br$. (4 marks)
- (ii) Give the IUPAC names of the isomers in (a) (i). (4 marks)
- (iii) Name the type of reaction that would take place between ammonia and the isomers. (1 mark)
- (iv) With reasons, identify the isomer that would be the most reactive. (1 mark)
- (b) Figure 1 shows part of a set-up used in Millikan's oil drop experiment.

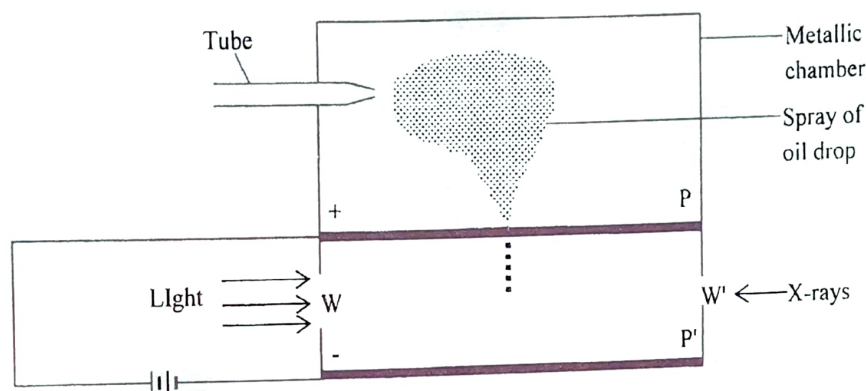


Fig. 1

- (i) State the role of:
- (I) X-rays; (1 mark)
 - (II) the window labelled W; (1 mark)
 - (III) the electrodes labelled P and P'. (1 mark)
- (ii) Give the expression for determining the mass of the oil drop in this experiment and define the terms there in. (3 marks)
- (iii) List **four** important results of determining the charge on the electron. (4 marks)

14. (a) Explain the nature of bonding found in the following molecules:



(2 marks)



(2 marks)



(2 marks)



(2 marks)

(b) Explain why helium has the highest first ionization energy than that of any other element in the periodic table.

(4 marks)

(c) Explain the 'lustre' property of metals.

(4 marks)

(d) Give **four** properties of solutions of alkali metals in liquid ammonia.

(4 marks)

15. (a) Give IUPAC names for the following ethers:



(1 mark)



(1 mark)



(1 mark)



(1 mark)



(1 mark)

(b) Account for the following observations:

(i) Ethers have significant dipole moments ($\approx 1.18D$);

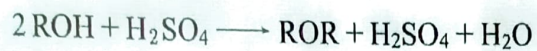
(2 marks)

(ii) Ethers have lower boiling points than isomeric alcohols;

(3 marks)

(iii) The water solubilities of ethers and isomeric alcohols are comparable. (2 marks)

- (c) The following equation represents formation of an ether from an alcohol in the presence of concentrated sulphuric acid.



Write the mechanisms for the reaction to illustrate the following routes:

(i) S_{N}^1 ; (4 marks)

(ii) S_{N}^2 . (4 marks)

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