**Name:**…………………………………………………...…………....Signature:………………......

**S.5**

# THE CHEMISTRY DEPARTMENT

**TEST ONE- 2024**

CHEMISTRY

**Paper 1**
2 hours

**INSTRUCTIONS:**

*Answer **all** questions in this paper.*

***All*** *answers must be written in the spaces provided.*

*The Periodic Table, with relative atomic masses, is attached at the end of the paper.*

*Mathematical tables (3-figure tables) are adequate or non-programmable scientific electronic calculators may be used.*

*Illustrate your answers, with equations where applicable.*

*Where necessary, use the following;*

> *Molar gas constant, $R=8.31\ JK^{-1}mol^{-1}$.*
> *Molar volume of a gas at s.t.p is 22.4 litres.*
> *Standard temperature = 273K.*
> *Standard pressure = $101325Nm^{-2}$*

| For Teachers'  Use Only | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | **Total** |
| | | | | | | | | | |

## SECTION A (46 MARKS)

*Answer **all** questions in this section*

1. Write the electronic configuration of each of the following species;

| Species | Electronic configuration |
|---------|--------------------------|
| $Ca$ | |
| $Cr$ | |
| $Cu$ | |
| $S^{2-}$ | |
| $Fe^{3+}$ | |
| $Mg^{2+}$ | |

(06 marks)

2. (a) Define the following terms;

  (i)  **Radioactivity**                                                                          *(01 mark)*
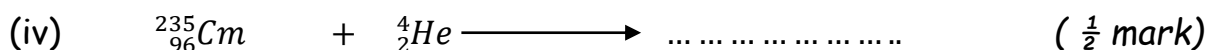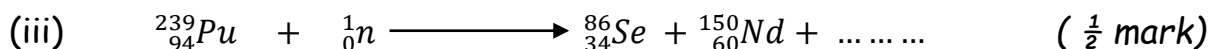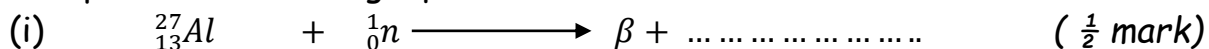
...............................................................................................................................................

...............................................................................................................................................

...............................................................................................................................................

  (ii)  **Half life**                                                                               *(01 mark)*

...............................................................................................................................................

...............................................................................................................................................

...............................................................................................................................................

(b) Complete the following equations for radioactive reactions

  (i)  $^{27}_{13}Al \quad + \quad ^{1}_{0}n \longrightarrow \beta + $ ...........................  ( $\frac{1}{2}$ *mark*)

  (ii)  $4^{1}_{1}H \longrightarrow ^{4}_{2}He \quad + $ ...................  ( $\frac{1}{2}$ *mark*)

  (iii)  $^{239}_{94}Pu \quad + \quad ^{1}_{0}n \longrightarrow ^{86}_{34}Se + ^{150}_{60}Nd + $ .........  ( $\frac{1}{2}$ *mark*)

  (iv)  $^{235}_{96}Cm \quad + \quad ^{4}_{2}He \longrightarrow $ ...........................  ( $\frac{1}{2}$ *mark*)

3. (a) State **Graham's law** of gaseous diffusion. *(01 mark)*

...................................................................................................................

...................................................................................................................

(b) A gaseous compound **X** containing 44% carbon, 51.9% nitrogen and the rest being hydrogen. Determine the empirical formula of **X**. *(03 marks)*

...................................................................................................................

...................................................................................................................

...................................................................................................................

...................................................................................................................

...................................................................................................................

...................................................................................................................

(c) 50 cm$^3$ of **X** diffused through a porous plug in 25 seconds. Under similar conditions, the same volume of hydrogen gas diffused in 6.8 seconds.
(i) Calculate the molecular mass of **X**. *(02 marks)*

...................................................................................................................

...................................................................................................................

...................................................................................................................

...................................................................................................................

...................................................................................................................

(ii)      the molecular formula of **X**. *(01 mark)*

...................................................................................................................

...................................................................................................................

...................................................................................................................

...................................................................................................................

4. (a) An organic compound **Q** contains carbon, hydrogen and oxygen only. On combustion , 0.463g of **Q** gave 1.1g carbon dioxide and 0.563g of water.

Determine the empirical formula of **Q** *(3 ½ marks)*

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..........................................................................................................................

(b) When vapourised, 0.1g of **Q** occupies 54.5cm$^3$ and 208°C and 98300Pa. Determine the;

   (i)       molecular mass of **Q** *(03 marks)*

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..........................................................................................................................

   (ii)      Molecular formula of **Q** *(02 marks)*

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

(c) Write the structural formula of all possible isomers of **Q** *(02 marks)*

...................................................................................................

...................................................................................................

...................................................................................................

5. The graph below shows first ionization energies of period 1 elements.
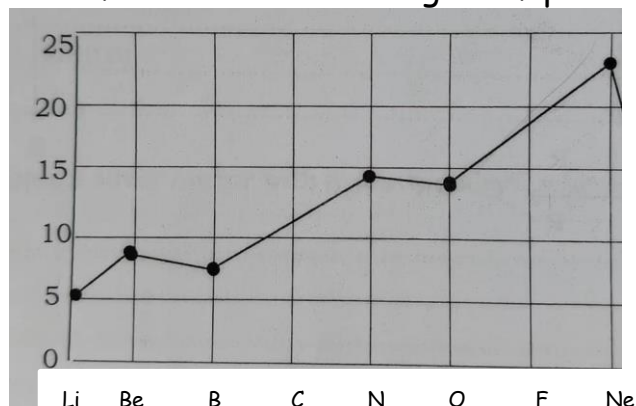


(a)  Define the term **first ionization energy**                    (01 mark)

...................................................................................................

...................................................................................................

...................................................................................................

(b)  Explain why;
    (i)      there is a general increase ionization energies from lithium
             to neon.                                                      (02 marks)

...................................................................................................

...................................................................................................

...................................................................................................

    (ii)     the ionization energy of beryllium is higher than that of
             boron.                                                           (02 marks)

...................................................................................................

...................................................................................................

...................................................................................................................

...................................................................................................................

       (iii)      ionization energy of oxygen is lower than that of nitrogen

*(02 marks)*

...................................................................................................................

...................................................................................................................

...................................................................................................................

...................................................................................................................

6. (a) A 96% stock solution of sulphuric acid has a specific gravity of $1.18gcm^{-3}$ .Calculate the;

    (i)      Concentration of the stock solution in moles per litre.

*( 03 marks)*

...................................................................................................................

...................................................................................................................

...................................................................................................................

...................................................................................................................

...................................................................................................................

(ii) volume of the stock solution required to prepare one litre of 2M sulphuric acid solution.         *(01 mark)*

...................................................................................................................

...................................................................................................................

...................................................................................................................

7. (a) Define the term **atomic radius**.         *(01 mark)*

...................................................................................................................

...................................................................................................................

...................................................................................................................

(b) The table below shows the atomic radii and ionic radii of the elements in Group II of the Periodic Table.

| Element | Be | Mg | Ca | Sr | Ba |
|---|---|---|---|---|---|
| Atomic radius(nm) | 0.089 | 0.136 | 0.174 | 0.191 | 0.198 |
| Ionic radius(nm) | 0.031 | 0.065 | 0.099 | 0.113 | 0.135 |

(i)      State and explain the trend in atomic radius of the elements
                                                                    *(03 marks)*

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

(ii)      Explain why the ionic radius is smaller than the atomic radius of corresponding neutral atom for each element.      *(03 marks)*

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

8.  (a) Define the following terms as applied to organic chemistry;
    (i)      **Homologous series**                                 *(01 mark)*

..............................................................................................................................

..............................................................................................................................

..............................................................................................................................

(ii)       **Structural isomerism**                                      *(01 mark)*

........................................................................................................

........................................................................................................

........................................................................................................

(iii)      **hydrocarbon**                                               *(01 mark)*

........................................................................................................

........................................................................................................

........................................................................................................

(b) An organic compound ,**W**, has a molecular formula of $C_5H_{10}$. Write the structural formulae and IUPAC names of any two;

**(i) chain isomers**                                                    *(02 marks)*

........................................................................................................

........................................................................................................

........................................................................................................

(ii)       **position isomers**                                          *(02 marks)*

........................................................................................................

........................................................................................................

........................................................................................................

(iii)      **geometric isomers**                                         *(02 marks)*

........................................................................................................

........................................................................................................

........................................................................................................

9. (a) State what is meant by the following terms;

(i)        **Primary standard.**                                         *(01 mark)*

........................................................................................................

........................................................................................................

........................................................................................................

(ii)    **Secondary standard**                                      *(01 mark)*

.................................................................................................................

.................................................................................................................

.................................................................................................................

(b)    (i) State **one** reason why concentrated hydrochloric acid is not a
       primary standard                                              *(01 mark)*

.................................................................................................................

.................................................................................................................

(ii)    Identify **one** substance that can be used to standardize
        hydrochloric acid                                           *(01 mark)*

.................................................................................................................

.................................................................................................................

(c)    5.7g of disodium tetraborate decahydrate(Borax)$(Na_2B_4O_7.10H_2O)$
       were dissolved in 100 cm$^3$ distilled water in a 250cm$^3$ volumetric
       flask, shaken to dissolve and the mixture made up to the mark with
       distilled water.25.0 cm$^3$ of the resultant solution is pipetted into a
       clean conical flask and titrated against dilute hydrochloric acid
       solution using phenolphthalein indicator. 18.0 cm$^3$of the acid was
       required for complete neutralisation.
       *(mole ratio for reaction between borax and HCl is 1:2)*
       Calculate the ;
       (i)      molarity of borax solution used.                    *(03 marks)*

.................................................................................................................

.................................................................................................................

.................................................................................................................

.................................................................................................................

.................................................................................................................

......................................................................................................................

......................................................................................................................

     (ii)       concentration of hydrochloric acid in grams per litre.

*(3 ½ marks)*

......................................................................................................................

......................................................................................................................

......................................................................................................................

......................................................................................................................

......................................................................................................................

......................................................................................................................

......................................................................................................................

**END**

# THE PERIODIC TABLE

| 1 | 2 | | | | | | | | | | | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.0 H 1 | | | | | | | | | | | | | | | | 1.0 H 1 | 4.0 He 2 |
| 6.9 Li 3 | 9.0 Be 4 | | | | | | | | | | | 10.8 B 5 | 12.0 C 6 | 14.0 N 7 | 16.0 O 8 | 19.0 F 9 | 20.2 Ne 10 |
| 23.0 Na 11 | 24.3 Mg 12 | | | | | | | | | | | 27.0 Al 13 | 28.1 Si 14 | 31.0 P 15 | 32.1 S 16 | 35.4 Cl 17 | 40.0 Ar 18 |
| 39.1 K 19 | 40.1 Ca 20 | 45.0 Sc 21 | 47.9 Ti 22 | 50.9 V 23 | 52.0 Cr 24 | 54.9 Mn 25 | 55.8 Fe 26 | 58.9 Co 27 | 58.7 Ni 28 | 63.5 Cu 29 | 65.7 Zn 30 | 69.7 Ga 31 | 72.6 Ge 32 | 74.9 As 33 | 79.0 Se 34 | 79.9 Br 35 | 83.8 Kr 36 |
| 85.5 Rb 37 | 87.6 Sr 38 | 88.9 Y 39 | 91.2 Zr 40 | 92.9 Nb 41 | 95.9 Mo 42 | 98.9 Tc 43 | 101 Ru 44 | 103 Rh 45 | 106 Pd 46 | 108 Ag 47 | 112 Cd 48 | 115 In 49 | 119 Sn 50 | 122 Sb 51 | 128 Te 52 | 127 I 53 | 131 Xe 54 |
| 133 Cs 55 | 137 Ba 56 | 139 La 57 | 178 Hf 72 | 181 Ta 73 | 184 W 74 | 186 Re 75 | 190 Os 76 | 192 Ir 77 | 195 Pt 78 | 197 Au 79 | 201 Hg 80 | 204 Tl 81 | 207 Pb 82 | 209 Bi 83 | 209 Po 84 | 210 At 85 | 222 Rn 86 |
| 223 Fr 87 | 226 Ra 88 | 227 Ac 89 | | | | | | | | | | | | | | | |

| 139 La 57 | 140 Ce 58 | 141 Pr 59 | 144 Nd 60 | 147 Pm 61 | 150 Sm 62 | 152 Eu 63 | 157 Gd 64 | 159 Tb 65 | 162 Dy 66 | 165 Ho 67 | 167 Er 68 | 169 Tm 69 | 173 Yb 70 | 175 Lu 71 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 227 Ac 89 | 232 Th 90 | 231 Pa 91 | 238 U 92 | 237 Np 93 | 244 Pu 94 | 243 Am 95 | 247 Cm 96 | 247 Bk 97 | 251 Cf 98 | 254 Es 99 | 257 Fm 100 | 256 Md 101 | 254 No 102 | 260 Lw 103 |

END.