

Name: Signature:

P525/1
CHEMISTRY
Paper 1
Jun./Jul. 2024
2 $\frac{3}{4}$ hours.

S.5

THE CHEMISTRY DEPARTMENT

NGS

MID TERM TWO 2024

CHEMISTRY

Paper 1

2 hours 45 minutes

INSTRUCTIONS:

Attempt 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, $R=8.31 \text{ JK}^{-1}\text{mol}^{-1}$.

Molar volume of a gas at s.t.p is 22.4 litres.

Standard temperature = 273K.

Standard pressure = 101325 Nm^{-2}

For Teachers' Use Only																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total

Answer all questions in this paper

1. (a) Write the electronic configurations of each of the following elements and ions; (4 $\frac{1}{2}$ marks)

(i) oxygen

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(ii) magnesium

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(iii) chlorine

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(iv) chromium

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(v) copper

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(vi) tin

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(vii) copper(I) ion (Cu^+)

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(viii) calcium ion (Ca^{2+})

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(ix) sulphide ion (S^{2-})

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2. (a) State what is meant by each of the following terms. Give **one** example in each case.

(i) Aliphatic compound

(1 $\frac{1}{2}$ marks)

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Example.....

(ii) Unsaturated hydrocarbon (1 ½ marks)

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Example.....

(iii) Functional group (1 ½ marks)

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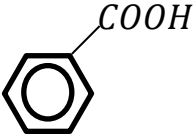
Example.....

(iv) Homologous series (1 ½ marks)

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Example.....

(b) For each of the following compounds, name the functional group and homologous series to which each compound belongs. (4 ½ marks)

Compound	Functional group	Homologous series
$\begin{array}{c} \text{CH}_3\text{C} = \text{CH}_2 \\ \\ \text{CH}_3 \end{array}$		
		
$\begin{array}{c} \text{CH}_3\text{CCH}_3 \\ \\ \text{O} \end{array}$		

3. (a) State what is meant by the terms **primary standard**
(01 mark)

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(b) (i) Identify any **two** commonly known primary standards used in volumetric analysis. (02 marks)

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(ii) With reference to any of the two compounds in (b)(i) above, state **two** reasons that qualify it as a good primary standard. (02 marks)

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(c) Sulphuric acid is not a primary standard but a secondary standard.
(i) State the reason that disqualifies the acid to be a primary standard. (01 mark)

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(ii) Concentrated sulphuric acid contains 98% by mass of the acid and has a density of 1.84gcm^{-3} . Calculate the volume of the concentrated acid required to prepare a litre of a 2M solution of sulphuric acid. (3 $\frac{1}{2}$ marks)

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

(i) Atomic radius (01 mark)

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(ii) First ionization energy (01 mark)

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(b) Briefly explain how atomic radius affects ionization energy (02 marks)

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(c) The table below shows the variation in atomic and ionic radii of group II elements.

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	0.0991	0.113	0.135

(i) State and explain the trend in atomic radius of the elements.

(04 marks)

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

(03 marks)

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

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(b) In each of the following cases, define the given type of isomerism and write **two structural formulae** of any **two** isomers of the given molecular formula(e).

(i) chain isomerism

(01 mark)

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Two chain isomers of C_6H_{14}

(02 marks)

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(ii) positional isomerism

(01 mark)

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Two positional isomers of C_3H_8O

(02 marks)

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(iii) functional group isomerism

(01 mark)

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Two functional group isomers of C_2H_6O

(02 marks)

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6. (a) State;

(i) what is meant by the term **ideal gas**. (1 $\frac{1}{2}$ marks)

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(ii) **Graham's law** of gaseous diffusion. (01 mark)

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(iii) **Dalton's law** of partial pressures. (01 mark)

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(b) (i) Explain why a mixture of ammonia and hydrogen chloride does not hold for Dalton's law of partial pressures. (01 mark)

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(ii) The time taken for 1.76cm^3 of oxygen to diffuse through a porous partition is 103 seconds. Another gaseous alkyne **Z** under the same conditions of temperature and pressure diffuses through the partition at a rate of 1.3cm^3 in 101 seconds. Determine the molecular formula of gas **Z**. (04 marks)

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7. (a) The first ionization energies of magnesium and aluminium are 738 and 578 kJmol⁻¹. Write equation to show :

(i) first ionization energy of magnesium. (01 mark)

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(ii) second ionization energy of aluminium. (01 mark)

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(b) The table below shows the first ionization energies of elements in Period 3 of the Periodic Table.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
First ionization energy(kJmol ⁻¹)	496	738	578	786	1012	1000	1251	1521

State and explain the general trend in ionisation energy of the elements. (04 marks)

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(c) Briefly explain why:

(i) the first ionization energy of argon is very high.
(02 marks)

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(ii) first ionization energy of aluminium is less than that of magnesium.
(03 marks)

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(iii) first ionization energy of phosphorus is higher than that of sulphur.
(03 marks)

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8. State what is meant by each of the following types of organic reactions. **In each case write an equation to illustrate your answer.**

(a) Nucleophilic substitution reaction. (01 mark)

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Equation (01 mark)

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(b) Addition reaction. (01 mark)

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Equation (01 mark)

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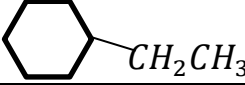
(c) Elimination reaction. (01 mark)

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Equation (01 mark)

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9. (a) State the **IUPAC** names of each of the following alkanes.(03 marks)

Alkane	IUPAC name
$\begin{array}{c} \text{CH}_3\text{CHCH}_2\text{CH}_3 \\ \\ \text{CH}_3 \end{array}$	
	
$\begin{array}{c} \text{CH}_3\text{CHCH}_2\text{CHCH}_3 \\ \qquad \\ \text{CH}_3 \quad \text{CH}_2\text{CH}_3 \end{array}$	

(b) Write the structural formulae of each of the following alkanes.

(02 marks)

IUPAC name	Structural formula
2,5-Dimethylhexane	
2,3-dimethylbutane	

10. When 142cm^3 of a hydrocarbon **Y**, molecular mass 58g was exploded with excess oxygen and cooled to room temperature, the volume of the residual gas was 694cm^3 . On treatment with concentrated potassium hydroxide solution, the volume decreased to 126cm^3 .

(i) Write general equation for combustion of **Y**. (01 mark)

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(ii) Determine the molecular formula of **Y**. (03 marks)

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(iii) Write the structural formula and IUPAC names of all possible isomers of Y. (02 marks)

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11. Real gases liquefy when subjected to certain conditions of temperature and pressure.

(a) Briefly explain how liquefaction of a gas can be affected by;

(i) Pressure. (01 mark)

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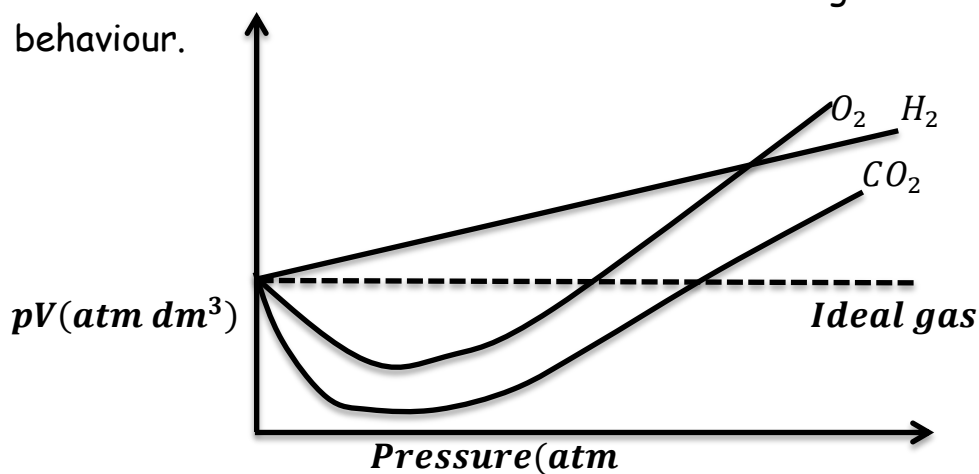
(i) Temperature (01 mark)

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- (b) The curves below show the deviation of some gases from ideal behaviour.



- (i) Explain why hydrogen shows a small deviation from ideal behaviour compared to other gases. (1 $\frac{1}{2}$ marks)

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- (ii) Compare the deviation of oxygen and carbon dioxide from ideal gas behavior. (02 marks)

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12. The table below shows the first **eight** successive ionization energies of element **X**.

Electron removed	1	2	3	4	5	6	7	8
Ionization energy(kJmol ⁻¹)	496	4563	6913	9544	13352	16611	20115	24491

- (a) Explain the trend in successive ionisation energies of the element **X**. (3 $\frac{1}{2}$ marks)

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(b) Deduce the:

- (i) group in the Periodic Table to which **X** belongs. (01 mark)

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(ii) formula of the phosphate formed by **X**. (01 mark)

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13. An organic compound **Q** contains 66.7% carbon, 11.1% hydrogen and the rest being oxygen. If the vapour density of **Q** is 36. Determine the molecular formula of **Q**. (04 marks)

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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.