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

P525/1

Chemistry

Paper 1

JUNE/JULY 2024

2 ¾ hours

UGANDA ADVANCED CERTIFICATE OF EDUCATION

S.5 CHEMISTRY

Paper 1

BEGINNING OF TERM 2

2 ¾ hours

INSTRUCTIONS TO CANDIDATES:

- Answer all questions in section A and any six questions in section B
- All questions must be answered in the spaces provided; no answer sheet must be attached.
- The Periodic Table, with relative atomic masses, is supplied.
- Mathematical 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 = 273 K
  Standard pressure = 101325 N m $^{-2}$

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

SECTION A. (46 MARKS)
Attempt all questions in this section.

1. When $142cm^3$ of a hydrocarbon Q, of formula C_xH_y, and molecular mass 58g; was exploded with excess oxygen and cooled to room temperature, the volume of the residual gas was $694cm^3$. When residual gas was passed through a combustion chamber with copper turnings, there was a decrease in volume by $126cm^3$.

(a) Write an equation for the reaction that occurred in combustion chamber **(01 mark)**

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 (b) (i) Determine the molecular formula of Y.   **(02marks)**

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(ii) Write the IUPAC names of any two possible isomers of Y.   **(01 mark)**

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(c) With appropriate reaction conditions, show how butan-2-ol can be obtained from one isomer above without using equations.   **(02 marks)**

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2. (a) What is meant by the term **ebullioscopic constant?** *(01 mark)*

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(b) (i) 2**.**7 g of ethanamide (CH_3CONH_2) was dissolved in 75g of ethanol. Calculate the boiling point of the resultant solution *[ebullioscopic constant, Kb of ethanol is 1**.**15^oC mol^{-1} kg^{-1} and the boiling point of ethanol is 78^oC]* *(02 marks)*

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(ii) State any **two** assumptions made in the calculation in b (i) above. *(01 mark)*

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3. (a) What is meant by **first electron affinity**? *(01 mark)*

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 (b) Write an equation for first electron affinity of oxygen. *(01 mark)*

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(c) Explain why the first electron affinity of oxygen is negative while the second electron affinity is positive. *(03 marks)*

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4. An organic compound M has a structural formula as shown below;
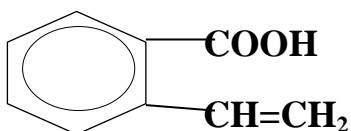
(a) Write the names of the functional groups of compound M. **(01 mark)**

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_____

(b) Name the reagent that can be used to identify each functional group named in (a) above and state what is observed in each case. **(02 marks)**

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(c) Using equations show how compound M can be converted to phenyl ethane.

(02 marks)

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5. 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	0.112	0.160	0.197	0.215	0.221
ionic radius	0.030	0.065	0.094	0.110	0.134

(a) What is meant by **atomic radius**? *(01 mark)*

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(b) Explain the trend in atomic radius of the group II elements above. *(2$\frac{1}{2}$ marks)*

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 (c) In each case, the ionic radius is smaller than the atomic radius. Explain this observation. *(02 marks)*

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6. (a) What is meant by an **ideal gas** *(01 mark)*

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(b) The curves below show deviations of some gases from ideal behavior.
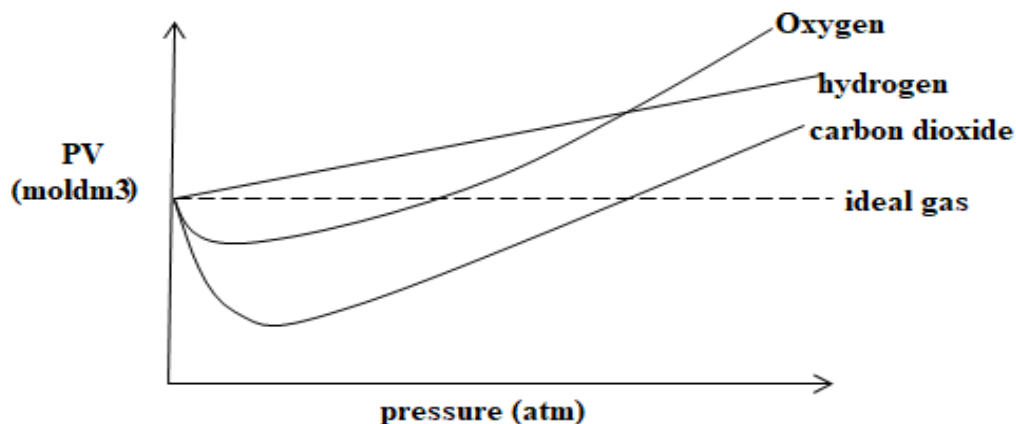
Explain why;

(i) Hydrogen doesn't show negative deviation from ideal behaviour. $(1\frac{1}{2}marks)$

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(ii) Carbon dioxide deviates more than oxygen from ideal behavior *(02marks)*

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(c) State conditions under which gases tend to have ideal behaviour. **(01 mark)**

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7. (a) Complete the following equations and write a mechanism for the reaction that occurs.

(i) $CH_3CH=CH_2$ _____HBr_____→ .... (02marks)

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(ii) $(CH_3)_3$ C-Br _____NaOH (aq)_____→ .... (02 marks)
                              Heat

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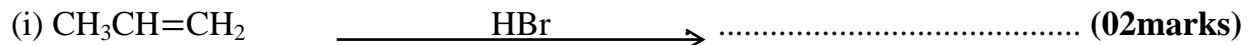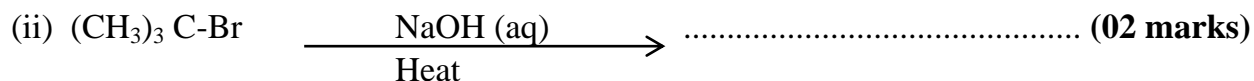
(b) Name the type of reaction in a (ii) above and give a reason for your answer.(01 mark)

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8. The table below shows the first four successive ionization energies of elements **Q, T,** and **P**

Element	1st I.E (KJmol-1)	2nd I.E (KJmol-1)	3rd I.E (KJmol-1)	4th I.E (KJmol-1)
Q	900	1800	14800	21000
T	800	2400	3700	25000
P	1090	2400	4600	6200

(a) State and explain the trend in the successive ionization energies of elements **A. ($2\frac{1}{2}$ marks)**

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(b) With a reason, state the element that belongs to group (**II**) of the periodic table (**02 marks**)

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9. An organic compound R has a simplest formula of C_3H_8O. When 0.698g of R was dissolved in 1000g of a solvent, there was a 0.19^0C depression in freezing point of solution. (Kf of the solvent = $1.63^0Ckg^{-1}mol^{-1}$).

(a) Determine the molecular formula of compound R.   (**02 marks**)

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(b) Write the structural formulae of any two isomers of R.   (**01 mark**)

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(c) Show how a named alkane can be synthesized from one isomer of **R.**   (**02 marks**)

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SECTION B. (54 MARKS)

Answer six questions from this section.

10. (a) State;

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

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(ii) Dalton's law of partial pressure of gases.   **(01 mark)**

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(b) A gaseous organic compound G diffuses through a porous partition in 2 minutes. However under similar conditions, the same volume of oxygen diffuses in 1.75minutes. Determine the molecular formula of Q, hence deduce the structural formulae of Q.

(04marks)

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(c) The figure below shows the mass spectrum of magnesium and the relative abundance of its isotopes. Determine the average atomic mass of magnesium.   *(03marks)*

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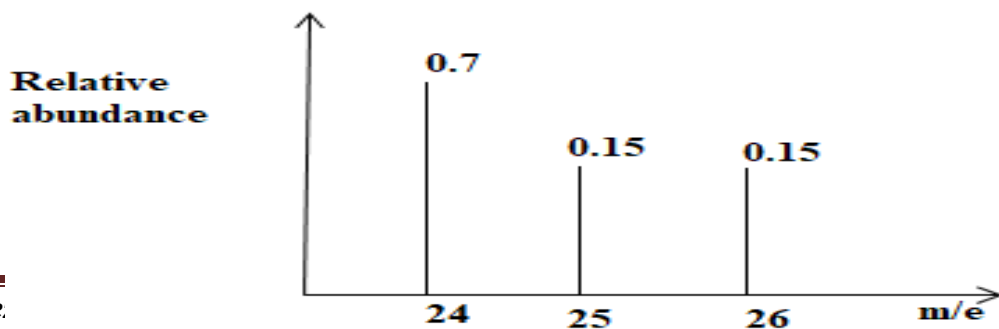
11. Benzene when mixed with chloroethane, they undergo a reaction forming compound W.

(a) State the;

(i) Condition(s) required for the reaction to occur.   **(01mark)**

_____

 (ii) I.U.P.A.C name of compound W.   **(0$\frac{1}{2}$ marks)**

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 (ii) Type of the reaction that occurs. Give a reason for your answer.   **(01$\frac{1}{2}$ marks)**

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(b) Write an equation for the reaction and outline a mechanism for the reaction that occurs.   **(03marks)**

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(c) Write equations to show how compound W can be converted to phenylethene.

(03 marks)

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(c) Write equations to show how the product in (b) above can be converted to phenyl ethene. **(02marks)**

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12. Sodium, aluminium, and chlorine are elements in the Period 3 of the Periodic Table.
 (a) Write the formulae of the oxide(s) of the each of the elements. **(02 marks)**

ELEMENT	OXIDE(S) OF ELEMENT
Sodium	
Chlorine	
Aluminium	

(b) Write an equation for the reaction that occurs when;
(i) One oxide of sodium reacts with water. **(01 mark)**

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(ii) Aluminium oxide is formed from its elements **(1½ marks)**

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(iii) Chlorine reacts with Aluminium. **(01 mark)**

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(c) Sodium hydroxide was added to a solution containing aluminium chloride drop wise until in excess. State what was observed and write an equation(s) for the reaction that occurred. **(3½ marks)**
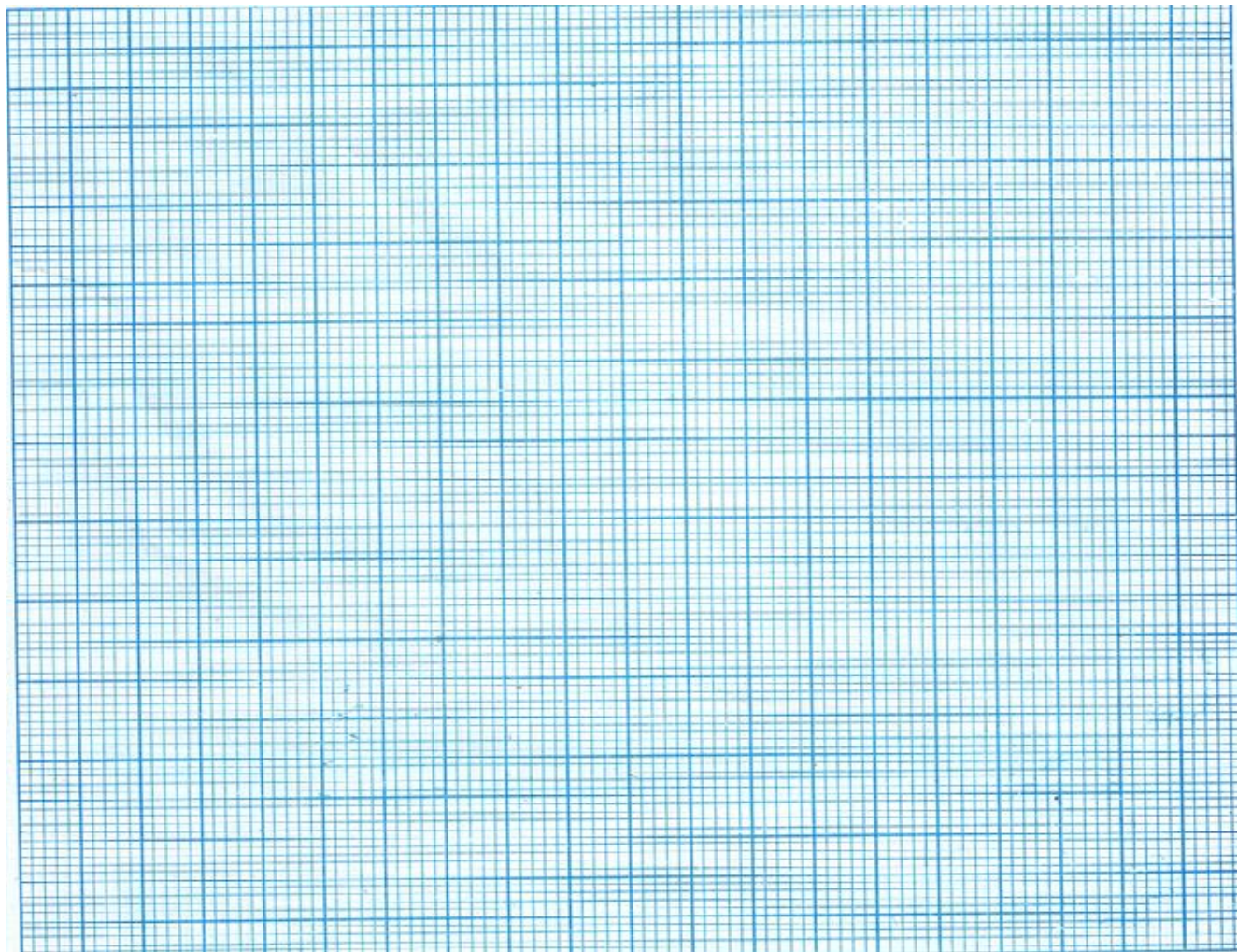
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13. (a) Explain why alkanes are generally unreactive organic compounds **(02 marks)**

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(b) The table below shows the boiling points of straight chain alkanes.

Alkanes	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	C_6H_{14}	C_7H_{16}
Boiling points (^0C)	-162	-89	-42	-0.5	36	69	98

(i) Plot a graph of boiling point against molecular mass of alkanes.   **(02 marks)**

(ii) Explain the trend in boiling points of the alkanes above.   **(03marks)**

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(c) From the table, A compound has molecular formula of C_5H_{12}. Arrange the isomers of this compound in order of decreasing boiling points and give a reason for your answer.

(02½ marks)

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14. (a) state the laws of osmotic pressure. **(02 marks)**

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(b) Describe how the RMM of polystyrene can be determined using osmotic pressure method. [Diagram not required] **(03 marks)**

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(c) When O.50g of polystyrene was dissolved in 250.0cm^3 of water; it produced a solution of osmotic pressure of 60.0Pa at 27^{0}C. Determine the molar mass of the polystyrene; hence calculate the number of styrene molecules in the polymer.

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15. Explain each of the following observations (Your answer should include balanced equations if any).

(a) When hydrogen iodide is treated with concentrated sulphuric acid, iodine is liberated whereas when hydrogen chloride is similarly treated, chlorine is not evolved.

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(b) An aqueous solution of sodium sulphite has a pH greater than 7 whereas that of sodium hydrogen sulphite is less than 7.

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(c) When hydrogen sulphide is bubbled through an aqueous solution of iron (III) chloride a yellow precipitate is observed.

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16. Write equations and mechanisms for the reaction that occurs when the following compounds react.

(a) Benzene with heated iron and bromine.   **(03marks)**

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(b) 2-methylpropan-1ol with heated concentrated sulphuric acid.   **(03marks)**

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(c) But-1-yne with hydrogen chloride.   **(03marks)**

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17. An organic compound K contains 9.09% hydrogen, 36.41% oxygen and the rest carbon.

(a) Determine the empirical formula of K.   **(02 marks)**

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(b) 0.54g of K occupies $150.9cm_3$ at a temperature of 19^0C and a 740mmHg.

(i) Determine the molecular formula of K.   **(02 marks)**

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 (ii) Write the structural formula of any two isomers of compound K.   **(01 mark)**

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(c) Compound K produces effervescence when reacted with sodium carbonate. Show how compound K can be converted to;

(i) Hexane. **(02 marks)**

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(ii) Propan-1-ol **(02 marks)**

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END

WISH YOU SUCCESS ALWAYS.