Name:……Signature:…….

P525/1
CHEMISTRY
Paper 1
May./June. 2021 **S.5**
2 ¾ hours.

THE CHEMISTRY DEPARTMENT

TEST - 2021

CHEMISTRY

Paper 1
2 hours 45 minutes

INSTRUCTIONS:

*Answer **all** questions in this section **A** and **six** questions in section **B**.*
***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	10	11	12	13	14	15	16	17	**Total**

SECTION A (46 MARKS)

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

1. (a) Complete the following equations.

(i) $^{27}_{13}Al + {}^{1}_{0}n \longrightarrow \beta + \ldots\ldots\ldots$ *(01 mark)*

(ii) $4^{1}_{1}H \longrightarrow {}^{4}_{2}He + \ldots\ldots\ldots$ *(01 mark)*

(iii) $^{239}_{92}U \longrightarrow {}^{239}_{91}U + \ldots\ldots\ldots$ *(01 mark)*

(b) An element **X** has two naturally occurring isotopes with isotopic masses and relative abundances as shown below.

Isotopic mass	Relative abundance
79	50.5
81	49.3

(i) State what is meant by the term relative atomic mass. *(01 mark)*

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(ii) Calculate the average atomic mass of **X**. *(02 marks)*

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2. An organic compound, **Q** has the structure;

$$CH_3CH = CHC \equiv CH$$

(a) Name the functional groups present in **Q**. *(02 marks)*

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(b) Write equation for the reaction between **Q** and:

(i) alkaline potassium permanganate solution. *(01 mark)*

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(ii) ammoniacal copper(I) chloride solution. *(01 mark)*

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(c) State what would be observed in (b) (i) *(01 mark)*

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3. Draw the structure and name the shape of each of the following species. *(4 ½ marks)*

Species	Structure	Shape
CrO_4^{2-}		
ClO_3^-		
SF_6		

4. 20 cm^3 of a hydrocarbon ***Z*** was exploded with 200 cm^3 of oxygen. On cooling to room temperature, the residual gases occupied 160 cm^3. When the residual gases were passed through sodium hydroxide solution, the volume reduced to 20 cm^3.

(a)(i) Write equation for the reaction between ***Z*** and oxygen. *(01 mark)*

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(b) Determine the molecular formula of ***Z***. *(2 ½ marks)*

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(c)Compound ***Z*** burns with a sooty flame. When ***Z*** was treated with hot alkaline potassium manganate(VII) solution followed by dilute hydrochloric acid, compound ***T*** was formed. ***T*** reacts with magnesium ribbon liberating hydrogen gas.

(i) Identify ***Z*** and ***T*** *(01 mark)*

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(ii) Write equation to show how ***Z*** can be obtained from an alkyne. *(1 ½ marks)*

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5. Complete the following organic reactions and name the major organic product in each case.

(a)  $+ \ HBr \longrightarrow$ *(1 ½ marks)*

Name of product

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(b)  $\xrightarrow{CH_3I/AlCl_3}$ *(1½ marks)*

Name of product

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(c) $CH_3CH = CH_2 \xrightarrow[2.\,H_2O/\,warm]{1.\,H_2SO_4}$ *(1 ½ marks)*

Name of product

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6. (a) Determine the oxidation state of aluminium and chromium in each of the following species respectively.

(i) Al_2O_3 *(01 mark)*

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(ii) $Cr_2O_7^{2-}$ *(01 mark)*

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(b) Write an equation to show the reaction between;

(i) Al_2O_3 and excess sodium hydroxide solution. *(1 ½ marks)*

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(ii) $Cr_2O_7^{2-}$ and hydrogen peroxide solution. *(1 ½ marks)*

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7. (a) A compound, **R** contains iron; 28%, Oxygen; 48% and sulphur; 24%. Calculate the empirical formula of **R**. *(02 marks)*

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(b) If the molecular mass of **R** is 400, determine the molecular formula of **R**. *(01 mark)*

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(c) A solution of **R** in water was added onto a piece of magnesium ribbon in a test tube. State what was observed and write equation for the reaction that took place.

Observation *(01 mark)*

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Equation *(1 ½ marks)*

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8. State what would be observed and write an equation for the reaction that would take place when each of the following compounds are reacted together.

   (a) Benzene and bromine in presence of aluminium chloride.

   (2 ½ marks)

   Observation:……

   ……

   Equation:……

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   (b) $CH_3CH = CH_2$ and bromine water. *(2 ½ marks)*

   Observation:……

   ……

   Equation:……

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9. During the manufacture of sulphuric acid by the Contact process, sulphur dioxide is catalytically oxidised to sulphur trioxide according to the following equation;

   $$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g),\ \Delta H^{\theta} = -197kJmol^{-1}$$

   The sulphur trioxide formed is then absorbed in 98% sulphuric acid to form compound **X**.

   (a) State the industrial conditions used to obtain maximum yield of sulphur trioxide. *(1 ½ marks)*

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(b) Write equation to show how compound **X** can be converted into sulphuric acid. *(01 mark)*

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(c) Write equation for the reaction between concentrated sulphuric acid and:

(i) Aluminium *(01 mark)*

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(ii) Phosphorus *(01 mark)*

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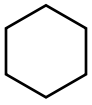
SECTION B: (54 MARKS)

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

10. Write equations to show how the following compounds can be synthesised. Indicate the condition(s) for the reaction(s).

(a)  from ethyne. *(2 ½ marks)*

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(b) Benzene from ethene *(3 ½ marks)*

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(c) Butanone from propyne *(3 ½ marks)*

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11. State what would be observed and write the equation for the reaction that would take place if;

(a) Propyne is bubbled through ammoniacal silver nitrate solution.
(02 marks)

Observation;……

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Equation:……

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(b) Acidified potassium permanganate solution is added to but-2-ene.
(02 marks)

Observation;……

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Equation:……

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(c) dilute sodium hydroxide solution is added drop wise until in excess to aqueous magnesium ions. *(02 marks)*

Observation;……

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Equation:……

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12.(a) State what is meant by the term freezing point constant of a substance. *(01 mark)*

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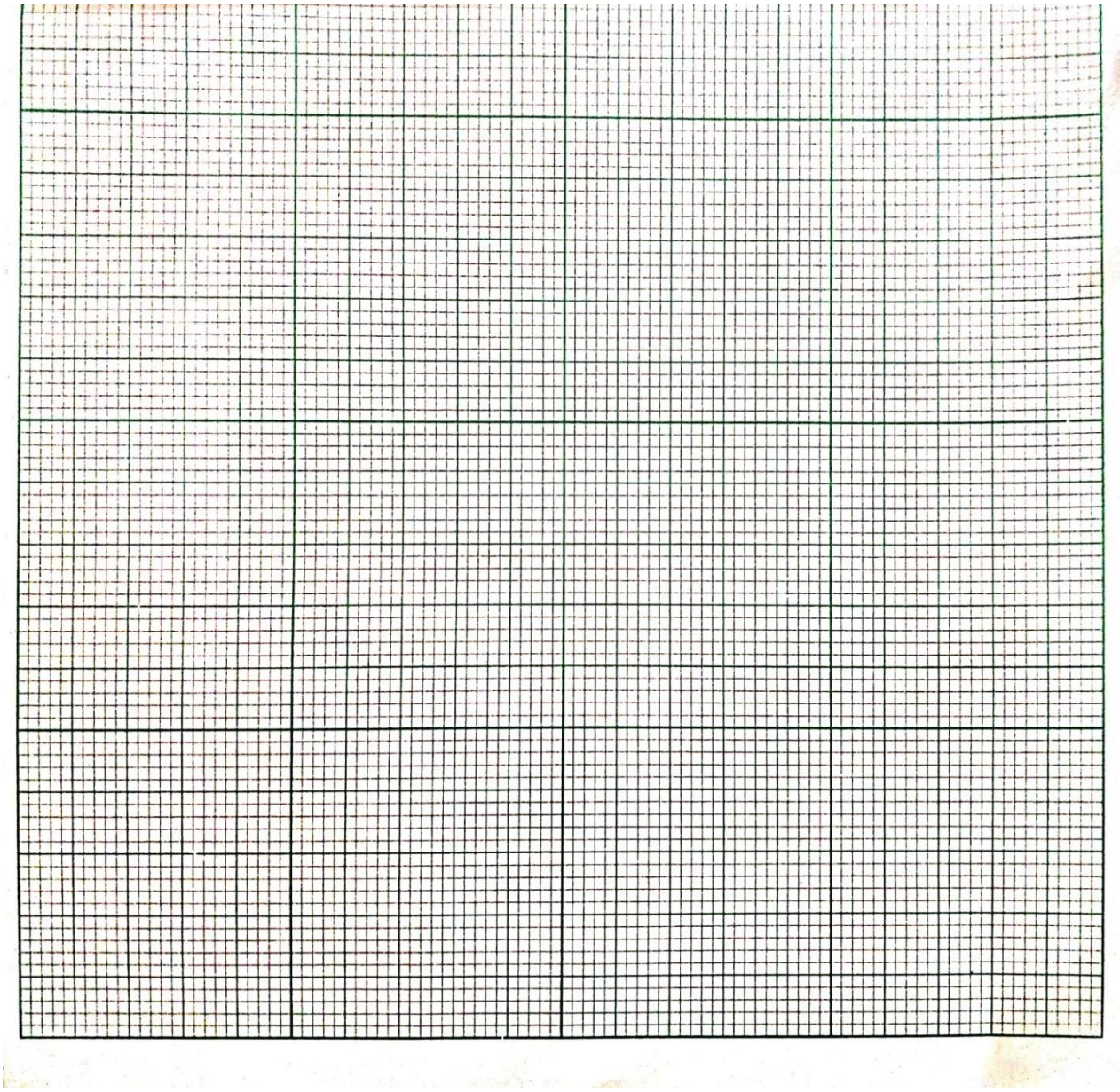
(b) The table below shows the freezing points of various concentrations of a non-volatile solute Q in water at 760mmHg.

Concentration of Q (gdm^{-3})	0	30	60	90	120	150
Freezing point(^{o}C)	0	-0.16	-0.32	-0.49	-0.65	-0.81

Plot a graph of freezing point depression against concentration of Q



(c) Determine the :

(i) slope of the graph you have drawn in (b). *(1 $\frac{1}{2}$ marks)*

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(ii) relative molecular mass of Q. $(K_f\ of\ water\ is\ 1.86°Ckg^{-1}mol^{-1})$

(2 ½ marks)

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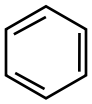
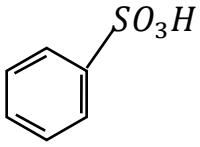
13. Write a mechanism to show how each of the following conversions can be effected.

(a)  to 

(03 marks)

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(b) $(CH_3)_2C = CHCH_3$ to $(CH_3)_2\overset{OH}{\overset{|}{C}}CH_2CH_3$ *(2 ½ marks)*

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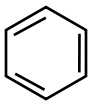
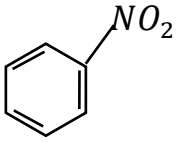
(c)  to 

(3 ½ marks)

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14. Compound ***Z*** contains 25.6% copper, 12.8% sulphur, 25.6% oxygen and the rest being water.

(a) (i) Calculate the empirical formula of ***Z***. *(02 marks)*

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(iii) Determine the molecular formula of ***Z***.
$(The\ formula\ mass\ of\ \boldsymbol{Z} = 250)$ *(1 ½ mark)*

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(b) Excess zinc powder was added to aqueous Z and the mixture allowed to stand.

(i) State what was observed. *(01 mark)*

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(ii) Write the equation for the reaction that took place.

(1 ½ marks)

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(c) To an aqueous solution of **Z** was added to dilute nitric acid followed by barium nitrate solution.

(i) State what was observed. *(01 mark)*

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(ii) Write the equation for the reaction that took place.

(1 ½ marks)

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15. The elements; sodium, magnesium, silicon and sulphur belong to Period 3 of the Periodic Table.

(a) For each element, write the formula and name the structure of the hydride it forms. *(04 marks)*

Element	Formula of hydride	Structure
Sodium		
Magnesium		
Silicon		
Sulphur		

(b) Write equation for the reaction that takes place between water and the hydride of;

(i) Magnesium *(01 mark)*

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(ii) Sulphur *(01 mark)*

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(c) Silicon hydride is hydrolysed by water whereas carbon hydride is not. Explain this observation. *(03 marks)*

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16. The boiling point of pure water is 100℃ at 760mmHg pressure. At the same pressure, a solution containing 1.576g of potassium chloride in 100g of water boils at 100.11℃.

(a) Calculate the boiling point constant, K_b for water. *(3 ½ marks)*

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(b) Explain why;

(i) the boiling point of potassium chloride solution is higher than that of pure water. *(2 ½ marks)*

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(ii) a 0.1M potassium chloride solution boils at the same temperature as a 0.2M glucose solution. *(03 marks)*

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17. Both chlorine and sodium hydroxide are manufactured by electrolysis of concentrated sodium chloride solution.

(a) Name the substance used as the:

(i) Cathode *(½ mark)*

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(ii) Anode *(½ mark)*

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(b) Write the equation(s) for the reaction(s) leading to formation of:

(i) Chlorine *(01 mark)*

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(ii) Sodium hydroxide *(2 ½ marks)*

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(c) State what would be observed and write the equation(s) for the reaction(s) that would take place if chlorine is bubbled through;

(i) Sodium iodide solution. *(1 ½ marks)*

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(ii) Hot concentrated sodium hydroxide solution. *(02 marks)*

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(d) Give a reason for your answer in (c)(i). *(01 mark)*

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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 TI 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.