Name: ..... Centre/Index No: .....

School..... Signature.....

P525/1
CHEMISTRY
Paper 1
2 ¾ hours

WAKISSHA

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 1

2 hours 45 minutes

Instructions to Candidates

- *Attempt **all** questions in section **A** and any **six** questions from section **B**.*
- *__All__ questions are to be answered in the spaces provided.*
- *A Periodic Table with relevant atomic masses is supplied at the end of the paper.*
- *Mathematical tables (3 figures) and non-programmable silent scientific calculators may be used.*
- *Illustrate your answers with equations where applicable.*
- *Molar gas volume at s.t.p = 22.4 dm^3*

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

SECTION A (46 MARKS)

Attempt **all** questions in this section.

1. Calcium phosphate partially dissociates in water to form a saturated solution of concentration $3.531 \times 10^{-5}\ gdm^{-3}$ at 25^0C.

(a) Write the;

(i) equation for the partial dissociation of Calcium phosphate in water. (01 mark)

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(ii) expression for the solubility product, Ksp. (01 mark)

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(b) Calculate the solubility product, Ksp of calcium phosphate at 25°C. State its units. (2½ marks)

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(c) State how the Ksp value in (b) above is affected when Calcium nitrate is added to the saturated solution of calcium phosphate at 25°C. (½ mark)

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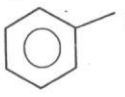
2. Name the reagent that can be used to distinguish between the following pairs of compounds. State what would be observed in each case when a member of each pair is separately treated with the reagent named. (02 marks)

(a)  (aq) and $CH_3COONa(aq)$

Reagent

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Observations

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(b) $(CH_3)_3C - OH$ and CH_3COCH_3 (02 marks)

Reagent

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Observations

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3. (a) Write the formulae and state the chemical nature of oxides formed by Beryllium and Barium. (2½ marks)

Element	Formulae of oxide(s)	Chemical nature
Beryllium		
Barium		

(b) Write equation(s) for the reaction(s) between the oxide(s) of;

(i) Beryllium with sodium hydroxide solution. (01 mark)

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(ii) Barium with dilute mineral acids. (02 marks)

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4. The physical states of chlorine, Bromine and Iodine at 298K and 760mmHg are gas, liquid and solid respectively.

(a) State reasons why the physical states vary among the group VII elements. (01 mark)

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(b) Write equation(s) for the reaction(s) that take place when;

(i) excess Chlorine gas is bubbled into sodium thiosulphate solution. (01 mark)

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Turn Over

(ii) Iodine is added to dilute potassium hydroxide solution and the resultant mixture warmed. (01 marks)

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5. (a) Complete the following equations for the nuclear reactions.

(i) $^{59}_{27}Co \longrightarrow {}^{59}_{25}Mn +$ ..... (½ mark)

(ii) $^{4}_{2}He + {}^{14}_{7}N \longrightarrow {}^{1}_{1}H +$ ..... (½ mark)

(iii) $^{235}_{92}U + {}^{1}_{0}n \longrightarrow$ .....$+ {}^{153}_{54}Xe + 3{}^{1}_{0}n$ (½ mark)

(b) Identify the type of nuclear reaction that occurs in;

(i) a(i) above. (½ mark)

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(ii) a(iii) above. (½ mark)

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(c) A fossil was found to contain 0.125g of carbon-14 isotope after 22400 years. Calculate the mass of carbon-14 in the living tissue given that the half-life of carbon-14 is 5600 years. (2½ marks)

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6. An organic compound Q has a molecular formula, $C_2H_4Cl_2$.

(a) Write the structural formulae and IUPAC names of all possible isomers of Q. (02 marks)

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(b) Each isomer in (a) above was separately refluxed with concentrated sodium hydroxide solution and the resultant cold mixture tested with Brady's reagent.

(i) State what would be observed in each case. (02 mark)

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(ii) Write equation(s) to show the reaction(s) that take place on reflux of each isomer with sodium hydroxide. (02 marks)

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7. (a) Butane-1, 4-dioic acid is a weak acid.

(i) Define the term weak acid. (01 mark)

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(ii) Write an equation to show that butane-1, 4-dioic acid is weak. (01 mark)

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(b) 1.18g of butane-1,4-dioic acid were dissolved in distilled water to make $200cm^3$ of solution whose pH was 3.20.
Calculate the acid ionization constant Ka for butane-1, 4-dioic acid and state its units. (04 marks)

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8. (a) Complete the following equations and in each case, write a mechanism for the reaction.

(i) $CH_3CH_2CH_2OH \xrightarrow[\text{Heat}]{KI/H_3PO_4}$ (02 marks)

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(ii) $CH_3COCH_3 \xrightarrow{HCN/\bar{O}H}$ (2½ marks)

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(b) State one reason why H_3PO_4 cannot be replaced by $conc.\ H_2SO_4$ in (a)(i) above. (01 mark)

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Turn Over

9. (a) Propanone reacts with Iodine in acidic medium according to the equation;

$$CH_3COCH_3(l) + I_2(aq) \xrightarrow{H^+} CH_3COCH_2I + HI$$

The kinetics of the reaction was examined by measuring the colour intensity of the reaction mixture.

(i) Sketch a graph to show how colour intensity varies with time. (01 mark)

(ii) Give a reason for your answer in a(i) above. (01 mark)

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(b) Briefly outline one other method by which the rate of the reaction in (a) above can be measured. (02 marks)

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(c) The rate equation for the reaction is given by;

Rate = $k[CH_3COCH_3]$

State the effect on the rate of reaction when;

(i) concentration of Iodine is doubled while the concentration of propanone remains constant. (½ mark)

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(ii) temperature is increased. (½ mark)

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(iii) the concentrations of both Iodine and propanone are doubled. (01 mark)

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SECTION B (54 MARKS)

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

10. (a) The partition coefficient of solute X between benzene and water at 25°C is 5.0.

(i) State three conditions under which the partition coefficient remains valid at 25°C. (1½ marks)

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(ii) Calculate the volume of benzene that extracts 80% of solute X from $50cm^3$ of its aqueous solution at 25°C. (2½ marks)

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(iii) State one method by which the percentage of solute X extracted in a(ii) above can be increased. (01 mark)

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(b) Ions of univalent metal M react with excess aqueous ammonia to form a soluble complex.

$$M^+(aq) + 2NH_3(aq) \longrightarrow M(NH_3)_2^+(aq)$$

Equal volumes of aqueous ammonia and 0.1M aqueous solution of M^+ ions were shaken with $1000cm^3$ of chloroform.
At equilibrium, the concentration of ammonia in the chloroform layer was 0.025 $moldm^{-1}$.
$10cm^3$ of the aqueous layer required $18.10cm^3$ of 0.4M nitric acid for complete neutralization.

Calculate the;

(i) concentration of free ammonia in the aqueous layer. (2½ marks)

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Turn Over

(ii) partition coefficient of ammonia between water and chloroform. (1½ marks)

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11. (a) A saturated compound R contains 38.710% carbon and 51.613% oxygen. The density of R at s.t.p is $2.7662gl^{-1}$.

(i) Calculate the empirical formula of R. (02 marks)

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(ii) Determine the molecular formula of R. (02 marks)

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(b) R reacts with sodium metal to liberate hydrogen gas but gives no effervescence on addition of sodium carbonate solution.

(i) Write the structural formula of R. (01 mark)

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(ii) State the reason why R has a higher boiling point than propanol. (01 mark)

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(c) R combines with benzene -1, 4-dicarboxylic acid to form a polymer called Terylene.

(i) State the type of polymerization that leads to the formation of Terylene. (01mark)

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(ii) Write the structural formula of Terylene. (01 mark)

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(iii) State any one use of Terylene. (01 mark)

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12. Chromium, Vanadium and Iron are transition elements which form compounds in variable oxidation states.

(a) Calculate the oxidation state of the transition element in each of the following chemical species.

(i) VO_3^- (½ mark)

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(ii) K_2MnO_4 (½ mark)

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(iii) $Fe(H_2O)_6^{3+}$ (½ mark)

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(b) State any two other general properties of transition elements. (01 mark)

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(c) In acidic medium, VO_3^- react according to the half equation.

$VO_3^-(aq) + 4H^+(aq) + e^- \longrightarrow VO^{2+}(aq) + 2H_2O(l)$

(i) State what would be observed when the acidified solution of VO_3^- is warmed with zinc dust. (01 mark)

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(ii) Write an equation for the redox reaction that occurs in c(i) above. (1½ marks)

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(d) State what would be observed and write an equation for the reaction when;

(i) Sodium hydroxide solution is added to a solution containing $Fe(H_2O)_6^{3+}$ ions.

Observation (½ mark)

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Equation (01 mark)

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(ii) Hydrogen sulphide gas is bubbled into an aqueous solution of K_2MnO_4. (01 mark)

Observation

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Equation (1½ mark)

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Turn Over

13. (a) In the contact process, sulphurtrioxide is produced according to the reversible reaction;

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g), \quad \Delta H < 0$$

(i) Write the expression for the equilibrium constant, Kc for the reaction. (½ mark)

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(ii) When **1** mole of sulphurdioxide was mixed with **2** moles of oxygen in a 2 litre vessel and the reaction carried out at 200°C, **1.92** moles of oxygen remained in the equilibrium mixture. Calculate the value for the equilibrium constant, Kc. (2½ marks)

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(b) State the effect of each of the following changes on the yield of sulphurtrioxide. Give a reason for your answer.

(i) increasing the temperature to 350°C. (01 mark)

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(ii) absorption of sulphurtrioxide by 98% sulphuric acid. (01 mark)

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(c) The sulphur trioxide obtained is used to prepare sulphuric acid which acts as a solvent of freezing point 10°C. A solution containing 0.630g of nitric acid in 200g of sulphuric acid freezes at 8.760°C.

(i) Calculate the relative formula mass of nitric acid in sulphuric acid.
(Cryoscopic constant of sulphuric acid is 6.2°C $Kg^{-1}\ mol^{-1}$) (02 marks)

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(ii) Explain your answer in c(i) above. (02 marks)
(Theoretical R.F.M of nitric acid = 63.0)

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14. (a) State how each of the following compounds can be prepared.

(i) Lead (IV) oxide. (1½ marks)

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(ii) Lead (IV) chloride. (1½ marks)

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(b) Write equations for the reaction between;

(i) Lead (IV) oxide and Manganese (II) sulphate solution in the presence of hot concentrated nitric acid. (1½ marks)

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(ii) Lead (IV) chloride and water (1½ marks)

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(c) Potassium chromate (VI) solution was added to Lead (II) acetate solution followed by excess sodium hydroxide solution.

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

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(ii) Write equation(s) for the reaction(s) that took place. (02 marks)

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15. The hydration energies of Lithium ions, Rubidium ions and Sulphate ions are -505, -375 and -561 $kJmol^{-1}$ respectively.

(a) What is meant by the term hydration energy? (01 mark)

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Turn Over

(b) (i) Compare the hydration energies of Lithium ions and Rubidium ions. (01 mark)

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(ii) Explain your answer in b(i) above. (02 marks)

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(c) Calculate the enthalpy of solution of Rubidium sulphate given that the lattice energy of Rubidium sulphate is -1236 $kJmol^{-1}$. (3½ marks)

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(d) State whether Rubidium sulphate is soluble in water or not. Give a reason for your answer. (1½ marks)

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16. Write equations to show how the following compounds can be synthesized.

(a) 2-hydroxyethanoic acid **from** ethanoic acid. (03 marks)

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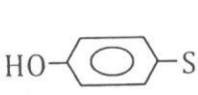
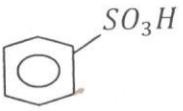
(b)  from  (3½ marks)

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(c) 2-methylpropan-2-ol from propanone. (2½ marks)

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17. The conductivity of solution X varies with concentration as shown in the table below.

Concentration ($moldm^{-3}$)	0.01	0.04	0.09	0.16	0.25
Conductivity $\Omega^{-1}cm^{-1} \times 10^{-3}$	1.340	4.760	9.360	13.920	17.750

(a) What is meant by the term electrolytic conductivity? (01 mark)

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(b) Plot a graph of molar conductivity against the square root of concentration. (03 marks)

From your graph.

(i) State whether X is a strong or weak electrolyte. Give a reason for your answer. (01 mark)

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(ii) Determine the molar conductivity of X at infinite dilution. (½ mark)

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(c) Calculate the ratio of X to sodium chloride required to give a solution of molar conductivity 125.4 $\Omega^{-1}cm^2mol^{-1}$. (02 marks)
(Molar conductivity of sodium chloride = $109\Omega^{-1}cm^2mol^{-1}$)

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(d) State one other factor that affects conductivity. (1½ marks)

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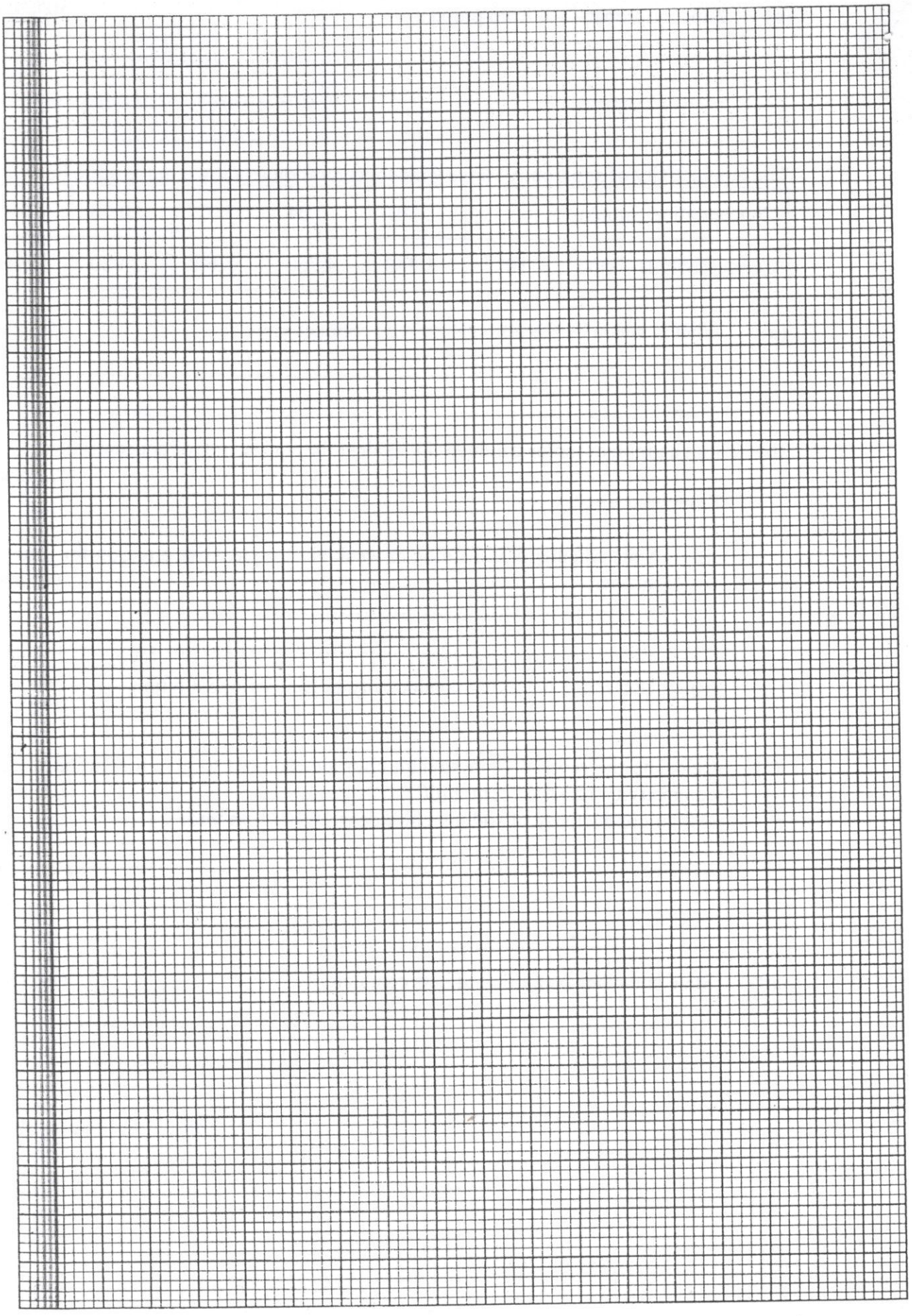

THE PERIODIC TABLE

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

			57 La 139	58 Ce 140	59 Pr 141	60 Nd 144	61 Pm (145)	62 Sm 152	63 Sm 150	64 Eu 152	65 Tb 159	66 Dy 162	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
			89 Ac (227)	90 Th 232	91 Pa 231	92 U 238	93 Np 237	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf 251	99 Es (254)	100 Fm (257)	101 Mv (256)	102 No (254)	103 Lw

1. 1 H ← Indicates atomic number.

2. H 1.0 ← Indicates relative atomic mass.

END