Our country, our future

525/1

S6 CHEMISTRY

Exam 27

PAPER 1

DURATION: 2 HOUR 45 MINUTES

Instructions to candidates:

- Attempt all questions in section A and any six 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.

FOR EXAMINER'S USE ONLY																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	TOTAL

1. (a) Define the term enthalpy of formation. (1 mark)

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(b) Calculate the enthalpy of formation sodium chloride from the following data.

(3 marks)

	ΔH^{θ} ($kJmol^{-1}$)
$Na(s) \longrightarrow Na(g)$	+109
$Cl2(g) \longrightarrow 2Cl(g)$	+242
$Na+(g) + Cl^{-}(g) \longrightarrow NaCl(s)$	−771
$Cl(g) + e^{-} \longrightarrow Cl^{-}(g)$	−364

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(c) Comment on the stability of sodium chloride. Give a reason for your answer.

(1 mark)

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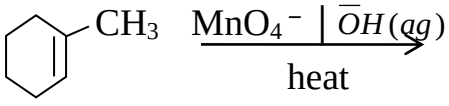
2. Complete the following reactions and in each case write the 1UPAC names of the major organic product. (1 ½ marks each)

(a) 

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(b) $BrCH_2CHCH_2CH_2Br \xrightarrow[\text{Heat}]{Et\bar{O}H \mid EtOH}$

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$\quad\quad\quad\quad CH_3$

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(c) $CH_3\,CHC \equiv CH + H_2 \xrightarrow{\text{Lindlar's catalyst}}$

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$\quad\quad\quad CH_3$

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3. 0.02M methylamine solution is 4% ionized at 25°C.

(a) Write ;

(i) an equation for the ionization of methylamine in water. (1 mark)

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(ii) an expression for the base ionization constant K_b for methylamine. (1 mark)

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(b) Calculate the

(i) pH of the methylamine solution ($K_w = 1.0 \times 10^{-14}\ mol^2\ dm^{-6}$)

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(ii) base ionization constant; Kb for methylamine. (1 ½ marks)

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4. (a) Write the formula of the hydrides of sodium and sulphur, in each case state the type of bonds present in the compounds. (2 marks)

Elements	Formula of hydride	Type of bond
Sodium		
Sulphur		

(b) Write equations to show how the hydrides react with water. (3 marks)

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5. (a) Define the term Osmotic pressure. (1 mark)

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(b) A polysaccharide has the formula $(C_{12}H_{12}O_{11})n$. A solution containing $5.00gdm^{-3}$ of the sugar has an osmotic pressure of $7.12 \times 10^2 Nm^{-2}$ at 20°C. Find the value of n. (3 ½ marks)

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(c) State any two assumptions made in (b) above. (1 mark)

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6. A powdered element T was investigated as shown in the table below

Experiment	Results
(a) A mixture of T and lead (IV) oxide was heated	A colourless gas with a chocking smell and turned acidified potassium dichromate from orange to green was evolved.
(b) Concentrated nitric acid is added to heated T, the products were diluted and barium nitrate solution added.	T dissolved in nitric acid with effervescence of a brown gas. On addition of barium nitrate solution a white precipitate was formed

(i) Identify T (1 mark)

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(ii) Write equations for the reactions in experiments (a) and (b) (4 marks)

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7. (a) $20cm^3$ of hydrocarbon Q with general formula C_nH_{2n-2} were mixed with $100cm^3$ of oxygen. The mixture was ignited and the residual gaseous product at room temperature bubbled through concentrated potassium hydroxide solution. The final volume was found to be $20cm^3$.

(i) Calculate the value of n in Q. (2 marks)

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(ii) Deduce the molecular formula of Q. (½ mark)

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(b) Q has two isomers X and Y. X decolourises bromine water but it does not react with ammoniacal silver nitrate solution. Y forms a white precipitate with ammoniacal silver nitrate solution.

(i) Identify isomers X and Y (1 mark)

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(ii) Write an equation for the reaction between (1 mark)

X and bromine water

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Y and ammoniacal silver nitrate solution. (1 mark)

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8. Name the reagent(s) that can be used to distinguish between each of the following compounds. State what would be observed in each case.

(a) KI(aq) and KCl(aq) (1 ½ marks)

Reagent(s)

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Observations

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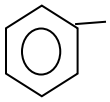
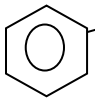
(b)  and  (1 ½ marks)

Reagent(s)

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Observations

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(c) $PbCO_3(s)$ and $BaCO_3(s)$ (1 ½ marks)

Reagent(s)

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Observations

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9. The electrode potentials of $S_2O_8^{2-}(aq) \mid SO_4^{2-}(aq)$ and $I_2(aq) \mid I^-(aq)$ are $^+2.01V$ and $^+0.54V$ respectively.

(a) Write an equation for the reaction that occurs at the;

(i) anode (1 mark)

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(ii) cathode (1 mark)

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(b) Write the ; (1 mark)

(i) Cathode

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(ii) Overall cell reaction (1 mark)

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(c) (i) calculate the e.m.f of the cell generated from the cell reaction in b(ii) above.

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(ii) State whether the above cell reaction is feasible or not. Give a reason for your answer (1 mark)

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SECTION B: (54 MARKS)

Answer only six questions from this section

10. Write equations to show how the following conversions can be effecte4d. Indicate all reagents and conditions necessary for each reaction.

(a) 1 – methylcyclobutene to 2 – methyl cyclobutanol. (3 marks)

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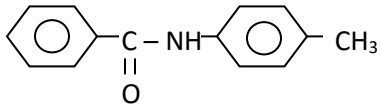
(b)  From benzene and bromomethane (4 marks)

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(c) Butane – 2, **–** diol to 2,3 –butane dionedioxime. (2 marks)

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11. (a) $Be(OH)_2$, $Mg(OH)_2$, $Ca(OH)_2$ and $Ba(OH)_2$ are the hydroxides of group II elements. Briefly describe how the hydroxides react with ;

(i) sodium hydroxide solution (2 marks)

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(ii) hydrochloric acid solution (2 marks)

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(b) The solubilities of the hydroxides of group II elements of the periodic table at 25^{o}C are given below

Hydroxide	$Be(OH)_2$	$Mg(OH)_2$	$Ca(OH)_2$	$Sr(OH)_2$	$Ba(OH)_2$
Solubility g/100g of water	Insoluble	0.002	0.150	0.900	4.000

(i) State and explain the trend in solubility of the hydroxides.

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(ii) Different masses of solid $Ca(OH)_2$ and $Ba(OH)_2$ containing the **same number of moles** were separately shaken with the same volume of water at 25°C. Identify the solution with higher pH value. Give a reason for your answer (1 ½ marks)

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12. (a) The partition coefficient of ammonia between water and trichloromethane at 25°C is 25.0,

(i) Define the term partition coefficient. (1 ½ marks)

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(ii) State two conditions under which the partition coefficient (K_D = 25.0) is valid other than constant temperature. (1 mark)

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(b) 25cm^3 of 0.0056M nickel (II) sulphate solution were added to an **equal** volume of ammonia solution at 25°C. The mixture was shaken with 50cm^3 of trichloromethane and allowed to stand until equilibrium was established. The trichloromethane layer required 32cm^3 of 0.0025M hydrochloric acid for complete neutralization. 7.060cm^3 of the aqueous layer required 20cm^3 of 0.02M hydrochloric acid. Nickel (II) ions react with ammonia according to the equation;

$Ni^{2+}(aq) + nNH_3(aq) \longrightarrow [Ni(NH_3)_n]^{2+(}aq)$

Calculate

(i) Molar concentration of the free ammonia in the aqueous layer.(2 1/2marks)

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(ii) Molar concentration of ammonia that reacted with nickel (II) ions (2 marks)

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(iii) Use your answer b (II) above to determine the value of n in $[Ni(NH_3)_n]^{2+}$

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13.(a) Describe a simple chemical test to distinguish between CH_3COCH_3 and CH_3CH_2CHO (2 marks)

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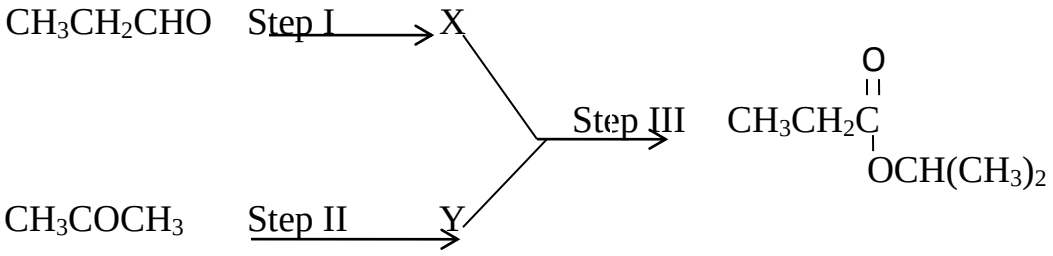
(b) Compound Z can be synthesized by the reaction between X and Y as shown below



(i) Identify compounds X and Y

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(ii) Name the type of reaction that occurs in steps I and I (1 mark)

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(c) Identify the reagents and state the conditions necessary for the reaction in

(i) step I (1 mark)

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(ii) step III (2 mars)

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(d) Write the mechanism for the reaction that occurs in step III

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14. Explain each of the following observations.

(a) An aqueous solution sodium sulphite when mixed with ammonium chloride produce a colourless gas that forms dense white fumes with concentrated hydrochloric acid on warming. (3 marks)

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(b) The acid dissociation constant (Ka) of chloric (1) acid is lower than the Ka for chloric (VII) acid at 25^{o}C, (2 marks)

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(d) When refluxed with aqueous potassium hydroxide followed by acidified silver nitrate solution. Chloroethane forms a white precipitate which chlorobenzene gives no observable change. (4 mark)

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15. HF,HCl, HBr and HI are hydrides of group VII elements

(a) Explain the variation in boiling points of the hydrides. (3 marks)

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(b) Aqueous solutions of the hydrides of the same concentration at constant temperature have different ph values.

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(i) Identify the hydride whose solution in water has the lowest pH (1 mark)

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(ii) Give a reason for your answer in b(i) above. (2 marks)

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(c) Write an equation for the reaction between

(i) The hydride of fluorine and excess silicon (IV) oxide (1 mark)

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(ii) Potassium manganate (VII) solution and the hydride of chlorine.
(1 mark)

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(iii) Concentrated sulphuric acid and the hydride of bromine. ` (1 mark)

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16. Lead (II) iodide is a sparingly soluble salt.

(a) Write an equation for the solubility of lead (II) iodide in water (1 mark)

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(b) The concentration of a saturated solution of lead (I) iodide at 40^{o}C is 0.122g per 100cm^{3} of solution
State whether a mixture of 50cm^{3} of 0.01M lead (II) nitrate and 50cm^{3} of 0.001M potassium iodide forms a yellow precipitate of lead (II) iodide or not. (show your working clearly) (6 marks)

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(c) The saturated solution of lead (II) iodide of concentration 0.122g per $100cm^3$ of solution was heated to 60^oC in a closed system

(i) State whether the solution remains saturated at 60^oC (½ mark)

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(ii) Give a reason for your answer. (1 ½ marks)

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17. A mixture of methanol and water at 50^oC is an ideal solution. The partial vapour pressure of methanol in the vapour above the solution varies according to Raoult's law as shown in the table below.

Partial vapour pressure of methanol (mmHg)	40.0	100.0	200.0	260.0	320.0
Mole fraction of methanol in solution	0.10	0.25	0.50	0.65	0.80

(a) (i) Define the term ideal solution. (1 mark)

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(ii) State Raoult's law (1 mark)

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(b) On the same axes, plot a graph of;

(i) Vapour pressure of methanol

(ii) Total vapour pressure above the solution against mole fraction of methanol.

(The composition of methanol in the vapour is 50% when its mole fraction in solution is 0.19)

(c) Use your graphs in (b) above to determine the

(i) Saturated vapour pressure of methanol at 50^{o}C. (1 mark)

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(ii) Saturated vapour pressure of water at 50^{o}C

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(d) Compare the volatility of methanol and water at 50^{o}C. Give a reason for your answer. (1 mark)

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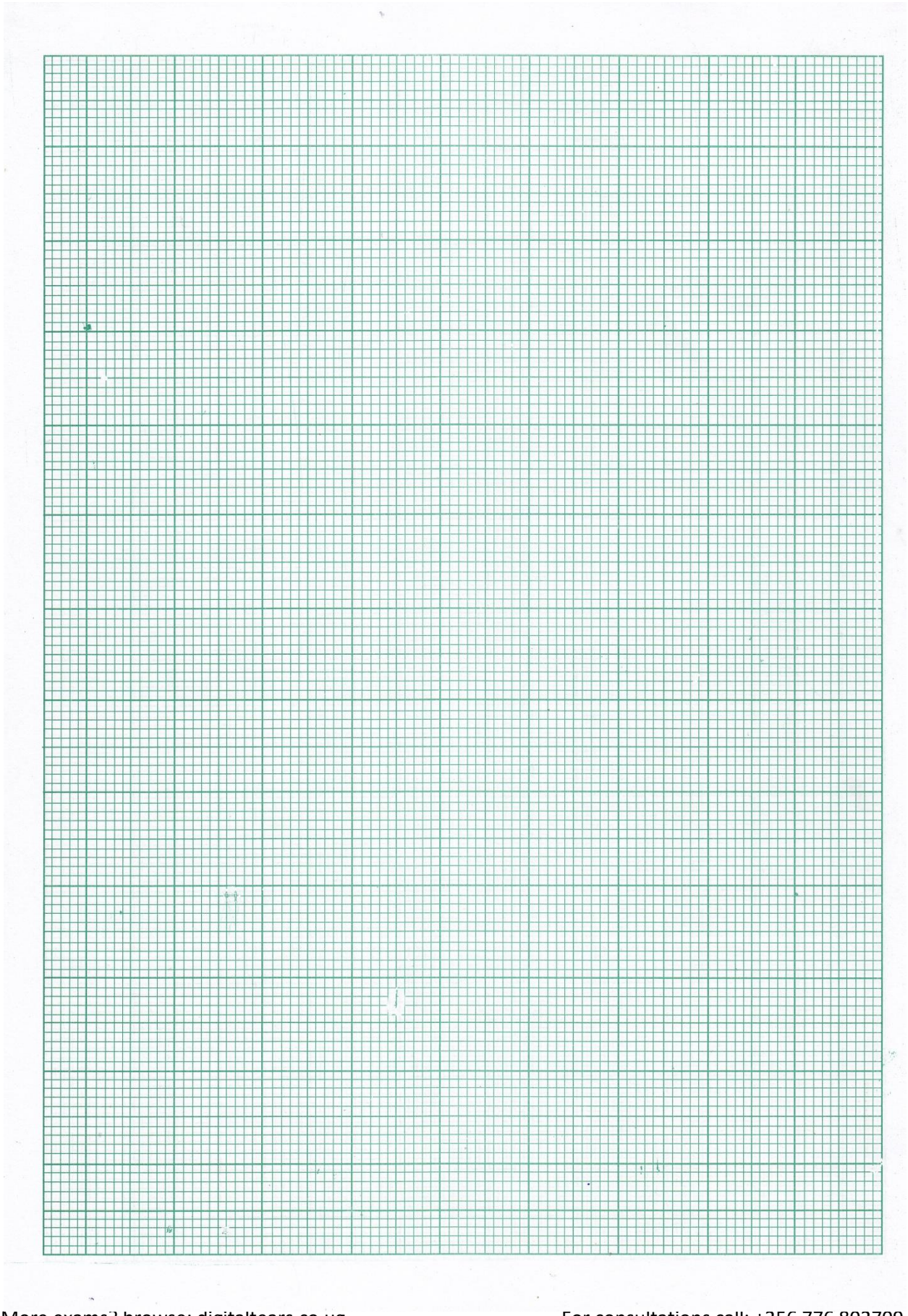
END



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. $\frac{1}{H}$ - indicates Atomic number.

2. $\frac{H}{1.0}$ - indicates relative Atomic number.

END.