

## SECTION A : ( 60 MARKS)

Answer **three** questions from this section.

1. When  $20\text{cm}^3$  of a gaseous alkyne  $P$ ,  $C_nH_{2n-2}$ , was exploded with  $135\text{cm}^3$  of excess oxygen and on cooling to room temperature, the residual gas occupied a volume of  $105\text{cm}^3$ . When the residual gas was passed through concentrated sodium hydroxide solution, the volume decreased by  $80\text{cm}^3$ .
- (a) (i) Write the equation for combustion of  $P$ . (01½ marks)  
(ii) Determine the molecular formula of  $P$ . (03½ marks)
- (b) Write the structural formulae and names of possible isomers of  $P$ . (03 marks)
- (c)  $P$  reacts with sodium metal in presence of liquid ammonia to form compound  $Q$ . Identify; (@01 mark)  
(i)  $P$  (ii)  $Q$
- (d)  $P$  was bubbled through ammoniacal silver nitrate solution.  
(i) State what was observed (0½ mark)  
(ii) Write equation for the reaction (01 mark)
- (e) Write equation and suggest a mechanism for the reaction between;  
(i)  $P$  and a solution of bromine in tetrachloromethane (03½ marks)  
(ii)  $Q$  and 1-bromopropane (02 marks)
- (f) With the aid of an equation, describe how  $P$  reacts with water. (3)
2. Some of the elements of group (II) of the periodic table are beryllium, magnesium, calcium, strontium and barium.
- (a) Write a general outermost electron configuration for the elements (01 mark)

- (b) The table below shows the variation in first ionization energy and melting points of group II elements.

Element	Be	Mg	Ca	Sr	Ba
Atomic number	4	12	20	38	56
First ionization energy( $\text{kJmol}^{-1}$ )	899	738	589	549	502
Melting point(K)	1553	923	1123	1043	993

- (i) On the same axes, plot graphs of first ionization energy and melting points of the elements against atomic number. (6 ms)
- (ii) Explain the shapes of each of the graphs in (b) (i) above.

(09 marks)

- (c) Beryllium, although in group II exhibits some chemical properties similar to an element in period 3 of the periodic table. Name the element with which Beryllium has similar chemical properties and write ionic equations for the reactions of Beryllium and the element you have named with sodium hydroxide.

(04 marks)

3. (a) (i) Explain what is meant by the term **lattice energy**

(02 marks)

- (ii) State **two** factors that affect the magnitude of lattice energy

(02 marks)

- (iii) Describe how the factors you have stated in a(ii) above affect lattice energy

(04 marks)

- (b) (i) Draw and label carefully a Born-Haber cycle for the formation of calcium oxide from its elements.

(04 marks)

- (ii) Use the data below to calculate the value of the lattice energies of calcium oxide and iron (II) oxide.

(06 marks)

		$\Delta H^\theta \text{ (kJmol}^{-1}\text{)}$
Standard enthalpy change of formation	Calcium oxide	- 635
	Iron(II) oxide	-278
Standard enthalpy change of atomisation	Calcium	+178
	Iron	+ 416
Standard molar 1 <sup>st</sup> + 2 <sup>nd</sup> ionisation energies	Calcium	+1735
	Iron	+230
Standard molar 1 <sup>st</sup> + 2 <sup>nd</sup> electron affinities	Oxygen	+657

- (iii) Compare the stability of calcium oxide and iron(II) oxide and give a reason for your answer. (02 marks)

4. (a) Define the terms;

(i) **Relative atomic mass** (02 marks)

(ii) **Relative abundance** (02 marks)

- (b) Briefly describe how the relative atomic mass of an element is determined by spectrometry with aid of a well labeled diagram. (10 marks)

(c) The mass spectrum of element Y shows four peaks of heights in ratio 2.1 : 4 : 2.2 : 1.6 with isotopic masses 10.692, 11.291, 10.928 and 12.029 a.m.u respectively. Determine the;

(i) relative abundances of the isotopes of Y. (04 marks)

(ii) relative atomic mass of Y. (02 marks)

## SECTION B: (40 MARKS)

Answer any **two** questions from this section

5. (a) Define the terms

(i) **Colligative property** (01 mark)

(ii) **Osmotic pressure** (01 mark)

(b)(i) Describe an experiment to determine the molecular mass of mannitol by osmotic pressure method. (06 marks)

(ii) State **three** limitations on this method. (01½ marks)

(c) The table below shows the osmotic pressure of a solution of mannitol of various concentrations at 25°C.

Concentration of the solution(gdm <sup>-3</sup> )	1.5	3.0	4.5	6.0	7.5	9.0	10.5
Osmotic pressure of the solution(atm)	0.20	0.40	0.60	0.81	1.05	1.20	1.40

(i) Plot a graph of osmotic pressure against concentration of the solution. (03½ marks)

(ii) Explain the shape of the graph. (03 marks)

(iii) Use the graph to determine the relative molecular mass of mannitol. (04 marks)

6. Explain the following observations

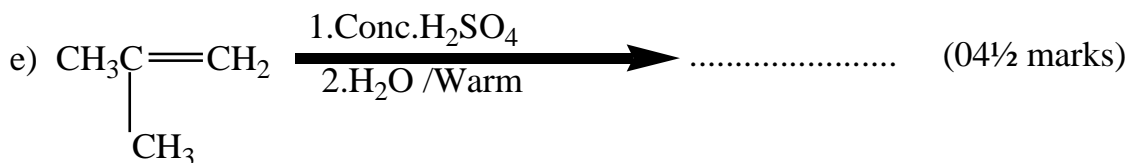
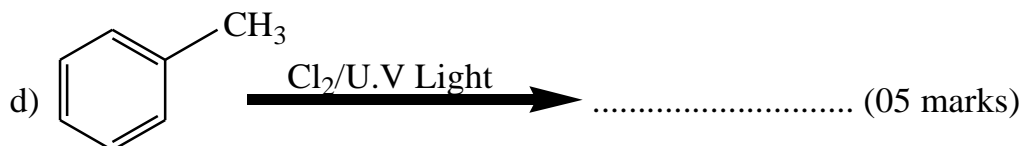
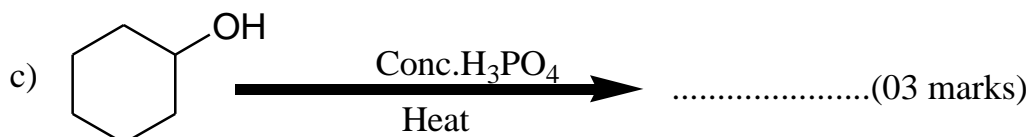
(a) Carbonic acid ( $H_2CO_3$ ) and sulphurous acid ( $H_2SO_3$ ) are both weak acids but their molecules exhibit different bond angles.

(04 marks)

(b) When an aqueous solution of sodium hydrogencarbonate is added to aluminium chloride solution, a white precipitate and bubbles of a colourless gas are observed. (05 marks)

- (c) The melting point of aluminium chloride is lower than that of aluminium fluoride. (04 marks)
- (d) The melting point of sulphur dioxide is much lower than that of silicon (IV) oxide. (03 marks)
- (e) Both 2-nitrophenol and 4-nitrophenol exhibit hydrogen bonding and yet the boiling points of the two compounds differ greatly. (04 marks)

7. Complete the following equations and in each case outline a mechanism for the reaction.



8. (a) (i) Describe the industrial manufacture of nitric acid starting from nitrogen and hydrogen as raw materials. (10 marks)

(ii) State **two** uses of nitric acid. (01 mark)

(b) State the conditions and write equations for the reaction(s) of nitric acid and:

(i) Magnesium (04 marks) (ii) Phosphorus (02½ marks) (iii) Sulphur (02½ marks)

# 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

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WELCOME TO SENIOR SIX, YEAR 2023  
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