SECTION A–46 MARKS
ATTEMPT ALL QUESTIONS IN THIS SECTION..

1. (a) Complete the following **equations** for nuclear reactions.

(i) $^{27}_{14}Si \longrightarrow {}^{27}_{13}Al + \ldots\ldots\ldots\ldots\ldots\ldots$ *(01 mark)*

(ii) $^{236}_{92}U + {}^{1}_{0}n \longrightarrow 2{}^{1}_{0}n + \gamma + {}^{147}_{60}Nd + \ldots\ldots\ldots$ (*01 mark)*

(b) When a radioactive isotope was left to stand, it decayed by **12.5%** of its original value in **45 days**. Calculate the **half-life** of the radioactive isotope. *(02½ marks)*

……

……

……

……

……

……..

2. (a) State **three** factors that can affect **electron affinity**. *(01½ marks)*

……

……

……

……

(b) Write equation for the **first electron affinity** of sulphur. *(01 mark)*

……

(c) The **first** and **second** electron affinities of sulphur are -200 and $+649\ kJ\ mol^{-1}$ respectively. Explain the difference in the electron affinities of sulphur. *(04 marks)*

……

……

……

……

……

……

……

……

3. Polystyrene is formed by polymerization of phenylethene.

(a) (i) Write the **structural formula** of polystyrene. *(01 mark)*

……

……

(ii) Name the **type** of polymerization involved in the formation of polystyrene. *(0½ mark)*

……

(b) The osmotic pressure of a solution containing **5.5 g** of polystyrene in **1** dm^3 of benzene is **1.0 x 10^{-3}**atmospheres at **20^0C**.

(i) Calculate the relative molecular mass of polystyrene.

(R = 0.082 atm $dm^3K^{-1}mol^{-1}$) *(02 marks)*

……

……

……

……

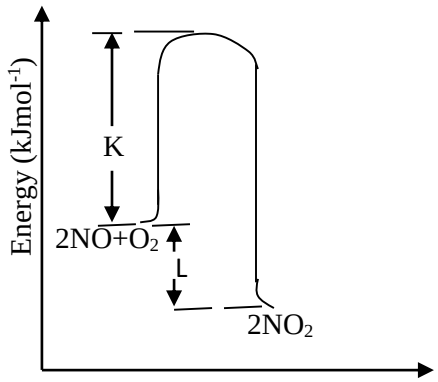
(ii) Determine the number of monomers that formed the polystyrene.
(01½ marks)

……

……

……

4. (a) The figure below shows the energy diagram for the reaction between nitrogen monoxide and oxygen.



Reaction co-ordinate

(i) Identify **K** and **L**.

K…… *(0½ mark)*

L…… *(0½ mark)*

(ii) State whether the reaction is **endothermic** or **exothermic**.
(0½ mark)

……

(iii) Give a reason for your answer in (a) (ii). *(0½ mark)*

……

(b) The experimental results in the table below were obtained for the reaction in (a).

Initial concentration ***(mol dm^{-3})***		**Rate of reaction** ***(mol $dm^{-3}s^{-1}$)***
NO	O_2	
0.03	0.03	2.7×10^{-5}
0.03	0.06	5.4×10^{-5}
0.06	0.03	10.8×10^{-5}

(i) Deduce the **order** of the reaction with respect to;
nitrogen monoxide. *(01 mark)*

……

Oxygen. *(01 mark)*

……

(ii) Write the **rate equation** for the reaction. *(01 mark)*

……

……

(c) Calculate the

(i) **rate constant (k)** for the reaction and state its units. *(01½ marks)*

……

……

……

5. When compound **Q** was steam distilled at **95^0C** and at **760mmHg**, the distillate contained **77.1%** by mass of **Q**. Calculate the **molecular formula** of **Q**.
*[The vapourpressure of water at **95^0C** is **526mmHg**]* *(04 marks)*

……

……

……

……

……

……

……

……

6. **10.0cm^3** of a hydrocarbon **P (C_xH_y)** was exploded in **90.0cm^3** of oxygen gas. On cooling to room temperature, the residual gases occupied **70.0cm^3**, when the residual gases were passed through potassium hydroxide solution, the volume reduced to **40.0cm^3**.
(a) Determine the **molecular formula** of hydrocarbon P. (03 marks)

……

……

……

……

……

……

……

……

……

……

……

(b) Write equations to show how hydrocarbon **P** can be prepared from **propan-2-ol**. (01½ marks)

……

……

……

7. Nitrogen reacts with hydrogen in a mole ratio of 1:3 to form ammonia gas.

a) Write:

(i) Equation for the reaction that takes place.

(0½ mark)

……

(ii) The expression for the equilibrium constant,Kc.

(0½ mark)

……

……

b) The percentage of ammonia in the equilibrium mixture of gases was found to be 15% at 600°C.Calculate the equilibrium constant (K_c) for the reaction at 600°C.

(03½ marks)

……

……

……

……

……

……

……

……

……

8. State what would be observed and write equation(s) for the reaction(s) that would take place when sodium hydroxide solution is added drop-wise until in excess to;

(a) Lead nitrate solution. *(03 marks)*

Observation.

……

……

Equation(s).

……

……

(b) Iron (II) chloride solution. *(02 marks)*

Observation.

……

Equation.

……

9. (a) (i) State the **conditions** for the reaction between benzene and sulphuric acid. *(01 mark)*

……

……

(ii) Outline a **mechanism** for the reaction in (a) (i). *(03marks)*

……

……

……

(b) Write equation(s) to show how the products in (a) (ii) can be converted to hydroxybenzene. *(01½ marks)*

……

……

SECTION B-54 MARKS
ATTEMPT ANY SIX QUESTIONS IN THIS SECTION.

10. (a) State what is meant by the term **enthalpy of solution**. *(01 marks)*

……

……

……

(b) The table below shows the heats of hydration and lattice energies of lithium chloride and sodium chloride.

Salt	Enthalpy of hydration (kJ mol^{-1})	Lattice energy (kJ mol^{-1})
LiCl	−882	+848
NaCl	−765	+788

Calculate the heat of solution of

(i) Lithium chloride *(01½ marks)*

……

……

……

(ii) Sodium chloride. *(01 marks)*

……

……

(iii) State how you would expect the **solubility** of the two salts to vary with temperature and give **reasons** for your answers. *(02½ marks)*

……

……

……

……

……

(c) Explain how **hydration energy** affects the solubility of salts in water. *(03 marks)*

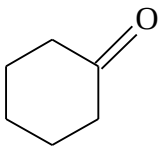
……

……

……

……

11. Complete the following equations and in each case write the accepted mechanism.

(a)  $\xrightarrow{NH_2NH_2/\ H^+}$ .....

(04 marks)

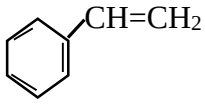
……

……

……

……

……..

(b)  $\xrightarrow{HI}$ …… *(03 marks)*

……

……

……

(c) $(CH_3)_2\overset{\overset{Cl}{|}}{C}CH_2CH_3 \xrightarrow[\text{Heat}]{\text{NaOH(aq)}}$ *(02 marks)*

……

……

……

……

……

12. (a) State how the following anhydrous chlorides can be prepared.

(i) Aluminium chloride. *(01mark)*

……

(ii) Phosphorous (III) chloride. *(01 mark)*

……

(b) Write equations for the reaction between water and the chlorides in (a).

(i) Aluminium chloride. *(01½ marks)*

……

(ii) Phosphorous (III) chloride. *(01½ marks)*

……

(c) Dilute sodium hydroxide solution was added drop-wise until in excess to a solution of aluminium chloride in water.

(i) State what was observed. *(01½ mark)*

…….....

.....

(ii) Write equation(s) for the reaction (s) that took place. *(2½ marks)*

……

……

……

13. A hydrocarbon **Y** contains **85.7%** carbon and has a density of $\mathbf{2.5}\boldsymbol{gl^{-1}}$ at **s.t.p**.

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

……

……

……

……

……

……

……

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

……

……

……

(c) Write the **structural formulae** of all the possible open chain isomers of **Y**. *(1½ marks)*

……

……

……

(d) (i) Ozonolysis of **Y** and subsequent work-up gave one compound. Identify **Y**. *(0½ mark)*

……

(ii) Write an **equation** to show how **Y** can be synthesized from butan-2-ol and indicate a mechanism for the reaction. *(03 marks)*

……

……

……

……

14. Write an equation for dissolution of each of the following compounds in water. State whether the resultant solution is **neutral**, **acidic** or **basic**.

a) Sodium Sulphide. (02 marks)

……

……

……

b) Ammonium Methanoate. (02 marks)

……

……

……

c) Phenyl Ammonium Chloride. (03 marks)

……

……

……

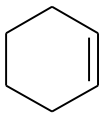
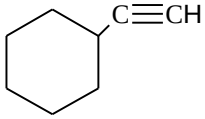
d) Sodium Benzoate. (02 marks)

……

……

……

15. Name the reagent(s) that can be used to distinguish between the following compounds. In each case state what would be observed when each compound is separately treated with the reagent.

(a)  and  *(03 marks)*

Reagent(s)

……

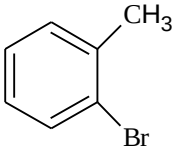
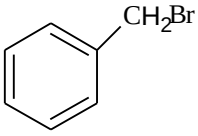
……...

Observation:

……

……

……

(b)  and  *(03 marks)*

Reagent(s)

……

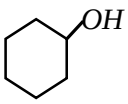
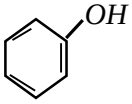
……

Observation:

……

……

……

(c)  and  *(03 marks)*

Reagent(s)

……

Observation:

……

……

……

16. The table below shows the atomic radius and the first ionization energy of some elements in period (III) of the Periodic Table.

Element	Na	Mg	Al	Si	P	S	Cl
Atom radius (nm)	0.186	0.160	0.143	0.117	0.110	0.104	0.099
First ionization energy (kj mol^{-1})	496	738	577	787	1060	1000	1251

(a) (i) State how **atomic radius** of the elements **varies** across the period. *(01 mark)*

……

……..……

(ii) Explain your answers in (a) (i). *(03 marks)*

……

……

……

……..……..

.....

.....

.....

(b) (i) Explain how **atomic radius affects** the **first ionization energy**. *(02marks)*

……

……

……..…

(ii) Why is the **first ionization energy** of aluminium **lower** than that of magnesium? *(03 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 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===

WELCOME TO SENIOR SIX, YEAR 2023

This is the last page of the printed paper, Page 17