SECTION A: (46 MARKS)
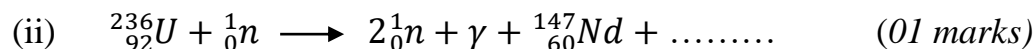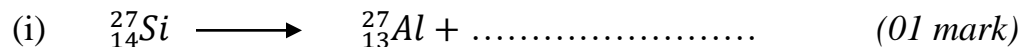
*Answer **all** questions from this section.*

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

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

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

   (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. *(2½ marks)*

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2. (a) State **three** factors that can affect electron affinity. *(1½ marks)*

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

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   (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)*

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3. Polystyrene is formed by polymerization of phenylethene.

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

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         (ii) Name the type of polymerization involved in the formation of
               polystyrene. *(½ mark)*

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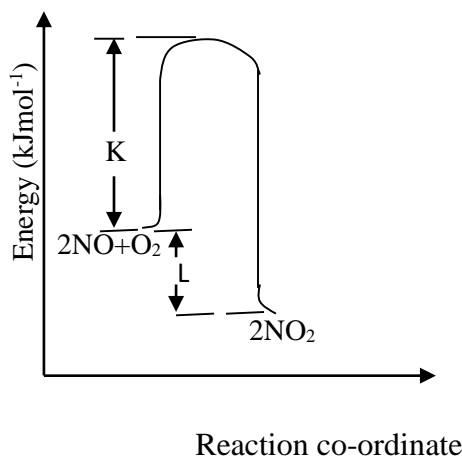 dm^3** of benzene is **1.0 x 10^{-3}atmospheres** at **20^0C**.

         (i) Calculate the relative molecular mass of polystyrene.*(R = 0.082
              atm dm³ $K^{-1}mol^{-1}$)* *(02 marks)*

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         (ii) Determine the number of monomers that formed the
               polystyrene. *(1½ marks)*

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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…………………………………………… (½ mark)

L…………………………………………… (½ mark)

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

(½ mark)

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(iii) Give a reason for your answer in (a) (ii). (½ mark)

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(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)

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Oxygen.   *(01 mark)*

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

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(c)   Calculate the

    (i)   rate constant (k) for the reaction and state its units.   *(1½ marks)*

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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)*

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6. Draw the structures and name the shapes for the following species.

(4½ marks)

species	Structure	Name
(i) SO_2		
(ii) H_2S		
(iv) SO_4^{2-}		

7. (a) Explain what is meant by the term an **ideal solution**. *(1½ marks)*

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(b) A mixture of liquids **A** and **B** behaves as an ideal solution. The vapour pressures of A and B are 473.2Pa and 139.8Pa respectively at 20⁰C. Calculate the composition of the vapour from a mixture containing 0.6 mole fraction of liquid **A** at 20⁰C. *(03 marks)*

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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.

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Equation(s).

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

Observation.

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Equation.

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

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

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(b)   Write equation(s) to show how the products in (a) (ii) can be converted
       to hydroxybenzene.   *(1½ marks)*

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SECTION B (54 MARKS)

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

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

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       (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   *(1½ marks)*

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

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       (iii) State how you would expect the solubility of the two salts to vary
              with temperature and give reasons for your answers. *(2½ marks)*

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

(03 marks)

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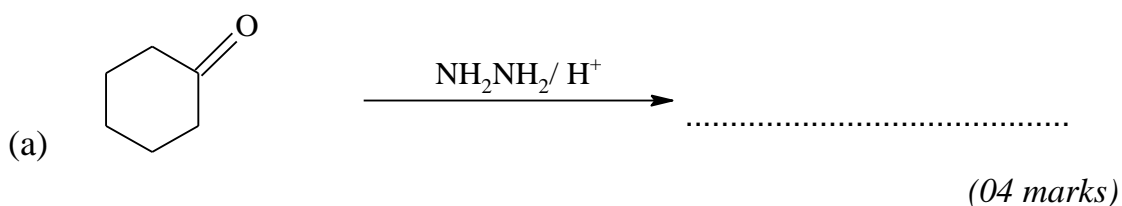..

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

(a)

$$NH_2NH_2/\ H^+$$

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(04 marks)

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(b)   CH=CH$_2$

$$HI$$ ....

(03 marks)

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(c) $(CH_3)_2CCH_2CH_3$ Cl

$$\xrightarrow[\text{Heat}]{\text{NaOH(aq)}}$$

(02 marks)

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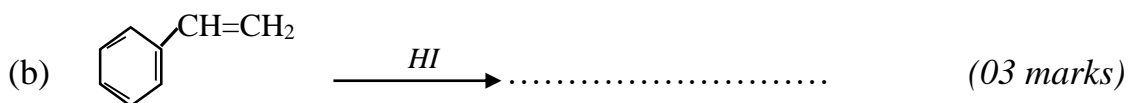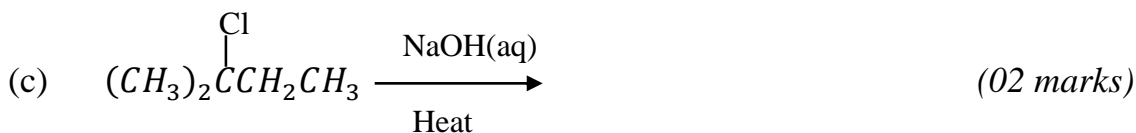
12. (a) State how the following anhydrous chlorides can be prepared.

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

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

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

     (i)   Aluminium chloride.   *(1½ marks)*

....

     (ii)   Phosphorous (III) chloride.   *(1½ 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.   *(1½ mark)*

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

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

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

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

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

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(d)   (i)   Ozonolysis of **Y** and subsequent work-up gave one compound.
                Identify **Y**.   *(½ marks)*

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

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14. (a) Define the term **partition coefficient**. *(01 mark)*

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(b) Copper (II) ions forms a complex $Cu(NH_3)_n{}^{2+}$ with ammonia. The table below shows the results of partition of ammonia between 0.1M copper(II) ions and trichloromethane.

$[NH_3]$ (0.1M Cu^{2+}(aq))	0.88	1.08	1.34	1.56	1.80
$[NH_3]$ ($CHCl_3$)	0.02	0.03	0.04	0.05	0.06

   (i) Plot a graph of $[NH_3]$ (0.1M Cu^{2+} (aq)) against $[NH_3]$ ($CHCl_3$).
   (03 marks)

   (ii) Determine the value of n in the complex. *(2½ marks)*

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(c) (i) Determine the partition coefficient, K_D of ammonia between aqueous copper (II) ions and trichloromethane. *(1½ marks)*

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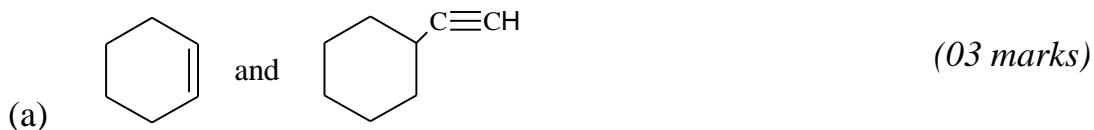
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   (ii) State how the value of K_D you have determined indicates about the distribution of ammonia. *(01 mark)*

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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.
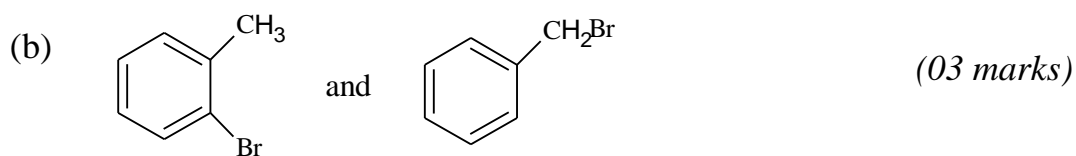

(a) $C{\equiv}CH$ and   (03 marks)

Reagent(s)

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Observation:

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(b)

CH_3 ... Br and CH_2Br (03 marks)

Reagent(s)

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Observation:

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(c) and *(03 marks)*

Reagent(s)

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Observation:

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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)*

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

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

(02marks)

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

(03 marks)

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♥ ===END===

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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 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