

SECTION A (60 Marks)

Answer only **three** questions from this section.

1. The elements beryllium, magnesium, calcium, strontium & barium belong to group (II) of the periodic table.

(a) Write the equation and state the conditions under which group (II) elements reacts with: (@04 marks)

- (i) Air.
- (ii) Water.
- (iii) Dilute sulphuric acid.

(b) The atomic radii and melting points of group (II) elements in the periodic table is given below:

Elements	Atomic radius (nm)	Melting points (°C)
Beryllium	0.112	1,283
Magnesium	0.160	650
Calcium	0.197	848
Strontium	0.215	770
Barium	0.222	710

Explain the trend in: (@03 marks)

- (i) Atomic radii.
 - (ii) Melting points of group (II) elements.
- (c) Although beryllium is in group (II) of the periodic table, in some of its properties resemble aluminium in group (III). State the reasons why beryllium differs in some of its properties from the rest of the elements in group (II). (02 marks)

2. (a). Both phenol and ethanol contains the same functional group.

(i) Name one reagent that can be used to distinguish between the two compounds. (01 mark)

(ii) State what would be observed if each of the compounds is treated with the reagent you have named and write equation for the reaction that occurs if any. (03 marks)

(iii) Describe three ways in which the chemistry of phenol is similar to that of ethanol. (03 marks)

- (iv) Mention two uses of phenol. (02 marks)
- (b). An aqueous solution of phenol turns moist blue litmus paper red whereas that of ethanol has no effect. Explain the observation. (04½ marks)
- (c) Write the equation and mechanism for the reaction between:
- Phenol and 2-chloropropane in alkaline conditions. (03 marks)
 - Ethanol and methanoic acid in presence of sulphuric acid. (04½ marks)
3. (a). State Hess's law of constant heat summation. (01 mark)
- (b). Explain what is meant by each of the following terms and in each case write an equation to illustrate your answer. (@02 marks)
- Lattice energy.
 - Hydration energy.
- (c). Explain two factors that affect the value of lattice energy of a compound. (03 marks)
- (d). In an experiment to determine lattice energy of anhydrous copper (II) sulphate, **4.0g** anhydrous copper (II) sulphate was added to **50g** of water and the temperature rose by **8.0°C**. When **4.0g** hydrated copper (II) sulphate was added to **50g** of water dropped from **24.5°C** to **23.6°C**. [SHC of solution = 4.2J/g/K]
Calculate the enthalpy of solution of:
- Anhydrous copper (II) sulphate. (03 marks)
 - Copper (II) sulphate-5-water. (03 marks)
- (e) State which one of the two copper (II) salts in (d) is more soluble in water and explain your answer. (03 marks)
- (f) Using a Born-Haber cycle determine the hydration energy of copper (II) sulphate. (03 marks)

4. (a) Describe how the molecular mass of a substance can be determined using freezing point depression method. Diagram not required) (07 marks)
- (b) Explain why the method you have described in a (i) is not suitable for determining the molecular mass of a polymer. (02 marks)
- (c) Calculate the freezing point of a solution containing 4.2g of ethane-1, 2-diol. [Molecular mass = 62 & K_f for water = 1.86°C/Kg] in 30g of water. (04 marks)
- (d) The osmotic pressure of various concentrations of solute X in methylbenzene at 25°C are given below in the table.
- | | | | | | | |
|---------------------------------------|-----|-----|-----|-----|-----|-----|
| Concentration (g/dm^3) | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 |
| Osmotic pressure (Nm^{-2}) | 23 | 37 | 53 | 75 | 92 | 99 |
- (i) Plot a graph of osmotic pressure against concentration. (03 marks)
- (ii) Use the graph you have drawn to determine the molecular mass of X. [universal gas constant, $R = 8.314\text{KJ/mol}$] (04 marks)

SECTION B (40 Marks)

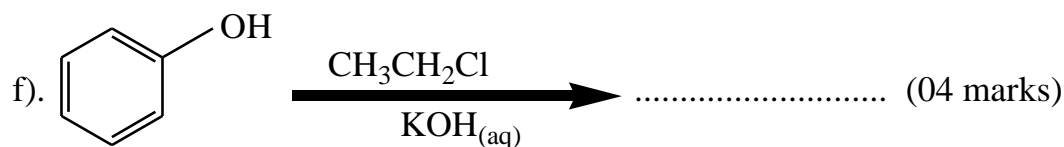
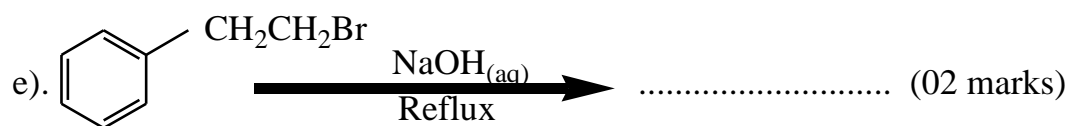
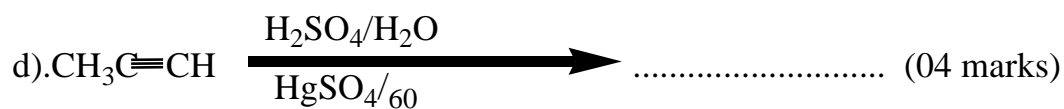
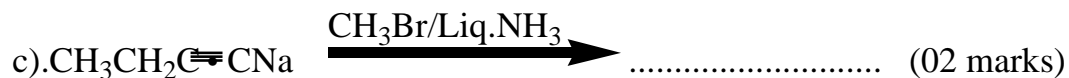
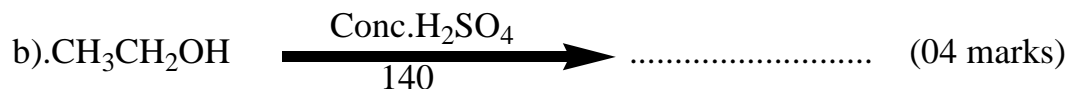
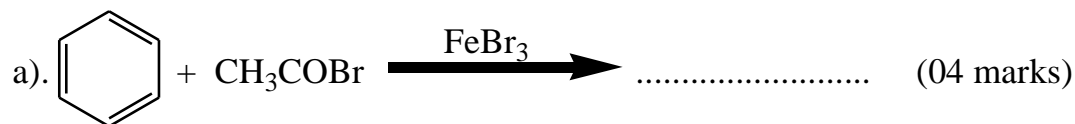
Answer only **two** questions from this section.

5. The boiling points of period 3 elements are shown in the table below.

Formula of Chloride	NaCl	MgCl ₂	AlCl ₃	SiCl ₄	PCl ₃	S ₂ Cl ₂	Cl ₂
Boiling point ($^\circ\text{C}$)	1,465	1,418	423	57	74	136	-35

- (a) Explain the trend in boiling points. (10 marks)
- (b) State the conditions and write the equation for the reaction between: (@02 marks)
- (i) AlCl_3 and water.
 - (ii) Chlorine and iron.
 - (iii) MgCl_2 and sulphuric acid.
 - (iv) SiCl_4 and calcium hydroxide powder.
 - (v) S_2Cl_2 and dilute sodium hydroxide solution.

6. Complete the following equations and write the suggested mechanism.



7. (a). The standard electrode potential for some half-cells are given below: $\text{Fe}^{3+}_{(\text{aq})}/\text{Fe}^{2+}_{(\text{aq})} \quad +0.76\text{V} \quad || \quad \text{I}_{2(\text{aq})}/\text{I}^{-}_{(\text{aq})} \quad +0.54\text{V}$

(i) What is meant by the term standard electrode potential? (01 mark)

(ii) Using a well labelled diagram, describe how the standard electrode potential of iron (III) sulphate can be determined. (06 marks)

(iii) Why is it not possible to measure the standard electrode potential of iron (III) sulphate absolutely? (02 marks)

(b) Write:

(i) The cell convention and equation for the overall reaction that occurs when the electrode potentials in (a) above are combined. (02½ marks)

(ii) Calculate the overall electrode potential for the cell. (01½ marks)

- (iii) State whether the reaction in (b) (i) is feasible or not. Give a reason for your answer. (01 mark)
- (c) A current of 40.5A was passed via molten lead (II) bromide for 4 hours and bromine liberated reacted with 94.0g of hydroxylbenzene. Calculate the number of moles of: (@02 marks)
- Bromine liberated.
 - Hydroxybenzene that reacted.
- (d) State what is observed and write equation for the reaction that took place between bromine and hydroxylbenzene in (c) above. (02 marks)
8. (a). Describe how aluminium can be extracted from bauxite. [Your answer should include relevant equations where necessary] (10 marks)
- (b) (i) Briefly describe how hydrated aluminium chloride, $[\text{AlCl}_3 \cdot 6\text{H}_2\text{O}]$ can be prepared from aluminium. (03 marks)
- (ii) State what would be observed when hydrated aluminium is strongly heated and write equation for the reaction. (02½ marks)
- (iii) State what would be observed when sodium carbonate solution is added to concentrated solution of aluminium chloride. (04½ 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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