

3 Yr. Degree/4 Yr. Honours 3rd Semester Examination, 2025 (CCFUP)

Subject : Chemistry

Course : CHEM3011 (MAJOR)

Full Marks: 60

Time: 3 Hours

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words  
as far as practicable.

1. Answer any ten questions from the following:

2×10=20

- Why is  $\text{H}_3\text{BO}_3$  not much soluble in water?
- $\delta$ -Bonds can be formed by d- and f-orbitals but not by s- and p-orbitals. Justify this statement.
- What do you mean by tripod ligand?
- The tendency of polymerization of the oxyanions lies in the sequence:  $\text{SiO}_4^{4-} > \text{PO}_4^{3-} > \text{SO}_4^{2-} > \text{ClO}_4^-$ . — Explain.
- What are Cryptands and Cryptates?
- Compare the Lewis basicity between  $(\text{CH}_3)_3\text{N}$  and  $(\text{SiH}_3)_3\text{N}$ .
- Why is  $[\text{Ag}(\text{NH}_3)_2]^+$  more stable than  $[\text{Ag}(\text{en})_2]^+$  [where en = ethylenediamine]? Give reason.
- How do the  $\pi$ -electron clouds also act as the donor sites in H-bonding?
- Why does  $\text{D}_2\text{O}$  show a higher boiling point than  $\text{H}_2\text{O}$ ?
- Establish with examples that hydroxylamine can act both as oxidizing and reducing agents.
- Why are interhalogen compounds more reactive than halogens except fluorine?
- Why is  $\text{PbCl}_2$  white whereas  $\text{PbI}_2$  is coloured?
- Explain the metallic properties of transition metals on the basis of Band Theory.
- "Xenon forms compounds only with highly electronegative elements." Justify.
- Explain the phenomenon of linkage isomerism giving examples of thiosulphate as ligand.

2. Answer any four questions from the following:

5×4=20

- On analysis, a complex compound is found to exhibit the ratio  $\text{Co} : \text{NH}_3 : \text{Cl} : \text{Br} = 1 : 4 : 2 : 1$ . Write down the structural formula of all possible isomers of the compound. 4
- Give examples of the following ligands: 1
  - $\sigma$  - donor  $\pi$  acceptor
  - $\pi$  - donor  $\pi$  - acceptor

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- (b) (i)  $XeF_6$  is distorted octahedron but  $TeCl_6^{2-}$  is a regular octahedron, although they are isoelectronic.— Explain. 3
- (ii) Perchloric acid is formulated as  $HClO_4$  but periodic acid is as  $H_5IO_6$ . Explain. 2
- (c) (i) Cite an example of non-innocent ligand. Point out the criteria of ligand to behave as a non-innocent ligand. Predict the oxidation state of iron in  $[Fe(H_2O)_5NO]SO_4$ . 3
- (ii) What are the possible geometries for the coordination numbers 4 and 6? 2
- (d) Explain the O-O bond length in  $O_2^+$ ,  $O_2^-$  and  $O_2^{2-}$  in the light of MO diagram. 3
- (e) (i) Explain the O-O bond length in  $O_2^+$ ,  $O_2^-$  and  $O_2^{2-}$  in the light of MO diagram. 3
- (ii) Mention the basic conditions to be satisfied in forming a hydrogen bond. 2
- (f) (i) Although In and Tl belong to same group of the periodic table, while In is (+3) valent in most of its compound, Tl is mostly (+1) valent. Why is it so? 2
- (ii) Explain why  $BCl_3$  exists but  $BH_3$  does not. In the qualitative analysis of borate, little  $H_2SO_4$  is to be added to the sample of borax, before addition of alcohol. Explain. 2+1
- (g) (i) He and Ne cannot form the clathrates with the crystals of quinol while the others inert gases can do the task.— Justify the statement. 2
- (ii) Explain why in n-type extrinsic semiconductors, the electrons are the majority carriers of electricity while the holes are the minority carriers. 3

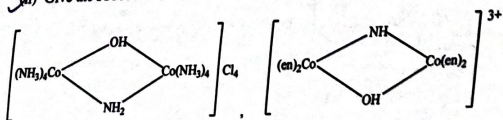
10×2=20

3. Answer any two questions from the following:

- (a) (i) Chromium (III) chloride forms three different hydrates of same composition  $Cr : Cl : H_2O = 1 : 3 : 6$ . The violet salt does not lose water over conc.  $H_2SO_4$  and gives 3 equivalents of  $AgCl$  on the treatment of  $AgNO_3$ . The two other hydrates, both being green, loses 1 and 2 mole(s) of  $H_2O$  over conc.  $H_2SO_4$  and respectively gives 2 and 1 equivalents of  $AgCl$  on treatment with  $AgNO_3$ . Write down the coordination structures of the three isomeric  $Cr(III)$  complexes and explain the type of isomerism involved. 3+1

2+2

(ii) Give the IUPAC names of the following complexes:



- (iii) 'Boron ( $B_2$ ) is paramagnetic while carbon ( $C_2$ ) is diamagnetic.'— Explain on the basis of MO theory. 2
- (b) (i) Suggest preparatory methods for the following compounds: basic beryllium acetate, boron nitride, carborundum, periodic acid. 1.5×4
- (ii) "Anhydrous  $AlCl_3$  is covalent while  $AlCl_3 \cdot 6H_2O$  is ionic"— explain. 2

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- (iii) State giving equation what happen when an aqueous solution of  $AlCl_3$  is heated with a mixture of KI and  $KIO_3$ . 2
- (c) (i) Why does sodium give a blue colour in liquid ammonia? 2
- (ii) Draw and explain the hybridised structure of  $B_2H_6$ . 2
- (iii) The acid strength in aqueous media runs as:  $H_3PO_2 > H_3PO_3 > H_3PO_4$ — Explain. 3
- (iv) State what happens when bismuth hydroxide is treated with alkaline stannite solution. Give the balanced ionic equation for the reaction. 1+2
- (d) (i) What are fullerenes? Are fullerenes aromatic? Comment on their ligational motif. 2+1+2
- (ii) On the basis of VSEPR theory, predict the structures of  $XeO_2F_2$ ,  $XeOF_2$  and  $XeOF_4$ . 3
- (iii) ' $PCl_3$  and  $SbCl_3$  behave differently with water.'— Give the chemical reactions. 2

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