BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF CHEMISTRY

MAIN EXAMINATION PAPER

DEGREE PROGRAMME: BSC HONS CHEMICAL TECHNOLOGY

COURSE: (CHT101) INORGANIC CHEMISTRY I

DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES

1. Answer **Question 1** and **Two** questions in **Section A** and **Two** from **Section B.**
2. Each question should start on a fresh page and marks will be allocated as indicated.
3. Each question carries **20 Marks.**

Question 1

(a) Explain why Zn and Zn(II) compounds are diamagnetic, irrespective of the coordination environment of the Zn^{2+} ion. **[4 marks]**

(b) Briefly explain hybridization and its significance in Valence Bond Theory (VBT). **[4 marks]**

(c) Explain why the ground state configuration of $1s^2 2s^1$ for a Li atom is energetically preferred over $1s^2 2p^1$. **[4 marks]**

(d) Briefly explain the Hund's rule, Aufbau principle and Pauli exclusion principle. **[6 marks]**

(e) Using IUPAC norms write the chemical formulas of the following compounds;

(i) Pentaamminechloridoplatinum(IV) nitrate **[1 marks]**

(ii)Tetraamminediaquacobalt(III)chloride **[1 marks]**

SECTION A: ANSWER ANY **TWO** QUESTIONS

Question 2

(a) Draw and label a complete Molecular Orbital (MO) energy level diagram for O_2. **[10 marks]**

(b) Using the MO diagram write the valence orbital occupancy (i.e. electron configuration) for O_2. **[2 marks]**

(c) Draw a Lewis diagram for O_2. **[2 marks]**

(d) Name a property of oxygen that is clearly shown by the molecular orbital energy level diagram but not by the Lewis diagram. **[1 mark]**

(e) Explain why when O_2 reacts with Na metal, the peroxide anion is generated (O_2^{2-}). **[5 marks]**

$$2Na(s)+O_2(g)\rightarrow Na_2O_2(s)$$

Question 3

Discuss the main reasons why the periodic table might need to be redesigned. **[20 marks]**

Question 4

(a) Briefly explain how inorganic chemistry can be used to promote sustainability. **[10 marks]**

(b) Highlight the limitations of the Bohr atomic model. **[4 marks]**

(c) Briefly discuss factors that affecting atomic orbital energies. **[6 marks]**

SECTION B: ANSWER TWO QUESTIONS

Question 5

(a) Based on the number of mole of chlorides precipitated with $AgNO_3$ solution in the complexes below, complete the table below. **[5 marks]**

Formula	Mole of Cl- precipitated	Complex Composition	Valence of the Metal	Primary Valence	Secondary Valence
$MnCl_3.4NH_3$	2				
$PtCl_2.2NH_3$	0				

(b) Show whether $Ni(CO)_5$ and $[Fe(CN)_4Br_2]^{3-}$ obey the 18-electrone rule. **[5 marks]**

(c) Consider the following complex: $[Cr(H_2O)_2(C_2O_4)_2]^-$

(i) Name the complex using the IUPAC norm. **[1 mark]**

(ii) Write down the metal oxidation state, electronic configuration and coordination number. **[3 marks]**

(iii) Draw possible structures of the complex showing the stereochemistry. **[4 marks]**

(iv) Calculate the spin only magnetic moment of the complex. **[2 marks]**

Question 6

(a) Outline the assumptions made in the Crystal Field Theory (CFT). **[6 marks]**

(b) Rationalize why $[Fe(OH_2)_6]^{2+}$ and $[Fe(CN)_6]^{4-}$ complexes, are paramagnetic and diamagnetic, respectively. **[4 marks]**

(c) Name and illustrate types of isomerism which may arise in each of the following cases.

(i) $[Zn(NH_3)_4][Cu(Cl_4]$ **[2 marks]**

(ii) $[Cr(OH)_3(NH_3)_3]^-$ **[2 marks]**

(iii) $[Fe(CN)_5(SCN)]^{4-}$ **[2 marks]**

(d) Draw the structure of the following compounds;

(i) Sodiumhexacyanoferrate(II) **[2 marks]**

(ii) Potassiumamminedicyanodioxoperoxochromate(VI) **[2 marks]**

Question 7

(a) Only one compound having the formula $[Zn(py)_2Cl_2]$ (where 'py' is pyridine) is known, but two different compounds (isomers) are known with composition $[Pt(py)_2Cl_2]$. Explain these observations and describe the structures of each of complexes. **[3 marks]**

(b)List three factors that affect the stability of coordination compounds. **[3 marks]**

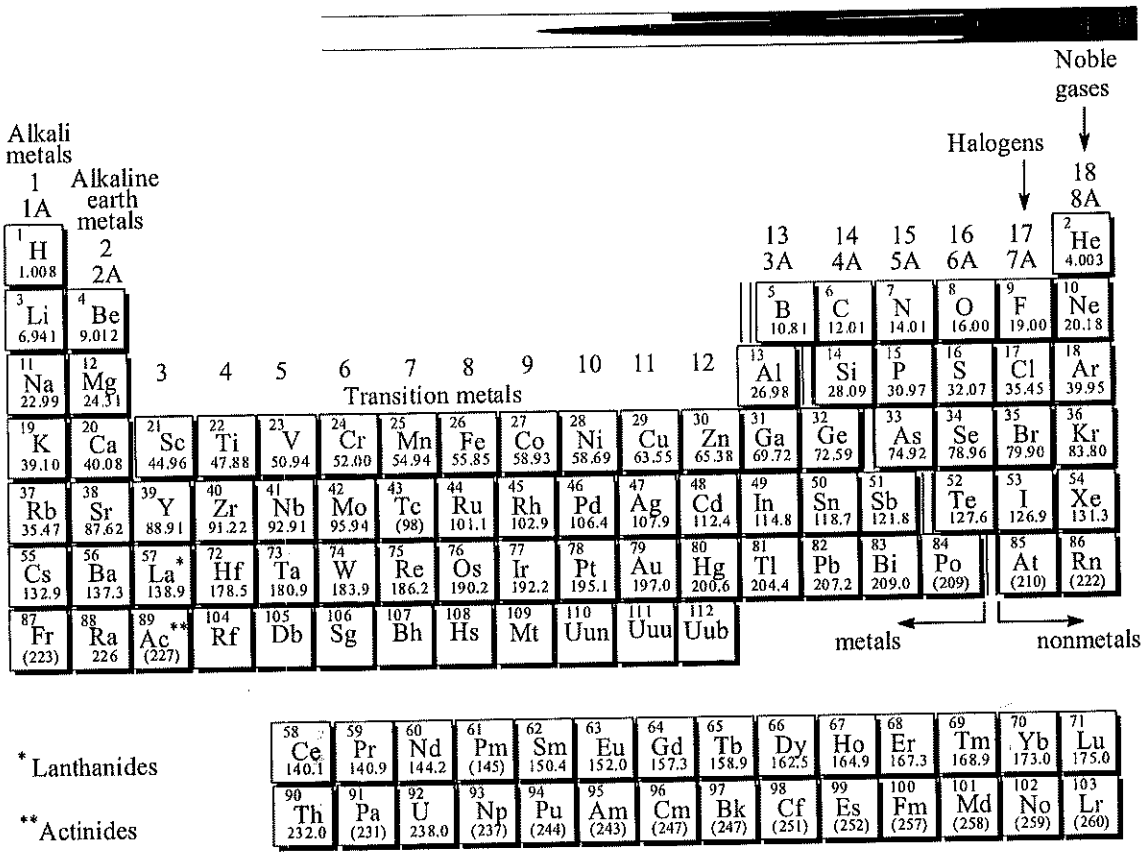
(c) Giving reasons explain which of the following complexes would undergo Jahn-Teller distortion. **[6 marks]**

(i) $[Fe(Cl_6]^{4-}$ (ii) $[MnCl_6]^{3-}$ (iii) $[CuCl_6]^{4-}$ (iv) $[CrCl_6]^{3-}$ (v) $[VCl_6]^{4-}$ (vi) $[Mn(CN)_6]^{4-}$

(d) Explain the key differences between Molecular Orbital (MO) and Valence Bond (VB) theory. **[6 marks]**

(e) Write chemical formulas of two complexes that can exhibit square planar geometry. **[2 marks]**

END OF EXAMINATION



* Lanthanides

** Actinides