

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

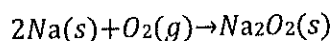
1. Answer **Question 1** and **Two** questions in **Section A** and **Two** from **Section B**.
2. Each question should start on a fresh page and marks will be allocated as indicated.
3. Each question carries **20 Marks**.

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]

**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
$\text{MnCl}_3 \cdot 4\text{NH}_3$	2				
$\text{PtCl}_2 \cdot 2\text{NH}_3$	0				

(b) Show whether $\text{Ni}(\text{CO})_5$ and $[\text{Fe}(\text{CN})_4\text{Br}_2]^{3-}$ obey the 18-electrone rule. [5 marks]

(c) Consider the following complex: $[\text{Cr}(\text{H}_2\text{O})_2(\text{C}_2\text{O}_4)_2]^-$

(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 $[\text{Fe}(\text{OH}_2)_6]^{2+}$ and $[\text{Fe}(\text{CN})_6]^{4-}$ 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) $[\text{Zn}(\text{NH}_3)_4][\text{Cu}(\text{Cl}_4)]$ [2 marks]

(ii) $[\text{Cr}(\text{OH})_3(\text{NH}_3)_3]^-$ [2 marks]

(iii) $[\text{Fe}(\text{CN})_5(\text{SCN})]^{4-}$ [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 $[\text{Zn}(\text{py})_2\text{Cl}_2]$ (where 'py' is pyridine) is known, but two different compounds (isomers) are known with composition $[\text{Pt}(\text{py})_2\text{Cl}_2]$. 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) $[\text{Fe}(\text{Cl}_6)]^{4-}$ (ii) $[\text{MnCl}_6]^{3-}$ (iii) $[\text{CuCl}_6]^{4-}$ (iv) $[\text{CrCl}_6]^{3-}$ (v) $[\text{VCl}_6]^{4-}$ (vi) $[\text{Mn}(\text{CN})_6]^{4-}$

(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

																		Noble gases ↓ 18 8A	
Alkali metals 1 1A		Alkaline earth metals 2 2A														Halogens ↓ 17 7A			
1 H 1.008																		2 He 4.003	
3 Li 6.941	4 Be 9.012													5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3	4	5	6	7	8	9	10	11	12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95		
Transition metals																			
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80		
37 Rb 35.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3		
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)		
87 Fr (223)	88 Ra 226	89 Ac (227)	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub								
												metals				nonmetals			

* Lanthanides

** Actinides

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)