CHT101-ME-01

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF CHEMISTRY

MAIN EXAMINATION PAPER

DEGREE PROGRAMME:	BSC HONS CHEMICAL TECHNOLOGY
COURSE:	INORGANIC CHEMISTRY I (CHT101)
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.

Question 1

(a) Briefly explain the following statements:

(i) Anions are bigger than the neutral parent atoms. [3 marks]

(ii) Cations are smaller than the neutral parent atoms. [3 marks]

(b) Name the following compounds

(i) $Na_4[Ni(CN)_6]$

(ii) $K_3[Co(CN)_5NO]$

(iii) $K_2[PtCl_5N]$

(iv) $K_2[Cr(CN)_2O_2(O_2)NH_3]$ [4 marks]

(c) Using the valence bond theory explain the bonding in $C=O$. [3 marks]

(d) Why does a Bonding Molecular Orbital have lower energy that the Atomic Orbitals from which it is constructed? [2 marks]

(e) Describe the factors that affect the stability of coordination compounds. [5 marks]

SECTION A: ANSWER ANY TWO QUESTIONS

Question 2

Consider H and He^+ in the ground state.

(a) Which of these two species will require more energy to remove the electron? Explain your answer. **[5 marks]**

(b) Calculate the energy required to excite the electron from an atom of H in the ground state. **[5 marks]**

(c) Calculate the energy required to excite the electron from a He^+ cation in the ground state. **[5 marks]**

(d) Explain why we cannot calculate the first ionization energy for He. **[5 marks]**

Question 3

(a) Describe Rutherford's experiment that showed atoms consisted of a concentrated positive charge with a high mass. Make sure you discuss the observations and the conclusions drawn. **[5 marks]**

(b) Draw and label a complete the valence molecular orbital energy level diagram for N_2.

[6 marks]

(c) From the MO diagram write the valence orbital occupancy (i.e. electron configuration) for N_2. **[2 marks]**

(d) Using the MO diagram briefly explain the effect of adding or removing electrons to N_2.

[2 marks]

(e) Compare and contrast the Molecular Orbital Theory (MOT) and Valence Bond Theory (VBT) in small molecules. **[5 marks]**

Question 4

(a) Explain how Heisenberg's uncertainty principle influences our understanding of the structure of an atom. **[5 marks]**

(b) Briefly define the terms diamagnetic and paramagnetic, and describe an experiment that would demonstrate whether a substance was diamagnetic or paramagnetic.

[5 marks]

(c) Briefly explain what is meant by the term "Pauli exclusion principle". How does the Pauli Exclusion Principle apply to electron configurations? **[5 marks]**

(d) Draw diagrams to show the shapes of the five d orbitals. **[5 marks]**

SECTION B: ANSWER ANY TWO QUESTIONS

Question 5

Give a detailed account of the five factors that affect the crystal field splitting in coordination compounds. **[20 marks]**

Question 6

Describe the Molecular Orbital Theory (MOT) and the Valence Bond Theory (VBT) in coordination compounds. **[20 marks]**

Question 7

(a) Draw figure to show the splitting of d orbitals in square planar complex. **[4 marks]**

(b) Calculate the Spin only for a d^8 metal ion in octahedral, square and tetrahedral complex. **[8 marks]**

(c) Explain the following terms.

(i) Primary valence

(ii) Secondary valence,

(iii) High-Low spin **[3x 2 marks]**

(d) Distinguish between homoleptic and heteroleptic complexes. **[2 marks]**

END OF EXAMINATION

PERIODIC TABLE OF ELEMENTS

Transition metals

Alkali metals 1 1A	Alkaline earth metals 2 2A	3	4	5	6	7	8	9	10	11	12	13 3A	14 4A	15 5A	16 6A	Halogens 17 7A	Noble gases 18 8A
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											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
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	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
** Actinides	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)

Constant	Symbol	Computational Value
Avogadro's constant	N_A	6.022×10^{23} mol^{-1}
Planck's constant	h	6.63×10^{-34}J.s
	$\hbar$	1.603×10^{-34} J.s
Rydberg constant	R	2.18×10^{-18} J
Universal Gas constant	R	0.08206 L.atm/K.mol OR 8.314 J/K.mol
Specific Heat Capacity (Water)	s	4.184 J/g.°C
Speed of light in vacuum	c	3.00×10^{8} m/s
Faraday's Constant	F	9.648×10^{4} C/mol
Electron charge	e	1.602×10^{-19} C