BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF CHEMISTRY

MAIN EXAMINATION PAPER

DEGREE PROGRAMME: BSC HONS CHEMICAL TECHNOLOGY/BscED

COURSE: INORGANIC CHEMISTRY I (CHT101)

DURATION: 2 HOURS

AUG 2024

INSTRUCTIONS TO CANDIDATES

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

Question 1

(a) (i) Briefly explain three properties of metalloids. [3 marks]

(ii) Explain why electron affinity generally becomes more negative on moving from left to right along a period. [3 marks]

(b) Write the formular of the following compounds:

(i) Sodiumhexacyanoferrate(II)

(ii) Potassium pentacyanonitrosylferrate(II)

(iii) potassium pentachloronitridoPalladate(II)

(iv) potassium ammine dicyanodioxoperoxochromate (VI)

[4 marks]

(c) Using the valence bond theory, explain the bonding in C_2H_4. [3 marks]

(d) Explain the difference between a double salt and a coordination complex. [2 marks]

(e) Calculate the Spin only for a d^8 metal ion in octahedral, square, and tetrahedral complex. [5 marks]

SECTION A: ANSWER ANY TWO QUESTIONS

Question 2

(a) Consider H and He^+ in the ground state.

(i) Which of these two species will require more energy to remove the electron. [1 mark]

(ii) Explain your answer in part (i) [4 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.

(d) Did your calculations in parts (b) and (c) support your answer to part (a) [2 marks]

(e) Explain why we cannot calculate the first ionization energy for He. [4 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 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 influence 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 is 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? [4 marks]

(d) Draw diagrams to show the shapes of the five d orbitals. [6 marks]

SECTION B: ANSWER ANY TWO QUESTIONS

Question 5

Explain in detail five factors that affect the crystal field splitting in coordination compounds. [20 marks]

Question 6

Give a detailed account 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 a square planar complex. [4 marks]

(b) Account for the differences in the magnitudes of the crystal field splitting parameters Δo and Δt and list the conditions under which tetrahedral complexes are likely to be formed in preference of octahedral complexes. [8 marks]

(c) Explain the following terms.

(i) Primary valence

(ii) Secondary valence

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

(d) Give one example of a homoleptic and heteroleptic complex. [2 marks]

END OF EXAMINATION

PERIODIC TABLE OF ELEMENTS

Alkali metals | Alkaline earth metals | Transition metals | Halogens | Noble gases

1 1A	2 2A	3	4	5	6	7	8	9	10	11	12	13 3A	14 4A	15 5A	16 6A	17 7A	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	$6.022\text{x}10^{23}$ mol^{-1}
Planck's constant	h	$6.63\text{x}10^{-34}$J.s
	$\hbar$	$1.603\text{x}10^{-34}$ J.s
Rydberg constant	R	$2.18\text{x}10^{-18}$ 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	$3.00\text{x}10^{8}$ m/s
Faraday's Constant	F	$9.648\text{x}10^{4}$ C/mol
Electron charge	e	$1.602\text{x}10^{-19}$ C