JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION (SCIENCES)

3rd YEAR 1ST SEMESTER 2022/2023 ACADEMIC YEAR

MAIN REGULAR

COURSE CODE: SPB 9308

COURSE TITLE: Co-ordination Chemistry

EXAM VENUE: **STREAM: (BEd. Science)**

DATE:

TIME: **EXAM SESSION:**

INSTRUCTIONS:

1. **Answer question 1 (Compulsory) in section A and ANY other 2 questions in Section B.**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**
4. **Some important information/formulas are found on the last page of this question paper**

SECTION A

Question 1

a) Provide Chemical formulae for the following coordinated compounds

i. Pentachlorotitanate(IV) ion (1 marks)

ii. Hexachlorovanadate(IV) ion (1 marks)

iii. Bromopentacarbonylmanganese(I) (1 marks)

iv. Pentaaquahydroxoiron(III) sulfate(VI) (1 marks)

v. Hexaamminevanadium(III) ion (1 marks)

a) Discuss in brief the behavior of the following properties of transition elements across the first period (3-*d* elements)

i. Boiling and melting points (3 marks)

ii. Density (3 marks)

iii. Electronegativity (3 marks)

iv. Ionic radius (3 marks)

b) Give the electronic configuration for Sc, Cr, Mn, and Zn. Use this information to explain why compounds of Sc and Zn are not colored (5 marks)

c) Use the electron box and arrow configurations in combination with Pauli exclusion principle and Hund's rule to demonstrate the electronic configuration of V^{+}, V^{2+}, V^{3+}, V^{4+}, and V^{5+}. (2 marks)

d) Draw the geometrical structures of $[Cu(Cl)_4]^{2-}$ and $[Cu(NH_3)_4]^{2+}$ Complex ions. (4 marks)

e) Determine the oxidation number and coordination number of $[Ag(NH_3)_2]^{+}$ and $[NiCl_2(NH_3)_2]$ complex ions (2 marks)

Section B. Answer any <u>TWO</u> questions

Question 2

f) Briefly describe the differences between (6 marks)

i. Monodentate and bidentate ligands

ii. Anionic and neutral ligands

iii. Neutral complexes, complex cations and complex anions

b) Transition metals form-colored compounds and complexes. These colors can vary depending on the charge on the metal ion and the number and type of groups of atoms (ligands) attached to the metal ion. In aqueous solutions, the ions form complexes with different colors. Give an explanation for the coloration. (4 marks)

c) Briefly describe bonding in H_2 and HF using molecular orbital theory. (10 marks)

Question 3

a) Discuss in brief the limitations of the valency Bond Theory (5 marks)

b) Using diagrams, illustrate the valence bond models for the following complex ions.

i. Octahedral Complex e.g. $[Cr(NH_3)_6]^{3+}$ (5 marks)

ii. Tetrahedral *e.g.* $[Zn(OH)_4]^{2-}$ (5 marks)

iii. Square Planar *e.g.* $[Ni(CN)_4]^{2-}$ (5 marks)

Question 4

a) In a tetrahedral crystal field, the 5 degenerate d orbitals are split into $3t_{2g}$ and 2_{eg} atomic orbitals. The two sets of degenerate orbitals are separated by an energy Δ_0. Illustrate this energy and describe factors that affect its size. (10 marks)

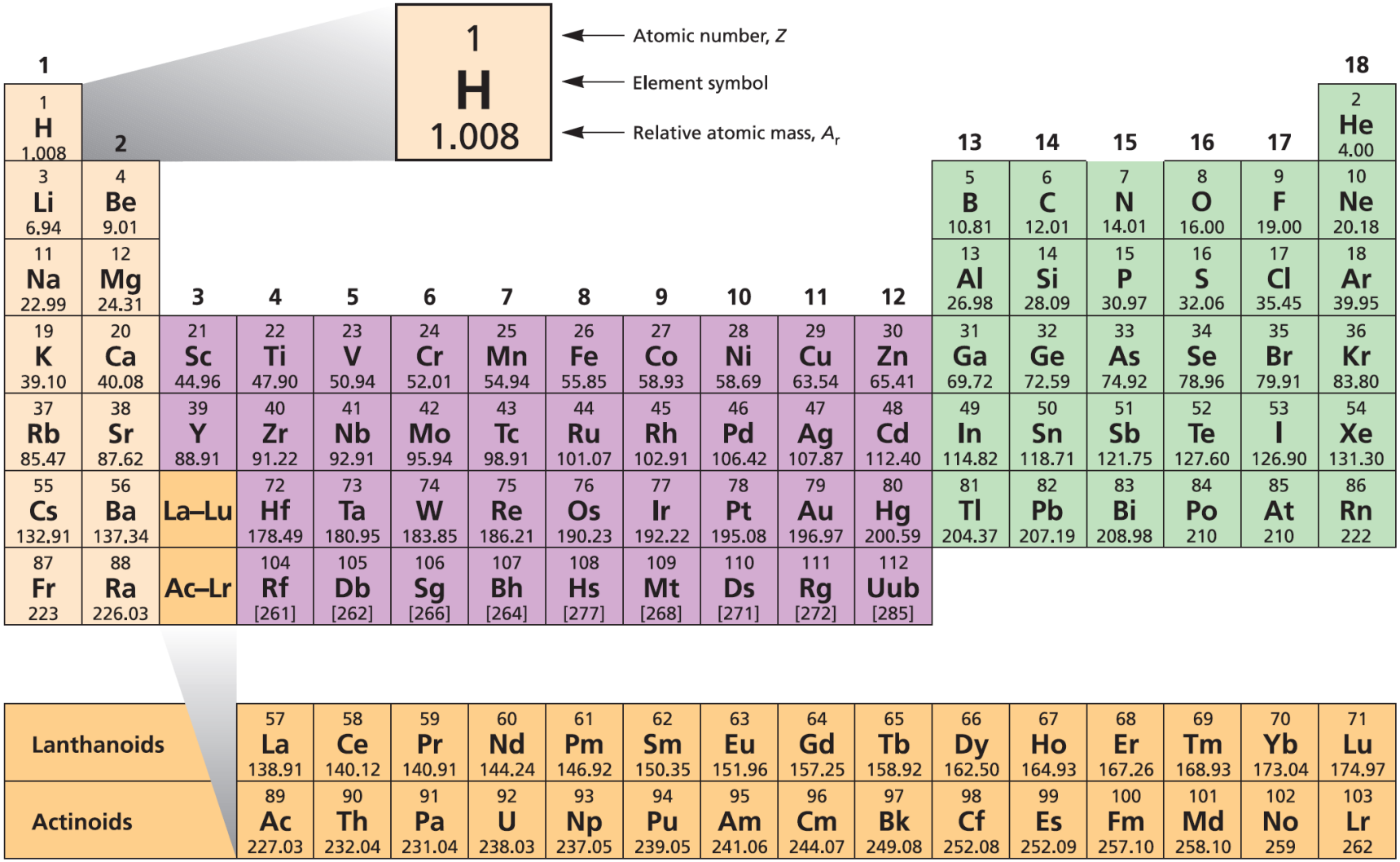
g) Ligand field theory (LFT) describes the bonding, orbital arrangement, and other characteristics of coordination complexes. It represents an application of molecular orbital theory to transition metal complexes. Briefly describe this theory. Use of diagrams is most preferred. (10 marks

Question 5

a) Briefly describe the Crystal Field Splitting Energy (CFSE) for the complex ion $[Fe(CN)_6]^{3-}$. (10 marks)

b) Given that the CFSE of $[Co(H_2O)_6]^{2+}$ is -0.8 Δ_{oct}, illustrate its spin state. (10 marks)

Periodic table



Geometry

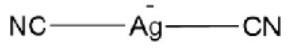
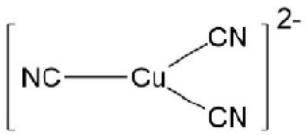
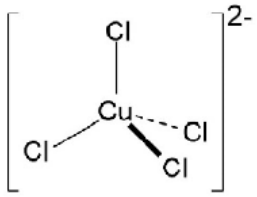
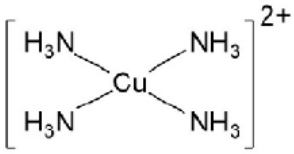
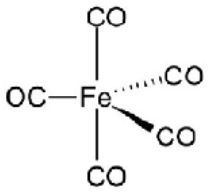
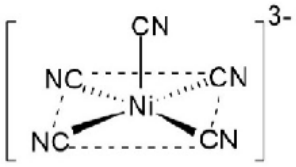
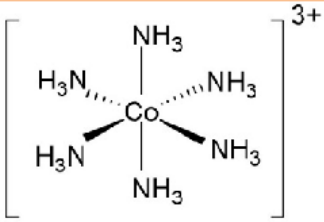
C.N.	Geometry (formula)		Example
2	Linear	$[ML_2]$	
3	Trigonal planar	$[ML_3]$	
4	Tetrahedral	$[ML_4]$	
4	Square planar	$[ML_4]$	
5	Trigonal bipyramidal	$[ML_5]$	
5	Square pyramidal	$[ML_5]$	
6	Octahedral	$[ML_6]$	

Table1: Variation of geometry with the coordination number of the metal