CHUKA  **UNIVERSITY**

UNIVERSITY EXAMINATIONS

RESIT/SPECIAL EXAMINATION

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE

CHEM 313: COORDINATION CHEMISTRY

STREAMS: BSC **TIME: 2 HOURS**

DAY/DATE: FRIDAY 05/11/2021 **8.30 A.M – 10.30 A.M.**

INSTRUCTIONS:

- Answer question **One** (Compulsory) and any other **Two** questions.

QUESTION ONE [30 MARKS]

(a) Write the IUPAC names of the following coordination compounds **(6 marks)**

(i) $[Fe(CN)_6]^{3-}$ (ii) $[Cr(H_2O)_3(NH_3)_3]Cl_3$ (iii) $K_3[Fe(C_2O_4)_3]$

(iv) $[Co(NH_3)_3(NO_2)_3]$ (v) $[Pt(NH_3)_4Cl_2][PtCl_4]$ (vi) $[Co(H_2O)_3(CH_3NH_2)_3]^{3+}$

(b) Draw the structures of all the isomers of each of the following species and state the type(s) of isomerism exhibited by each species **(6 marks)**

(i) $[Co(NH_3)_4Cl_2]^+$ (ii) $[Co(NH_3)_3Cl_3]$

(iii) $[Co(NH_3)_5NO_2]^{2+}$ (iv) $[Cr(NH_3)_5Cl]NO_2$

(c) Describe bonding in the $[Mn(H_2O)_6]^{3+}$ ion using the valence bond theory **(3 marks)**

(d) State three limitations of the valence bond theory **(3 marks)**

(e) Calculate the spin only magnetic moment of each of the following species **(6 marks)**

(i) $[Cr(NH_3)_6]Br_3$ (ii) $[CoCl_4]^{2-}$ (iii) $[Ni(CN)_4]^{2-}$ (iv) $[Fe(CN)_6]^{3-}$

(f) Discuss, with the aid of relevant diagrams and calculations, the Jahn-Teller effect in $[CuCl_6]^{4-}$ complex **(6 marks)**

QUESTION TWO [20 MARKS]

(a) State the assumptions and the limitations of the valence bond theory **(4 Marks)**

(b) Discuss bonding in the $[Co(NH_3)_6]^{3+}$ complex using the valence bond theory **(6 Marks)**

(c) Discuss the factors that influence the magnitude of the ligand field splitting parameter, Δ,

(6 Marks)

(d) Sketch the energy-level splitting diagram for the d-orbitals in a square planar field. Hence or otherwise, explain why d^8 complexes assume the square planar geometry **(4 Marks)**

QUESTION THREE [20 MARKS]

(a) Construct a well-labeled σ-only molecular orbital diagram for a ML_6 octahedral complex

(6 Marks)

(b) With an aid of relevant diagrams, explain the effects of π-bonding on Δ_o and explain the arrangement of ligands in the spectrochemical series **(6 Marks)**

(c) State Hund's rules for ordering terms **(2 Marks)**

(d) Arrange the following in order of increasing energy and identify the ground term from each set of terms: **(3 Marks)**

(i) ^1P, ^3P, ^3F, ^1G (ii) ^3P, ^5D, ^3H, ^1I, ^1G (iii) ^6S, ^4P, ^4G, ^2I

(e) Construct an Orgel diagram for a d^8 configuration and write the possible electronic transitions **(3 Marks)**

QUESTION FOUR [20 MARKS]

(a) Calculate the ligand field stabilization energy (LFSE) of each of the following complexes

(6 marks)

(i) $[Mn(H_2O)_6]^{2+}$ (ii) $[RuCl_6]^{2-}$

(iii) $[Mn(CN)_6]^{3-}$ (iv) $[CoI_4]^{2-}$

(b) The complex $[VF_6]^{3-}$ has two absorption bands at 14,800 and 23,250 cm^{-1} and a third band in the ultraviolet. Calculate Δ_o and B for this complex **(8 marks)**

(c) Construct a well labelled molecular orbital for the square planar $[Ni(CN)_4]^{2-}$ complex and populate it with electrons **(6 marks)**
