CHUKA UNIVERSITY

UNIVERSITY EXAMINATIONS

THIRD YEAR EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE IN FOOD SCIENCE AND TECHNOLOGY AND HUMAN NUTRITION & DIETETICS

CHEM 313: COORDIATION CHEMISTRY

STREAMS: BSc (CHEM), BSc (IND CHEM), BED (SCI) **TIME: 2 HOURS**

DAY/DATE: FRIDAY 09/7/2021 **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) Discuss the factors that influence the ligand field splitting parameter, Δ_o, **(6 marks)**

(b) 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) $[CoI_4]^{2-}$

(c) Draw a well labelled molecular orbital diagram for the Fe $(H_2O)_6]^{2+}$ and populate it with electrons **(6 marks)**

(d) Use a suitable molecular orbital diagram to explain the effect of a π-acceptor ligand on the ligand field splitting parameter, Δ_o **(2 marks)**

QUESTION THREE [20 MARKS]

(a) A compound consists of Pd, Cl and NH_3 in the ratio of 1:4:4.

(i) When $AgNO_3$ is added to an aqueous solution of the compound, 2 moles of Cl^- per mole of Pd are precipitated as AgCl. Write the formula of the compound **(2 marks)**

(ii) Draw all the unique isomers of the compound **(2 marks)**

(b) Determine the ground state term symbols of the following complexes **(6 marks)**

(i) $[Fe(CN)_6]^{3-}$ (ii) $[Ni(H_2O)_6]^{2+}$ (iii) $[Cr(NH_3)_6]^{3+}$

(c) Order the energies of the following d^2 terms and identify the ground state term (^1D, ^3F, ^1G, ^3P and ^1S **(2 marks)**

(d) Construct a well labelled Orgel diagram for $[V(H_2O)_6]^{3+}$ complex **(4 marks)**

(e) The electronic spectrum of an aqueous solution of $[V(H_2O)_6]^{3+}$ exhibits absorption bands at λ_{max} = 17000, 25000 and 38000 cm^{-1}. Assign the electronic transitions **(3 marks)**

(f) Explain why a solution of the $[Mn(H_2O)_6]^{2+}$ complex has very light pink color **(1 mark)**

QUESTION FOUR [20 MARKS]

(a) The most intense absorption band in the visible spectrum of $[Mn(H_2O)_6]^{2+}$ is at 24,900 cm^{-1} and has a molar absorptivity of 0.038 $Lmol^{-1}cm^{-1}$. Calculate the concentration of $[Mn(H_2O)_6]^{2+}$ that is required to give an absorbance of 0.10 in a cell of path length 1.00 cm **(2 marks)**

(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 (**8 marks**)

(d) Explain the following observation: an aqueous solution of $KMnO_4$ is intense purple (**2 marks**)
