



KENYATTA UNIVERSITY
UNIVERSITY EXAMINATIONS 2010/2011
INSTITUTIONAL BASED PROGRAMME (IBP) – AUGUST SESSION
EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE AND
BACHELOR OF EDUCATION (SCIENCE)

SCH 301: COORDINATION AND ORGANOMETALLIC CHEMISTRY

DATE: Tuesday, 3rd January, 2012

TIME: 11.00 a.m. – 1.00 p.m.

INSTRUCTIONS:

Answer all questions
Periodic table is attached

- 1) Briefly explain the following terms as used in coordination chemistry.
 - a. Coordination number
 - b. Strong field ligand
 - c. Lewis acid
 - d. Low spin complex

(10 marks)

- 2) Consider the complexes $[\text{Fe}(\text{CN})_6]^{3-}$ and $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$.
 - a. Name the two complexes
 - b. Predict their molecular geometries
 - c. Use Valence Bond theory to discuss the bonding and orbital hybridization in each of them.
 - d. Would you expect them to show the same or different colours? Give your reasoning.

(12 marks)

- 3) Explain the following observations.
 - a. The complex ion $\text{Fe}(\text{CN})_6^{3-}$ is paramagnetic and has **one** unpaired electron. The complex ion $\text{Fe}(\text{SCN})_6^{3-}$ is also paramagnetic but has **five** unpaired electrons. Briefly explain why the $\text{Fe}(\text{SCN})_6^{3-}$ complex ion has so many more unpaired electrons compared to the $\text{Fe}(\text{CN})_6^{3-}$ complex ion. Hint: a picture is worth a thousand words (although you should use some words to explain the picture)!
 - b. $[\text{NiCl}_4]^{2-}$ is tetrahedral while $[\text{PtCl}_4]^{2-}$ is square planar.

- c. Coordination compounds containing Cu^{2+} are colored but those containing Cu^+ are not?
(10 marks)
- 4) "Cobalt Yellow" is a pigment used in oil paints, and contains the coordination compound $\text{K}_3[\text{Co}(\text{NO}_2)_6]$. Note that NO_2^- is a strong-field ligand.
- Write the IUPAC name for "Cobalt Yellow"
 - What is the coordination number of cobalt atom in the compound
 - How many unpaired electrons are there on the cobalt atom in this compound?
 - What is the electron count around cobalt atom in this compound?
(10 marks)
- 5) Consider an octahedral complex ML_6 from which we withdraw two *trans* ligands. Let the ligands to be withdrawn be from the Z axis.
- With the help of a well-labeled diagram discuss how the energies of the d-orbitals change as soon as the distance between the two *trans* ligands and the central metal atom/ion becomes greater than the distance between the remaining four ligands and the central metal ion/atom.
 - Discuss what happens to the energies of the d-orbitals when the two ligands are finally fully withdrawn.
 - Would you expect the changes in energy of the d orbitals to be different if only one ligand was fully withdrawn instead of two? Explain your answer.
(10 marks)
- 6) Sketch and name all possible geometric isomers of the following coordination metal complexes.
- $[\text{PtCl}_2(\text{NH}_3)_2]$
 - $[\text{Cr}(\text{en})_2\text{Cl}_2]\text{Cl}$
 - $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$
(12 marks)
- 7) Name any two naturally occurring coordination compounds and one synthetic coordination compound that have biological or commercial importance.
(6 marks)

