

**NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY**  
**DEPARTMENT OF APPLIED CHEMISTRY**  
**END OF SECOND SEMESTER EXAMINATIONS – MAY 2011**  
**INORGANIC CHEMISTRY II – SCH 1201**  
**TIME: (3) THREE HOURS**

**INSTRUCTIONS TO CANDIDATES**

**MATERIAL**  
Periodic Table

**INSTRUCTIONS TO STUDENTS**

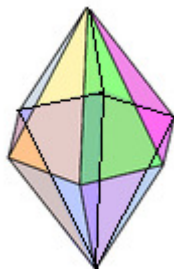
Answer All questions in section A and All questions in Section B.

Answer each question on a FRESH page.

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**SECTION A** Answer ALL questions. Each question carries 10 marks

- 1 .(a) In naming coordination compounds prefixes such as *fac-* and *mer-* are used. In what circumstances are these prefixes used? Use a simple general formula to illustrate your answer. [4 marks]
- (b) Draw the structure of the following complex:  
Di- $\mu$ -chlorobis(diaquaplatinum(II)) Sulphate [2 marks]
- (c) Name the following geometry, and state the principal coordination number(s) that produce this geometric arrangement.



[4 marks]

- 2 .(a) What two properties are generally important in a solvent for electrochemical reactions. [2 marks]
- (b) Boric acid,  $B(OH)_3$ , acts as an acid in water, but does not do so via ionization of a proton. Rather, it serves as a Lewis acid towards  $OH^-$ . Explain with the use of a balanced equation [2 marks].
- (c) Briefly discuss Bronsted-Lowry definition and show how it is included as a special case in the solvent system definition [4 marks]

- (d) Distinguish between solvolysis and solubility. [2 marks]
3. (a) What is an icosahedron? For which element is it the most characteristic structural feature? [2 marks]
- (b) Germanium and Lead are elements in the same group (IVA). Both elements react with halides to form  $\text{MX}_2$  molecule. Write the general formula of the other possible halide products. For a chosen halide, compare the stabilities of the  $\text{MX}_2$  molecules of the two elements [4 marks]
- (c) Sulphur forms both discrete polyatomic molecules and extended structures.  
(i) Name the most thermodynamically stable polyatomic molecule of sulphur  
(ii) What is the general name for the  $\text{S}_n$  chains? [4 marks]
4. (a) Why are tetrahedral complexes usually not low spin? [2 marks]
- (b) What is a strong field ligand? Give one example [2 marks]
- (c) One advantage of the ligand field theory is that it can be extended to include  $\pi$ -bonding. Which kind of  $\pi$ -bonding increases the magnitude of the LFSE? Explain. [4 marks]
- (d) What is an acceptor  $\pi$ -ligand? Give two examples [2 marks]

## **SECTION B**

*Answer ALL questions from this section.*

**Question number five (5) must be answered on the tear-off sheet which must be detached from the question paper and attached to the answer book.**

5. The diagram on the tear-off sheet shows the d-orbital splitting in various geometries of complex compounds.
- (a) In each section of the diagram from (a) to (f) identify and label the d-orbitals in their energy levels [8 marks]
- (b) In each section of the diagram from (a) to (f) state the geometry (or geometries) that coincides with the pattern of d-orbital splitting. [8 marks]
- (c) The symbols *e*, *t*, and *a* are symmetry labels defined in the group theory of orbitals. State what each symbol signifies. [4 marks]

6. (a) Substitution reactions of Octahedral complexes. There are four main mechanisms that have been established for these reactions. Name these four mechanisms and use the substitution of ligand X by ligand Y in the  $ML_5X$  complex to illustrate each. [8 marks]
- (b) Name the following complex compounds and ions:  
(i)  $[Co(NH_3)_5Cl]Cl_2$   
(ii)  $[Co(NH_3)(NO_2)Cl]Cl$   
(iii)  $[Co(NH_3)(ONO)Cl]Cl$   
(iv)  $(NH_4)_2[Ni(C_2O_4)_2(H_2O)_2]$  [6 marks]
- (c) There are two well established mechanisms for electron transfer reactions in complex compounds. Name these mechanisms and briefly discuss them. Use reaction equations to illustrate your answers. [6 marks]
7. (a) Name an important industrial process that employs a molten salt as a solvent [2 marks]
- (b)  $HBr$ ,  $HClO_4$ , and  $HI$  are relatively strong Bronsted acids. For these acids to be distinguished according to acid strength they have to be studied in solvents such as sulphuric acid. What is a Bronsted acid? Write the Bronsted equilibrium for the solvent sulphuric acid indicating the strongest acid and strongest base that can exist in it. [6 marks]
- (c) How is the solvent *Aqua Regia* prepared? Which two molecules in mixture give the solvent a high oxidizing power? Give one example of the application of the solvent. [6 marks]
- (d) Separate the following solvents into protic and non-protic groups. For the protic group, write the possible Bronsted and Lowry pairs.  
 $NH_3$ ,  $HCl$ ,  $BrF_3$ ,  $IF_5$ ,  $Cl_3PO$ ,  $AsCl_3$ ,  $CH_3CONH_2$ . [6 marks]

***END OF QUESTION PAPER!!!***

P.T.O

Tear off this page and attach it to your answer sheet.

Candidate's Registration No:.....

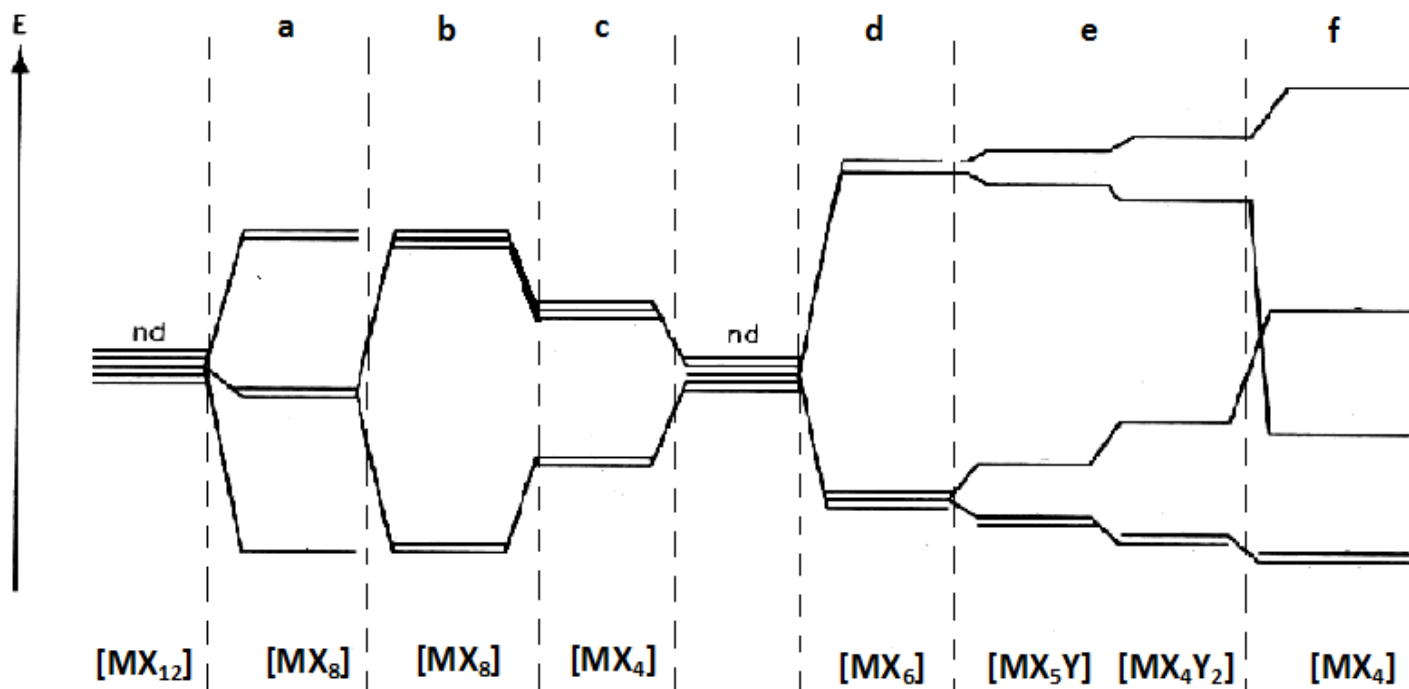


Fig: Splitting of d-orbital energy levels in ligand fields of different symmetries.

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