

**Ollscoil na hÉireann, Gaillimh**  
**National University of Ireland, Galway**

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**AUTUMN 2002**

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**THIRD UNIVERSITY B.Sc. EXAMINATION IN SCIENCE**  
**(INCLUDING DENOMINATED DEGREES)**

**Inorganic Chemistry (CH307)**

Professor J. Evans  
Professor R.N. Butler  
Professor P. McArdle  
Professor. D. Cunningham  
Professor. M.J. Hynes  
Dr. T. Higgins

Time Allowed: Two Hours

**Answer Question 1 and Three Other questions**

**All questions carry equal marks. Leave the first page of the Answer Book blank and list on it clearly the numbers of the questions attempted.**

1. See accompanying sheet for multiple choice question.
2. Describe in detail two mechanisms by which electron transfer occurs in transition metal complexes. Give examples of each and clearly describe how they may be distinguished. Refer to the role of ligand substitution in making this choice.  
**[25 marks].**

**.....more on the next page**

3. Answer (a) and (b)

- (a) Describe a bonding scheme suitable for the bond between M and CO in  $M(CO)_n$  [10 marks]
- (b) Give valence electron counts for the following systems and indicate those which are likely to be stable and those which are not;  $(\eta^5-C_5H_5)Mn(CO)_2$ ,  $(\eta^5-C_5H_5)V(CO)_4$ ,  $Fe(CO)_3(PPh_3)Br_2$ ,  $(\eta^2\text{-butene})Mo(CO)_3Br$  and  $(\eta^3\text{-allyl})(\eta^5-C_5H_5)Mo(CO)_2$ . [15 marks]

4. Define the term oxidative addition and give some examples of an important applications in which the oxidative addition reaction is involved. Describe some of the mechanisms which have been suggested for oxidative addition reactions. [25 marks]

5. Describe the TASSO method and apply it to the bonding in ferrocene. [25 marks]

6. Answer each of the following.

- (a) Describe the crystal field splitting patterns for coordination compounds which exhibit the following geometries;
- (i) octahedral,
  - (ii) tetrahedral,
  - (iii) tetragonally distorted octahedral,
  - (iv) squareplanar. [8 marks]
- (b) Using crystal field theory explain the observations;
- (i) Many Ni(II) complexes are square planar.
  - (ii) Cu(II) complexes are tetragonally distorted.
  - (iii) Complexes of Pd(II) are usually square planar. [9 marks]
- (c) Explain the following observations;
- (i) There are more tetrahedral complexes for Co(II) than for other transition metal ions
  - (ii) Chromium (III) complexes, with a few exceptions, are all hexacordinate. [8 marks]

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**7. Answer (a), (b) (c) and (d).**

**(a)** For the coordination cation,  $[\text{Co}(\text{NH}_3)_6]^{3+}$ ;

**(i)** Draw a molecular orbital bonding scheme.

**[3 marks]**

**(ii)** Label energy levels with appropriate symmetry symbols and as bonding, antibonding or non bonding.

**[4 marks]**

**(iii)** Show the 10Dq energy transition

**[3 marks]**

**(iv)** Show all valence electrons

**[3 marks]**

**(b)** Explain the terms,  $\delta$ -donor ligand,  $\pi$ -acceptor ligand and  $\pi$ -donor ligand

**[3 marks]**

**(c)** Show how donor/acceptor behaviour relates to the position ligands in the spectrochemical series

**[3 marks]**

**(d)** Describe how the molecular orbital diagrams for  $\delta$  donor,  $\pi$  acceptor and  $\pi$  donor ligand differ

**[6 marks]**

**8. Answer (a), (b) (c) and (d).**

**(a)** Describe the key features of protein structure.

**[6 marks]**

**(b)** Show how metal ions interact with proteins.

**[6 marks]**

**(c)** Give an example of a metalloprotein exhibiting each of the following functions.

**(i)** Catalysis

**[2 marks]**

**(ii)** Switching

**[2 marks]**

**(iii)** Redox chemistry

**[2 marks]**

**(d)** Describe the key structural features for each example in (c).

**[7 marks]**