[This question paper contains 2 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7935 **L**

Unique Paper Code : 2173550008

Name of the Paper : DSE: Transition Metal Cluster – Introduction and Applications

Name of the Course : **B.Sc. (Hons.) Chemistry**

Semester : VIII

Duration : 2 Hours Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **four** questions.
3. **All** questions carry equal marks.

1. (a) Determine x assuming 18-electron rule is obeyed:
   (i) $[\eta_5 - (C_5H_5)\ W\ (CO)_x]_2$
   (ii) $[\eta_5 - (C_5H_5)\ Mn(CO)_x]_2$
   (iii) $[Co(CO)_3]^x$

   (b) Name and explain with examples, the three types of bonding present in metal clusters.

   (c) Write the points of differences between metal – ligand complex and heteronuclear cluster. (6,6,3)

2. (a) Draw the structures of the following transition metal clusters :
   (i) $[Fe_4(CO)_{12}\ (\mu_3 - CO)]^{2-}$
   (ii) $Re_4H_4(CO)_{12}$
   (iii) $Os_3H_2(CO)_{10}$

   (b) Explain the bonding in eclipsed and staggered forms of $[Re_2Cl_8]^{2-}$ cluster ion.

   (c) What are low nuclearity metal clusters? Give the characteristics of metal and ligands, which form such clusters, conveniently. (6,6,3)

3. (a) Calculate the total number of M – M bonds and number M – M bonds per metal in the following transition metal clusters :

P.T.O.

(i) $Fe_3(CO)_{12}$
(ii) $Ru_4(CO)_{12}$
(iii) $Co_2(CO)_8$

(b) What is the meaning of σ- and μ-complexes of metal-borane and metalcarborane?

(c) How is the ability to bridge CO ligands varies down the group for transition metals? Explain giving examples? (6,6,3)

4. (a) Determine the structure of the following Transition Metal Clusters using Wade's Rule :
(i) $Co_6(CO)_{16}$
(ii) $Os_5C(CO)_{15}$
(iii) $Ru_6C(CO)_{17}$

(b) Write the steps involved in hydrogenation of alkenes using $[HIr4(CO)_{11}]$ as catalyst.

(c) Complete the following reactions :

(i) $2\,Fe(CO)_5 \xrightarrow{h\vartheta}$ _____ + _____

(ii) $Ru_3(CO)_{12} + [Fe(CO)_4]^- \rightarrow$ _____ + _____ (6,5,4)

5. (a) Give example/s of boranes or carboranes [p-block clusters], which are analogous to :
(i) $CpFe(CO)_2$
(ii) $Mn(CO)_4$
(iii) $Ni(CO)_2$

(b) Give an example each of tetranuclear tungsten cluster and hexanuclear molybdenum cluster. Draw their structures also.

(c) State whether $Co_6(CO)_{15}$, $[Fe_6(CO)_{18}]^{2-}$ and $[B_6H_6]^{2-}$ isolobal in nature. Explain. (6,6,3)

6. Write short notes on **any three** of the following :
(a) Chevrel Clusters
(b) Zintl Clusters
(c) Water gas shift reaction
(d) Molecular Orbital Diagram of CO (5,5,5)