**PG Odd Semester (CBCS) Exam., December—2016**

## CHEMISTRY

**( 1st Semester )**

Course No. : CHMCC–101

**( Inorganic Chemistry—I )**

*Full Marks* : 70

*Pass Marks* : 28

*Time* : 3 hours

*The figures in the margin indicate full marks
for the questions*

Answer **five** questions, taking **one** from each Unit

UNIT—I

1. *(a)* Furnish point group symmetry labels for the following species. Explain, giving suitable illustrations :     2×3=6

   *(i)* $[Co(en)_3]$    (en = ethylenediamine)

   *(ii)* $POBrCl_2$

   *(iii)* $BrF_5$

**( 2 )**

*(b)* Sketch $BF_3$ with the fluorines labelled as $F_1$, $F_2$ and $F_3$ and show (figuratively) :    4

$$S_3^4 \quad C_3^1$$
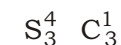
*(c)* Answer the following giving a rationale :     2×2=4

   *(i)* Is the skew form of $H_2O_2$ is chiral?

   *(ii)* Ferrocene has pentagonal anti-prism geometry. Is it polar?

2. *(a)* Show how symmetry elements are lost in going from $BF_3$ to $BClF_2$ and BClBrF.    6

*(b)* Give examples of the molecules that possess :    4

   *(i)* Only $i$

   *(ii)* $C_3$ and $_h$

   *(iii)* Only

   *(iv)* $D_3$ point group

*(c)* Taking appropriate matrix represen-tations, show that $C_2$ $_v$ $_v$ for $H_2O$ molecule.    4

( 3 )

UNIT—II

**3.** *(a)* Predict the shapes of the following species and describe the type of hybrid orbitals on the central atom :    $1\frac{1}{2}\times4=6$

   *(i)* $SbF_6$

   *(ii)* $NO_2$

   *(iii)* $XeOCl_2$

   *(iv)* $ICl_4$

*(b)* Based on LCAO-MO approximation discuss the metallic band in lithium. Draw the density of states (DOS) profile of the metallic band.    4

*(c)* Construct the MO energy level diagram of $BeF_2(g)$ using Walsh diagram. Predict the shape and explain.    4

**4.** *(a)* Construct the MO energy level diagram of $NH_3$ molecule and discuss on which atom bonding and anti-bonding orbitals are concentrated.    3+1=4

*(b)* What is absolute hardness? Illustrate the trend for halogens $(X_2, X$   F, Cl, Br and I$)$.    1+3=4

( 4 )

*(c)* Write brief notes on the following :    3+2=5

   *(i)* Jahn-Teller distortion

   *(ii)* Bent's rule

*(d)* Show a band diagram for '*n*-type' semiconductor and explain.    1

UNIT—III

**5.** *(a)* Using Wade's electron counting rules, calculate the number of skeletal electrons of $B_5C_2H_7$ and nomenclate the geometry of the cluster.    2

*(b)* Draw the Lipscomb topological diagram of $B_6H_{10}$, using Styx rule and calculate the number of orbitals and electrons available for boron framework.    2+2=4

*(c)* $B_6H_{10}$ can act as an acid as well as base. Explain by taking suitable examples.    2

*(d)* Give the synthetic scheme of 1,2-dicarba-*closo*-dodecaborane and draw its structure.    2

*(e)* Metallocarboranes can be prepared using polyhedral expansion reaction. Explain by taking a suitable example.    3

*(f)* What are amphiboles? Give one example.    1

**6.** *(a)* Write down the preparation process of phosphazenes. Draw two different conformations of $(NPCl_2)_4$. What will happen when $(NPCl_2)_3$ reacts with $CH_3MgI$? 3

*(b)* Draw the structure of $S_4N_4$ and discuss its properties. 3

*(c)* What are non-stoichiometric oxides? Give a brief overview of their applications. 5

*(d)* Complete the following reactions : 3

(i) $HPO_4^{2-}$  $MoO_4^{2-}$  $\xrightarrow{H^+ , 25\,°C}$  ?

(ii) $WO_4^{2-}$  $\xrightarrow[Co^{2+} , 100\,°C]{H^+ (pH\ 6\cdot0)}$  ?

(iii) $[P_2W_{18}O_{62}]^{6-}$  $\xrightarrow[25\,°C]{HCO_3^-}$  ?

UNIT—IV

**7.** *(a)* How does ozone $(O_3)$ form in the atmosphere? Discuss various pathways leading to ozone depletion and hole formation in the ozone layer. Show the ozone cycle.
1+3+1=5

*(b)* What is Minamata disease? Explain the biochemical effect of mercury (Hg), when consumes at high level. Name two antidotes for detoxification of mercury.
2+3+2=7

*(c)* Write a short note on cryptands. 2

**8.** *(a)* Write a brief account on domestic and industrial wastewater treatment. 4

*(b)* What is meant by ionophores? Discuss the structures of 'nonactin' and 'valinomycin' ionophores and comment on their transport properties. 2+4+1=7

*(c)* Demonstrate the active transport with the help of $Na^+$-$K^+$ pump through cell membrane. 3
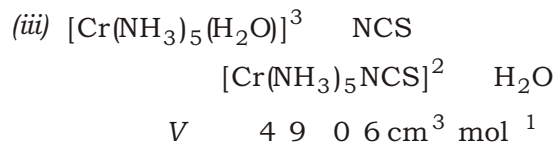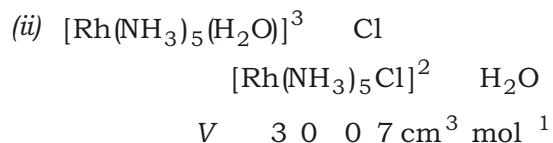
UNIT—V

**9.** *(a)* Account for the volume of activation for water exchange in the following reactions : 2×3=6

(i) $[Co(NH_3)_5(H_2O)]^{3+}$  $Cl^-$

$[Co(NH_3)_5Cl]^{2+}$  $H_2O$

$\Delta V$  $1\cdot4$  $0\cdot8\ cm^3\ mol^{-1}$

    *(ii)* $[Rh(NH_3)_5(H_2O)]^{3+} + Cl^-$

$$[Rh(NH_3)_5Cl]^{2+} + H_2O$$

$$\Delta V^{\neq} = -3.0 \pm 0.7 \, cm^3 \, mol^{-1}$$

    *(iii)* $[Cr(NH_3)_5(H_2O)]^{3+} + NCS^-$

$$[Cr(NH_3)_5NCS]^{2+} + H_2O$$
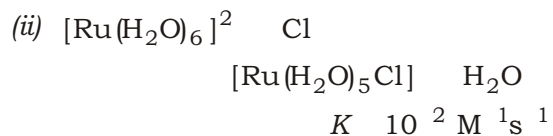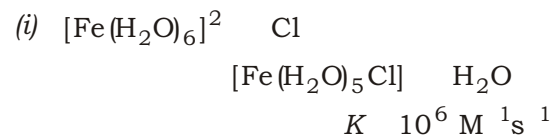
$$\Delta V^{\neq} = -4.9 \pm 0.6 \, cm^3 \, mol^{-1}$$

*(b)* What are different classes of electron transfer reactions? In the light of electron transfer mechanism, explain that the reduction of $[Co(NH_3)_5Cl]^{2+}$ is about $10^{10}$ times faster than $[Co(NH_3)_6]^{3+}$.

              5

*(c)* Account for the difference in rate constants for the following reactions :    3

    *(i)* $[Fe(H_2O)_6]^{2+} + Cl^-$

$$[Fe(H_2O)_5Cl]^+ + H_2O$$

$$K = 10^6 \, M^{-1}s^{-1}$$

    *(ii)* $[Ru(H_2O)_6]^{2+} + Cl^-$

$$[Ru(H_2O)_5Cl]^+ + H_2O$$

$$K = 10^{-2} \, M^{-1}s^{-1}$$

**10.** *(a)* Write a rate law for a dissociative reaction

$$ML_5X \xrightleftharpoons[k_{-1}]{k_1} ML_5 + X$$

$$ML_5 + Y \xrightarrow{k_2} ML_5Y$$

              4
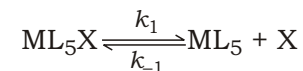
*(b)* Show Ray-Dutt twist pathways racemization of trischilate complex.    4

*(c)* Explain, how oxygen-17 NMR can be used for determination of rate constant of water exchange reaction.    4

*(d)* Write a short note on anation reaction.    2

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