PG/IS/CEM-103/14

M.Sc. 1st Semester Examination, 2014

CHEMISTRY

(*Inorganic*)

PAPER – CEM- 103

Full Marks : 40

Time : 2 hours

Answer any five questions taking at least two from each Group

The figures in the right hand margin indicate marks

GROUP –A

1. (*a*) Verify that the scalar product of vectors $\vec{A}$ and $\vec{B}$ in *n*-dimensional space is equal to the sum of the products of the lengths of projections of the vectors in *n*-orthogonal axes with no cross terms. 3

(*b*) Find the order of the improper axis in the following molecules and identify the other elements of symmetry generated by this axis
(*i*) Ferrocene (eclipsed)
(*ii*) $[CoCl_4]^{2-}$. 2

(*c*) A borane molecule has its styx number 1004. Predict the formula of the molecule and draw the possible structure. 2

(*d*) Identify Closo/Nido/Arachno/Hypo boranes $[B_5H_9]^{2-}$, B_8H_{16}. 1

2. (*a*) What do you mean by subgroup of a group ? Find out the subgroups present in the group D_{4h}. 3

(*b*) Construct the "group multiplication table" for H_2O molecule. Determine the classes present in this molecule. 2

(*c*) Calculate the styx number of $[B_5H_9]^{2-}$ ion and establish its most probable structure. 3

3. (*a*) Prove that if *P* is conjugate with *Q* and *R*, then *Q* and *R* are conjugate with each other. 2

(*b*) Identify the point group for each of the following molecules/ions : 2

(*i*) Ferrocene (staggered)

(*ii*) $XeOF_4$

(*iii*) BF_4^-

(*iv*) $[Re_2Cl_8]^{2-}$.

(*c*) Show that no two classes of a group can share a common element. 2

(*d*) Complete the following reactions : 2

(*i*) $Ph_3PAuCl + C_2RLiB_{10}H_{10} \longrightarrow$

(*ii*) $[C_2B_9H_{11}]^{2-} + BrMn(CO)_5 \longrightarrow$

(*iii*) $2\,[C_2B_9H_{11}]^{2-} + FeCl_2 \longrightarrow$

(*iv*) $B_5H_9 + C_2H_2 \xrightarrow{490^\circ C}$

4. (*a*) "In $[Zn(H_2O)_6]^{2+}$ the pK_a is around 9·0, however, in carbonic anhydrase enzyme i.e. $(imidazole)_3\,Zn-OH_2$ the pK_a is around 7·0."—Explain. 2

(*b*) What happens when OsO_4 is treated with aqs. KOH in NH_3 ? Draw the structure of the complex and mention the oxidation state of the central metal ion. 2

(*c*) What are the differences between first genera -tion and second generation BNCT agents ? 2

(*d*) Using "Great Orthogonality Theorem" prove that the sum of the squares of the characters in any irreducible representation equals to the order of the group. 2

GROUP –B

5. (*a*) What do you mean by active and passive transport ? 2

(*b*) What is antiporter enzyme ? Mention one antiporter enzyme and cite its function. 2

(*c*) Discuss the 1D electronic conduction property of $K_2[Pt(CN)_4]\cdot 3H_2O$ complex. 2

(*d*) What is Wolfarm's red salt ? 1

(*e*) How will you synthesize ruthanate and per-ruthanate from ruthenium tetroxide ? What are the oxidation state of 'Ru' ? 1

6. (*a*) Discuss the recycling of iron in red blood cells. 2

(*b*) Draw the active site structure of the enzyme carboxypeptidase. Schematically present and discuss the functional mechanism of carboxypeptidase enzyme. What is the role of Zn(II) metal ion in this enzyme ? 1 + 3 + 1

(*c*) How ruthenium dinitrogen complex is synthesized ? 1

7. (*a*) $[Cr(H_2O)_6]^{3+}$ shows three absorption bands at 17400, 24600 and 37900 cm^{-1}. Assign three bands and calculate *Dq*. 2

(*b*) Schematically present the coordination sphere around iron (III) in transferrin. 1

(*c*) Derive the matrix form of Sn(x) symmetry operation. 3

(*d*) Show that when a C_4 axis and a plane containing this axis present, then there must be a second plane which also contain this C_4 axis and at an angle of 45° to the first plane. 2

8. (*a*) d^7-high spin octahedral and tetrahedral complexes contain same number of unpaired electrons, but, the magnetic moment of octahedral complex is greater than tetrahedral complex.—Explain. 3

(*b*) Draw the molecular orbital energy level diagram of $[Co(Cl)_4]^{2-}$, indicating symmetric of atomic and molecular orbitals. 3

(*c*) How can you explain metal-ligand orbital overlap with the help of ESR spectroscopy ? 2