

2016

CHEMISTRY

(Major)

Paper : 5.4

(Inorganic Chemistry)

Full Marks : 60

Time : 3 hours

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

Objective-type questions (choose the correct
option) : 1×5=5

1. The point-group symmetry of $P(C_6H_5)_3$ is

(a) D_{3h}

(b) C_3

(c) D_3

(d) C_{3v}

(2)

2. TEL is an/a

- (a) ionic organometallic compound
- (b) sigma-bonded organometallic compound
- (c) electron-deficient organometallic compound
- (d) None of the above

3. Vitamin B₁₂ contains

- (a) Zn
- (b) Fe
- (c) Co
- (d) Mo

4. Which of the following statements is true about the octahedral complexes of Ni²⁺?

- (a) Both strong- and weak-field complexes are diamagnetic
- (b) The strong-field complex is diamagnetic and the weak-field complex is paramagnetic

(3)

(c) The strong-field complex is paramagnetic and the weak-field complex is diamagnetic

(d) Both strong- and weak-field complexes are paramagnetic

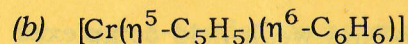
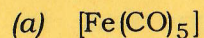
5. [Fe₂(CO)₉] is diamagnetic, because of

- (a) the presence of one CO as a bridging ligand
- (b) the metal-metal (Fe—Fe) bond in the molecule
- (c) the presence of a monodentate CO ligand
- (d) the oxidation state of iron is zero

Very short answer-type questions : 2×5=10

6. What are the symmetry point groups for the eclipsed and staggered forms of ferrocene? State which one between the two will have the centre of inversion (*i*) as one of the symmetry elements.

7. Do the following organometallic species obey the 18-electron rule?



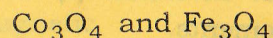
8. What is the Cr—Cr bond order in the compound $\text{Cr}_2(\mu\text{-O}_2\text{CCH}_3)_4(\text{H}_2\text{O})_2$?

9. Iron(II) salts undergo oxidation in air but the cobalt(II) salts do not. Explain.

10. Predict the magnetic properties of the species $[\text{CoF}_6]^{3-}$ and $[\text{Co}(\text{NH}_3)_6]^{3+}$.

Short answer-type questions (any three) : $5 \times 3 = 15$

11. What are spinels? Why do some AB_2O_4 compounds having transition elements as A and/or B prefer the inverse spinel structure and some others the normal spinel structure? Predict the structure of the following spinels : $1+2+2=5$



12. What are organometallic compounds? Comment on the stability of the M—C bond in organometallic compounds. Explain giving suitable examples. $2+3=5$

13. Give the methods of preparation of Zeise's salt and discuss its structure. For a given metal-ethylene complex, the IR stretching frequency of the C=C bond is found to be 1516 cm^{-1} whereas the corresponding frequency for free C_2H_4 is observed at 1625 cm^{-1} . Explain. $3+2=5$

14. What is the nature of the dioxygen binding site in haemoglobin? How do you conclude that the protein part of haemoglobin is also involved in the reversible binding of O_2 ? 5

15. The spin-only magnetic moments (μ) for $[\text{NiCl}_4]^{2-}$ and $[\text{Ni}(\text{CN})_4]^{2-}$ ions have been found to be 2.87 BM and 0 BM respectively. Using the μ values, predict the geometry of the complex ions and also comment on the hybridization of Ni^{2+} ion in each case. $3+2=5$

(6)

Essay-type questions (any *three*) : $10 \times 3 = 30$

16. What are symmetry elements and symmetry operations? Illustrate the improper rotation operation S_4 with the help of a diagram. Discuss how both tetrahedral and octahedral geometries may be stated to have cubic symmetry. Take help of diagrams as appropriate. $3+2+5=10$

17. Discuss the importance and shortcomings of crystal-field theory. Does this theory address the formation of metal-ligand bonds? Use crystal-field theory to predict the electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ and the magnetic moment of the species $[\text{Co}(\text{SCN})_4]^{2-}$. $6+2+2=10$

18. (a) Give the method of preparation for the binuclear species $[\text{Re}_2\text{Cl}_8]^{2-}$ and discuss its bonding giving an appropriate diagram. 5

(b) Comment on the organometallic compounds of Sn and describe their utilities. 5

(7)

19. Distinguish between homogeneous and heterogeneous catalyses. Discuss the catalytic cycle of hydroformylation of alkenes by a cobalt carbonyl catalyst. An increase in CO partial pressure above a certain threshold decreases the rate of the cobalt-catalyzed hydroformylation of 1-pentene. Suggest an interpretation of this observation.

$1+6+3=10$

20. Write short notes on any *two* of the following topics : $5 \times 2 = 10$

(a) Ziegler-Natta catalysts

(b) Molecular-orbital theory in coordination chemistry

(c) Role of metal ions in biology
