

Roll No.

E-305

M. Sc. (First Semester)
EXAMINATION, Dec.-Jan., 2020-21
CHEMISTRY

Paper First

(Group Theory and Chemistry of Metal Complexes)

Time : Three Hours]

[Maximum Marks : 80

Note : Attempt all Sections as directed.

Section—A

1 each

(Objective/Multiple Choice Questions)

Note : Attempt all questions.

Choose the correct answer :

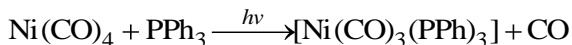
1. The molecule (i) SO_2 , (ii) XeOCl_4 and (iii) PH_3 belongs to :

- (a) (i) C_1 (ii) D_{4h} (iii) D_{3h}
- (b) (i) C_{2v} (ii) C_{4v} (iii) C_{3v}
- (c) (i) C_{2v} (ii) D_{4h} (iii) D_{3v}
- (d) (i) D_{2h} (ii) C_{4v} (iii) D_{3v}

P. T. O.

2. In the ionic solid state PCl_5 exists as an ionic solid composed of PCl_4^+ cation and PCl_6^- anions but the vapour is molecular. To what point groups do the ionic species in the solid belong ?
- (a) C_{4v} and O_h respectively
 - (b) T_d and D_{6h} respectively
 - (c) T_d and O_h respectively
 - (d) D_{4h} and O_h respectively
3. Which of the following does not contain a C_3 axis ?
- (a) POCl_3
 - (b) $[\text{NH}_4]^+$
 - (c) $[\text{H}_3\text{O}]^+$
 - (d) ClF_3
4. The number of symmetry elements in diborane molecule :
- (a) 2
 - (b) 4
 - (c) 6
 - (d) 8

5. Among the following the correct statement is :
- (a) The no. of irreducible representation is equal to the classes of symmetry operation.
 - (b) The no. of irreducible representation is equal to the order of symmetry point group.
 - (c) The irreducible representation contained in any point are always of one dimension.
 - (d) Symmetry point group may not contain a totally symmetric irreducible representation.
6. The rate of the reaction depends on :



- (a) Concentration of both the reactant
 - (b) Concentration of Ni(CO)_4 only
 - (c) Concentration of PPh_3 only
 - (d) The steric bulk of PPh_3
7. The decreasing order of Δt of the following complexes are :
- (A) $[\text{CoCl}_4]^{2-}$
 - (B) $[\text{CoBr}_4]^{2-}$
 - (C) $[\text{Co(NCS)}_4]^{2-}$
- (a) $(\text{C}) > (\text{A}) > (\text{B})$

- (b) $(A) > (B) > (C)$
- (c) $(B) > (A) > (C)$
- (d) $(C) > (B) > (A)$
8. The correct d -electron configuration showing spin-orbit coupling is :
- (a) $t_{2g}^6 + e_g^2$
- (b) $t_{2g}^6 + e_g^0$
- (c) $t_{2g}^4 + e_g^0$
- (d) $t_{2g}^3 + e_g^2$
9. Which of the following is hexadentate ligand ?
- (a) Acetyl acetato
- (b) 1, 10-phenonthrline
- (c) Ethylene diamine
- (d) Ethylene diamine tetraacetic acid
10. CrO_4^{2-} is coloured due to :
- (a) d - d transition
- (b) $M \rightarrow L$ charge transfer
- (c) $L \rightarrow M$ charge transfer
- (d) None of the above

11. The ring size and the number of linked tetrahedral present in

$[\text{Si}_6\text{O}_8]^{12-}$ respectively are :

- (a) 6 and 6
- (b) 12 and 6
- (c) 12 and 12
- (d) 6 and 12

12. Silicate with continuous 3D framework are :

- (a) *Neso*-silicates
- (b) *Soro*-silicates
- (c) *Phyllo*-silicates
- (d) *Tecto*-silicates

13. Number of chelating rings present in $[\text{Ni}(\text{DMG})_2]$ is/are :

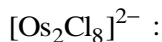
- (a) Four (2-five membered, 2-two membered)
- (b) Four (2-five membered, 2-three membered)
- (c) Four (2-five membered, 2-four membered)
- (d) Four (2-five membered, 2-six membered)

14. Which statement is correct ?

- (a) A dissociative mechanism is a 2-step mechanism with the leaving group departing in the second step.

- (b) An associative mechanism is a 2-step mechanism; the intermediate has a lower coordination number than the starting complex.
- (c) In a dissociative interchange mechanism, bond breaking dominates over bond formation.
- (d) In an associative interchange mechanism, the entering group associates with the substrate after the leaving group has departed.
15. Three of the following ions are kinetically inert, one is labile. Which ion is labile ?
- (a) Rh^{3+}
- (b) Ti^{3+}
- (c) Ru^{2+}
- (d) Cr^{3+}
16. Arrange the following cluster in decreasing order of metal-metal bond length :
- (A) $[\text{Re}_2\text{Cl}_4(\text{PMe}_2\text{Ph})_4]^{2+}$
- (B) $[\text{Re}_2\text{Cl}_4(\text{PMe}_2\text{Ph})_4]^{1+}$
- (C) $[\text{Re}_2\text{Cl}_4(\text{PMe}_2\text{Ph})_4]$
- (a) $(A) > (B) > (C)$
- (b) $(C) > (B) > (A)$
- (c) $(B) > (A) > (C)$
- (d) $(C) > (A) > (B)$

17. Find out the bond order of the following $[\text{Mo}_2\text{Cl}_8]^{4-}$ and



- (a) Both 4
- (b) Both 3
- (c) 3 and 4 respectively
- (d) 4 and 3 respectively

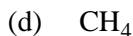
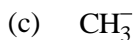
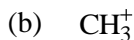
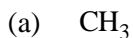
18. The reaction of BCl_3 with NH_4Cl gives product A which upon reduction by NaBH_4 gives product B. Product B upon reacting with HCl affords compound C, which is :

- (a) $\text{B}_3\text{N}_3\text{H}_6$
- (b) $[\text{ClBNH}]_3$
- (c) $\text{Cl}_3\text{B}_3\text{N}_3\text{H}_9$
- (d) $(\text{ClH})_3\text{B}_3\text{N}_3(\text{ClH})_3$

19. According to isolobal principle, structure of $[\text{Ni}(\text{CO})_2]\text{PB}_{10}\text{H}_{11}$ is :

- (a) *closo*
- (b) *nido*
- (c) *archano*
- (d) *hypho*

20. Which among the following is isolobal with $\text{Fe}(\text{CO})_5$?



Section—B

2 each

(Very Short Answer Type Questions)

Note : Attempt all questions.

1. Write the symmetry elements and point group of PCl_5 .
2. What are sub-group ? Explain with suitable example.
3. Write the limitation of CFT.
4. How many metal-metal bond present in $\text{Ir}_4(\text{CO})_{12}$ and $\text{Os}_4(\text{CO})_{15}$.
5. Discuss the stability of the complex with respect to ligands.
6. What are silicones ?
7. What are carboranes ?
8. Calculate framework electron of $\text{Fe}_6\text{C}(\text{CO})_{16}$.

Section—C

3 each

(Short Answer Type Questions)

Note : Attempt all questions.

1. What are abelian and non-abelian group ?
2. Find out the point group of the following :
 - (i) SF_4
 - (ii) I_3^-
 - (iii) IF_7
3. Apply vibrational spectroscopy to distinguish terminal metal carbonyl from the bridging metal carbonyl.
4. Write notes on metal nitrosyls and tertiary phosphine as ligands.
5. What are iso- and hetero-polyacids ? Briefly discuss the iso- and heteropolyacids and Mo and W.
6. Describe the spectrophotometry method for determining the stability constant of metal complexes in solution.
7. Discuss the structure and bonding of phosphazene.
8. Describe the types of bonds in higher boranes.

Section—D

5 each

(Long Answer Type Questions)

Note : Attempt all questions.

1. Discuss the properties, character and spectroscopy active modes of C_{3v} point group.

Or

For H_2O molecules :

- (a) Obtain a reducible representation for the different motion.
 - (b) Reduce this reducible representation using standard formula and character table of C_{2v} point group.
 - (c) Obtain irreducible representation of each kind.
 - (d) Show which irreducible representation will be IR and Raman active.
2. Discuss the molecular orbital theory for the bonding of octahedral complex.

Or

What is π -acidity ? Discuss the type of π -bonding in metal complexes. Why π -bonding ligands behave as strong field ligand ?

3. What do you understand by mean of stability constant of metal complexes ? On what factors does the stability of a complex ion depends ?

Or

What are the silicates ? How are they classified ?

4. What do you mean by quadruple bonding ? Discuss the structure and bonding of $\text{Re}_2\text{Cl}_8^{2-}$.

Or

Borazine is isoelectronic structure of benzene and known as inorganic benzene :

- (a) How can borazine be synthesized ? Write its reactions.
- (b) Despite parallel physical properties of benzene and isoelectronic borazine why chemical properties of both the compounds are different.