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M.Sc. CHEMISTRY
First Semester
Inorganic Chemistry -I
(MSC - 02)

Duration: 3Hrs.

Full Marks: 70

Part-A (Objective) =20
Part-B (Descriptive)=50

(PART-B: Descriptive)

Duration: 2 hrs. 40 mins.

Marks: 50

1. Answer the following questions (any five):

2 × 5 = 10

- (a) Define *LS* coupling and *jj* coupling.
- (b) Explain two limitations of crystal field theory.
- (c) What is meant by quenching of the orbital momentum?
- (d) If one $[\text{CuL}_6]^{2+}$ complex ion solution is blue and another is green, which would be expected to have higher value of Δ_o ?
- (e) What are Wade's rules and give an example for each type of borane?
- (f) What is PAN? What are the characteristics of PAN?
- (g) What is "BOD" and "COD"?

2. Answer the following questions (any five):

3 × 5 = 15

- (a) What is nephelauxetic effect? Explain nephelauxetic series.
- (b) The vanadium atom has the ground configuration $[\text{Ar}]3d^34s^2$. Given that a d^3 configuration gives rise to 2P , 4P , 2D , 2F , 4F , 2G and 2H terms, determine the value of L, S and J for the ground state.
- (c) What is an Orgel diagram? Construct the Orgel diagram for a Co^{2+} (d^7) ion in octahedral field.
- (d) Classify the following as *clos*o, *nido* or *arach*no:
(i) $\text{CB}_{10}\text{H}_{13}^-$, (ii) $\text{NCB}_{10}\text{H}_{11}$, (iii) $\text{C}_2\text{B}_9\text{H}_{11}[\text{Os}(\text{CO})_3]$.

- (e) Explain, briefly, the structure of silicates.
- (f) Write a short note on green house effect.
- (g) What is soil profile? Write a short note on soil profile.

3. Answer the following questions (any five):

5 × 5 = 25

- (a) Describe the construction of the *ligand group orbitals* (LGOs) appropriate for σ -bonding in an octahedral ML_6 complex?
- (b) The aqueous solution of $KMnO_4$ is deep purple colored. Characterize the origins of the transitions responsible for the color (with diagram). State two favorable requirements for LMCT transitions.
- (c) What is Jahn-Teller effect? How does it affect the stability of the metal complexes? Predict the structure of $[Cr(OH_2)_6]^{2+}$ keeping in mind the probable Jahn-Teller distortions.
- (d) What is spin crossover? What factors cause spin crossover? Elaborate the process of "hysteresis" occurring during spin crossover in an iron complex.
- (e) Give an example of a carborane anion isolobal to $C_5H_5^-$ fragment. Which metallocarborane do you expect to form by this carborane anion? Draw the metallocarborane.
- (f) Explain, what are graphene and fullerene. Draw the structures and explain the importance of each.
- (g) What is ozone hole? Write an explanatory note on mechanism of ozone depletion.

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(The figures in the margin indicate full marks for the questions)

Duration: 20 minutes

Marks – 20

PART A- Objective Type

A. Choose the correct answer:

1 × 20 = 20

- (1) As a ligand F^- is
 - (a) only a σ -donor
 - (b) only a π -donor
 - (c) a σ -donor and a π -acceptor
 - (d) none is true

- (2) According to *Wade's* rule, the number of framework electrons for the *nido* series equals to –
 - (a) $2n$
 - (b) $2n + 2$
 - (c) $2n + 4$
 - (d) $2n + 6$

- (3) The square planar geometry is particularly common for complex with metal ions having
 - (a) d^6 electrons
 - (b) d^7 electrons
 - (c) d^8 electrons
 - (d) d^9 electrons

- (4) The phosphorous oxide P_2O_5 is one of the strongest desiccants and reacts with water to form oxoacids. Which one is the correct acid formed?
 - (a) H_3PO_3
 - (b) H_3PO_4
 - (c) H_3PO_5
 - (d) H_3PO_6

- (5) The thermal stability of the binary halogen compounds: (A) IF, (B) ClF, (C) ICl, and (D) IBr, follows the order –
- (A) > (B) > (C) > (D)
 - (B) > (C) > (D) > (A)
 - (C) > (D) > (A) > (B)
 - (D) > (A) > (B) > (C)
- (6) Choose the INCORRECT statement from the following –
- The H–F bond is stronger than the H–Cl bond
 - The C–F bond (in CF₄) is stronger than the C–Cl bond (in CCl₄)
 - The F–F bond (in F₂) is stronger than the Cl–Cl bond (in Cl₂)
 - The Li–F bond is a stronger than the Li–Cl bond
- (7) The magnetic moment of the complex [Mn(NCS)₆]^{4–} is 6.06 μ_B. What is its d-electron configuration?
- t_{2g}⁵e_g⁰
 - t_{2g}⁴e_g¹
 - t_{2g}³e_g²
 - t_{2g}²e_g³
- (8) The oxidation number of sulphur in dithionite [S₂O₄]^{2–} and dithionate [S₂O₆]^{2–} are, respectively,
- +3 and +4
 - +3 and +5
 - +4 and +5
 - +4 and +6
- (9) The species which does not show temperature-independent paramagnetism –
- Low spin Fe²⁺ complexes
 - Low spin Co³⁺ complexes
 - MnO₄[–]
 - CrO₄^{2–}
- (10) The Δ_o of the following complexes: (A) [ReF₆]^{2–}, (B) [TcF₆]^{2–}, and (C) [MnF₆]^{2–} follows the order –
- (C) > (B) > (A)
 - (C) > (A) > (B)
 - (B) > (C) > (A)
 - (A) > (B) > (C)
- (11) Complete transfer of electrons from ligand (HOMO) to metal (LUMO) is possible in which pair of complexes:
- FeI₃ and [Co(H₂O)₆]³⁺
 - HgI₂ and MnO₄[–]
 - PbI₂ and [CrO₄]^{2–}
 - [PtCl₄]^{2–} and [AuCl₄][–]
- (12) The Δ_o of the following complexes: (A) [CoF₆]^{3–}, (B) [Co(en)₃]³⁺, (C) [Co(H₂O)₆]³⁺, and (D) [Co(NH₃)₆]³⁺ follows the order –
- (D) > (C) > (B) > (A)
 - (A) > (B) > (C) > (D)
 - (B) > (D) > (C) > (A)
 - (C) > (D) > (B) > (A)

- (13) Pick which one of the following pairs is isolobal to each other –
- P_4 and $(CH)_4$
 - CH_3 and NH_3
 - CH^- and BH
 - BH and CH_2^-
- (14) The CFSE for the complex $[Co(NH_3)_6]^{3+}$ is –
- + 6 Dq
 - 4 Dq
 - 14 Dq
 - 24 Dq
- (15) For a Laporte allowed transition, $\Delta l = \pm 1$ and for a spin allowed transition:
- $\Delta S = 0$
 - $\Delta S = 1$
 - $\Delta S = -1$
 - $\Delta S = \pm 1$
- (16) O_3 undergoes photolysis due to UV radiation from the sunlight, according to the reaction:
- $$O_3 + h\nu \rightarrow O_2^* + O^*$$
- Here wavelength of the radiation is –
- <315 nm
 - <400 nm
 - 340 – 400 nm
 - None
- (17) Which of the following is a constituent of photochemical smog?
- N_2O_5
 - PAN
 - N_2O_3
 - None
- (18) The bright blue color of aqueous $[Cr(H_2O)_6]^{2+}$ and yellow color of $PbCrO_4$ are due to
- LMCT transition in the first and d-d transition in the second
 - LMCT transition in both
 - d-d transition in both
 - d-d transition in the first and LMCT transition in the second
- (19) Which of the following soil water types is not available for plants?
- Gravitational water
 - Capillary water
 - Hydrosopic water
 - All
- (20) The most abundant element in the earth crust is -
- Oxygen
 - Silicon
 - Iron
 - Aluminium