SET A

M.Sc. CHEMISTRY
SECOND SEMESTER
INORGANIC CHEMISTRY-II
MSC – 202 [REPEAT]

[USE OMR FOR OBJECTIVE PART]

Duration: 3 hrs. **Full Marks: 70**

Objective

Time: 30 min. **Marks: 20**

Choose the correct answer from the following: ***1×20=20***

1. Spin crossover is most commonly observed in complexes of which metal ion?
   a. Cu^{2+} b. Zn^{2+}
   c. Fe^{2+} d. Ni^{2+}

2. Diamagnetic correction is applied during magnetic susceptibility measurements to account for:
   a. The presence of unpaired electrons b. The crystal structure of the compound
   c. The effect of external pressure d. The contribution of paired electrons

3. Which of the following is a key reason for the occurrence of temperature independent paramagnetism (TIP)?
   a. Thermal excitation of electrons b. Mixing of ground and excited states due to magnetic field
   c. Crystal field splitting d. Formation of metal-ligand bonds

4. In the complex $K_4[Cr(CN)_6]\cdot 3H_2O$, the chromium ion is in the (+3) oxidation state. Considering the nature of the cyanide ligand and its ligand field strength, what would be the magnetic moment of this complex in terms of Bohr magnetons (BM)?
   a. 0 BM, as all the electrons are paired in a low-spin octahedral configuration
   b. 4.90 BM, as Cr^{3+} undergoes a high-spin octahedral configuration with 5 unpaired electrons
   c. 2.83 BM, corresponding to a low-spin octahedral configuration with 2 unpaired electrons
   d. 1.73 BM, corresponding to a weakly paramagnetic low-spin octahedral configuration

5. Which of the following statements best explains the effect of spin-orbit coupling on the electronic properties of a transition metal complex?
   a. Spin-orbit coupling strengthens the crystal field splitting and increases the splitting energy in weak-field complexes.
   b. Spin-orbit coupling is significant only in first-row transition metal complexes and has no noticeable effect on second and third-row metals.
   c. Strong spin-orbit coupling causes the mixing of electronic states, leading to the lifting of degeneracy and the potential for low-spin states in high-field complexes.
   d. Spin-orbit coupling generally reduces the number of unpaired electrons in a complex by promoting electron pairing in weak-field ligands.

6. The spectroscopic ground state symbol and the total number of electronic transition of $[Ti(H_2O)_6]^{2+}$ are
   a. $^3T_{1g}$ and 1
   b. $^3A_{2g}$ and 3
   c. $^3T_{1g}$ and 3
   d. $^3A_{2g}$ and 2

7. Which of the following octahedral complex shows $^3A_{2g} \rightarrow {}^3T_{2g}$ transition as the lowest energy visible band in its electronic spectrum?
   a. $[Cr(NH_3)_6]^{3+}$
   b. $[Co(NH_3)_6]^{3+}$
   c. $[FeF_6]^{3-}$
   d. $[Ni(H_2O)_6]^{2+}$

8. Which of the following complexes is expected to exhibit the highest energy d-d transition?
   a. $[Fe(H_2O)_6]^{2+}$
   b. $[Fe(CN)_6]^{4-}$
   c. $[Fe(en)_3]^{2+}$
   d. $[Fe(SCN)_6]^{3-}$

9. The ground state term symbol of Ni^{2+} ions is
   a. ^3F
   b. ^3A
   c. ^3P
   d. ^3E

10. The ground state term for $t_{2g}^6e_g^2$ in octahedral field is
    a. ^3E_g
    b. $^2T_{1g}$
    c. $^4T_{1g}$
    d. $^3A_{2g}$

11. The composition of calomel is
    a. AgCl
    b. Hg_2Cl_2
    c. HgCl
    d. KCl

12. The reaction $2H_2O_2$ (aq) $\rightarrow 2H_2O$ (l) + O_2 (g) is ---------- reaction
    a. Disproportionation
    b. Comproportionation
    c. Split
    d. Free radical

13. Dimals are salicylates of
    a. As and Pr
    b. Nd and Gd
    c. Am and U
    d. Pr and Nd

14. Based on standard electrode possible, which pair will *not* undergo redox reaction (Given: Fe^{3+}/Fe^{2+}=+0.77, Ag^+/Ag=+0.84, Cu^{2+}/Cu=+0.34, I_2/I^- = +0.54)
    a. Ag^+ and Cu
    b. Fe^{3+} and Ag
    c. Fe^{3+} and Cu
    d. Fe^{3+} and I^-

15. The orange red colour of Ce^{+4} is due to
    a. f-f transition
    b. d-d transition
    c. f-d transition
    d. Charge transfer transition

16. Identify the *incorrect* statement about actinides
    a. All are non-radioactive
    b. Uranium is an actinide
    c. Actinide contraction is present
    d. The last electron enters 5f shell

17. The ligands that support quadruple bonds are
    a. pi-donor but not pi-acceptor
    b. sigma-donor but not sigma- acceptor
    c. sigma-acceptor but not pi- donor
    d. sigma donor only

18. Polyoxometallate anion can be prepared by carefully adjusting
    a. pressure
    b. pH and concentration
    c. temperature
    d. the volume

19. Charge-transfer originates from a redistribution of
    a. Electric Charge density within the molecule
    b. Electronic charge density within and outside the molecule
    c. only in the exterior
    d. Not in the interior

20. The characteristics of a mixed valence complex is that the ion strongly absorbs light in the
    a. mid infrared region
    b. near infrared region
    c. far infrared region
    d. UV region

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Descriptive

Time : 2 hrs. 30 mins. **Marks : 50**

[Answer question no.1 & any four (4) from the rest]

1. a. Compare the "Gouy and Faraday" methods for determining magnetic susceptibility by listing two advantages and two disadvantages of each. **2+2+2+2 +2=10**
   b. Write the selection rules for electronic transition in metal complexes.
   c. Define standard electrode potential and write its relation with free energy (ΔG).
   d. Why species of Ln^{+3} ions are considered to be more stable than Ln^{+2} and Ln^{+4} species in solids and solution?
   e. What is ruthenium red? What are its applications?

2. a. What is the Curie-Weiss law, and how does it describe the relationship between temperature and the magnetic susceptibility of materials? **3+2+3+2 =10**
   b. Explain the principle behind "Gouy method" for measuring the magnetic susceptibility of a substance.
   c. How do spin motion and orbital motion contribute to the magnetic properties of transition metal complexes?
   d. Define the following terms: Magnetic permeability, magnetic susceptibility, ferromagnetism and antiferromagnetism

3. a. Explain the concept of orbital contribution to the magnetic properties of transition metal complexes, and illustrate it with a detailed example. **3+2+2+3 =10**
   b. Describe the antiferromagnetic behavior observed in copper-acetate complexes and explain the possible pathways for this interaction.
   c. What do you mean by "Racah parameter"?
   d. Write down the differences between "Orgel and Tanabe Sugano" diagram.

4. a. Draw "Orgel Diagram" for "F" ground term. State limitations of it. 5+5=10

b. Discuss how relaxation of Laporte and spin selection rules can occur. Write the number of possible d-d transition of $[Cu(NH_3)_6]^{2+}$ and assign those.

5. a. Explain the difference between comproportionation and disproportionation reactions using suitable example. 3+3+4 =10

b. Explain briefly the working of silver-silver chloride electrode.

c. Consider the following two reactions

(i) $CuO + H_2 \rightarrow Cu + H_2O$

(ii) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$

Identify which of the above reaction is not a redox reaction and explain why?

6. a. What are the types of coupling present in lanthanides? Determine the magnetic moment (μ) of Gd^{3+}. 3+3+1+3 =10

b. What is the most common type of transition exhibited by Ln^{+3} ions? Write its characteristics.

c. Write the structural details of UO_2F_2.

d. Write briefly the steps involved in actinide separation.

7. a. Show the Latimer diagram for chlorine in acidic solution and explain briefly the steps. 2+2+2+4 =10

b. Calculate the emf of the cell. $Zn \mid Zn^{2+}$ (0.001M) $\mid\mid Ag^{+}$ (0.1M) $\mid$ Ag. The standard potential of Ag/Ag^{+} half-cell is +0.80 V and Zn/Zn^{2+} is -0.76 V.

c. What are the consequences of decrease in basicity of lanthanides?

d. What are dinitrogen complexes? How pentammine(dinitrogen) ruthenium(II) could be synthesised?

8. a. What is Creutz-Taube ion metal complex? How was the compound isolated? 3+4+3 =10

b. What is Tungsten Bronze? Outline the properties of Sodium Tungsten Bronze.

c. What is quadruple bond? Name the first compound to be synthesised containing quadruple bond.

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