RANI RASHMONI GREEN UNIVERSITY
DEPARTMENT OF CHEMISTRY
Semester – II, Internal Examination – 2025
M.Sc. Course in Chemistry
Course ID: CHEM-C21

Full Marks: 25 **Time: 1 h**

Answer all the questions. Candidates are required to write answers in their own words and with proper scientific representations, if needed.

Unit 1: Chemical bonding

Q. 1. (a**)** What is Bent's rule? Explain with an example.

(b) What are the hybridization and shape of ICl^{2+} and ICl^{2-}?

(c) Considering the molecular orbital theory of B_2 molecule rationalized the position of $2\sigma_g$ and $1\pi_u$ energy level.

[2+1+2]

Or

Q. 2. (a**)** In PF_4Me all the four P-F bond length are same, whereas in PF_3Me_2 not all P-F bond length are same. Give an explanation.

(b) Homonuclear diatomic molecule of early member of Group 2 elements in the periodic table shows different distributions of molecular orbital energy levels in comparison to that of the later elements. Give suitable explanation of the above observation.

(c) Draw the MO diagram of N_2 molecule. From that diagram comments on the bond order, bond length, magnetic behaviour of N_2^+ and N_2^- ions and highlight the various frontier orbitals?

[1+2+2]

Unit 2: Coordination Chemistry-2

Q. 3. (a) Find out the ground state term for V^{3+} ion.

(b) Calculate the total number of microstates for p^2 and d^7-configurations.

(c) For complex $[Ni(H_2O)_6]^{2+}$ three absorption bands are observed at 8700 cm^{-1} , 14500 cm^{-1} and 25300 cm^{-1} . Draw the Orgel diagram for the complex ion and calculate the value of Δo and Racah parameter B'.

[1+1+3]

Or

Q.4 (a) Calculate the value of μ_{eff} for $[Ni(en)_3]^{2+}$ taking into account the spin-orbit coupling

(Given λ =-315 and Δ_o =11500 cm^{-1})

(b) "Tetrahedral complex $[CoCl_4]^{2-}$ is more intensely blue in colour where as the high spin complexes of Co^{2+} ion are of faint colour."-explain

(c) Identify the compound having orbital contribution towards magnetic moment but the $\mu_{obs} < \mu_{so}$?

(i) $[Cr(H_2O)_6]^{3+}$ (ii) $[Fe(CN)_6]^{4-}$

[2+2+1]

Unit-3:Organometallics-I

Q.5 (a) Explain the hapticity mode of binding in organometallic compounds & draw the η^1, η^3 and η^5 mode of binding by cyclopentadienyl-ligand in $(C_5H_5)ML_n$, where M = metal and L = ligand.

(b) Find the value of *m* and *n*, in $[Re(CO)_5(PF_6)_3]^m$ and $[Fe(CO)(CN)_5]^n$ by considering that both molecules obey the 18-electron rule.

[3+2]

Or

Q.6 (a) How many different sets of CO-frequencies do you expect in the IR-study of compound $[Fe_2(CO)_9]$. Justify your answer & mention their frequency order.

(b) Identify the σ-donor, π-donor and π-acceptor ligands from the following: CO, NH_3, H^-, OH^-. [3+2]

Unit 4: Selected topics on the chemistry of *s*- and *p*- block elements

Q.7 (a) Using the concept of Valance Bond theory, draw the orbital diagram 3c-2e B-H-B bond.

(b) If a *closo* borane contain sixteen skeletal electrons, what will be the formula of the borane? Also, provide the formula of *nido* and *arachno* borane containing same number of skeletal electrons.

(c) Comments on the reactivity and thermal stability of *closo*, *nido* and *arachno* borane?

[1+2+2]

Or

Q.8 (a) On the basis of Lipscomb's '*styx*' rule calculate the structure of diborane (6)? If the '*styx*' code of a borane is 3203, what will be the number of 3c-2e bond(s) and 2c-2e B-B bond(s) in that borane?

(b) On the basis of Wade-Mingos rule, what structure category dose decaborane(14) and pentaborane(11) belongs?

(c) How many vertice(s) will remain unoccupied by the boron atom(s) in case of *arachno*, *closo* and *nido* borane respectively?

[2+2+1]

Unit 5: Error and chemical analysis

Q.9 (a) The following values were obtained for the determination of Cadmium in a sample of dust:

4.3, 4.1, 4.0 and 3.2 $\mu g\ g^{-1}$

Applying the Q-test, decide whether the last value, 3.2, should be rejected or not. [Given: Q critical for a sample size of four is 0.831]

(b) Explain about the determinate error (source of error) and how can be eliminated this error? **[**2+3]

Q.10 (a) "High precision does not always mean high accuracy"-explain

(b) Certain Coal sample were analysed for their 'C' content by two different analytical methods. Following results were obtained:

Sample	Method A (in %)	Method B (in %)
1	62.1	62.8
2	60.8	60.9
3	61.9	62.2
4	60.9	60.5
5	59.7	59.9
6	61.4	61.2

Decide by use of an appropriate't'-test whether the different results of the two methods are significant at a confidence level of 90 %.

Sample size	't'			
	Confidence Level			
	90 %	95 %	99.9 %	99.5 %
6	1.943	2.447	3.707	4.317

[2+3]