B. Sc. Chemistry Examination, 2022
(3rd Year, 5th Semester, CBCS, Supplementary)
Chemistry (Core)
Paper – Core / Chem/Th- 14
Organometallics; Inorganic Reaction Mechanism and Coordination Chemistry of Non-Transitional Elemments + Quantum Mechanics - II, Electrical and Magnetic Properties of Materials
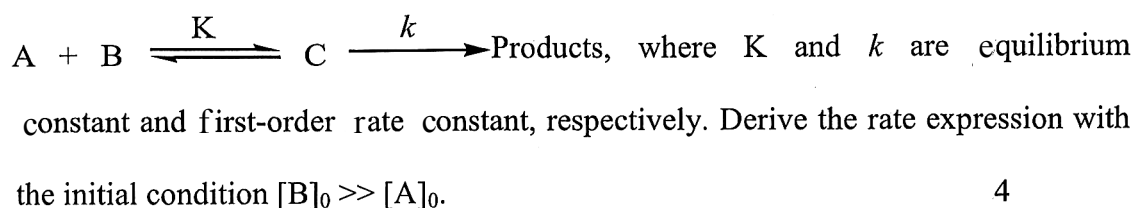
Time : Two hours   Full Marks : 40

(20 marks for each unit)
Use a separate answer script for each unit.
UNIT - 5141 - I

1. For the reaction scheme:

   $$A + B \underset{}{\overset{K}{\rightleftharpoons}} C \xrightarrow{k} \text{Products,}$$ where K and k are equilibrium constant and first-order rate constant, respectively. Derive the rate expression with the initial condition $[B]_0 \gg [A]_0$.   4

2. The free energy profile for a pure dissociative (D) substitution in an octahedral transition metal complex should be smelled with two transition states having difference in energy. Discuss critically.   3

3. For capturing K^+ (among alkali metal ions like Li^+, Na^+, K^+ and Cs^+), 18–Crown–6 is the best host. State the probable reasons for this. Do you agree that this reaction is a selective one for K^+?   3

4. The $\upsilon(NO)$ stretching frequency depends on the M—N—O angle in the nitrosyl complexes. Comment.   2

5. Define oxidative addition reaction with one example.   2

6. Determine the number of metal-metal bonds(s) in the following complexes which obey the 18 electron rule.   2

   i) $(CO)_2Rh(\mu\text{-}Cl)_2Rh(CO)_2$

   ii) $(\eta^5\text{-}C_5H_5)(CO)Fe(\mu\text{-}CO)_2Fe(CO)(\eta^5\text{-}C_5H_5)$

7. Arrange the following species with the increasing order of $\upsilon(CO)$ stretching frequency. Give explanation.   2

   $[Ni(CO)_4]$, $[Co(CO)_4]^-$ and $[Fe(CO)_4]^{2-}$

8. Explain why in $[Pt(C_2(CN)_4)(PPh_3)_2]$, the C—C bond length is close to the single bond distance.   2

[Turn over

UNIT : 5142-P

9. (a) Draw the quantum probability density curves in v=2 and v=7 states of one dimensional Harmonic Oscillator. How do they differ from the classical probability curves?   2

(b) Find the eigenvalues of $\hat{l}_z$ and $\hat{l}^2$ operators for the spherical harmonics $Y_{3,-2}(\theta, \varphi)$ where the symbols have their usual significances.   1

(c) Compare the wave functions of a particle in box with infinite potential at the walls and a linear harmonic oscillator with proper justification.   2

10. Answer the following questions: 3 ×3

(a) Given the normalized wave function for 1s electron of H atom : $\pi^{-1/2}a_0^{-3/2}e^{-r/a_0}$, calculate the average distance of an electron from the nucleus in the ground state of H atom.

(b) Evaluate the uncertainty in linear momentum at the zero point level of one dimensional harmonic oscillator.

(c) Write down the differential equation containing azimuth angle (φ) as a variable of a rigid rotor. Solve it using the boundary conditions.

11. (a) How do the HOMO-LUMO separation in atoms and molecules affect the polarizability?

(b) The presence of a dielectric in a parallel plate capacitor decreases its electric field - Explain.

(c) Considering only the effect of spin of unpaired electrons calculate the change in apparent mass of 0.1 M of a solution of CoF_6^{3-} ion in one cm diameter test tube suspended in a Gouy balance when magnetic field of 5000 G is turned on.

1.5+2+2.5