Assuming ideal behavior, calculate the molar polarization, dipole moment, and the dielectric constant of the molecule associated with the vapor at STP. $2\frac{1}{2}$

(c) What is the basis of measuring the magnetic susceptibility by Gouy balance method (no derivation is needed). 2

B. Sc. Chemistry Examination, 2023

(5th Semester, CBCS)

CHEMISTRY (CORE)

Paper: Core/Chem/Th/14

Time : Two Hours Full Marks : 40

(20 marks for each unit)

Use a separate answer script for each unit.

UNIT - 5141 - I

Answer ***all*** questions.

1. Predict which of the complexes $[V(CO)_6]^-$, $[Cr(CO)_6]$, or $[Mn(CO)_6]^+$ has the shortest C-O bond length. 2

2. Give examples of η^6, η^7 and η^8 ligands. Give an example of a triple-decker cyclopentadienyl complex. 2

3. Which one of the given complexes (a) or (b) will undergo ligand substitution faster with PPh_3? Why?
   (a) $V(CO)_6$ (b) $[V(CO)_6]^-$ 2

4. Determine the number of M-M bond(s) in the following complexes that obey 18 electron rule.
   (a) $Fe_2(CO)_9$ (b) $CO_2(CO)_8$ 2

5. Comment on the C-C bond length in the following complexes. 2
   (a) $[PtCl_3(C_2H_4)]^-$ (b) $[Pt(PPh_3)_2(C_2(CN)_4)]$

6. Boric acid has weak acidity, but in the presence of glycerol its acidity is remarkably increased. Explain. 3

7. 18-Crown-6 captures K^+ ion specifically. Explain the reasons behind it. 3

8. The kinetics of protonic acid catalysed iodination of acetone shows first-order dependence in both [acetone] and $[H^+]$ but zero order in [iodine]. Explain the proposed mechanistic steps for this reaction with proper explanation of each step. 4

UNIT - 5142 - P

9. (a) Write down the normalized wave function in the m^{th} state of a linear quantum harmonic oscillator having mass μ and force constant *k*. What would happen to the oscillator if m is very large? 1
   (b) Determine the eigen values of $\hat{l}_z$ and $\hat{l}^2$ operators for the spherical harmonics $Y_{3,-1}(\theta, \phi)$ of a rigid rotor. 1

   (c) Write down the Hamiltonian operator for the H_2 molecule. What is Born-Oppenheimer approximation? Mention its importance in molecular quantum mechanics. $1\frac{1}{2}$
   (d) Find the commutator $\left[\hat{l}_x, \hat{l}_z\right]$, where $\hat{l}_x$ and $\hat{l}_z$ are x and z component angular momentum operators of a rotating particle. $1\frac{1}{2}$

10. Answer the following questions : 3x3
   (a) Evaluate the uncertainty in position of a one-dimensional quantum harmonic oscillator in the ground state.
   (b) Derive the normalized angular function of the azimuth angle (ϕ) of a rigid rotor from the part of the Schrödinger equation involving ϕ.
   (c) Find the ground-state electronic energy of H atom using the following radial wave function $R(r) = 2\alpha_0^{-3/2} e^{-r/\alpha 0}$, where α_0 is Bohr/s radius.

11. (a) Induced charge per unit area is nothing but the polarization of a molecule – Justify. $1\frac{1}{2}$
   (b) Molar polarization of a certain vapor obeys the following relation.

$$P_m\left(cm^3\,mol^{-1}\right) = 60 + \frac{20.5}{T}(K)$$