Answer Five Questions Only of the following:-

1 a) Compare between the Galvanic cell and electrolytic cell, referring to the chemical reaction and the sign of the potential and the change of free energy of each cell. [24 marks]

b) A cell is made of Sn and Cu electrodes as follows:
   \[ \text{Sn/} \text{Sn}^{2+}(a=1)/\text{Cu}^{2+}(a=1)/\text{Cu} \]
   
   \((e^0)_{\text{red.}}\) for Sn = -0.140 volt, \((e^0)_{\text{red.}}\) for Cu = +0.34 volt. Write the cell reaction, then calculate the E.M.F and \(\Delta G^0\) of the cell. [19 marks]

2 a) Show how can you calculate the displacement equilibrium when a metal such as Cu is dipped in aqueous KCN to form a comparatively stable complex. [25 marks]

b) To what extent will mercuric ions oxidize ferrous ions according to the reaction:-
   \[ \text{Fe}^{2+} + \text{Hg}^{2+} \rightarrow \text{Fe}^{3+} + \text{Hg}^+ \]
   
   where all activities are equal to unity, \((e^0)_{\text{red.}}\) \text{Fe}^{3+}/\text{Fe}^{2+}=+0.771\ volt, and \((e^0)_{\text{red.}}\) \text{Hg}^{2+}/\text{Hg}^+=+0.920\ volt\ at\ 25^\circ\ C\ [18 \text{ marks}]

3 a) If CO gas molecule absorbs at 3000 cm\(^{-1}\), calculate the force constant. Give the unit and the type of spectrum. [22 marks]

b) Sketch a molecular electronic spectra for \(\text{Ar}–\text{N}=\text{N}–\text{Ar}\) molecule and their corresponding transitions. Refer to their respective energy. [22 marks]
4 a) Calculate the translational, rotational and vibrational degrees of freedom in HCl gas molecule in terms of KT. [22 marks]

b) If C\textsuperscript{12}O\textsuperscript{16} gas molecule absorbs at 3.84 cm\textsuperscript{-1} for \( J = 0 \rightarrow J = 1 \) rotational transition, calculate energy space factor and bond length. Show in what region of light lies this spectrum. [22 marks]

5 a) Write briefly on the following:-
   (i) Characters of wave function of a system. [15 marks]
   (ii) Probability [12 marks]

b) For a particle in one dimensional system, calculate the normalized wave function of the \((\sin bx)\) wave. [15 marks]

6 a) Calculate the energy requires for an electron to move between two levels n and n+1, of one-dimensional system. [20 marks]

b) For a particle in three-dimensional system, show that the energy of any general state depends on the quantum numbers in each coordinate. [22 marks]

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**Physical Constants:** \( N_A = 6.022\times10^{23} \text{ mol}^{-1} \), \( \pi = 3.142 \), \( R = 8.3145 \text{ JK}^{-1} \text{ mol}^{-1} \), \( h = 6.626\times10^{-34} \text{ J.s} \), amu = \( 1.66056 \times 10^{-27} \text{ kg} \), F = 96500 coulomb, \( k_B = 1.38066 \times 10^{-23} \text{ J.K}^{-1}. \)

With all best wishes

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