

INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY, HYDERABAD
MIDSEM EXAM for "Chemistry Topics for Engineers" (SC2-309)

TOTAL TIME: 90 min. Total points: 60.
Total of 10 questions.

1. [5 points] What is cyclic voltammetry? Draw a schematic voltammogram for an illustrative reversible redox reaction, explain various features and processes in it.
2. [5 points] Given that the standard potentials of Cu^{2+}/Cu and Cu^+/Cu are +0.340 V and +0.522 V respectively, find the standard EMF $E^0(\text{Cu}^{2+}/\text{Cu}^+)$.
3. [5 points] The transfer coefficient of a certain electrode in contact with M^{3+} and M^{4+} in aqueous solution at 25°C is 0.42. The current density is found to be 55.0 mA cm^{-2} when the overpotential is 125 mV. What is the overpotential required for the current density of 75 mA cm^{-2} . Under normal conditions, will this be large overpotential? What is the process that will dominate (anodic or cathodic)?
4. [5 points] Suppose that a charge-transfer transition (electronic transition) in a one-dimensional system can be modelled as a process in which a Gaussian wave-function centered on $x=0$ and with 'a' makes a transition to another Gaussian wave-function centered on $x=a/2$. Evaluate the transition dipole moment.
5. [5 points] Write a short note on Franck-Condon principle.
6. [5 points] Write a short note on the principle of LASER and its action.
7. [5 points] What is fluorescence and phosphorescence? Use Jablonski diagram to illustrate various processes in them. What differentiates between them?
8. [10 points] Identify the various contributions to the intensity of NMR transition and derive the formula for intensity of such a transition. Given that for ^1H nuclei, $\gamma_N = 2.675 \times 10^8\text{ T}^{-1}\text{ s}^{-1}$; for a sample containing 1 million protons, find the population difference between up and down spins, and thus the intensity in a 10 T machine.
9. [5 points] For the benzene radical anion, draw a schematic EPR spectrum. Explain various features in it.
10. [10 points] State the gross and specific selection rules for following spectroscopies: (a) rotational, (b) vibrational (c) rotational-vibrational (d) vibrational raman and (e) rotational raman spectroscopies. You may want to make a table.

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