

# PES UNIVERSITY, BANGALORE

(Established Under Karnataka Act 16 of 2013) **UE21CY141A**

**END SEMESTER ASSESSMENT B.TECH I SEMESTER, March, 2022**

**UE21CY141A – Engineering Chemistry**

**Answer All Questions**

**Max Marks:100**

**Time: 3 Hrs**

1.	a)	For a rigid rotor model of a rotating heteronuclear diatomic molecule: i) Derive an expression for the moment of inertia of the molecule. ii) Draw the energy level diagram from $J=0$ to $J=6$ . iii) Calculate the energy required (in $\text{cm}^{-1}$ ) for the molecule to move from $J=4$ to $J=5$ level if $B=13.84 \text{ cm}^{-1}$ (Given: Speed of light $=3 \times 10^{10} \text{ cm/s}$ , $\pi=3.14$ , Planck's constant $=6.627 \times 10^{-34} \text{ Js}$ ).	5
	b)	State Beer-Lambert's law. For the following electronic transitions, draw the energy level diagram, spectrum and state the condition for such a transition to occur: i) Electronic transition from $v''=0$ to $v'=0$ ii) Electronic transition from $v''=0$ to $v'=2$	5
	c)	For HCl molecule: i) Calculate the reduced mass and force constant (in $\text{N/m}$ ) if the vibrational spectrum of the molecule shows a single intense line at $3100 \text{ cm}^{-1}$ assuming it to be a harmonic oscillation model. ii) If the same molecule were to undergo anharmonic oscillations, calculate the wave number of fundamental absorption and first overtone given the anharmonicity constant of the molecule is $0.0174$ and the equilibrium vibrational frequency is $3100 \text{ cm}^{-1}$ . (Avogadro's number $=6.023 \times 10^{23}$ , speed of light $=3 \times 10^{10} \text{ cm/s}$ , $1 \text{ amu}=1.66 \times 10^{-27} \text{ kg}$ , gram molar mass of $\text{H}=1.0$ and $\text{Cl}=35.5$ , $\pi=3.14$ , Planck's constant $=6.627 \times 10^{-34} \text{ Js}$ )	6
	d)	How does the size of the particle being in nanoscale influence the following properties – (i) Surface area (ii) Electrical conductivity	4
2.	a)	For the Pb-Ag system (i) Draw a neat and labelled phase diagram. (ii) Calculate degrees of freedom along the depression in melting point curves and at the eutectic point. (iii) Give the difference between eutectic and eutectoid in two component Fe-C system.	5
	b)	(i) Draw a neat and labelled diagram of a one component water system. (ii) Using Clausius Clapeyron equation account for the negative slope of the melting point curve in the phase diagram of one component water system.	4
	c)	(i) Derive Nernst equation for a single electrode potential using thermodynamic principles. (ii) For the given cell: $\text{Fe/Fe}^{2+} (0.05) // \text{Ag}^+ (0.1) / \text{Ag}$ , Write the overall cell reaction, calculate $E_{\text{cell}}^0$ and $E_{\text{cell}}$ at $25^\circ\text{C}$ . (Given $E_{\text{Fe/Fe}^{2+}}^0 = -0.44 \text{ V}$ ; $E_{\text{Ag}^+/\text{Ag}}^0 = 0.7996 \text{ V}$ )	6
	d)	What is asymmetric electrode potential with reference to a glass electrode? The emf of a cell set up by combining glass electrode and a saturated calomel electrode at $298 \text{ K}$ was found to be $0.1069 \text{ V}$ when a buffer of pH value 4 was used. With a solution of unknown pH at the same temperature, the cell offered an emf of $0.157 \text{ V}$ . Give the cell representation. Calculate the pH of the solution. (Given $E_{\text{SCE}} = 0.2412 \text{ V}$ )	5
3.	a)	Fill the following table for Mg water activated battery. Anode Cathode Electrolyte Anodic reaction	6



		Cathodic reaction		
		Any two applications		
	b) ✓	Draw a neat and labelled diagram of a direct $\text{CH}_3\text{OH}-\text{O}_2$ polymer electrolyte membrane fuel cell, Write its anodic and cathodic reaction. State any two advantages of fuel cells over batteries? Calculate the efficiency of fuel cell, if the voltage is 1.32V. (Given: $\text{H}_2 + 1/2\text{O}_2 \rightarrow \text{H}_2\text{O}$ $\Delta H_f$ of water = -285.6 KJ $F = 96500 \text{ C/mole}$ )		7
	c) ✓	What is Ragone plot? Indicate the position of the following energy storage/conversion device in the Ragone plot - capacitors, Super capacitors, batteries and fuel cell.		3
	d) ✓	Why are lithium ion batteries safer than lithium batteries? Calculate the energy density (in Wh/kg) and power density (in W/kg) of 15 kg of lead acid battery which contains 3kg of anode material and discharges constant current for 8 hours. The voltage of the battery is 2.1 V. (Given: Atomic mass of lead 207, number of electrons released in the redox reaction is 2, $F = 96500 \text{ C}$ )		4
4.	a) ✓	What is corrosion? Draw a neat and labeled diagram of the galvanic cell formed on the surface of metal which is differentially aerated. Write all the possible cathodic reactions as per electrochemical theory of corrosion.		6
	b) ✓	How do the following factors influence the rate of corrosion i) pH ii) Nature of corrosion product iii) The ratio of anodic to cathodic area		6
	c) ✓	If an iron article is exposed to acid medium in the absence of oxygen, account for the following, i) Iron becomes brittle. ii) Corrosion control in the above condition can be achieved by the addition of antimony oxide.		4
	d) ✓	Give reasons: (i) Iron bolts in copper vessels are undesirable. (ii) Steel tank should be maintained at its passivating potential during anodic corrosion protection technique.		4
5.	a) ×	Represent graphically the change in tensile strength with increasing molecular weight of a polymer. Justify: (i) Polyacetylene (PA) conducts electricity but polyethylene does not. (ii) Kevlar fiber is much stronger than steel.		6
	b) ✓	Calculate the number average molecular weight, weight average molecular weight and polydispersity index of a polymer which contains 10 molecules with molecular weight 4300, 20 molecules with molecular weight 4600 and 30 molecules with molecular weight 6100.		5
	c) ×	Write the steps involved in the synthesis and give one property and application each of the below mentioned polymers- (i) Epoxy resin (ii) Butyl Rubber		6
	d)	State any two principles of Green Chemistry and give relevant examples.		3