

END SEMESTER ASSESSMENT (ESA) B.TECH II SEMESTER MAY 2019

UE18CY101: ENGINEERING CHEMISTRY

Time: 3 Hrs

Answer All Questions

Max Marks: 100

1	a)	Given that the spacing of the lines in the pure rotational spectrum of $^{27}\text{Al}^1\text{H}$ is constant at 12.604 cm^{-1} , calculate the moment of inertia and bond length of the molecule. (Given: Atomic masses of Al = 26.9815 amu and H = 1.008 amu, Avagadro's number = 6.023×10^{23} , Speed of light = $3 \times 10^{10}\text{ cm/s}$, $\pi = 3.14$, Planck's constant = $6.627 \times 10^{-34}\text{ Js}$, $1\text{ amu} = 1.66 \times 10^{-27}\text{ kg}$)	6
	b)	State Franck-Condon principle. With the help of suitable diagram, show the vibrational-electronic transitions and corresponding spectra for the following cases. i) Transitions takes place from $v'' = 0$ to $v' = 2$. ii) Transitions takes place from $v'' = 0$ to beyond the dissociation energy of the molecule.	5
	c)	i) Why real molecules do not obey simple harmonic oscillator model? ii) The force constant of a HF is 970 N/m . Calculate reduced mass and the spacing between two consecutive levels. (Use simple harmonic oscillator model). (Given: Atomic masses of H = 1.008 and F = 18.99, Avagadro's number = 6.023×10^{23} , Speed of light = $3 \times 10^{10}\text{ cm/s}$, $1\text{ amu} = 1.66 \times 10^{-27}\text{ kg}$, Planck's constant = $6.627 \times 10^{-34}\text{ Js}$, $\pi = 3.14$)	5
	d)	i) Define component with respect to the phase rule. Mention the number of phases and components for the following closed system $\text{NH}_4\text{Cl (s)} \rightleftharpoons \text{NH}_3\text{(g)} + \text{HCl(g)}$ ii) Write the phase rule applicable for Pb-Ag system. Calculate the number of degrees of freedom at eutectic point.	4
2	a)	i) Draw a neat labeled phase diagram of water system indicating the different areas, lines and temperature and pressure values at triple point and critical point. ii) Mention the phases that are in equilibrium with each other on meta stable curve. iii) Explain why melting point curve has a negative slope.	6
	b)	For the following cell: $\text{Ag}/\text{Ag}_2\text{CrO}_4/\text{CrO}_4^{2-}(0.25\text{ M})//\text{Fe}^{3+}(0.2\text{ M}),\text{Fe}^{2+}(0.8\text{ M})/\text{Pt}$ i) Write the half cell reactions. ii) Calculate E°_{Cell} and E_{Cell} at 298 K (Given: $E^\circ_{\text{Ag}/\text{Ag}_2\text{CrO}_4/\text{CrO}_4^{2-}} = 0.446\text{ V}$, $E^\circ_{\text{Fe}^{3+},\text{Fe}^{2+}} = 0.77\text{ V}$, $R = 8.314\text{ J/K/mol}$, $F = 96500\text{ C/mol}$)	5
	c)	i) Draw a neat labeled diagram of glass electrode and give its electrode representation. ii) Write the cell representation for a galvanic cell formed with glass electrode as cathode and calomel electrode as anode. iii) When a buffer of $\text{pH} = 7.00$ is used an EMF of 0.729 V is recorded in the above cell at 298 K . When the solution of unknown pH is used, an EMF of 0.524 V is recorded. Calculate the pH of the solution. (Given : $E_{\text{SCE}} = 0.2412\text{ V}$)	7

	d)	Calculate the EMF of the following cell $\text{Hg-Zn(C}_1\text{)/Zn}^{2+}\text{(0.25 M)/Zn-Hg(C}_2\text{)}$ at 298 K if the concentrations of zinc amalgam are; $C_1 = 0.2$ g per 100 g of mercury and $C_2 = 0.1$ g per 100 g of mercury. (Given : $E^\circ_{\text{Zn}^{2+}/\text{Zn}} = -0.76$ V, $R = 8.314$ J/K/mol, $F = 96500$ C/mol)	2								
3	a)	i) Draw a neat labeled diagram of $\text{H}_2 - \text{O}_2$ fuel cell which uses solid oxide as an electrolyte and write the reactions taking place at anode and cathode. ii) Why the above fuel cell is operated at high temperature? iii) Calculate the efficiency of the above fuel cell if the cell voltage is 1.16 V, Enthalpy of formation of water is -285.3 kJ/mol and $F = 96500$ C/mol.	7								
	b)	i) Draw Ragone plot and specify the position of supercapacitors, batteries and fuel cells. ii) Using the Ragone plot discuss the position of fuel cell.	3								
	c)	i) What are reserve batteries? Write the reactions taking place at anode and cathode in magnesium water activated batteries. ii) Calculate capacity, power density (W/kg) and energy density (Whr/kg) of a battery if 2.2 g of Lithium is stored in the battery and battery lasts for 120 mins. The battery weighs 110 g and gives steady voltage of 3.3 V. (Given : $F = 96500$ C/mol, atomic mass of Li is 7)	6								
	d)	What are supercapacitors? Why porous materials are used as electrode materials in supercapacitors? Mention any one advantage and disadvantage of supercapacitors.	4								
4	a)	i) What is galvanization? Describe the different steps involved in galvanization process. ii) Why galvanized articles are not used to store food items?	5								
	b)	What is anodic protection? Mention any one advantage of this method. Draw potential current curve used to explain active-passive transitions of metals.	4								
	c)	What is stress corrosion? Describe the caustic embrittlement with relevant reactions.	5								
	d)	Explain the effects of following factors on corrosion of metal i) Nature of the corrosion product ii) Ratio of anodic to cathodic area iii) Temperature	6								
5	a)	Calculate weight average and viscosity average molecular weight of a polymer which contains 15 molecules with molecular weight 4500, 20 molecules with molecular weight 5000 and 30 molecules with 7000 molecular weight. The value of Mark-Houwink coefficient is 0.52.	4								
	b)	Give the synthesis of epoxy resin from bisphenol-A. How is epoxy resin cured?	5								
	c)	Complete the table for Kevlar <table><tr><td>Monomers used (write structure)</td><td></td></tr><tr><td>Type of polymerization</td><td></td></tr><tr><td>Advantage</td><td></td></tr><tr><td>Disadvantage</td><td></td></tr></table>	Monomers used (write structure)		Type of polymerization		Advantage		Disadvantage		5
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	d)	i) Give any two principles of Green chemistry ii) Explain the different steps involved in the sol-gel synthesis of nanomaterials.	6								
