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PES University, Bangalore
(Established under Karnataka Act No. 16 of 2013)

UE19CY101

END SEMESTER ASSESSMENT (ESA) B.Tech I SEMESTER DECEMBER 2019

UE19CY101: ENGINEERING CHEMISTRY

Time: 3 Hrs | Answer All The Questions | Max Marks: 100

1.	a)	Give an expression for the rotational energy and draw the rotational levels of a diatomic molecule treated as a rigid rotor. The bond length of BrF molecule is 178 pm. Calculate the minimum energy (in cm^{-1}) needed for the molecule to start rotating (Rigid rotor model). (Given: gram atomic masses of Br and F are 79.904 and 18.998 respectively, 1amu = 1.66×10^{-27} kg N=6.023×10^{23} mol^{-1}, h = 6.626×10^{-34} J s, c = 3×10^{8} m s^{-1}).	6
	b)	The force constant of HCl molecule is 516 N m^{-1}. Calculate zero point energy (in cm^{-1}) of HCl molecule if it is treated as simple harmonic oscillator. (Given: N=6.023×10^{23} mol^{-1}, h = 6.626×10^{-34} J s, c = 3×10^{8} m s^{-1}, Atomic masses of H and Cl are 1.008 amu and 35.45 amu respectively)	4
	c)	State Franck –Condon principle. As dictated by Franck-Condon principle, explain the vibrational-electronic spectrum: i) Where (0,0) line has maximum intensity ii) Continuum is observed Draw the energy level diagram and the resulting spectrum.	5
	d)	For a system of C components in P phases at equilibrium, Justify: i) The number of intensive variables = P(C-1)+2 ii) The number of equations = C(P-1) Get an expression for the degree of freedom for the above system.	5
2.	a)	Draw a neat labelled phase diagram of water system. Calculate degree of freedom at triple point and on sublimation line. In the above phase diagram locate the critical point. What is the state of water beyond critical point?	5
	b)	For redox electrodes, i) Derive Nernst equation for the electrode in which following redox reaction takes place using principles of thermodynamics. $Fe^{3+} + e^{-} \rightleftharpoons Fe^{2+}$ ii) Quinhydrone electrode is a redox electrode. Justify.	5
	c)	A Galvanic cell is constructed by combining decinormal silver-silver chloride electrode with a chlorine gas electrode in which chlorine gas at 7 atm pressure is in contact with HCl solution of concentration 0.86 N. (Given: Reduction potentials are $E^{0}_{Pt/Cl2/Cl^{-}} = 1.36$ V and $E^{0}_{Ag/AgCl/Cl^{-}} = 0.22$ V) For the above cell: i) Write cell representation ii) Write the oxidation and reduction reactions at electrodes iii) Calculate E^{0}_{cell} and E_{cell} at 298 K	5
	d)	Glass electrode is a membrane electrode. i) Draw a neat labelled diagram of glass electrode ii) What is alkaline error? iii) In the determination of pH of unknown solution using glass electrode and saturated calomel electrode assembly the potentials recorded are 0.2094 V and -0.3011 V in contact with a buffer solution of pH=4 and in contact with a unknown solution respectively. Calculate the pH of unknown solution. (Given: E_{SCE}=0.244 V)	5

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3.	a)	Zinc-air battery has high energy density. Answer the following for zinc-air battery. i) Give the composition of anode, cathode, electrolyte and separator. ii) Write oxidation and reduction reaction taking place during discharge. iii) Account for the high energy density.	5
	b)	Give any two reasons for the selection of lithium as anode material in lithium batteries. A lithium battery which weighs 2 kg contains 50 g lithium as anode material offers an emf 4 V and discharges 5 A constant current. Calculate the following: i) Capacity of anode (As) ii) Energy density (Wh/kg) iii) Power density (W/kg) (Given: Atomic mass of lithium is 7, number of electrons transferred is 1, F = 96500 C mol^{-1})	5
	c)	A solid oxide fuel cell (SOFC) is very high temperature fuel cell. Answer the following for SOFC. i) Draw a neat labelled diagram of SOFC. ii) Write the reaction at anode and cathode if H_2 is the fuel. iii) Calculate the efficiency of above fuel cell if enthalpy of the cell reaction is -285.8 kJ and the cell voltage is 1.23 V.	6
	d)	A supercapacitor is known for high capacitance. i) Account for high capacitance of supercapacitor with two valid reasons ii) Draw Ragone plot and locate the position of supercapacitor and fuel cell	4
4.	a)	Justify, Corrosion is reverse process of extractive metallurgy. Describe the electrochemical theory of corrosion with appropriate reactions at anode and cathode in the presence of oxygen. If iron is exposed to ambient atmosphere write the reactions leading to formation of corrosion products in presence of: i) More oxygen ii) Less oxygen	7
	b)	Identify the type of corrosion and formation of anode and cathode area in the following cases: i) A nail partially inside wood ii) Copper pipe with iron joints iii) Iron article with ruptured tin coating	6
	c)	Give reason: i) Iron corrodes faster in coastal region ii) Arsenic oxide is used as cathodic corrosion inhibitor iii) Aluminium undergoes corrosion in alkaline medium	3
	d)	What is anodic protection? Explain, how passivation potential range is determined with the help of voltage vs current plot.	4
5.	a)	Give the synthesis of polymethylmethacrylate (PMMA) from acetone. Mention any two applications of PMMA.	4
	b)	Explain following properties of polymer with respect to their structure. i) Kevlar exhibits high degree of crystallinity ii) Cured epoxy resin is a thermosetting plastic iii) Protonic doped polyaniline is an electronic conductor (Give structure)	6
	c)	What are nanoparticles? Give any two applications of nanomaterials. Give reason for the following statement. "The absorption band of nanoparticles shows blue shift as the size of the nanoparticle decreases".	4
	d)	Calculate weight average and viscosity average molecular weight of a polymer which contains 50 molecules with molecular weight 8×10^3 and 200 molecules with molecular weight 5×10^2. (Given: Exponent in Mark–Houwink equation, a=0.7) Explain briefly any one principle of green chemistry with appropriate example.	6

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