Question Paper

Exam Date & Time: 05-May-2024 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

SECOND SEMESTER B.TECH. DEGREE EXAMINATIONS - APRIL / MAY 2024
SUBJECT: CHM 1071-CHM/CHM 1071-B/CHM 1051-B - ENGINEERING CHEMISTRY

Marks: 50 **Duration: 180 mins.**

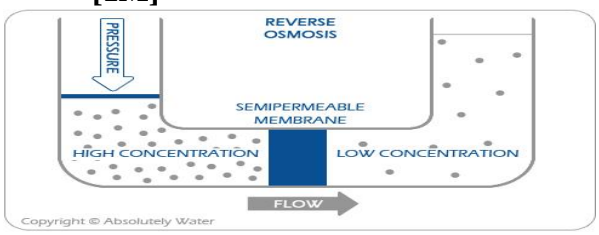
Answer all the questions.

Q. No.	Description	Marks	CO (1-5)	BL (1-6)
1 (A)	What is meant by ion-selective electrode? Derive an expression for electrode potential of glass electrode and write any two merits of it.	**4**	**CO1**	**L3**
1 (B)	Distinguish between the following: i) Activation and Concentration polarization ii) Electroplating and Electroless plating iii) Fuel Cell and Galvanic Cell iv) Primary and secondary batteries	**4**	**CO1**	**L2**
1 (C)	A galvanic cell consists of copper plate immersed in 10 M solution of $CuSO_4$ and iron plate immersed in 1M $FeSO_4$ at 298 K. Write the cell reaction and calculate E.M.F. of the cell.	**2**	**CO1**	**L2**
2 (A)	i) The concentration of yeast t-RNA in an aqueous solution is 10 M. The absorbance is found to be 0.209 when this Solution is placed in a 1.00 cm cuvette and 258 nm radiations are passed through it. a) Calculate the specific absorptivity, including units, of yeast t-RNA. and b) What will be the absorbance if the solution is 5 M? ii) Explain the conductometric titration of weak acid Vs weak base with illustration.	**4**	**CO2**	**L3**
2 (B)	Define reverse osmosis. Describe with a neat diagram how sea water is purified using this technique. Write any two advantages of it.	**4**	**CO4**	**L2**
2 (C)	i) Define electrodialysis. ii) Distinguish between hard water and soft water (Any two points).	**2**	**CO4**	**L2**
3 (A)	Discuss the autocatalytic nature of pitting corrosion with a suitable example. Explain any one primary and secondary factor each affecting the rate of pitting corrosion.	**4**	**CO3**	**L3**
3 (B)	Differentiate (Any two points) between anodic and cathodic protection methods of corrosion control. Explain how use of	**4**	**CO3**	**L2**

<table>
<tr><td></td><td>anodic and cathodic inhibitor helps in decreasing the rate of corrosion.</td><td></td><td></td><td></td></tr>
<tr><td>3 (C)</td><td>Give reason for the following;
i) The position of a metal is fixed in electrochemical series but not in galvanic series.
ii) Bolt and nut made of same metal is preferred in practice.</td><td>2</td><td>CO3</td><td>L2</td></tr>
<tr><td>4 (A)</td><td>Differentiate between the following (Any two points each)
i) Nematic and smectic phases
ii) Thermotropic and lyotropic liquid crystal.
iii) Physical vapour deposition and chemical vapor deposition techniques.
iv) Top down method and bottom - up approach.</td><td>4</td><td>CO5</td><td>L3</td></tr>
<tr><td>4 (B)</td><td>i) Polyethylene sample has the following composition.<table><tr><td>Degree of polymerization</td><td>400</td><td>300</td><td>200</td><td>100</td></tr><tr><td>% of composition</td><td>10</td><td>20</td><td>30</td><td>40</td></tr></table>Calculate the number average molecular weight, weight average molecular weight and PDI of the given polymer sample. Given: Molecular weight of monomer is 28.
ii) What is the effect of plasticizer on glass transition temperature of polymer?</td><td>4</td><td>CO5</td><td>L2</td></tr>
<tr><td>4(C)</td><td>i) Why polyvinyl chloride (PVC) has higher strength than Polyethylene?
ii) Write any two factors that affect the properties of composite materials.</td><td>2</td><td>CO5</td><td>L2</td></tr>
<tr><td>5 (A)</td><td>Compute, compare and comment on the accuracy of method of determining the pH of an unknown solution in the following cases.
When a saturated calomel electrode (E = 0.2422 V) connected to a hydrogen electrode which is dipped in a solution of unknown pH, showed a potential of 0.39 V.
When the saturated calomel electrode connected to a glass electrode which is dipped in a buffer solution of pH = 2.2 gave an emf of 0.24 V and with the solution of unknown pH gave an emf of 0.26 V.</td><td>4</td><td>CO1</td><td>L3</td></tr>
<tr><td>5 (B)</td><td>(i) List out the various steps involved in the sol-gel method of nano material synthesis.
(ii) Distinguish (Any 4 points) between particle reinforced and fiber reinforced composites.</td><td>4</td><td>CO5</td><td>L3</td></tr>
<tr><td>5 (C)</td><td>Describe the mechanism of wet corrosion</td><td>2</td><td>CO3</td><td>L2</td></tr>
</table>

Scheme of evaluation

Q. No.	Description
1 (A)	Defination of Ion selective electrode 1M The electrode which is sensitive to a specific ion present in an electrolyte whose potential depends upon the activity of specific ion in the electrolyte is called ion selective electrode. To Deduce the electrode potential : 2M The overall potential of the glass electrode is given by: Eg = Eb + Eref. + Easy. It has three components: The boundary potential Eb, Internal reference electrode potential Eref. Asymmetric potential Easy Eb = E1 – E2 = (RT/nF) ln C1 – (RT/nF) ln C2 = L + (RT/nF) ln C1 Eb depends upon $[H^+]$ Eg = Eb + EAg/AgCl + Easy = L + (RT/nF) ln C1 + EAg/AgCl + Easy. = Eog + (RT/nF) ln C1 = Eog + 0.0592 log [H+] Eg = Eog – 0.0592 pH Any two merits -1M
1 (B)	Any two differences for each 1 x 4M
1 (C)	For the cell representation ½ M Fe/FeSO4(Aq) (1M)::CuSO4(Aq) (10M) $E^0_{Cell} = E^0$cathode $-E^0$ anode = 0.34 -(-0.44) = 0.78 V ½ M Ecell value + proper substitution Ecell = 0.78 +(0.0592 /2) =0.8096 1M
2 (A)	i) **a)** 0.0209 dm^3/mol/cm **1M** **b)** 0.1045 **1M** ii) Reaction **0.5 M**

	Graph **0.5 M** Explanation **1M**
2 (B)	**Definition:** A process by which pure solvent is separated from its contaminates by using semipermeable membrane and applying high pressure on concentrated side. **[1M]**  **[1M]** In this process, pressure (of the order 15 to 40kg cm^{-2}) is applied to the sea water /impure water (to be treated) to force its pure water out through the semi permeable membrane; leaving behind the dissolved solids (both ionic as well as non-ionic). The principle of reverse osmosis, as applied for treating saline/ sea water, is illustrated in figure. The membrane consists of very thin films of cellulose acetate, affixed to either side of perforated tube. However, more recently superior membranes made of polymethacrylate and polyamide polymers have come into use. **[1M]** **Advantages (Any two)** **[1M]** (i) Reverse osmosis possesses a distinct advantage of removing ionic as well as non – ionic , colloidal and high molecular weight organic matter (ii) It removes colloidal silica which is not removed by demineralization. (iii) The maintenance cost is almost entirely on the replacement of the semi permeable membrane (iv) The life time of membrane is quite high, about two years (v) The membrane can be replaced within a few minutes there by providing nearly uninterrupted water supply. (vi) Due to low capital cost, simplicity, low operating cost and high reliability, the reverse osmosis is gaining ground at present for converting sea water into drinking water and for obtaining water for very high-pressure boilers.
2 (C)	i) Define electrodialysis. **1M** ii) Distinguish between hard water and soft water (Any two points). **1M** (Any two points)
3 (A)	Autocatalytic nature of pitting corrosion-It is self-stimulating and self-propagating. The gravity effect is a direct result of the autocatalytic nature of pitting. The initially formed pit produces condition which are both stimulating and necessary for the continuing activity of the pit. 1 M Example: Corrosion of stainless steel in NaCl medium 1M Explaining any one primary factor affecting pitting corrosion- 1M One Secondary factor affecting pitting corrosion -1M
3 (B)	Any two difference between anodic and cathodic protection methods of corrosion control 1M Explanation for anodic inhibitor with example 1 M Cathodic inhibitor – Retarding any one hydrogen evolution reaction with example 1 M Cathodic inhibitor – Retarding any one oxygen reduction reaction with example 1 M

3 (C) Proper reason 1M each

4 (A)

i) Any two points [1M]

Nematic phase	Smectic phase
The properties resemble liquids	The properties resemble solids
Only orientational order, no positional order	Possess both orientational order and positional order

ii) Any two points [1M]

Thermotropic LCs	Lyotropic LCs
Mesophases are temperature dependent	Mesophases are concentration dependent
Exhibit nematic and smectic mesophases, generally	Exhibit lamellar and cubic mesophases, generally

iii) Any two points [1M]

Features	PVD	CVD
Mechanism of deposition	Thermal energy	Chemical reaction
Deposition rate	High	Moderate
Deposited species	Atoms & ions	Precursor molecules dissociate into atoms
Energy of deposited species	Low (0.1-0.5 eV)	Low; can be high with plasma-assisted CVD
Throwing power	Poor	Good

iv) Any two points [1M]

Top down approach: Start with the bulk material and "cut away material" to make the what you want.

Eg: Ball milling process

Bottom up approach: Building what you want by assembling it from building blocks (such as atoms and molecules).

Atom-by-atom, molecule-by-molecule, or cluster-by-cluster.

Eg: Sol-gel process

4 (B)

i) Number average molecular weight = **5600 g/mol** **[1M]**

Weight average molecular weight = **7000 g/mol** **[1 M]**

PDI = **1.25** **1M**

ii) Plasticizers reduce the T_g of the polymer by reducing the cohesive forces of attraction between the polymers.

4(C)	i) Polyethylene molecule is simple and uniform, hence movement of molecule one over other is possible, i.e., slipping power is high. Hence it has lesser strength. But in case of polyvinyl chloride (PVC), bulky chlorine atoms are present along the chain length hence, movement is restricted, i.e., slipping power is less. Hence it has higher strength compared to polyethylene. **[1M]** ii) **[1M]** Properties of composite materials are determined by three factors. (Any two) a) The materials used as component phases in the composite b) The geometric shapes of the constituents c) The manner in which the phases interact with one another.
5 (A)	When a saturated calomel electrode (E = 0.2422V) connected to a hydrogen electrode: $Pt\|H_2\|H^+(X)\ \|\|KCl\|Hg_2Cl_2\|Hg$ pH = (E_{cell} – 0.2422) / 0.0592 = (0.39-0.2422) / 0.0592 = 2.49 (**1M**) When the saturated calomel electrode connected to a glass electrode $Hg\|Hg_2Cl_2\|$ KCl (saturated) || test solution | glass membrane | H^+(0.1M) | AgCl | Ag $E_{cell} = E_{cathode} - E_{anode}$ **(0.5M)** $= E_g - E_{cal}$ $= E^0_g - 0.0592pH - E_{cal}$ $pH = (E^o_g - E_{cell} - E_{cal.}) / 0.0592$ $E^o_g = 0.0592\ pH + E_{cell} + E_{cal}$ = 0.0592x2.2 + 0.24 + 0.2422 = 0.612 V **(0.5M)** $pH = (E^o_g - E_{cell} - E_{cal}) / 0.0592$ = (0.612 - 0.26 - 0.2422) / 0.0592 = 1.85 (**1M**) Comment: By comparing the two methods, the pH obtained by glass electrode is <2 so it is an erroneous value as the glass electrode has its limitation that it shows acidic error in highly acid medium. (**1M)**
5 (B)	(i) List out the various steps involved in the sol-gel method of nano material synthesis. Any four steps 4 X 0.5M = 2M (ii) Distinguish (Any 4 points) between particle reinforced and fiber reinforced composites. 4 X 0.5M = 2M
5 (C)	Consider the wet corrosion of Iron i.e., rusting of iron Rusting takes place when iron is exposed to oxygen in the presence of humidity/moisture. • At anode: $Fe \rightarrow Fe^{2+} + 2e^-$ (**0.5M**) • At cathode: $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$ (**0.5M**) $2Fe^{2+}(aq) + 4OH^- \rightarrow 2Fe(OH)_2$ (**0.5M**) In presence of enough oxygen: $4Fe(OH)_2 + O_2 + 2H_2O \rightarrow 4Fe(OH)_3$ or

	$2Fe_2O_3.6H_2O$ (Yellow rust) (**0.5M**) or In the presence of limited oxygen: $6Fe(OH)_2 + O_2 \rightarrow 2Fe_3O_4.6H_2O \rightarrow 2Fe_3O_4$ (Black rust)