Engineering Chemistry Important Questions

UNIT-I

Chapter 1. Chemical Bonding

1. What is Ionic bond? Explain the factors influencing the ionic bond formation.

2. Discuss the energy changes during the formation of covalent bond taking H_2 as an example.

3. Explain the salient features of Valence Bond Theory.

4. Explain the salient features of Molecular Orbital Theory and draw MO diagram of H_2 molecule & calculate its bond order.

5. Dipole moment of HCl molecule is 1.03D. For complete transfer of electrons, the charge on H^+ & Cl^- ions would be equal to 4.8×10^{-10} esu. The length of HCl bond is 1.275×10^{-8} cm. Calculate the % of ionic character in HCl.

6. The dipole moment of HF is 1.98D when HF forms H^+ and F^- ions by complete transfer of electrons. The charge on the ion is 4.8×10^{-10} esu and bond length is 0.98×10^{-8} cm. Calculate the percentage of ionic character in HF.

7. The dipole moment of LiH is 1.964×10^{-29} coulomb meter. When LiH forms Li^+ and H^- ions by complete transfer of electrons, the charge on the ion is 1.602×10^{-19} coulombs and bond length is 1.596×10^{-10} m. Calculate the percentage of ionic character in LiH.

8. Explain the formation of hydronium ion and ammonium ion**.**

Chapter 2. Electrical Energy Systems

1. What is single electrode potential? Derive an expression for electrode potential of an electrode.

2. Explain capacity, voltage and energy efficiency of a battery?

3. Explain the construction, working and applications of calomel electrode. How is it useful in the determination of electrode potential?

4. Explain the construction, working and applications of lead-acid battery and lithium ion battery.

5. Describe the construction, working and applications of methanol-oxygen fuel cell. Discuss the suitability of using methanol as a fuel and sulphuric acid as an electrolyte in the fuel cell.

6. The standard electrode potential of Cd electrode is –0.40 V. If the Cd electrode is dipped in 0.025 M $CdSO_4$ solution at 25 ^{0}C, what is the potential developed?

7. The *emf* of a cell $Mg|Mg^{2+}$ (0.01) || $Cu^{2+}|Cu$ is measured to be 2.78V at 298K. The standard electrode potential of Mg electrode is –2.37V. Calculate the electrode potential of copper electrode.

8. The E^0 values of $Li|Li^+$, $Zn|Zn^{++}$, $Cu|Cu^{++}$, and $Ag|Ag^+$ are -3.0V, -0.77V, +0.33V and +0.80V respectively. Which combination of the electrodes you use to construct a cell of highest *emf* if the ionic concentrations are 0.1M, 1.0M, 10M and 0.01M in the same order. Justify your answer.

9. Calculate the potential of Zn-Ag cell at 298K if the concentration of Zn^{+2} and Ag^+ are 1.3×10^{-3} M and 5.2×10^{-6} M respectively. E^0 value of the cell at 298K is 1.5V. Calculate the change in free energy ΔG for the reduction of one mole of Ag^+. Given: 1 Faraday = 96.5 kJ/V mole.

10. An electrochemical cell consists of Mg electrode dipped in 0.05M $Mg(NO_3)_2$ solution and Ag electrode dipped in 0.4M $AgNO_3$ solution. The standard electrode potentials of Mg and Ag electrodes are -2.37V and 0.80V respectively. Represent the cell, write the cell reactions and calculate the *emf* of the cell.

11. If the emf of $Zn|Zn^{+2}(1M)$ || $Ni^{+2}(1M)|Ni$ is 0.51V and $Ni|Ni^{+2}(1M)$ || SCE is 0.49V, then calculate $E^o_{Zn+2/Zn}$. Given: E^o_{SCE} = 0.24V.

12. Calculate the voltage in the following cell $Mn|Mn^{+2}$ || $Fe^{+2}|Fe$, when Fe rod is immersed in 1M $FeSO_4$ solution and Mn rod is immersed in 0.1M $MnSO_4$ solution. Given: $E^0_{Fe+2/Fe}$ = -0.4V and $E^0_{Mn+2/Mn}$ = -1.18V.

Chapter 3. Polymers

1. Explain the free radical mechanism of addition polymerization by taking ethylene as an example.

2. Discuss the preparation, properties and applications of PMMA and Polyurethane.

3. Explain the synthesis, properties and applications of Epoxy resin.

4. Explain the mechanism of conduction in Polyacetylene.

5. Calculate the molecular weight of the given addition polymer: $[-CH_2-CH(CH_3)-]_{1000}$.
   Given: atomic mass of C = 12, H = 1.

6. A polymer sample contains 1, 2, 3 & 4 molecules having molecular weights 1×10^5, 2×10^5, 3×10^5 and 4×10^5 respectively. Calculate the number average and weight average molecular weight of the polymer.

7. A polymer of polypropylene is found to have the following composition.

(i) $R\text{-}[CH_2\text{-}CH(CH_3)\text{-}]_{400}R$ 20%

(ii) $R\text{-}[CH_2\text{-}CH(CH_3)\text{-}]_{500}R$ 30%

(iii) $R\text{-}[CH_2\text{-}CH(CH_3)\text{-}]_{600}R$ 50%

Calculate the number average and weight average molecular masses of the polymer (atomic mass of C = 12, H = 1, neglect the molecular mass of R).

UNIT-II

Chapter 4. Plating Techniques

1) Give the importance of plating techniques.

2) Explain the determination of throwing power of plating bath solution using Haring - Blum cell.

3) Discuss the process of gold plating using acid cyanide bath and mention its engineering applications.

4) What is electroless plating? Mention the advantages of electroless plating over electro plating.

5) What is electroless plating? Describe the electroless plating of copper in the preparation of PCB.

6) Calculate the throwing power of a plating bath in a Haring - Blum cell if the distances of the two cathodes from the anode are 6 cm and 5 cm and the quantities of metal deposited are 72 mg and 75 mg respectively. In the same cell if one of the cathode which was fixed at 6 cm was moved to 8 cm from the anode, calculate mass of metal deposited on the electrode.

7) Calculate the percentage of throwing power of plating bath solution in a Haring - Blum cell if the distances between the two cathodes are 6.6 cm and 4 cm from the anode and the masses of the plating on the cathodes are 52 mg and 55 mg respectively.

8) The throwing power of an electrolyte in a Haring Blum cell is 75%. In an experiment, 68 mg of the metal was deposited at the nearest cathode kept at a distance of 4.8 cm from the cathode. At what distance must the cathode be kept if the metal deposited on it is 64 mg?

Chapter 5. Wafer Technology

1) Explain with neat diagram, the manufacture of electronic grade silicon by CVD process.

2) Describe the process of zone refining in the purification of silicon.

3) Discuss in detail the process of Czhochralski crystal pulling technique in the production of single crystal silicon.

4) Describe the fabrication process of silicon wafers by thermal oxidation with relevant reactions?

5) Explain with neat diagram the process of diffusion for the development of silicon wafers of known dopant concentration.

6) Describe the technique of ion implantation used for doping process with neat diagram.

7) What is epitaxial growth? Explain with neat diagram a typical vapour phase epitaxial growth system.

8) Explain with neat diagram different lithographic steps involved in selective diffusion over a wafer.

9) A silicon crystal is to be grown by Czhochralski process and is to contain 5×10^{15} boron atoms per cm^3. Given: $K_0 = 0.8$ for boron in silicon, atomic weight of B = 10.81g/mole, density of Si = $2.33 g/cm^3$, Avogadro number = 6.023×10^{23} atoms/mole.
   (a) Determine the initial concentration of boron atoms in the melt to produce the required density.
   (b) If initial amount of silicon in the crucible is 50 kg, how many grams of boron should be added?

10) Define segregation constant (K_0). A semiconductor crystal with acceptor concentration, NA is $2x10^{16}$ atoms/cm^3 must be obtained by Czhochralski crystal pulling technique. What weight of Boron must be added to the melt if it contains 10 Kg of Si?
    Given: $K_0 = 0.8$ for Boron in Si;
    Atomic weight of B = 10.81g/mole, Density of Silicon = 2.33 g/cm^3,
    Avogadro number = 6.023×10^{23} atoms/mole

11) A silicon crystal is to be pulled from the melt and doped with phosphorus. If Si weight is 1 Kg, how many grams of phosphorus should be introduced to achieve a donor concentration of 2×10^{15} atoms/cm^3 during initial growth?
    Given: $K_0 = 0.32$ for P in Si;
    Atomic weight of P = 30.97g/mole, Density of Si = $2.33 g/cm^3$, Avogadro number = 6.023×10^{23} atoms/mole.

12) Determine the ratio of silicon consumed to the thickness of grown SiO_2 layer over the wafer. If SiO_2 layer of 1000 ^oA is to be grown, what would be the thickness of used silicon? Given:
Atomic weight of Si = 28.09 g/mol. Density of Si = 2.33 g/cm^3.
Molecular weight of SiO_2 = 60.08 g/mol.
Density of SiO_2 = 2.20 g/cm^3.

13) Determine the ratio of Si consumed to the thickness of grown SiO_2 layer over the wafer. If 100 ^oA thick Si is used for the process, what would be the thickness of SiO_2 grown? Given: Atomic weight of silicon = 28.09 g/mol. Density of silicon = 2.33 g/cm^3. Molecular weight of SiO_2 = 60.08 g/mol. Density of SiO_2 = 2.20 g/cm^3.

14) Calculate the increase in thickness of Silicon wafer during the process of oxidation, if 50 ^oA thick Si is used for the process. Given: Atomic weight of Si = 28.09 g/mol. Density of Si = 2.33 g/cm^3. Molecular weight of SiO_2 =60.08 g/mol. Density of SiO_2 = 2.20 g/cm^3.

15) Phosphorus is implanted in n-type silicon sample with a uniform doping concentration of 5 x 10^{16} atoms/cm^3. If the beam current density is 2.5 $\mu A/cm^2$ and the implantation time is 8 minutes, calculate the implantation dose.

Chapter 6. Material Chemistry

1) Define liquid crystals and explain the classification of liquid crystals with examples.

2) Explain the process of liquid crystal display with respect to 201.

3) Explain the process of fluorescence and phosphorescence with help of Jablonski diagram.

4) What are thermoelectric and piezoelectric materials and mention their properties and applications.

UNIT-III

Chapter 7. Instrumental Methods of Measurement

1) Give the advantages of instrumental methods of analysis over conventional methods.

2) Explain the principle and methodology involved in potentiometer.

3) State Lambert – Beer's law. Explain the principle and methodology involved in colorimeter.

4) Discuss with neat diagram working of double beam ultraviolet spectrophotometer.

5) In the potentiometric determination of FAS, the equivalence point was found to be 8.2 ml when 100 ml of FAS solution was titrated against 0.4 N $K_2Cr_2O_7$ solution at 25^0C. Calculate the amount of ferrous ammonium sulphate.

6) In the colorimetric estimation of copper, the optical density values for the series of solution of concentrations 1×10^{-3}, 2×10^{-3}, 3×10^{-3}, 4×10^{-3}, 5×10^{-3}, 6×10^{-3} and 7×10^{-3} moles/dm^3 are 0.08, 0.16, 0.25, 0.33, 0.42, 0.50 and 0.58 respectively. Verify Beer-Lamberts law with the graph and calculate the amount of copper present in the supplied solution whose OD is 0.21

Chapter 8. Environmental Chemistry

1) Discuss the sources and ill effects of fluoride and nitrate in drinking water.

2) Explain the determination of total hardness of water by EDTA method.

3) Describe the process of BOD determination of a sewage sample by Winkler's method.

4) Describe the determination of COD of a sewage sample.

5) Calculate the temporary hardness and permanent hardness of water sample which contains 16.2 mg/liter of $Ca(HCO_3)_2$, 14.6 mg/liter of $Mg(HCO_3)_2$, 22.2 mg/liter of $CaCl_2$, 18.0 mg/liter of $MgSO_4$ and 55.0 mg/liter of NaCl.

6) 50 ml of water sample requires 10 ml of 0.01 N EDTA when titrated using buffer solution whose pH is 10 to attain the end point. Calculate the total hardness of water sample in terms of ppm equivalent of $CaCO_3$ per liter.

7) 25 ml of waste water was diluted to 500 ml and equal volumes are filled in two BOD bottles. In the blank titration 100 ml of diluted waste water when titrated immediately required 6.1 ml of 0.02 N thiosulphate solution. 100 ml of the incubated sample after 5 days required 3.6 ml of 0.02 N thiosulphate solution. Calculate BOD of the waste water.

8) 20 ml of sewage sample for COD is reacted with 25 ml of $K_2Cr_2O_7$ and the un-reacted $K_2Cr_2O_7$ requires 9.0 ml of N/4 FAS solution. Under similar conditions, in blank titration, 15.0 ml of FAS is used up. Calculate the COD of the sewage sample.

9) Define BOD and COD. In COD experiment, 30 ml of an effluent sample required 9.8 ml of 0.01 N $K_2Cr_2O_7$ solution for oxidation. Calculate the COD of sewage sample

April_2022

15ECHB102

SRN

I Semester B.E. Examination
(Common to All)
Engineering Chemistry (15ECHB102)

Duration: 3 hours **Max. Marks: 100**

Note: *i) Answer any TWO full questions from UNIT-I, any TWO full questions from UNIT-II and any ONE full question from UNIT-III.*

UNIT-I

1 a. Explain the salient features of Molecular Orbital Theory and draw the MO diagram of H_2 molecule and calculate its bond order. (07 marks)

b. Explain the free radical mechanism of addition polymerization by taking ethylene as an example. (07 marks)

c. An electrochemical cell consists of iron electrode dipped in 0.1 M $FeSO_4$ and silver electrode dipped in 0.05 M $AgNO_3$ solution. The standard reduction potential values of iron and silver are -0.44 V and 0.80 V respectively. Write the cell representation, cell reactions and calculate emf of the cell at 298 K. (06 marks)

2 a. Define single electrode potential. Derive Nernst equation for single electrode potential of an electrode. (07 marks)

b. What are polymers? Explain the synthesis, properties and applications of polyurethanes. (07 marks)

c. Define ion bond. The dipole moment of HCl molecule is 1.03D. For complete transfer of electrons, the charge on H^+ and Cl^- ions would be equal to 4.8×10^{-10} esu. The length of HCl bond is 1.275×10^{-8} cm. Calculate the percentage of ionic character in HCl. (06 marks)

3 a. Describe the construction, working and applications of methanol-oxygen fuel cell. (07 marks)

b. Explain the construction, working and applications of lead-acid battery. (07 marks)

c. A polymer sample contains 2, 3, 4 and 5 molecules having molecular weights 2×10^5, 3×10^5, 4×10^5 and 5×10^5 respectively. Calculate the number average and weight average molecular weights of a polymer sample. (06 marks)

UNIT-II

4 a. Describe the electroless plating process of copper and its application in the preparation of PCB with neat diagram. (07 marks)

b. Describe with neat diagram the fabrication process of thermal oxidation with relevant reactions. (07 marks)

c. Explain the process of fluorescence and phosphorescence with the help of Jablonski diagram. (06 marks)

5 a. Discuss in detail the process of Czhochralski crystal pulling technique in the production of single crystal silicon. (07 marks)

b. What are liquid crystals? Explain the classification of liquid crystals with example. (07 marks)

c. Determine the ratio of silicon consumed to the thickness of grown SiO_2 layer over Si wafer. If SiO_2 layer of 5000Å is to be grown, what would be the thickness of used Si? Given: Atomic weight of Si = 28.09 g/mole, Density of Si = 2.33 g/cm^3, Molecular weight of SiO_2 = 60.8 g/mole and Density of SiO_2 = 2.20 g/cm^3. (06 marks)

6 a. Describe with block diagram, the technique of ion implantation employed for the fabrication of n or p type Si wafers. (07 marks)

b. Define throwing power. Explain the determination of throwing power of plating bath solution using Haring-Blum Cell. (07 marks)

c. A silicon crystal is to be pulled from the melt and doped with phosphorus. If Si weight is 1 kg, how many grams of phosphorus should be introduced to achieve a donor concentrations of 2×10^{15} atoms/cm^3 during initial growth?
Given: $K_O = 0.32$ for 'P' in silicon; Atomic weight of 'P' = 30.97 g/mole; Density of Si = 2.33 g/cm^3; Avogadro number = 6.023×10^{23} atoms/mole. (06 marks)

UNIT-III

7 a. Explain the principle and methodology involved in potentiometry with respect to FAS. (07 marks)

b. Discuss with neat diagram the working of double beam UV-Spectrophotometer. (07 marks)

c. In the colorimetric estimation of copper, the optical density values for the series of solutions of concentrations $1x10^{-2}$, $2x10^{-2}$, $3x10^{-2}$, $4x10^{-2}$, $5x10^{-2}$, $6x10^{-2}$ & $7x10^{-2}$ moles/dm^3 are 0.08, 0.16, 0.25, 0.33, 0.42, 0.50 & 0.58 respectively. Verify Beer-Lamberts law with neat graph and calculate the amount of copper present in the supplied solution whose optical density is 0.21. (06 marks)

8 a. Discuss the determination of total hardness of sample of water by Na_2EDTA method. (07 marks)

b. Explain the determination of COD of a sewage sample. (07 marks)

c. Define COD. 20 ml of sewage sample for COD is reacted with 25 ml of $K_2Cr_2O_7$ solution and the unreacted $K_2Cr_2O_7$ requires 9.0 ml of 0.25 N FAS solution. Under similar condition, in blank titration 15.0 ml same FAS is used up. Calculate the COD of the sewage sample. (06 marks)