**Sample Questions for reference (Engineering Chemistry)**

**[Module-1] Water**

* How caustic embrittlement occurs due to the use of hard water? Explain with suitable reactions involved.
* What are the disadvantages of hard water in various industries?
* Distinguish between temporary and permanent hardness. Explain disadvantages of hardness in any six industries.
* Distinguish between carbonate and non-carbonate hardness. Write the reactions of lime and soda with following impurities present in hard water; a) Acids b) CaSO4 c) CO2
* A sample of water on hardness estimation, found to contain:

| **Impurity** | **Ca(HCO3)2** | **Mg(HCO3)2** | **CaCl2** | **MgSO4** | **CaSO4** |
| --- | --- | --- | --- | --- | --- |
| **Quantity**  **(mg/L)** | **1.62** | **14.6** | **1.11** | **24** | **13.6** |

Calculate the temporary and permanent hardness of above sample.

* Distinguish between temporary and permanent hardness (4 points).

Write the reaction of lime and soda with following impurities

1. Mg(HCO3)2 B ) CO2 C) Al2(SO4)3  D) H2SO4

* What is equivalence of CaCO3 hardness? Find the equivalence of CaCO3 hardness in ppm and degree Clarke from following data;

1. 73 mg of Ca(CO3)2 dissolved in 500 ml water
2. 34 mg of CaSO4 dissolved in 1 lit water

* Define hardness of water. Determine temporary, permanent and total hardness of water having following impurities; Mg(NO3)2= 7.4 mg/L, CO2= 22 mg/L, KNO3= 10 mg/L, MgCO3= 2.05 mg/L, CaCl2= 3.33 mg/L, NaHCO3= 12 mg/L
* Explain the process of determining all types of hardness using EDTA titrations derive the necessary formula.
* State, what is temporary and permanent hardness? Calculate temporary hardness, permanent hardness and total hardness of hard water sample having the following constituents: Mg(HCO3)2 = 7.3 ppm, NaHCO3 = 4.2 ppm, Ca(HCO3)2 = 8.1 ppm, MgCl2 = 3.8 ppm, Ca(NO3)2 = 4.1 ppm, NaNO3 = 10 ppm
* If, 50 mL standard hard water having 1000 mg/L CaCO3 equivalent hardness, requires 25 mL EDTA for titration. 50 mL unknown sample hard water requires 35 mL of same EDTA for titration. After boiling and filtration, 50 mL unknown sample hard water requires 18 mL of same EDTA for titration. Calculate each type of hardness from the given information.
* 50 ml of standard hard water (1.2 g/lit CaCO3) required 13 ml of EDTA for titration using EBT indicator. 100 ml of water sample required 18 ml of same EDTA for titration while 50 ml of boiled water sample required 6 ml of EDTA. Calculate the temporary, permanent and total hardness.
* Give the formulae of finding the quantities of lime and soda requirement. What is the reaction of lime and/or soda with the following constituents in hard water:

a) Ca(HCO3)2, b) MgCl2, c) Ca(NO3)2

* Calculate the quantities of lime and soda (both 100% pure) for softening of 4 x 106 liters of water containing the following constituents:

CaCl2= 2.22 ppm, Mg(HCO3)2 = 29.2 ppm, H2SO4 = 9.8 ppm, MgCl2= 95 ppm, CaSO4 =

2.72 ppm, KCl = 100 ppm

* Calculate the amount of lime (90 % pure) and soda (95 % pure) in kg, required for softening of 100000 litres of hard water having the following chemical constituents: Ca(HCO3)2 = 16.2 mg/L, Mg(HCO3)2 = 14.6 mg/L, CaSO4 = 1.36 mg/L, CaCl2 = 11.1 ppm, MgCl2 = 9.5 ppm.
* Explain the principle, working of cold lime-soda method / hot lime-soda method with suitable diagram.
* Calculate the quantity of lime (80% pure) and soda (70% pure) for softening of 50000 liter of water having following impurities: Ca(HCO3)2= 8.1 ppm, MgCO3 = 2.1 ppm, H2SO4= 4.9 ppm, MgCl2= 1.9 ppm, Ca(NO3)2= 4.1 ppm, KNO3= 10 ppm
* An exhausted zeolite softener was regenerated by passing 80 litres of 150 g/litre solution of NaCl. Calculate the volume of water softened (having 600 ppm hardness) using this zeolite softener.
* Explain the ion exchange process for the removal of hardness with a schematic diagram. Write the reactions during the softening and regeneration processes.
* Explain the demineralization process of softening hard water with suitable reactions and a suitable diagram.
* 50 ml of hard water (1 g CaCO3/liter) required 22 ml of EDTA solution for titration using EBT. 50 ml of unknown water sample required 18 ml of same EDTA for titration. 100 ml of boiled water sample required 14 ml of same EDTA solution. Calculate temporary hardness.
* Explain with suitable diagram and reactions softening of hard water using Zeolite Permutit Method. Write its 2 advantages over lime soda Method.
* 25000 liter of hard water was softened by ion exchange column. For the regeneration of exhausted column 175 liter of 0.1 N HCl solution was used. Calculate the hardness of hard water.
* For BOD and COD numerical refer study material
* Explain five opportunities for the use of AI and IoT techniques in water resource management.
* Explain five applications of AI and IoT for water quality management.

**[Module-2] IMP Engineering materials**

**Polymers**

1. How we can classify the polymers on the basis of
2. SOURCES
3. TACTICITY
4. THERMAL PROPERTIES
5. INTERMOLECULAR FORCES
6. STRUCTURE
7. Write difference between –
8. Thermoplastic and thermosetting
9. Addition and condensation Polymerization
10. What is Polymerization? Explain Addition Polymerization. Identify type of polymerisation – (Polypropylene, Polyamide)
11. What is Polymerization? Explain Condensation Polymerization. Identify type of polymerisation – (Polypropylene, Polyamide)
12. What is Number average Molecular weight, Weight average Molecular weight and Polydispersity index?
13. Give any two applications of the polymer mentioned below -

Poyethylene, Poly Propylene, Polystyrene, Polybutene, Spandex, Kevlar and Polyterpthalate

1. Explain the working principle of following fabrication method with labelled diagram –
2. Compression moulding
3. Transfer moulding
4. Injection moulding
5. Extrusion moulding
6. Explain compression moulding? For which type of polymer it is applicable?
7. Which type of moulding is used for coating the wires used for insulation?
8. What are conducting polymers? How can we classify it?
9. Explain –
10. Intrinsic Conducting Polymer
11. Extrinsic Conducting Polymer
12. Write a note on Doped Conducting Polymers (DCP)
13. What are biodegradable polymers? State the advantages of Biodegradable polymer
14. Numerical based on average molecular weight

**Nanomaterials**

1. What are nanomaterials? How can we classify nanomaterials?
2. Expalin –
3. Surface Effect
4. Quantum Effect
5. What are the top-down and bottom-up approaches in the synthesis of nanoparticles?
6. What are Fullerenes? Mention its properties and applications.
7. What are quantum dots? Mention its properties and applications.
8. What are CNT’s? Mention its properties and applications.
9. Explain the following methods of Carbon Nanotubes preparation:
10. Arc method
11. Laser ablation Method
12. Chemical Vapour Deposition Methods

**Biomaterials**

1. What are biomaterials?
2. Applications of metals and alloys in biomedical field
3. What are bioceramics? Classify them
4. Properties and Applications of bioceramics
5. Applications of ceramic nano-biocomposites
6. Write two advantages and two limitations of using stainless steel as biomedical implant.

**MEMS**

1. What is MEMS?
2. Discuss the applications of silicon as a substrate in MEMS
3. Discuss the applications of MEMS as chemical and biological sensors
4. Describe the working principle of chemical and biosensors
5. Applications of MEMS as chemical and biological sensors

**[Module-3] Sustainable Energy**

1. State five advantages and five limitations of Renewable energy resources.
2. Give eight characteristics of ideal fuel.
3. Explain the synthesis method of Biodiesel. State the advantages and limitations of biodiesel.
4. Calculate GCV and NCV for sample of coal containing: Carbon: 82%, Hydrogen= 5%, Nitrogen= 2.5%, Sulphur=1.5% and ash =3%.
5. Explain the construction and working of solar water heater with the help of suitable diagram.
6. What is power alcohol? State four advantages and four limitations of power alcohol.
7. Calculate GCV and % Hydrogen for coal sample having NCV= 7890 Kcal /Kg and following composition: Carbon = 80 %, Nitrogen = 4%, Oxygen = 5 %, Sulphur = 3%.
8. Li-ion battery
9. Ni-Cd battery
10. Lead Acid battery
11. Solar Photovoltaic cell for the generation of electricity

**[Module-4] Spectrophotometery**

1. What is spectroscopy and spectrophotometery? What are electroanalytical techniques?
2. State and derive Beer’s law.
3. State and derive Lambert’s law
4. State and derive Beer -Lambert’s law
5. Explain the construction and working of a single-beam spectrophotometer with neat labelled diagram.
6. Explain the construction and working of a double-beam spectrophotometer with neat labelled diagram.
7. State the Applications of Beer -Lambert’s law?
8. State the advantages and limitations of UV-Vis spectrophotometery.
9. What is fundamental modes of vibrations in IR spectroscopy?
10. Discuss finger print region in IR spectroscopy with suitable examples.
11. Explain with the help of neat diagram construction and working of combined glass electrode in pH meter.
12. Calculate absorbance and molar absorptivity of KMnO4 solution having 3.5 x 10-4 g/litre concentration which absorbs 60 % of incident radiation at 545 nm of 1 cm path length cuvette. [Mol. Wt. = 158 g/mol]
13. Explain the principle of conductometric titration with suitable example.
14. If the molar absorptivity of a given substance is 4700 dm3mol-1cm-1. The transmittance of this solution is 0.7 in the cell of path length 1 cm. calculate the concentration of the solution. What will be the concentration of the solution if the transmittance will be 0.8 and the cell path length will be increased to 2 cm.
15. What is the condition for a molecule to be IR active? Explain with suitable examples. Give the IR frequency range for mid, far and finger print regions.

**[Module-5] Computers and Chemistry**

1. What is computational chemistry? State its advantages
2. Describe various computational methods
3. Discuss the various quantum mechanics methods
4. Elaborate on the scope of Cheminformatics and Bioinformatics
5. State the limitations and applications of Bioinformatics
6. Distinguish between Cheminformatics and Bioinformatics
7. What is e-waste? elaborate on the various sources of e-waste
8. Discuss about the composition of e-waste
9. Describe the effects of e-waste on Human health and environment
10. Need of E-waste Management
11. Roles and Responsibilities of consumers / citizens in e-waste management
12. Roles and Responsibilities of industries in e-waste management
13. Roles and Responsibilities of government in e-waste management