Chapter-wise Weightage

Engineering Chemistry [ESE 2022-23 (SEM-I)]

- Water: 25
- Polymer: 15
- Energy: 25
- Spectroscopy: 20
- Green/Nano: 15

Sample Questions for reference (Engineering Chemistry)

Water

- A sample of water on hardness estimation, found to contain:

Impurity	$Ca(HCO_3)_2$	$Mg(HCO_3)_2$	$CaCl_2$	$MgSO_4$	$CaSO_4$
Quantity (mg/L)	1.62	14.6	1.11	24	13.6

  Calculate the temporary and permanent hardness of above sample.

- Define COD method and state its two advantages over BOD.
- 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) $CaSO_4$ c) CO_2
- Distinguish between temporary and permanent hardness (4 points).

Write the reaction of lime and soda with following impurities
A) $Mg(HCO_3)_2$ B) CO_2 C) $Al_2(SO_4)_3$ D) H_2SO_4

- What is equivalence of $CaCO_3$ hardness? Find the equivalence of $CaCO_3$ hardness in ppm and degree Clarke from following data;
  a) 73 mg of $Ca(CO_3)_2$ dissolved in 500 ml water
  b) 34 mg of $CaSO_4$ dissolved in 1 lit water

- Define hardness of water. Determine temporary, permanent and total hardness of water having following impurities; $Mg(NO_3)_2$= 7.4 mg/L, CO_2= 22 mg/L, KNO_3= 10 mg/L, $MgCO_3$= 2.05 mg/L, $CaCl_2$= 3.33 mg/L, $NaHCO_3$= 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: $Mg(HCO_3)_2$ = 7.3 ppm, $NaHCO_3$ = 4.2 ppm, $Ca(HCO_3)_2$ = 8.1 ppm, $MgCl_2$ = 3.8 ppm, $Ca(NO_3)_2$ = 4.1 ppm, $NaNO_3$ = 10 ppm

- If, 50 mL standard hard water having 1000 mg/L $CaCO_3$ 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 $CaCO_3$) 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) $Ca(HCO_3)_2$, b) $MgCl_2$, c) $Ca(NO_3)_2$

- Calculate the quantities of lime and soda (both 100% pure) for softening of 4×10^6 liters of water containing the following constituents:
  $CaCl_2$= 2.22 ppm, $Mg(HCO_3)_2$ = 29.2 ppm, H_2SO_4 = 9.8 ppm, $MgCl_2$= 95 ppm, $CaSO_4$ = 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: $Ca(HCO_3)_2$ = 16.2 mg/L, $Mg(HCO_3)_2$ = 14.6 mg/L, $CaSO_4$ = 1.36 mg/L, $CaCl_2$ = 11.1 ppm, $MgCl_2$ = 9.5 ppm.

- Calculate the quantity of lime (80% pure) and soda (70% pure) for softening of 50000 liter of water having following impurities: $Ca(HCO_3)_2$= 8.1 ppm, $MgCO_3$ = 2.1 ppm, H_2SO_4= 4.9 ppm, $MgCl_2$= 1.9 ppm, $Ca(NO_3)_2$= 4.1 ppm, KNO_3= 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 removal of hardness with schematic diagram. Write the reactions during softening and regeneration process.

- Explain the demineralization process of softening hard water, with suitable reactions with suitable diagram.

- 50 ml of hard water (1 g $CaCO_3$/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 regeneration of exhausted column 175 liter of 0.1 N HCl solution. Calculate the hardness of hard water.

- What is BOD / COD. Give the significance of each with suitable formulae.

- 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 ion exchange process for removal of hardness with schematic diagram. Write the reactions during softening and regeneration process.

- Distinguish between COD and BOD (6 points). Give formula for COD and BOD calculation.

- 5o 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.

- State, what is temporary and permanent hardness? Calculate temporary hardness, permanent hardness and total hardness of hard water sample having the following constituents: $Mg(HCO_3)_2$ = 7.3 ppm, $NaHCO_3$ = 4.2 ppm, $Ca(HCO_3)_2$ = 8.1 ppm, $MgCl_2$ = 3.8 ppm, $Ca(NO_3)_2$ = 4.1 ppm, $NaNO_3$ = 10 ppm

- If, 50 mL standard hard water having 1000 mg/L $CaCO_3$ 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.

- How caustic embrittlement occurs due to the use of hard water? Explain with suitable reactions involved. What are the consequences of hard water in pharmaceutical industries?

- Calculate the COD of 20 mL effluent sample, which after reaction with $K_2Cr_2O_7$, H_2SO_4, Ag_2SO_4 mixture, required 7 mL of 0.1 N FAS solution. The blank titration required 15 mL of 0.1 N FAS solution.

- The sewage sample containing 200 ppm dissolved oxygen after 5 days of BOD reaction, if the dilution factor of this reaction is 2 and the initial dissolved oxygen content was 750 ppm. Calculate the BOD.

- Explain the demineralization process of softening hard water, with suitable reactions (no diagram required).

- 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) $Ca(HCO_3)_2$, b) $MgCl_2$, c) $Ca(NO_3)_2$

- Calculate the quantities of lime and soda (both 100% pure) for softening of 4×10^6 liters of water containing the following constituents: $CaCl_2$= 2.22 ppm, $Mg(HCO_3)_2$ = 29.2 ppm, H_2SO_4 = 9.8 ppm, $MgCl_2$= 95 ppm, $CaSO_4$ = 2.72 ppm, KCl = 100 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.

- An exhausted zeolite column required 150 litres of 10 % (w/v) NaCl solution for regeneration. Calculate the volume of 450 ppm hard water that can be passed through the column before getting exhausted.

- Draw only neat labeled diagram of hot lime soda process for water softening.

Polymers

- Distinguish between Condensation polymers and addition polymers or Condensation polymerization and addition polymerization.

- Distinguish between Thermosetting plastics and thermoplastics or thermosetting polymers and therm-softening polymers

- Explain with suitable examples, following ingredients and there use in compounding of plastics: a) Filler b) Binder c) Catalyst d) Pigment e) Lubricant f) Plasticizers

- What are bio-degradable polymers? Give the properties (any two) and uses (any two) of plexi-glass and Kevlar polymer.

- Explain the preparation, properties and uses of poly-paraphenylene terephthalamide polymer.

- Explain the classification of polymer with suitable example on the basis of

  a) Tacticity b) Origin c) polymerization

- Explain the synthesis, properties and applications of the following polymers (any one will be expected in the exam):
  1. Poly Vinyl Acetate (PVAc)
  2. Poly Methyl Methacrylate (PMMA)
  3. Poly-Paraphenylene Terephthalamide (KEVLAR)

4. Polylactic acid
5. PDMS

- Explain the following conducting polymers with suitable examples. State two applications of conducting polymers.
  1. Intrinsically conducting polymers
  2. Doped conducting polymers
  3. Extrinsically conducting polymers

- State six characteristics of thermosetting polymers. What is average molecular weight of a polymer? Give the formula for Mark-Houink equation for calculation of viscosity average molecular weight.

- In a polymeric mixture, there are 500 molecules with molecular weight 5000, 700 molecules with molecular weight 3500 and 300 molecules with molecular weight 2000. Find Mn, Mw and P.D.I.

- In a given polymer, there are 200 molecules of molecular weight 2000, 100 molecules of molecular weight 5000 and 300 molecules of molecular weight 3000. Find number average, weight average and PDi of the polymer.

- In a polymer having composition as given in the following table, calculate number average, weight average molecular mass and PDI.

Molecular weight	**Number of molecule**
500	100
1000	200
3000	1000
5000	3000

- Explain the synthesis, properties and applications of polycarbonate polymer.

- State the functions of plasticizers in compounding of plastics process. Give one example of plasticizer used in plastic industry.

- Discuss chemical vapor deposition method for the synthesis of SWNT and MWNT. Draw neat labeled diagram for the same.

- Explain with suitable examples, following ingredients and there use in compounding of plastics: Filler b) Binder c) Catalyst d) Pigment

- In a given polymer, there are 200 molecules of molecular weight 2000, 100 molecules of molecular weight 5000 and 300 molecules of molecular weight 3000. Find number average, weight average and PDi of the polymer.

- What is molding of plastics? Explain compression molding method with suitable diagram.

- Explain, doped conducting polymers with suitable examples. State two applications of conducting polymers.

- What are bio-degradable polymers? Give the properties (any two) and uses (any two) of plexi-glass and Kevlar polymer.

- What is compounding of plastic. Explain the two functions of any four components of compounding mixture.

- Explain synthesis, properties and applications of dimethyl siloxane polymer.

- What is thermosetting polymer? Explain the fabrication of thermosetting polymer with schematic diagram.

- What is polymerization? Explain with schematic diagram working of transfer moulding

- Explain the following term with suitable example

- Explain synthesis, properties (four points) and uses (four points) of polyvinyl acetate.

- Calculate number average and weight average molecular mass for a polymer having following composition in its poly dispersed solution as given in the table.

Polymer	**Number of molecule**
$-(CH_2\text{-}CH_2)-_{350}$	550
$-(CH_2\text{-}CH_2)-_{500}$	300

$+CH_2\text{-}CH_2+_{750}$	150

ENERGY

- Discuss the necessity of renewable energy resources in India (5 points). State any two challenges in their implementation.
- What is calorific value? Explain the process of experimental determination of % carbon and % Hydrogen using combustion technique (diagram not expected).
- Discuss the process of refining of petroleum from crude oil (diagram not required). State the advantages of catalytic cracking over thermal cracking (any 4).
- What is unleaded petrol? State its advantages.
- State: a) Octane number b) Cetane number
- A sample of coal contains: C = 90 %, H = 5 %, O = 2 %, S = 2 %, N = 1 %. Calculate, GCV and LCV of coal in cal/g.
- An air dried coal weighing 3.5 gm was taken for volatile matter determination. After loss of volatile matter the coal sample weighed 2.03 gm. If it contains 5 % moisture find the % Volatile matter present in this coal sample.
- State any four important characteristics of an ideal fuel.
- A coal sample contains, C = 80 %, H_2 = 4 %, O_2 = 3 %, N_2 = 3 %, S = 2 %, Ash = 4 %, Moisture = 4 %. Calculate the quantity of air required for the complete combustion of 3 kg of coal, if 30 % excess air is supplied.
- Explain the construction and working of solar photo-voltaic cell with neat labeled diagram.
- Calculate GCV of coal sample containing C = 70%, H = 8%, S = 3%, N = 8%, ash = 5%
- 1.8 gram of coal sample is heated in combustion tube experiment. The vapour released during experiment was absorbed in $CaCl_2$ tube and KOH bulb. The increase in mass of $CaCl_2$ tube and KOH bulb was found to be 0.8 g and 2.96 g respectively. Calculate the percentage carbon in coal sample.

- A coal has C = 72%, H = 8%, N = 6%, S = 3%, O = 5% and remaining ash Calculate the amount of air required for combustion of 5 Kg of coal.

- Explain construction and working of flat plate collector. Give to advantages.

- Knocking b) Octane number c) Gross calorific value d) Centigrade heat unit e) Cetane number

- Explain five advantages and challenges in utilizing solar energy.

- 2.2 gram of coal in Kjeldahl's method gave NH_3 gas which required 15 ml of 0.5 N H_2SO4 for neutralization. 1.8 g of coal in bomb calorimeter experiment gave 0.35 gram of $BaSO_4$ residue. Calculate the % N and % S of coal.

- Explain proximate analysis and give the significance each parameter involved.

- Explain Ultimate analysis and give the significance each parameter involved.

- State the carbon composition, boiling range and applications of the following components of fractional distillation of crude oil:
    1. Petroleum ether
    2. Gasoline
    3. Kerosene
    4. Diesel
    5. Lubricating oil
    6. Naphtha
- Explain fixed bed catalytic cracking with the help of suitable diagram.

- Explain fluid bed or moving bed catalytic cracking with the help of suitable diagram.

SPECTROSCOPY

- What is conductometric titration? Explain the determination of equivalence point for titration of weak acid and strong base

- What is finger print region in IR spectroscopy? Write IR frequencies of following functional group.
  Carbonyl group C=O bond b) Ether C-O bond c) alkane C-H bond

- What are frequencies for near, mid and far IR spectroscopy? What is the condition for a molecule to absorb IR frequencies?
- Derive an expression for Beer's law and Lambert's law. Also derive combined Beer's law and Lambert's law.

- Why there is a need of standardization of pH electrode? Discuss the process of standardization of pH meter using various buffer solutions.

- State five applications of UV-Visible spectroscopy. Give five limitations of Beer-lambert's law.

- Give the IR frequencies of following :
  a) C-Br (in haloalkanes) b) N-H stretching (in amines) c) C-O stretching (in ethers) d) =C-H stretching (in alkenes) e) CN stretching (in cyanides)

- Calculate the fundamental modes of vibrations for the following molecules:
  a) Benzene b) Carbon dioxide c) Phenol d) Water e) Anisole

- Explain the principle involved in conductometric titration. When HCl is titrated with NH_4OH solution, having 0.1 N concentrations each, explain the nature of graph of conductance VS volume of base added.

- 6.5×10^{-4} M solution of an absorbing species is placed in a cell of path length 1 cm. Transmittance measured is 62 %. Calculate the absorbance and molar absorptivity of the solution?

- With the help of schematic diagram explain construction and working of single beam/double beam spectrophotometer. Explain the functions of each component involved.

- State Beer-Lambert's law. Calculate the molar absorptivity of 2.3×10^{-4} mol dm^{-3} solution which absorbs 60 % of incident light measured in cuvette of 1 cm path length.

- Calculate the number of fundamental modes of vibration for:
  a) Toluene b) Benzene

- The transmittance of 2.5×10^{-4} M solution was found to be 80 % in path length of 1 cm.

Calculate the a) absorbance b) Molar absorptivity c) % T for the path length of 2 cm. Explain with the help of suitable graphical diagram, Coductometric titration of acetic acid versus ammonium hydroxide.

- Explain with the help of graph the conductometric titration of mixture of strong acid and weak acid against strong base.

GREEN CHEMISTRY / NANOTECHNOLOGY

- Define green Chemistry. Calculate percentage atom economy for the following reaction with respect to Cinnamaldeyde.

$$C_6H_5CHO + CH_3CHO \rightarrow C_6H_5CH{=}CH\ CHO + H_2O$$

- Discuss with suitable examples, why there is a need of,
  - Designing safe chemicals and products
  - Energy efficient chemical processes

- Why, 'Prevention of waste' is one of the important principles of green chemistry?

- Justify the, 'Non-hazardous chemical synthesis' principle of green chemistry using green chemistry route and the conventional synthesis route of some industrially important chemical product.

- State any five properties and five applications of carbon nanotubes (CNTs).

- Explain five applications of Nanomaterials in medicine and electronic field

- Explain structure, properties (4 points) and applications (4 points) of C_{60} Fullerene.

- Calculate the atom economy for following Friedel-Craft acylation reaction for benzene

$$C_6H_6 + CH_3\text{-}CO\text{-}Cl \text{ --------> } C_6H_5COCH_3 + HCl$$

- Explain why properties of nano materials are different from its properties in bulk form with respect to quantum confinement effect and surface area.

- Explain the following methods of synthesis of CNTS:

- Arc method
- CVD method
- Laser Ablation method

- Explain conventional route and green route for the synthesis of the following:
  - Indigo dye
  - Adipic acid

- Explain the traditional and green way to synthesize Indigo dye. Identify which principle of Green Chemistry is justified.