2. CHEMISTRY

Course Content

General & Physical Chemistry (Section A)

Unit 1: Chemical Bonding and Shape of Molecules - 3 teaching hours

1. Hybridization and concept of sigma and pi bond
2. Valence shell Electron Pair Repulsion (VSEPR) theory
3. Prediction of molecular geometry (Shape of molecules) on the basis of VSEPR and hybridization. (BeF_2, BF_3, NH_3, H_2O, CH_4, H_2O, C_2H_2 C_2H_4 H_2S)

Unit 2: Volumetric Analysis - 8 teaching hours

1. Different ways of expressing the concentration of solutions
   i. Molarity, ii. Normality iii. Molality iv. Gram /Litre v. Percentage
2. Titration : i. acid-base titration ii. Redox titration
3. Primary standard substances, primary standard solution , secondary standard solution, end point, equivalence point, neutral point, indicators
4. Derivation of normality equation
5. Relation between normality and molarity
6. Selection of indicators in acid-base titration and pH curve
7. Solving related numerical problems

Unit 3: Ionic Equilibrium - 12 teaching hours

1. Introduction
2. Ionization of weak electrolyte (Ostwald's dilution law)
3. Degree of ionization and ionization constant
4. Strength of acids and base interm of K_a, K_b and pK_a and pK_b values
5. Acid-base concept
   i. Arrhenius concept of acids and bases. ii. Bronsted lowry concept of acids and bases
   iii. Lewis concept of acids and bases.
6. Ionization of water, pH and pH scale.
7. Hydrolysis of salts. (qualitative concept)
8. Solubility product principle and its application
9. Common ion effects and its application
10. Application of solubility product principle in qualitative analysis
11. Buffer Solution (Solving numerical problems related with solubility, solubility product, pH and pOH)

Unit 4: Electrochemistry - 10 teaching hours

1. Introduction
2. Electrolysis; strong and weak electrolyte
3. Arrehenius theory of ionization
4. Faraday's laws of electrolysis
5. Criteria of product formation during electrolysis
6. Electrolytic conduction, equivalent and molar conductivities
7. Variation of conductivity with concentration
8. Electrode potential, standard electrode potential, standard hydrogen electrode and its applications
9. Eletrochemical series and its use to predict the feasibility of redox reactions
10. Electrochemical cell (Galvanic cell)
11. EMF of electrochemical cell in the standard state (Solving related numerical problems)

Unit 5: Energetics of Chemical Reactions - 8 teaching hours

1. Introduction , unit of energy
2. Some thermodynamical terms: system, surrounding , boundary , universe different types of system, state function, state variables and internal energy
3. Exchange of energy between the system and surrounding
4. Different types of thermodynamic process
5. The first law of thermodynamics
6. Sign convention of heat and work
7. Enthalpy, enthalpy change in chemical reactions
8. Hess's law of constant heat summation
9. Heat of neutralization, heat of solution, heat of combustion, heat of vapourization, heat of formation and bond energy (Solving related numerical problems)

Unit 6: Chemical Thermodynamics - 6 teaching hours

1. Spontaneous process
2. Second law of thermodynamics
3. Entropy and its physical concept
4. Entropy change in phase transformation
5. Entropy and spontaneity
6. Entropy changes and their calculation
7. Gibb's free energy and prediction for the feasibility of reaction
8. Standard free energy change and equilibrium constant
9. Influence of temperature on spontaneous process (Calculation involving in standard free energy change and equilibrium constant)

Unit 7: Chemical Kinetics - 10 Teaching hours

1. Concept of reaction rate
2. Average rate and instantaneous rate of a reaction
3. Factors that influences the rate of reaction
4. Rate law equation, rate constant and its units
5. I^{st} order, II^{nd} order, III^{rd} order and zero order reactions
6. Order and molecularity of a reaction
7. Integrated rate law for a first order reaction
8. Half-life of a reaction (first order)
9. Explaining the increase in reaction rate with temperature or collision theory (qualitative concept only)
10. Concept of activation energy as the energy barrier, activated complex and effect of catalyst on the rate of reaction (Solving related numerical problems)

Organic Chemistry

Section B

Unit 8: Aromatic Hydrocarbon - 3 teaching hours

1. Definition, characteristics of aromatic compounds, Huckel's rule, structure of benzene, isomerism and orientation of benzene derivatives
2. Preparation of benzenes from
   i. decarboxylation ii. phenol iii. ethyne iv. chlorobenzene
3. Physical properties of benzene
4. Chemical properties of benzene
   i. Addition reaction : hydrogen, halogen and ozone
   ii. Electrophilic substitution reactions: nitration, sulphonation, halogenation Friedal craft's alkylation and acylation
   iii. Combustion of benzene and uses

Unit 9: Haloalkanes and Haloarenes - 8 teaching hours

9.1. Haloalkanes:

1. Introduction, classification and isomerism
2. Preparation of monohaloalkanes from alkanes, alkenes and alcohols
3. Physical properties of monohaloalkanes
4. Chemical properties
   - Substitution reactions
   - Elimination reaction (dehydrohalogenation)
   - Grignard's reactions
   - Reduction reactions
   - Wurtz's reaction
5. Polyhaloalkane ;
   - Laboratory preparation of trichloromethane from ethanol and propanone
   - Physical properties of trichloromethane
   - Chemical properties : oxidation, reduction, action on Silver Powder, conc. nitric acid, propanone, aqueous alkali, Carbylamine reaction, Remer Tiemann reaction , Iodoform reaction, etc.

9.2 Haloarenes:

1. Preparation of chlorobenzene from i. benzene ii. benzene diazonium chloride
2. Physical properties
3. Chemical properties
   - Low reactivity of haloarene as compared to haloalkane in term of nucleophilic substitution reaction
   - Reduction of chlorobenzene
   - Electrophilic substitutre reactions
   - Action with Na, Mg and chloral etc.
   - Uses

Unit 10: Alcohols and Phenols - 10 teaching hours

10.1. Alcohols:

1. Introduction, classification, nomenclature and isomerism
2. Distinction of primary, secondary and tertiary alcohol by Victor Meyer's Method
3. Preparation of monohydric alcohols form i. haloalkane ii. Grignard's reagents using aldehydes and ketones iii. primary amines iv. Ester
4. Industrial preparation ethanol form: i. Oxo-process ii. Fermentation of sugar iii. hydroboration of ethane
5. Physical properties monohydric alcohols
6. Chemical properties of monohydric alcohols

- Reaction with HX. PX_3, PCl_5 $SOCl_2$
- Action with reactive metals like Na, K, Li
- Esterification process
- Dehydration of alcohols.
- Oxidation of primary, secondary and tertiary alcohol with oxidizing agents.
- Reduction of alcohols (Catalyic dehydrogenation)
- Laboratory test of ethanol
- Absolute alcohol, methylated spirit, rectified spirit; alcoholic beverage.

• Preparation and uses of ethan- 1, 2.diol (glycol)
• Preparation and uses of Propan – 1, 2, 3 triol (glycerol)

10.2. Phenols:

1. Introduction to phenol
2. Preparation of phenol from i. chlorobenzene ii. Diazonium salt and iii. benzene sulphonic acid
3. Physical properties of phenol
4. Chemical properties
   - Acidic nature of phenol
   - Action with PCl_5, PX_3, NH_3, Zn, Na benzene diazonium chloride and phthalic anhydride
   - Acylation reaction, Kolbe's reaction, Reimer–Tiemann's reaction
   - Electrophilic substitution: halogenation, nitration, sulphonation, bromination and Friedal Craft's alkylation
   - Laboratory test of phenol
   - Uses of phenol

Unit 11: Ethers - 4 teaching hours

11.1 Aliphatic Ethers:

1. Introduction, nomenclature classification, isomerism in ether
2. Preparation of ethers from i. alcohol ii. Williamson's etherification process
3. Laboratory preparation of ethoxy ethane form ethanol
4. Physical properties of ether
5. Chemical properties of ethorxyethane

- action with HI , PCl_5, con. HCl, Conc. H_2SO_4 air and Cl_2
- Uses of ethoxy ethane

11.2 Aromatic Ether:

- Preparation of methoxy benzene (anisole)
- Halogenation, nitration and sulphonation reactions

Unit 12: Aldehydes and Ketones - 11 teaching hours

12.1 Aliphatic Aldehydes and Ketones

1. Introduction, structure of carbonyl group, nomenclature and isomerism in carbonyl compound
2. Preparation of aldehydes and ketones from
   i. Dehydrogenation and oxidation of alcohol
   ii. Ozonolysis of alkenes
   iii. Acid chloride
   iv. Gem dihaloalkane
   v. Calalytic distillation of fatty acid
   vi. Distillaiton of salt of fatty acid
   vii. Catalyic hydration of alkynes
3. Physical properties
4. Chemical properties
   i. Addition reaction: addition of H_2, HCN, $NaHSO_3$ and Grignand's reagents

ii. Action with ammonia derivatives; NH_2OH, NH_2-NH_2, phenyl hydrazine, semicarbazides and 2,4-DNP
iii. Reduction properties of aldelydes
– Oxidation with Tollen's reagent, Fehling's solution
iv. Aldol condensation reaction; clemenson's reduction Wolf- Kischner reduction, Action with PCl_5, action with $LiAlH_4$
v. Special reaction of methenal; cannizzaro's reaction, action with ammonia, action with phenol. formalin and its uses

12.2 Aromatic Aldelydes and Ketones :

- Preparation of benzaldelyde from toluene
- Properties of benzaldelyde
- Important reaction benzaldehyde different form aliphatic aldehydes:
  - Perkin condensation - Benzoin condensation
  - Electrophilic substitution reaction - Cannizzaro's reaction
- Preparation of acetophenone by Friedal Craft's acylation

Unit 13: Carboxylic Acids - 10 teaching hours

13.1 Aliphatic Carboxylic Acids:

- Introduction, nomenclature, examples
- Preparation of monocarboxylic acids from
  i. aldehydes ii. nitriles iii. Grignard's reagents iv. dicarboxylic acid v. sodium alkoxide. vi. trihaloalkanes
- Physical properties of monocarboxylic acids
- Chemical properties: Action with alkalies metal oxides, metal carbonates, metal bicarbonates, PCl_3, $LiAlH_4$ and dehydration of carboxylic acid, esterification, halogenation
- Effect of constituents on the acidic strength of carboxylic acid
- Laboratory preparation of methanoic acid
- abnormal behaviour of methanoic acid
- Uses of carboxylic acid

13.2 Derivatives of Carboxylic Acid:

1. Nomenclature, preparation and properties of i. Acid halides ii. Acid amides iii. Acid anhydrides and iv. Esters

13.3 Aromatic Carboxylic Acids:

- Preparation of benzoic acid
- Physical and chemical properties
- Uses of benzoic acid

Unit 14: Nitrocompounds: - 4 teaching hours

14.1 Aliphalic Nitrocompounds (Nitroalkane):

1. Introduction and nomenclature
2. Preparation from haloalkane and alkane
3. Physical properties
4. Reduction of nitroalkane
5. Uses

14.2 Aromatic Nitrocompounds:

1. Laboratory preparation of nitrobenzene
2. Physical properties
3. Chemical properties:
   - Reduction in different media - Electrophilic substitution reactions - Uses of nitrobenzene

Unit 15: Amino Compounds (Amines and Aniline) - 7 teaching hours

15.1 Aliphatic Amines:

1. Introduction, nomenclature and classification
2. Separation of primary , secondary and tertiary amines by Hoffmann's method
3. Preparation of primary amines from haloalkane, nitriles, nitroalkanes and amides
4. Physical properties
5. Chemical Properties: basicity of amines, comparative study of basic nature of 1°, 2° and 3° amines. Reaction of Primary amines with chloroform, conc. HCl, R-X, RCOX and nitrous acid ($NaNO_2$ / HCl)
6. Test of 1°, 2° and 3° amines. (nitrous acid test)

15.2 Aromatic Amine (Aniline):

1. Laboratory preparation of aniline
2. Physical properties

3. Chemical properties: bassicity of aniline, comparision of basic nature of aniline with aliphatic amines; alkylation, acylation, diazotization, carbylamine and coupling reaction
4. Electrophilic substitution : Nitration, sulphonation and bromination
5. Uses of amine

Unit 16: Molecules of Life - 8 teaching hours

1. Carbohydrates: definition, classification of carbohydrates, various examples of carbohydrate of different class. structure of glucose and fructose, function of carbohydrates, sugar and nonsugar
2. Protein :definition, amino acid, essential and non-essential aminoacids, peptide linkage, hydrolysis of aminoacids, denaturation of protein, zwitter ions, functions of aminoacids
3. Nucleic acid: definition, basic compo ents of nucleic acid; doule helix, difference between RNA and DNA; biological function of nucleic acid
4. Lipid: definition, fatty acids, fat as ester of fatty acid and difference between fats and oils, function of lipid
5. Enzymes and their functions

Unit 17: Chemistry in Service to Mankind - 10 teaching hours

1. Polymer: definition, natural and synthetic polymers, homopolymers and co-polymer Preparation of some polymers; PVC, polyethene, polystyrene, Teflon, Nylon-66, Bakelite and their uses
2. Dyes: definition, natural and synthetic dyes, names and structure of some common drug, drug addiction
3. Fertilizer: definition, chemical and organic fertilizers, nitrogen fertilizer, phosphatic fertilizer; fertilizer as pollution
4. Pesticides: insecticides, herbicides. weedicides and fungcides (examples and their uses)

Inorganic Chemistry

Section C

Unit 18: Heavy Metals -18 teaching hours

1 General Characteristics of Transition Metals

18.1. Copper:

1. Position in periodic table
2. Occurrence and extraction of copper form copper pyrites
3. Properties and uses
4. Chemistry of (i) blue vitriol (ii) black oxide of copper (iii) red oxide of copper

18.2 Zinc:

1. Position in periodic table
2. Occurrence and extraction of zinc from zinc blende
3. Properties and uses of copper
4. Preparation properties and uses of zinc white and white vitriol
5. Galvanization

18.3 Mercury:

1. Occurrence and extraction of Hg from Cinnabar
2. Properties of mercury
3. Mercury poisoning and uses of Hg
4. Preparation, properties and uses of (i) Calomel (ii) Corrosive Sublimate

18.4. Iron:

1. Occurrence and extraction 2. Varieties of Iron
3. Properties of Iron
4. Manufacture of Steel by
   i. Bessemer process ii. Open hearth process
5. Heat treatment of steel
6. Stainless steel
7. Rusting of iron and its prevention
8. Uses and biological importance of iron
9. Structure and uses of green vitriol, Ferric chloride Mohr's salt

18.5. Silver:

1. Extraction of Silver by cyanide process and its uses
2. Preparation and uses of
   iv. Silver chloride
   v. Silver nitrate

Practical

The following is the list of experiments. The students are required to perform in the practical classes in Grade XII.

A. Experiments based on recovery and preparation of salt.

1. To recover blue vitriol crystal from the given mixture of copper sulphate and Sodium chloride;
2. To recover $CaCO_3$ from the mixture of $CaCO_3$ and $MgCO_3$ (dolomite); and
3. To obtain hydrated calcium sulphate form the given marble chips.

B. Experiments on volumetric analysis (Titration)

4. To prepare primary standard solution of Na_2CO_3 and standardize the given acid solution HCl by the standard solution;
5. To determine the strength of approximate $\frac{N}{10}$ NaOH solution with the help of standard decimal solution of HCl supplied
6. To determine the strength of bench sulphuric acid (H_2SO_4) with the help of standard NaOH or Na_2CO_3 solution and express the concentration in (i) normality (ii) molarity (iii) gm/litre (iv) percentage (Double titration)
7. To standardize the given approximate $\frac{N}{10}$ $KMnO_4$ solution with the help of primary standard oxalic solution. (Redox titration) ;
8. To determine the enthalpy of neutralization of a strong acid and strong base;
9. To complete salt analysis by dry and wet ways. (at least 3 salts);
10. To detect foreign elements present in a given organic compounds. (N, S and X);
11. To identify the functional group present in the organic compounds. (OH, -COOH, - CHO, > CO, - NH_2); and
12. To test the presence of
    a. Saturated or unsaturated fats, b. Carbohydrate,
    c. Proteins, d. Phenol.

Note: The experiment no.9 requires 4 practical periods. The experiment no. 10 requires 3 practical periods, the experiment no. 11 requires 3 periods and remaining experiments require 1 period of each. (2 theory periods will be equivalent to 1 practical period.)

Exam Oriented Model Question

Time: 3 hrs. **Full Marks:- 75**
Pass Marks:- 27

Group A

Attempt any fifteen questions. **[15×2=30]**

1. What will be the shape of a molecule whose central atom is sp^2 hybridized. Also, give an example of it. **(From Unit 1)**
2. 3.2 g H_2SO_4 is dissolved in 200mL of water. Calculate molarity of the solution. ***[Ans: 0.2 M]*** **(From Unit 2)**
3. Write suitable examples to show water acts as Bronsted-Lowry acid and base. **(From Unit 3)**
4. How many coulombs are required for the following oxidation.
   (i) 0.1 mol of Zn to Zn^{2+}. ***[Ans: 1.93 × 10⁴C]***
   (ii) 0.1 mol of $H_2C_2O_4$ to CO_2? **(From Unit 4)** ***[Ans: 1.93 × 10⁴C]***
5. State the first law of thermodynamics. **(From Unit 5)**
6. Find out the entropy change for the vaporization of benzene at 353K. The enthalpy of vaporization of benzene is 30.54 $kJmol^{-1}$. ***[Ans: 86.5 JK^{-1} mol^{-1})*** **(From Unit 6)**
7. Define rate of a chemical reaction. What is meant by rate law of a chemical reaction. **(From Unit 7)**
8. Give any two methods of preparation of benzene. **(From Unit 8)**
9. Chloroform does not give white precipitate with $AgNO_3$ solution, why ? **(From Unit 9.1)**
10. Mention a chemical test to distinguish propan-1-ol from propan-2-ol. **(From Unit 10.1)**

11. How can we prepare methoxy benzene by williamson's etherification process ? **(From Unit 11.2)**

12. What happens when formaldehyde is heated with ammonia. Give the structure and name of the product formed. **(From Unit 12.1)**

13. Identify the compound A and B in the following reaction and give it's IUPAC name. **(From Unit 13.2)**

$$CH_3COOH \xrightarrow[(ii)\ NH_3]{(i)\ SOCl_2} A \xrightarrow[\Delta]{(Br_2 + NaOH)} B$$

14. What are the products obtained when nitrobenzene is reduced in acidic and neutral medium ? **(From Unit 14.2)**

15. Methylamine is more basic than aniline, how ? **(From Unit 15.1)**

16. What is meant by denaturation of protein ? **(From Unit 16)**

17. Differentiate between DNA and RNA. **(From Unit 16)**

18. Name the monomers of Bakelite and Nylon-66. **(From Unit 17)**

19. What is an analgesic ? Give one example of it. **(From Unit 17)**

20. Define the terms hardening, tempering and annealing. **(From Unit 18.4)**

21. Which compound of silver is used in photography ? Mention one method to prepare this compound. **(From Unit 18.5)**

22. What is the action of heat on white vitriol ? **(From Unit 18.2)**

Group B

Attempt any five questions. **[5×5=25]**

23. Describe laboratory method of preparation of diethylether. **(From Unit 11.1)**

24. An organic compound A ($C_5H_{10}O$) reacts with phenylhydrazine to form Phenylhydrazone. The compound does not reduce Fehlings solution but gives positive Iodoform test. The compound on Clemensen's reduction given n-pentane. Identify the organic compound giving necessary chemical equations. **(From Unit 12.1)**

25. Give two chemical methods of preparation of phenol. Although phenol is more acidic than alcohol, it does not give CO_2 gas with $CaCO_3$. Why ? How do you convert phenol into
(a) Salicylaldehyde (b) Picric acid. **(From Unit 10.2)**

26. (a) State and explain second law of thermodynamics. What are the criteria for a reaction to be spontaneous. **(From Unit 6)**

(b) Define Hess law of constant heat summation. The standard enthalpies of formulation of $H_2O_2(\ell)$ and $H_2O(\ell)$ are - 188 $kJmol^{-1}$ and – 286 $kJmol^{-1}$ respectively. Calculate the enthalpy change for the decomposition of 68 g of H_2O_2 into H_2O and O_2. Is the reaction exothermic or endothermic ? **(From Unit 5)**

[Ans: –196 kJ; Exothermic)

27. State and explain Faradays first law of electrolysis and using this law define electro-chemical equivalent. **(From Unit 4)**

An electric current is passed through a solution of (i) Silver nitrate and (ii) a solution of 10g of hydrated $CuSO_4$ Crystals in 500 mL of water, Pt-electrode being used in each case. After 30 minutes it was found that 1.307 g silver had been deposited. What was the concentration of Cu^{2+}, after electrolysis ?
(Atomic masses : Cu = 63.5, Ag = 108 amu) **(From Unit 4)**

[Ans: 4.3218 gL^{-1})

28. Write a method of preparation of blue vitriol. Describe it's action with.
(i) Ammonia solution till excess (ii) aquous potassium iodide. **(From Unit 18.1)**

29. Describe the different steps involved in extraction of zinc from zinc blende. **(From Unit 18.2)**

Group C

Attempt any two questions. **[10×2=20]**

30. Describe the factors that affect the rate of a chemical reaction.
The following rate data were obtained at 303 K for the reaction $2A + B \rightarrow C + D$.

Experiment	[A] $MolL^{-1}$	[B] $MolL^{-1}$	[Initial rate] $MolL^{-1}s^{-1}$
1	0.1	0.1	6×10^{-3}
2	0.3	0.2	7.2×10^{-2}
3	0.3	0.4	2.88×10^{-1}
4	0.4	0.1	2.4×10^{-2}

[Ans: rate = k[A] [B]²; 1 w.r.to [A] & 2 w.r.to [B] & overall (1 + 2) = 3; k = mol^{-2} L^2s^{-1})
What is the rate law ? What is the order with respect to each reactant and overall order ? Give the unit of k. **(From Unit 7)**

31. (a) How is anlydrous formic acid prepared in laboratory ? Suggest a suitable chemical test to distinguish between methanoic acid from ethanoic acid. **(From Unit 13.1)**
(b) How will you convert Toluene into m-bromo phenol ? **(From Unit 10.2)**

32. How is aniline prepared in laboratory ? Describe the process involved. Convert the following : **(From Unit 15.2)**
(i) Aniline into azodye (ii) Benzaldehyde into cinnamic acid.

33. Write short notes on any two: **[5×2=10]**
(a) Separation of 1°, 2° and 3° amines by Hoffmann's Method. **(From Unit 15.1)**
(b) Selection of indicator in acid base titration. **(From Unit 2)**
(c) Extraction of Iron from Haematite. **(From Unit 18.4)**
(d) Chemistry of Calomel. **(From Unit 18.3)**

Exam Questions

Section A: General & Physical Chemistry

Unit 1: Chemical Bonding and Shape of Molecules

Very Short Questions

(All questions are of equal value, 2 marks each.)

1. Define hybridization and write any two features of tetrahedral hybridization. 1+1 **[Q.N.1, 2072'C']**
2. What are the features of tetrahedral hybridization? Write an example of it. 1+1 **[Q.N.1, 2072'D']**
3. State the mode of hybridization in B of BF_3 and C of C_2H_6. **[Q.N.1, 2072'E']**
4. What is the mode of hybridization in carbon of acetylene ? Write any two correct features of this hybridization. 1+1 **[Q.N.1, Supp. 2071]**
5. Predict the geometry of molecules having:
a) sp^3 hybridization
b) sp hybridization with an example of each. **[Q.N. 1, Set 'C' 2071]**
6. Write any two features of sp^3hybrid orbital with an example. 1+1**[Q.N. 1, Set 'D' 2071]**
7. Which kind of hybridization results into tetrahedral geometry ? Mention any one character of such hybridization. **[Q.N.1, 2070 'Supp']**
8. What is meant by hybrid orbital? Write an example of it. **[Q.N. 1, 2070 'C']**
9. Why do NH_3 and BF_3 have dissimilar geometries? **[Q.N. 1, 2070 'D']**
10. Mention any two importance character of hybrid orbital. **[Q.N. 1, Supp. 2069]**
11. Nitrogen of ammonia gets sp^3 hybridization but ammonia molecule has trigonal pyramid geometry. Give reason. **[Q.N. 1, Set 'A' 2069]**

12. What is the mode of hybridization of B in BF_3? Write any two important features of this hybridization. [Q.N. 1, Set 'B' 2069]
13. Write any two important characters of tetrahedral hybridization. [Q.N.1,2068]
14. Mention one example of each :
(i) Tetrahedral hybridization (ii) Trigonal hybridization [Q.N. 1, 2067]
15. What is the mode of hybridization of the central atom whose molecular geometry is tetrahedral ? And, give an example of it. [Q.N. 1, 2066]
16. Predict the mode of hybridization in
(i) C of C_2H_4 [Q.N.1(i), 2065]
(ii) B of BF_3 [Q.N.1(ii), 2065]
17. Why is H-O-H bond angle in water molecule comparatively higher than H-S-H bond angle in H_2S molecule ? [Q.N. 1, 2064]
18. Define hybridisation. Draw the orbital picture of a hydrocarbon showing tetrahedral structure. [Q.N.1, 2063]
19. How do you predict the molecular geometry of NH_3 based on VSEPR model ? [Q.N.1, 2062]
20. The bond angle at the central atom in NF_3 is 107°, whereas in BF_3 is 120°. What factor accounts for the difference in bond angles ? [Q.N. 1, 2061]
21. How would you interprete that all four C-H bonds of methane are identical ? [Q.N. 1, 2060]
22. Draw the molecular orbital picture of ethene. [Q.N. 1, 2059]
23. Draw the orbital picture of ethyne indicating sigma and pi bonds. [Q.N. 1, 2058]
24. How doyou predict the molecular geometry of NH_3based on VSEPR model ? [Q.N. 1, 2057]
25. Draw the shapes of sp and sp^2hybrid orbitals. [Q.N. 1, 2056]
26. Identify the hybridization of the indicated atom in each of the following molecules.
(a) Be in BeF_2 (b) B in BF_3 (c) N in NH_3 [Q.N. 2, 2053]
27. Predict the structure of methane based on hybridization. [Q.N. 1, 2052]

Short Questions

(All questions are of equal value, 5 marks each.)

1. Using VSEPR theory explain the shapes of BeF_2 and BF_3. [Q.N. 24, 2056]
2. Explain the state of hybridization of c-atoms in ethyne molecule. [Q.N. 23, 2055]
3. What do you understand by sp^2 hybridization ? Using any example explain the molecular geometry involved. [Q.N. 24, 2054]

Long Questions

(All questions are of equal value, 10 marks each.)

1. Write notes on : VSEPR model. [Q.N. 31(iv), 2061]

Unit 2: Volumetric Analysis

Very Short Questions

(All questions are of equal value, 2 marks each.)

1. Distinguish between end point and equivalence point of reaction. 1+1 [Q.N.2, 2072'C']
2. A sample of Na_2CO_3 weighing 0.53 g is added to 101 mL of 0.1N H_2SO_4 solution. Will the resulting solution be acidic, basic or neutral? [2] [Q.N.2, 2072'E']
3. Define the terms :
(i) seminormal solution (ii) alkalimetry [Q.N.2, 2070 'Supp']
4. Define secondary standard solution with a suitable example. [Q.N. 2, 2070 'C']
5. Distinguish between decinormal solution and decimolar solution. [Q.N. 2, Supp. 2069]
6. Write an example of redox titration. Why is it called so ? [Q.N. 17, 2067]
7. What is normality ? How is it related with molarity ? [Q.N.17, 2065]
8. What do you mean by equivalent weight of an element ? [Q.N. 3, 2054]

9. What are the requisites for a substance to be a primary standard ? [Q.N. 3, 2053]
10. Define decinormal solution. [Q.N. 3, 2052]

Short Questions

(All questions are of equal value, 5 marks each.)

1. Explain selection of indicators in acid base titrations. [Q.N. 26, Supp. 2069]
2. Define the terms: 1+4
   (i) End point (ii) Equivalence point
   (iii) Indicators (iv) Basicity of acid
   (v) Acidimetry [Q.N. 26, Set 'A' 2069]

Long Questions

1. Write short notes on:
   (a) Selection of indictors in acid base titration. [Q.N. 33 (d), Set 'B' 2069]
2. Define the terms:
   i) Primary standard solution. ii) Normality factor.
   iii) Acidity of base iv) Alkalimetry.
   What is meant by redox titration ? Write an example of it. [Q.N.30, 2068]
3. Define the terms :
   (a) gram equivalent weight
   (b) equivalent point of reaction
   (c) end point of titration [Q.N. 30(i), 2064]
4. Define indicator. Explain how are indicators selected in acid base titration ? [Q.N. 30(ii), 2064]
5. Define indicator. How is a suitable indicator selected for a particular titration ? [Q.N. 30(b), 2062]

Numerical Problems

1. What is meant by redox titration? 4g of a divalent metal was dissolved in 100cc of $2MH_2SO_4$ (f = 1.01). The excess acid required 30cc of 1NNaOH for complete neutralization. Find the atomic mass of the metal. 1+4 [Q.N.25, 2072'C']
   [Ans : 535]
2. Which one has higher concentration and why? 1+1 [Q.N.2, 2072'D']
   a) 80g/L NaOH solution and 3 M NaOH solution.
   [Ans: 3M NaOH]
   b) 5.3 g/L Na_2CO_3 and $\frac{N}{10}$ Na_2CO_3 solution.
   [Ans: Same concentration]
3. What is meant by normality factor? How may mL of conc. HNO_3 of specific gravity 1.41 containing 69% by mass are required to prepare 500mL of 0.5N HNO_3.
   [Ans: 20.43 mL] 1+4 [Q.N.25, 2072'D']
4. Define normality and molarity. Write their relationship. A commercial sample of sulphuric acid has specific gravity 1.8 g/mL. 10 mL of this acid was diluted upto 1 L with water. 10mL of the diluted acid required 30 mL of N/10 NaOH for complete neutralization. Calculate the percentage purity of H_2SO_4 in the commercial sample.
   [Ans: 81.67%] [2+3] [Q.N.26, 2072'E']
5. What is meant by normality factor? What volume of 95% sulphuric acid (density = 1.85 g/cc) and what mass of water must be taken to prepare 100cc of 15% solution of sulphuric acid (density = 1.1g/cc) 1+4 [Q.N.25, Supp. 2071]
   [Ans : 9.4 cc of 95% H_2SO_4 (density 1.85 g/cc) and 92.6 g of H_2O]
6. Calculate the normality and molarity of 5% NaOH solution. 1+1 [Q.N.2, Supp. 2071]
   [Ans : Normality = 1.25N, Molarity = 1.25 M]
7. What mass of 90% pure $CaCO_3$ is required to neutralize 2 litre deci-normal solution of HCl?
   [Ans : 11.11 g] 1 + 1 [Q.N. 2, Set 'C' 2071]

8. Differentiate between primary standard and secondary standard solution. What volume of 12M NaOH and 2M NaOH should be mixed to get 2 liters of 9M NaOH solution? 2+3
[Ans : 1.4 L and 0.6L] **[Q.N. 25, Set 'C' 2071]**

9. How many moles of H_2SO_4 are required to neutralise 4 litres of 2N NaOH solution? 1+1
[Ans : 4 mol] **[Q.N. 2, Set 'D' 2071]**

10. Define acidimetry:
A solution of conc. hydrochloric acid contain 38% HCl by mass
a) What is the molarity of this solution if the density of the solution is 1.19g/cc.
[Ans : 12.4 M]
b) What volume of the conc. HCl is required to neutralize 1 litre of 0.1 M NaOH solution?
[Ans : 8.1 mL] 1+4 **[Q.N. 25, Set 'D' 2071]**

11. Define acidity of a base giving an example. 0.8g of a divalent metal was dissolved in 100 cc. of 1.28 N HCl and the solution was diluted to 200 cc.
50 cc of this dilute solution required 54.6cc of 0.22N NaOH for complete neutralization. Calculate the atomic mass of the metal. 1+4 **[Q.N.25, 2070 'Supp']**
[Ans: 20]

12. 0.8 g of a divalent metal was dissolved in 100cc of 1.28 N HCl and the solution was diluted to 200 cc. Then 50 cc of this solution required 54.6cc of 0.22 N NaOH for neutralisation. Find the atomic weight of the metal.
[Ans : 20] **5[Q.N. 23,2070 'C']**

13. What volume of water should be added to 500mL of 2N (f=0.98) Na_2CO_3 to make it exactly N/10? 1+1 **[Q.N. 2, 2070 'D']**
[Ans : 9300 mL]

14. Define normality. 0.8 g of a divalent metal was dissolved in 100mL of 1.28N HCl and the solution was diluted to 200mL. Then, 50mL of the solution required 54.6mL of 0.22N NaOH for neutralization. Find the atomic weight metal.
[Ans : 20] 1+4 **[Q.N. 26, 2070 'D']**

15. x cc of 5N HCl was diluted to one litre of normal solution. Calculate the value of x.
[Ans: 2000 cc] **[Q.N. 2, Set 'A' 2069]**

16. What mass of Na_2CO_3 is required to make 50cc of it's seminormal solution?
[Ans: 1.325 g] **[Q.N. 2, Set 'B' 2069]**

17. Calculate the strength in g/L of NaOH whose pH value is 11. **[Q.N.13, 2068]**
[Ans: 0.04 g/L]

18. Convert the followings: **[Q.N.17, 2068]**
i) 2.5 M H_3PO_4 into Normality.
[Ans: 7.5 N]
ii) 4.9 M H_2SO_4 into gram/litre.
[Ans: 480. 2g/L]

19. 4 g of NaOH was added to 20cc of 2N H_2SO_4 solution and the volume was diluted to one litre. Predict whether the dilute solution is acidic, basic or neutral and also calculate the resulting normality of the dilute solution in term of g/L. **[Q.N.30, 2068]**
[Ans: 0.06N; 2.4 g/L]

20. Define : (i) acidity of base (ii) End point
What volumes N/2 and N/10 HCl must be mixed to give 2 litres of N/5 HCl ?
$\left[\textit{Ans: 0.5L of } \frac{N}{2} \textit{ HCl and 1.5L of } \frac{N}{10} \textit{ HCl}\right]$ **[Q.N. 25, 2067]**

21. What is the normality of 20 cc of 2M phosphoric acid (H_3PO_4)?
(Ans: 6N) **[Q.N. 17, 2066]**

22. What are the Primary and Secondary standard solutions ? Calculate the resulting normality of a solution prepared by mixing 20 mL of 0.8 M NaOH with 25 mL of 0.4 M H_2SO_4 solutions. **[Q.N. 25, 2066]**
(Ans: 0.089N)

23. Define decinormal solution. 3g of a trivalent metal was completely dissolved with 750mL of 1N HCl. The residual solution further required 1000mL of N/2 NaOH for the complete neutralization. Find the atomic mass of the metal.
[Ans: 36] **[Q.N.25, 2065]**

24. 0.715 g of $Na_2CO_3 .xH_2O$ required 20 mL of seminormal hydrochloric acid solution for complete reaction. Find the value of *x*. **[Q.N. 30(iii), 2064]**
[Ans : x = 2]

25. 0.315 g, of a dibasic acid required 50 mL of decinormal sodium hydroxide solution for complete neutralization. Find the molecular mass of the acid.
[Ans: Molecular mass = 126] **[Q.N.18, 2063]**

26. Define normality and molarity of a solution. Find their relationship for a given solution. 1 g of NaOH is added to 2 litres of xM H_2SO_4 solution, so that the pH of the resulting solution is 7. Find the value of *x*.
[Ans: x = 6.25 × 10^{-3}] **[Q.N.26, 2063]**

27. Define normal solution. What is the normality of 500mL. solution of sodium hydroxide containing 30g NaOH ? 2
[Ans : 1.5 N] **[Q.N. 13, 2062]**

28. (a) Provide a short definition of each of the following terms :
(i) equivalent weight (ii) standard solution (iii) neutralization point
(iv) primary standard (v) indicator.
(b) 7.35 g of a dibasic acid was dissolved in water and diluted to 250 mL. 25 mL of this solution was neutralized by 15 mL. of N NaOH solution. What is Equivalent weight and Molecular weight of the acid ? **[Q.N. 30, 2061]**
[Ans : Eqvt. wt. = 49, Molecular wt. = 98]

29. 5 g of a diacidic base is completely neutralised by 50 mL 2(N) HCl.
Find the molecular weight of the base. 2
[Ans: Molecular wt. = 100] **[Q.N. 13, 2060]**

30. What volume of decinormal solution of HCl is required to neutralise 25mL NaOH containing 8g NaOH in one litre solution? 2
[Ans: 50 mL] **[Q.N. 13, 2059]**

31. x g of a metal (eq. wt =12) was completely dissolved in 100 cc of $\frac{N}{2}$ HCl. The volume was then made up to 500 cc. 25 cc of this diluted acid required 17.5 cc $N/_{10}$ NaOH for complete neutralisation. Find the value of x. 5
[Ans : x = 0.18 g] **[Q.N. 26, 2059]**

32. x g of Na_2CO_3reacts completely with 20 mL of 1M HCl. Calculate the value of x. 2
[Ans: x = 1.06 g] **[Q.N. 13, 2058]**

33. Two litres of 1M HCl is mixed with one litre of 1M NaOH solution. Calculate the strength of the salt formed and the pH of the resulting solution. 5**[Q.N. 26, 2058]**
[Ans: Strength = 0.33M, pH = 0.48]

34. What volume of water must be added to 40 mL of 0.25(N) acid solution in order to make it exactly decinormal? 2
[Ans: 60 mL] **[Q.N. 13, 2057]**

35. (a) Define molar solution, end point and indicator. Calculate the molarity of 5% H_2SO_4 solution.

(b) 7.5 g of a dibasic acid dissolved in water and the solution made up to 250cc. 25 cc of this acid requires 16.3 cc (N) NaOH for complete neutralization. Calculate the molecular weight of the acid. 5+5=10 **[Q.N. 30, 2057]**

[Ans: (a) Molarity = 0.51 M (b) Molecular wt. = 92.02]

36. 100 mL of 0.1 M HCl is mixed with 50 mL of 0.1M KOH. Calculate the concentration of acid in terms of g/L in the resulting solution. 5
[Ans: Gram/Litre = 1.21] **[Q.N. 21, 2056]**

37. Find the equivalent weight of H_3PO_4 in the reaction
$Ca(OH)_2 + H_3PO_4 \rightarrow CaHPO_4 + 2H_2O$. 2
[Ans: 48.5] **[Q.N. 1, 2055]**

38. 20 mL of a sulphuric acid solution neutralizes 0.265 g of Na_2CO_3. Calculate the normality of the acid solution. 5
[Ans: Normality = 0.25 N] **[Q.N. 21, 2055]**

39. X g of magnesium (equivalent weight = 12) reacts with 20 mL of N (E = 0.95) acid. Calculate the weight of X. 10
[Ans: wt. of x = 0.228 g] **[Q.N. 27(b), 2054]**

40. 25 cc an alkali solution is mixed with 8 cc of 0.75 (N) acid solution and for complete neutralization, it further requires 15 cc of 0.8 (N) acid solution. Find the strength of the given alkali solution. 5
[Ans: 0.72N] **[Q.N. 19, 2053]**

41. If 20mL of 0.5N NaOH is mixed with 30mL of 0.3 N HCl. Is the resulting solution acidic or basic ? Calculate the normality with respect to the acidic or basic final solution. 2
[Ans: Normality = 0.04N) **[Q.N. 19, 2052]**

Unit 3: Ionic Equilibrium

Very Short Questions

(All questions are of equal value, 2 marks each.)

1. Define Lewis concept of base and point out its limitation. **1+1 [Q.N.3, 2072'D']**
2. Define Bronsted concept of acid and base with an example of each. [2] **[Q.N.3, 2072'E']**
3. Give an example of each of the following: **0.5×4 [Q.N.3, Supp. 2071]**
   (i) Lewis acid (ii) Lewis base
   (iii) Acidic salt (iv) Bronsted-lowry acid.
4. Define the terms:
   a) Degree of ionization
   b) Bronsted–Lowry acid **1+1[Q.N. 3, Set 'C' 2071]**
5. What happens when HCl gas is passed through a saturated solution of NaCl and why? **2[Q.N. 3, Set 'D' 2071]**
6. State Ostwald's dilution law. What is its limitation ? **[Q.N.3, 2070 'Supp']**
7. Define Lewis acid and Lewis base giving one example of each. **[Q.N. 3, 2070 'D']**
8. Define common ion effect. **[Q.N. 3, Supp. 2069]**
9. Write suitable examples to show water acts as Bronsted-lowry acid and base. **[Q.N. 3, Set 'B' 2069]**
10. Whether the aqueous solution $CaCl_2$ is acidic, basic or neutral. Give reason. **[Q.N. 14, 2067]**
11. (i) Write the conjugate acid and conjugate base of NH_3. **[Q.N. 15(i), 2064]**
    (ii) Predict whether the aqueous solution of $CuSO_4$ acidic, basic or neutral. **[Q.N. 15(ii), 2064]**
12. Water is a Lewis base as well as a Bronsted acid. Explain. **[Q.N. 15, 2062]**
13. Explain the fact that the aqueous solution of sodium carbonate is basic, while the aqueous solution of sodium chloride is neutral. **[Q.N. 18, 2062]**
14. Define Lewis acid and Lewis base. Give one example of each. **[Q.N. 15, 2061]**
15. Why is aqueous solution of $FeCl_3$ acidic? **[Q.N. 15, 2059]**
16. Define Lewis acid and base giving one example from each. **[Q.N. 16, 2058]**

17. What happens when dry HCl gas is passed through saturated solution of sodium chloride? [Q.N. 15, 2057]
18. Why is aq. Na_2CO_3 basic? [Q.N. 16, 2057]
19. Explain why sodium chloride precipitates from a saturated salt solution when hydrogen chloride gas is passed into the solution. [Q.N. 4, 2055]
20. What do you understand by Equilibrium state in a reversible reaction ? [Q.N. 5, 2054]
21. What will happen when HCl gas is passed over a saturated solution of NaCl, also explain the principle involved. [Q.N. 8, 2054]

Short Questions

(All questions are of equal value, 5 marks each.)

1. Define the terms: 2+3[Q.N.23, 2072'C']
   i) Standard electrode potential ii) Electrochemical series
   The standard electrode potentials are given as:
   $E°_{Zn^{2+}/Zn} = -0.76V$
   $E°_{Fe^{3+}/Fe^{2+}} = +0.77V$
   i) Construct a cell notation for a galvanic cell indicating anode and cathode.
   ii) Calculate the emf at 1M solution of ions.
   iii) Will the reaction $Zn^{2+} + 2Fe^{2+} \rightarrow Zn + 2Fe^{3+}$ occur?
2. Explain Bronsted and Lewi's concepts of acid and base with suitable examples. [Q.N. 26, 2062]
3. Write a concise account of solubility product principle. [Q.N. 30(a), 2062]

Long Questions

(All questions are of equal value, 10 marks each.)

1. Write notes on:
   (a) Applications of solubility principal and common-ion effect in salt analysis.[Q.N.33(a), 2072'C']
   (b) Application of solubility product principle and common ion effect in salt analysis. [Q.N. 33 (c), 2070 'C']
   (c) Lewis concept of acid and bases. [Q.N. 33 (c), Supp. 2069]
   (d) Solubility product [Q.N. 33 (c), Set 'A' 2069]
   (e) Solubility product principle and its application. [Q.N. 31(iv), 2066]
   (f) pH and pH scale. [Q.N. 31(iii), 2061]
   (g) Lewi's concept of acids and bases. [Q.N. 31(i), 2060]
   (h) Solubility product principle. [Q.N. 31(b), 2059]
   (i) Solubility product principle [Q.N. 31(a), 2058]
   (j) Common ion effect [Q.N. 31(a), 2057]
   (k) Law of mass action [Q.N.31(a), 2056]
2. Define the following terms and give one example of each:
   (i) Bronsted Lowry acid and base. [Q.N.30.(a, i), 2065]
   (ii) Lewis acid and base. [Q.N.30.(a, ii), 2065]

Numerical Problems

1. Calculate the pH of 0.1N H_2SO_4. 2[Q.N.3, 2072'C']
   [Ans : 1]
2. What is meant by the terms:
   i) common ion effect ii) Solubility product constant (Ksp)
   Explain the common ion effect and solubility product principle in qualitative salt analysis. What will be the resulting pH of a solution prepared by mixing 200 mL of aquous solution of HCl (pH = 2) with 300 mL of an aquous solution of NaOH(pH = 12).
   [Ans: pH = 7] 2+4+2+2 **[Q.N.30, 2072'D']**
3. Define the terms:
   i) Degree of ionization. ii) Ostwald's dilution law.
   Calculate the pH of a saturated solution of $Mg(OH)_2$, Ksp for $Mg(OH)_2$ is 8.9×10^{-12}.
   [Ans: pH=10.35] [1+1+3] **[Q.N.27, 2072'E']**

4. Write short note on solubility product and its application in analytical chemistry. The solubility product (Ksp) of $Ca(OH)_2$ at 25°C is 4.42×10^{-5}. A 500 mL of a saturated solution of $Ca(OH)_2$ is mixed with an equal volume of 0.4M NaOH. How much $Ca(OH)_2$ is precipited ? **5+5 [Q.N.32, Supp. 2071]**

[Ans : 742.22 mg of $Ca(OH)_2$]

5. State the following terms:
   (a) Ostwald's Dilution Law (b) Degree of dissociation
   (c) Ionic product of water (d) Common ion effect
   (e) pH value of a solution

   Why is Ostwald's dilution law not applicable to strong electrolyte. What mass of KOH should be dissolved in one litre of its solution to prepare a solution having pH value 12 at 25°C? (At. wt. of K = 39)

   [Ans :0.56g] **[Q.N. 30, Set 'C' 2071]**

6. State the following terms:
   (a) Ostwald's Dilution Law (b) Degree of dissociation
   (c) Ionic product of water (d) Common ion effect
   (e) pH value of solution

   Why is Ostwald dilution law not applicable to strong electrolyte? What mass of KOH should be dissolved in one litre of its solution to prepare a solution having pH value 12 at 25°C? (At. wt. of K = 39)

   [Ans : 0.56g] **[Q.N. 32, Set 'D' 2071]**

7. 200 mL of an aqueous solution of HCl (pH = 2) is mixed with 300 mL of an aqueous solution of NaOH (pH = 12). What will be the pH of resulting mixture solution ? 5 **[Q.N.24, 2070 'Supp']**

   [Ans: pH = 11.3]

8. Calculate the pH of 1g/L NaOH solution. **2[Q.N. 3, 2070 'C']**

   [Ans : 12.39]

9. What is meant by degree of ionization? 0.41 g of NaOH is placed in 100mL of 0.1N H_2SO_4. Find the pH of the resulting solution. **1+4 [Q.N. 27, 2070 'D']**

   [Ans : pH = 11.4]

10. What is pHof solution of NaOH whose concentration is 0.4 g/L.

    [Ans: 12] **[Q.N. 3, Set 'A' 2069]**

11. Define degree of ionization. Calculate the pH of 1.0 M solution of acetic acid. To what volume one litre of this solution be diluted so that the pH of the solution that is formed will be twice of original value [Ka=1.8×10^{-5}]

    [Ans: pH= 2.87, 543412.6L] **1+2+2 [Q.N. 28, Set 'B' 2069]**

12. Define solubility product principle. 0.00143 g. of AgCl dissolve in one litre of water at 25°C to form a saturated solution. What is the solubility product of the salt ? (Ag = 108, Cl = 35.5) **2+3 [Q.N. 26, 2068]**

    [Ans: 1.0×10^{-10}]

13. Define the terms:
    (i) Common ion effect (ii) pH of a solution
    (iii) Lewis base iv) Degree of ionization
    (v) Ilioic product of water (vi) Ostwald's dilution law.

    A sample of AgCl was treated with 5mL of 2M Na_2CO_3 solution to produce Ag_2CO_3. The remaining solution contained 0.003 g of Cl^- per litre. Calculate the solubility product of AgCl. (Ksp of $Ag_2CO_3 = 8.2\times10^{-12}$)

    [Ans: 1.7×10^{-10} mol^2 L^{-2}] **[Q.N. 29, 2067]**

14. The pH of a solution of KOH is 10. Calculate the hydroxyl ion concentration. 2

    (Ans: 1×10^{-4} molL^{-1}) **[Q.N. 14, 2066]**

15. 49 g of H_2SO_4 is present in 1000 mL of its solution. What is the pH of the solution ?

    [Ans: 0] **[Q.N.14, 2065]**

16. What is ionic product of water ? The pH of 0.1 M HCN solution is 5.2. What is value of ionization constant (ka) for the acid ? 1+4=5
[Ans: 3.98 x 10^{-10}] **[Q.N.30.(b), 2065]**

17. Define pH. Calculate the pH of 0.1M H_2SO_4. **[Q.N. 16, 2064]**
[Ans : pH = 0.698]

18. What is meant by solubility product of sparingly soluble electrolyte ? The solubility of AgCl in water at 298 K is 1.43×10^{-3} g L^{-1}, calculate its solubility in 0.5M KCl solution. 2+3
[Ans : 1.984 x 10^{-10} mol L^{-1}] **[Q.N. 26, 2064]**

19. Calculate the hydroxide ion concentration of a solution having pH 10.5.
[Ans: 3.16 x 10^{-4} g ions/litre] **[Q.N.13, 2063]**

20. What are ionisation constant and degree of ionisation of a weak electrolyte ? How do they vary as temperature ? Calculate the pH of 0.1 M acetic acid solution having Ka 1.8×10^{-5}. 2+1+2
[Ans: pH = 2.87] **[Q.N.25, 2063]**

21. Calculate the pH of an aqueous solution containing 10^{-7} moles of NaOH per litre. 2
[Ans : pH = 7.302] **[Q.N. 14, 2060]**

22. The solubility product constant of $BaSO_4$ in water at 25°C is 1×10^{-10} mol^2L^{-2}. Calculate the solubility of $BaSO_4$ in g/L [Ba = 137] 2
[Ans: Solubility of $BaSO_4$ = 2.33 x 10^{-3} gram/litre] **[Q.N. 15, 2060]**

23. Define ionic product of water. Why does Kw of water increases with temperature ? 10 cc N/2 HCl,30 cc N/10 HNO_3 and 60 cc N/5 H_2SO_4 are mixed together. Find the pH of the mixture. 1+1+3
[Ans: pH of the mixture = 0.698] **[Q.N. 26, 2060]**

24. Calculate the pH value of 0.04 (N) HNO_3 solution, assuming HNO_3 to be completely ionised. 2
[Ans : pH = 2.39] **[Q.N. 16, 2059]**

25. Explain Bronsted and Lowry concept of acids and bases. Calculate the degree of ionization of HCN having concentration 0.01 M (Ka of HCN = 4.8×10^{-10}). Also calculate H^+ ion concentration and pH. 10
[Ans: H^+ = 2.1 x 10^{-6}, pH = 5.6] **[Q.N. 30, 2059]**

26. Calculate the hydrogen ion concentration of a solution whose pH is 9.5. 2
[Ans: 3.16 x 10^{-10}M] **[Q.N. 15, 2058]**

27. Define solubility product. The solubility of CaF_2 in water 18°C is 2.05×10^{-4} mole/lit. Calculate its solubility product. 1+4=5
[Ans: 3.45 x 10^{-11} mole/litre] **[Q.N. 25, 2057]**

28. The pH of HCl solution is 3. Calculate the strength of HCl in terms of molarity. 2
[Ans: pH = 0.01] **[Q.N. 5, 2056]**

29. The solubility product of CuS is 8.0 X 10^{-45} at a certain temperature. Find its solubility at this temperature. 5
[Ans : 8.94 x 10^{-23} mol L^{-1}] **[Q.N. 22, 2056]**

30. 10^{-2} mole of KOH is dissolved in 10 litres of water. What will be the pH of the solution ? 2
[Ans: pH = 11] **[Q.N. 2, 2055]**

31. The solubility product of chalk is 9.3×10^{-8}. Calculate its solubility in g/L. 5
[Ans: Solubility = 3.04 x 10^{-2} gL^{-1}] **[Q.N. 22, 2055]**

32. What will be the H^+ ion concentration of a solution having pH 5.5 ? 2
[Ans: 3.16 x 10^{-6} mol L^{-1}] **[Q.N. 2, 2054]**

33. The solubility of CaF_2 in water at 18°C is 2.05 × 10^{-4} mole per litre. Calculate its solubility product. 5
[Ans: 3.446 x 10^{-11} mol^3L^{-3}] **[Q.N. 22, 2054]**

Unit 4: Electrochemistry

Very Short Questions

(All questions are of equal value, 2 marks each.)

1. Why does $AgNO_3$ solution become bluish when copper rod is dipped in it? (The standard reduction potential of Cu and Ag are + 0.3V and +8.0 V respectively) 1+1 **[Q.N.4, 2072'D']**
2. What is meant by single electrode potential? Name any two factors that affect the magnitude of single electrode potential. 1+1 **[Q.N. 4, Set 'C' 2071]**
3. What is meant by standard hydrogen electrode? Write an important use of it. [1+1] **[Q.N.4, 2072'E']**
4. How would you justify that value of one Faraday is 96500 coulomb.2 **[Q.N. 4, Set 'D' 2071]**
5. Mention important application of standard hydrogen electrode giving example. 2 **[Q.N.4, 2070 'Supp']**
6. Mention one important application of standard hydrogen electrode giving example. **[Q.N. 4, 2070 'C']**
7. How is single electrode potential originated? **[Q.N. 4, Supp. 2069]**
8. Define the term:
   i) electrochemical equivalent ii) equivalent conductance **[Q.N.14, 2068]**
9. Will the reaction occur : $Zn^{++} + 2\ Fe^{++} \longrightarrow Zn + 2Fe^{+++}$.
   Give standard reduction potentials are:
   $E°_{Zn^{2+}/Zn} = -0.76$ V,
   $E°_{Fe^{2+}/Fe} = +0.80$ V.
   Give reason. **[Q.N. 13, 2066]**
10. Can a solution of 1M $CuSO_4$ be stored in a vessel made of nickel metal ? If not, why ?
    Given: $E°_{Ni^{2+}/Ni}$
    $E°_{Cu^{2}+/Cu} = (+)\ 0.34$ V **[Q.N.13, 2065]**
11. Define Rusting of iron. **[Q.N.19, 2065]**
12. How is single electrode potential originated ? **[Q.N. 13, 2064]**
13. What is meant by :
    i. One ampere current is passing through a solution. **[Q.N.15(i), 2063]**
    ii. The standard reduction potential of Cu^{+2}/Cu is 0.34 V. **[Q.N.15(ii), 2063]**
14. Define the terms (i) Cell constant and (ii) Molar conductivity. **[Q.N. 18, 2060]**
15. Construct a galvanic cell in which the cell reaction is:
    $Fe(S) + H_2SO_4(aq) \rightarrow FeSO_4(aq) + H_2(g)$ **[Q.N. 14, 2058]**
16. Define standard electrode potential. **[Q.N. 14, 2057]**
17. How does specific conductance decreases and equivalent conductance increases with dilution ? **[Q.N. 8, 2056]**
18. State Faraday's Second Law. **[Q.N. 3, 2055]**
19. Define the term electrochemical equivalent. **[Q.N. 4, 2054]**
20. What is E.C.E. ? **[Q.N. 4, 2053]**
21. What is E.C.E. (Electro–chemical Equivalent) ? **[Q.N. 4, 2052]**

Short Questions

(All questions are of equal value, 5 marks each.)

1. What is meant by electrochemical cell ? Design a Galvanic cell in which the reaction $Zn(s) + 2\ Ag^+(aq) \rightarrow Zn^{2+}(aq) + 2Ag(s)$, takes place. Further predict. 1+2+1+1+1 **[Q.N.23, Supp. 2071]**
   (i) Which of the electrode is negatively charged ?
   (ii) The carriers of the current in the cell.
   (iii) Individual reaction at each electrode.

2. What is meant by electrochemical cell? Design a Galvanic cell in which the reaction $Zn(s) + 2Ag^{+}(aq.) \longrightarrow Zn^{2+}(aq.) + 2Ag(s)$ takes places
Further predict:
a) which of the electrode is negatively charged
b) the carriers of the current in the cell
c) individual reaction at each electrode **[Q.N. 23, Set 'D' 2071]**
3. State and explain Faraday's second law of electrolysis. Show that the electric charge carried by transfer of 1 mole of electron is one Faraday. **[Q.N.24, 2063]**
4. Distinguish between (a) electrolytic and voltaic cells (b) oxidation and oxidizing agent.
Four metals, labelled A, B, C and D react with each other and with acids in the following way : B displaces only C from solution. Only A and D displace hydrogen from 1M HCl. None of the metals will displace D from solution. Arrange the four metals in an activity series with hydrogen. **[Q.N. 26, 2061]**
5. How is single electrode potential originated ? Predict which one of the following reactions occur spontaneously ?
(i) $2\,Fe^{+2} + Sn^{+4} \rightarrow 2\,Fe^{+3} + Sn^{+2}$
(ii) $2\,Fe^{+3} + Sn^{+2} \rightarrow 2\,Fe^{+2} + Sn^{+4}$
Given standard reduction potentials of
Fe^{+3}/Fe^{+2} and Sn^{+4}/Sn^{+2} are + 0.77V and + 0.15V respectively. **[Q.N. 27, 2060]**

Long Questions

(All questions are of equal value, 10 marks each.)

1. Represent graphically the variation of equivalent conductivity of strong electrolyte and weak electrolyte with concentration. Why do equivalent conductivity of strong electrolyte and weak electrolyte vary differently with dilution? 2+3 **[Q.N. 28, 2070 'D']**
2. Write short notes on :
(a) Variation of electrolytic conductances with concentration. **[Q.N. 31(i), 2064]**
(b) Faraday's laws of electrolysis. **[Q.N. 31(d), 2062]**

Numerical Problems

1. Calculate the number of coulombs required to deposit 40 g/L of aluminium from molten Al_2O_3. 2 **[Q.N.4, 2072'C']**
[Ans : 428460C]
2. Define the term: 2+1.5+1.5**[Q.N.23, 2072'D']**
i) Electrochemical equivalent ii) Standard electrode potential
How many coulombs are required to produce:
i) 80gm of aluminium from molten Al_2O_3
[Ans: 856920C]
ii) 24gm of magnesium from MgCl
[Ans: 193000C]
3. State Faraday's laws of electrolysis? Silver is electrodeposited on a metal plate of surface area 800 cm^2 by passing 0.2 ampere of current for 3 hours. Calculate the thickness of Ag deposited.
(Given specific gravity of Ag = 10.47 and atomic mass = 108) [2+3] **[Q.N.28, 2072'E']**
[Ans: 0.002mm]
4. How many coulombs of electric charge are required to deposit ?
(i) 4.6 g of sodium (ii) 3 mole of aluminium
(Atomic masses of Al = 27 and Na = 23) **1+1 [Q.N.4, Supp. 2071]**
[Ans : 19300 C, 868500 C]
5. Define weak electrolyte giving an example of it. Chromium metal can be plated out from and acidic solution containing CrO_3 according to the following equations:
$CrO_3(aq.) + 6H^{+} + 6e^{-} \rightarrow Cr(s) + H_2O$

Calculate:

i) How many gram of Cr will be plated out by 2400 coulumb ?

ii) How long will it take to plate out 1.5 g of Cr by using 12.5 amp current? (At. mass of Cr = 52)

[Ans : (i) 0.22g, (ii) 668.085s 1+2+1+1**[Q.N. 23, Set 'C' 2071]**

6. State Faraday's IInd law of electrolysis. Equal amount current was passed through an aqueous solution of tri-valent metallic salt and dil. H_2SO_4. The volume of H_2 liberated was 96.5mL at 27°C and 765 mmHg pressure. The weight of the metal deposited was 0.74g. Calculate the atomic weight of the metal.

[Ans: 279.72] 1+4 **[Q.N.23, 2070 'Supp']**

7. State Faraday's 2nd law of electrolysis. Equal amount of current was passed through an aqueous solution of trivalent metallic salt and dil. H_2SO_4. The volume of H_2 liberated was 96.5 mL at 27°C and 765 mm Hg 'pressure' and weight of metal deposited was 0.74 g. Calculate atomic weight of the metal.

[Ans : 284.6] 5 **[Q.N. 24, 2070 'C']**

8. How many number of coulombs are required to deposit 81g of Aluminum when the electrode reaction is: $Al^{+++} + 3e^- \rightarrow Al$ 2**[Q.N. 4, 2070 'D']**

[Ans : 868500 C]

9. State Faraday's 1st law of electrolysis.

0.1978 g of copper is deposited by a current of 0.2 ampere in 50 minutes. What is the electrochemical equivalent of copper? 1+4 **[Q.N. 25, Supp. 2069]**

[Ans : 3.297×10^{-4} g/C]

10. Distinguish between electrochemical equivalent and chemical equivalent. A metalic spoon is coated with silver by passing a current of 5 Amp through $AgNO_3$ solution for 5 hrs. What is the thickness of silver plating if the area of the spoon is 12 cm^{-2} (density of silver is 10.5 gcm^{-2}) **[Q.N. 25, Set 'A' 2069]**

[Ans: 0.8 cm]

11. Convert the following: 1+1**[Q.N. 4, Set 'B' 2069]**

i) 4.0×10^{12} electrons into coulombs.

[Ans: 6.408×10^{-7}C)

ii) Chemical equivalent of Magnesium into Electro chemical equivalent.

[Ans: 1.24×10^{-4} gC^{-1})

12. Give any two differences between electrochemical and electrolytic cell. You are given zinc rod, copper rod, zinc sulphate and copper sulphate solutions and standard electrode potential of zinc and copper are –0.76V and 0.34V respectively.

(a) Represent an electrochemical cell indicating anode and cathode

(b) Write net cell reactions.

[Ans: $Zn + Cu^{2+} \rightarrow Cu + Zn^{2+}$]

(c) What will be the emf of the cell?

[Ans: + 1.10V) **[Q.N. 27, Set 'B' 2069]**

13. What is meant by standard elecrtode potential ? The standard electrode potential for the following electrode are; 1+2+1+1

$Zn^{++} + 2e^- \longrightarrow Zn$, $E° = -0.76V$

$Fe^{+++} + e^- \longrightarrow Fe^{++}$, $E° = +0.77V$

i) Represent a suitable galvanic cell and point out which one will be cathode ?

[Ans: $Zn/Zn^{2+}//Fe^{3+}/Fe^{2+}$]

ii) With 1M solutions of the ions what will be emf ?

[Ans: 1.53V]

iii) Will the reaction $Zn^{++} + 2Fe^{++} \rightarrow Zn + 2Fe^{+++}$ occur ? Give reason.

[Ans: No] **[Q.N.24, 2068]**

14. Define on Faraday electricity. How many grams of silver could be plated out on a serving tray by passing electricity through a solution of Ag(I) salt for 8 hours at a current of 9 ampere ? What is the area of the tray, if the thickness of the silver plating is 0.002 cm. ? Density of silver is 10 g/cm^3.
(atomic mass of Ag = 107.8) 1+4[Q.N. 24, 2067]
[Ans: 14475 cm^2]

15. Define:
i) Electrochemical Cell ii) Equivalent Conductance
A current of 2.5 amphere passes through the solution of a metal sulphate for 30 minute and deposits 1.52 g of metal at cathode. Find the equivalent weight of the metal.
(Ans: 32.6 g) 1+1+3=5 **[Q.N. 24, 2066]**

16. State Faraday's 1st Law of electrolysis. What current strength is required to deposite whole copper from 1 litre of 1M $CuSO_4$ solution by passing electricity through it in 10 minute. 1.5+3.5=5
[Ans: 321.66A] **[Q.N.24, 2065]**

17. Calculate the equivalent conductance of 0.1 N KCl solution having specific resistance 83.3 Ohm cm. **[Q.N. 14, 2064]**
[Ans : 120 ohm^{-1} cm^2 eq^{-1}]

18. Calculate the equivalent conductivity of 0.12 (N) solution of an electrolyte, whose conductivity is 0.024 S cm^{-1}. 2
[Ans : 200 S cm^2 eqv^{-1}] **[Q.N. 14, 2062]**

19. Find the molar conductivity of 0.01 M acetic acid having specific conductivity 1.46 10^{-4} ohm^{-1} cm^{-1} .mol^{-1} 2
[Ans : 14.6 ohm^{-1} cm^{-1} mol^{-1}] **[Q.N. 14, 2059]**

20. State and explain Faraday's laws of electrolysis. How long a current of 3 ampere has to be passed through a solution of $AgNO_3$ to coat a metal surface of 80 cm^2 with 0.005 mm thick layer? (density of Ag= 10.5 g/cc) 10
[Ans: 125.09 seconds] **[Q.N. 30, 2058]**

21. You are given standard reduction potential of Cu^{+2} /Cu and Fe^{+2} /Fe as + 0.34 V and – 0.44 V respectively.
a) Construct a galvanic cell indicating anode and cathode
b) Write the cell reaction and calculate the standard emf of the cell. 5
[Ans: Standard EMF of the cell = 0.78V] **[Q.N. 26, 2057]**

22. How many coulombs of electricity is required to discharge 0.1 mole of Na^+ ?
[1 Faraday = 96500 coulomb.] 2
[Ans: 9650 Coulomb] **[Q.N. 4, 2056]**

Unit 5: Energetics of Chemical Reactions

Very Short Questions

(All questions are of equal value, 2 marks each.)

1. Distinguish between enthalpy of combustion and enthalpy of formation. 1+1 **[Q.N.5, 2072'C']**
2. What is meant by state function? Give its example. 1+1 **[Q.N.5, 2072'D']**
3. Distinguish between intensive and extensive property with examples. [1+1] **[Q.N.5, 2072'E']**
4. Distinguish between extensive and intensive properties giving one example of each. 1+1 **[Q.N.5, Supp. 2071]**
5. Define state function and give any two correct examples of it. 1+1**[Q.N. 5, Set 'D' 2071]**
6. State the first law of thermodynamics and write its mathematical relation.1+1 **[Q.N.5, 2070 'Supp']**

7. Define the terms: [Q.N. 6, 2070 'C']
i. Extensive properties ii. Internal energy.
8. State first law of thermodynamics. [Q.N. 5, 2070 'D']
9. State the first law of thermodynamics. [Q.N. 16, 2067]
10. Comment the statement "The decrease of enthalpy is the sole criterian for the feasibility of the process." [Q.N. 16, 2066]
11. State Hess's Law of constant heat summation. [Q.N.16, 2065]
12. Define the terms :
(i) Enthalpy of a reaction. [Q.N. 16(i), 2062]
13. Draw energy profile diagrams for exothermic and endothermic reactions. [Q.N. 17, 2058]
14. Define exothermic and endothermic reaction. [Q.N. 6, 2055]
15. State Hess's law of constant heat summation. [Q.N. 7, 2055]
16. State whether the following properties are extensive properties or intensive properties of (a) Entropy (b) Temperature. [Q.N. 7, 2054]

Short Questions

(All questions are of equal value, 5 marks each.)

1. State and explain first law of Thermodynamics, and, hence deduce H=E+PV, where all the symbols have their usual meanings. [Q.N. 25, 2052]

Long Questions

(All questions are of equal value, 10 marks each.)

1. Write short notes on: Hess's Law of constant heat summation and its application [Q.N.33(i), Supp. 2071]
2. Write short note on Hess's Law of constant heat summation. [Q.N. 33 (d), 2070 'D']
3. Define enthalpy of a reaction. State and explain Hess Law of constant heat summation. [Q.N.30(a), 2063]
4. Estimate the enthalpy change for the reaction
$H_{2\,(g)} + Cl_{2(g)}$ 2HCl
Given: bond energy of H–H = 435kJ/mol
bond energy of Cl–Cl = 243kJ/mol
boud energy of H–Cl= 430kJ/mol [Q.N. 25(b), 2053]

Numerical Problems

1. Write any two applications of Hess's law. Heat of formation of ethyl alcohol, water and carbondioxide are –64.1Kcal, –68.5Kcal and –95Kcal. Calculate the heat of combustion of ethyl alcohol. 1+4[Q.N.24, 2072'C']
[Ans : 331.4 Kcal]
2. Define heat of formation. Heat of combustion of methane, carbon and hydrogen are –210Kcal, –94Kcal and –68Kcal respectively. Calculate the heat of formation of methane. 1+4[Q.N.24, 2072'D']
[Ans: – 20 Kcal]
3. The enthalpy of reaction for $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ is –92.4 kJ. Calculate the enthalpy of formation of ammonia. [2] [Q.N.6, 2072'E']
[Ans:-46.2 kJ/mol]
4. Calculate the standard enthalpy of formation of water in the following reaction:
$2H_2(g) + O_2(g) \rightarrow 2H_2O(\ell)$, $\Delta H = -136$ Kcal.
[Ans : –68 Kcal] 2[Q.N. 5, Set 'C' 2071]
5. State Hess's law of constant heat summation. Calculate the enthalpy of formation of benzene, if enthalpy of combustion of benzene and carbon are –3280 $kJmol^{-1}$ and – 395 $kJmol^{-1}$ respectively. The enthalpy of formation of water is –285$KJmol^{-1}$. 1+4
[Ans : + 55 $kJmol^{-1}$] [Q.N. 25, 2070 'C']

6. Define Hess's law of constant heat summation. Enthalpy of formation of methane is –440kJ, enthalpy of formation of water and carbon–di–oxide are –72 kJ and –93kJ respectively calculate the heat of combustion of methane. 1+4 **[Q.N. 24, Supp. 2069]**
[Ans : + 163 kJmol^{-1}]

7. Calculate the enthalpy of formation of NH_3 from the following equation:
$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, $\Delta H = -186$ kJ. 2**[Q.N. 5, Supp. 2069]**
[Ans : – 93 kJmol^{-1}]

8. Define enthalpy of combustion. Enthalpy of formation of benzene is 55kJ, enthalpy of formation of water and carbondioxide are -395kJ and -285 kJ respectively. Calculate the enthalpy of combustion of benzene.
[Ans: 2950 kJmol^{-1}] **[Q.N. 24, Set 'A' 2069]**

9. Calculate the enthalpy of formation of NH_3, from the following equation.
$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, $\Delta H = -186$ kJ.
[Ans: – 93 kJmol^{-1}) **[Q.N. 6, Set 'A' 2069]**

10. Calculate the enthalpy of formation of NH_3 from the following equation.
$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, $\Delta H = -186$ kJ. **[Q.N. 5, Set 'B' 2069]**
[Ans: – 93 kjmol^{-1})

11. Mention the important applications of Hess's Law of constant heat summation. The standard heat of formation of $So_2(g)$ and $So_3(g)$ are – 296.6KJ and – 396KJ respectively. Calculate ΔH for the reaction: 2+3

$$SO_2(g) + \frac{1}{2}O_2(g) \longrightarrow SO_3(g)$$ **[Q.N.25, 2068]**

[Ans: – 99.4 kJ]

12. Define Hess's Law of constant heat summation. Calculate the heat of combustion of glucose from the following data: 1+4=5

$C(s) + O_2(g) \rightarrow CO_2(g)$, $\Delta H = -395$ kJ

$H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(l)$, $\Delta h = -269$ kJ

$6C(s) + 6H_2(g) + 3O_2(g) \rightarrow C_6H_{12}O_6(s)$, $\Delta H = -1169$ kJ

(Ans: – 2815 kJmol^{-1}) **[Q.N. 26, 2066]**

13. The latent heat of fusion of ice is 336 Jg^{-1}. Calculate the molar entropy of fusion of ice at its normal melting point. **[Q.N. 17, 2064]**
[Ans : entropy of fusion of ice = 22.15 Jmol^{-1} K^{-1}]

14. The standard enthalpy of formation of H_2O (l), CO_2 (g) and C_6H_6 (l) are -286, -393.5 and + 49.02 kJmol^{-1} respectively at 298 K. Calculate the standard enthalpy of combustion of C_6H_6 (*l*) at the given temperature. 4
[Ans: –3268.02 kJ] **[Q.N.30(b), 2063]**

15. What is meant by enthalpy of formation ? 1+4=5
Calculate the enthalpy of formation of ethane at 298K, if the enthalpies of combustion of C, H and C_2H_6 are –94.14, –68.47 and –373.3 Kcal. respectively.
[Ans : –20.39 Kcal] **[Q.N. 24, 2062]**

16. Distinguish between:
a. Internal energy and enthalpy b. Exothermic and endothermic reaction.
(ii) Calculate the heat of formation of naphthalene from the following data:
$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -94.405$ Kcal.
$H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(l)$ $\Delta H = -68.3$ Kcal
$C_{10}H_8(s) + 12O_2(g) \rightarrow 10CO_2(g) + 4H_2O(l)$ $\Delta H = -1231.6$ Kcal
(Naphthalene) 10
[Ans: Heat of formation of naphthalene = +14.35 Kcal] **[Q.N. 28, 2056]**

17. Calculate the standard heat of formation of $CH_4(g)$ from the following informations.
$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ $\Delta H = -890.3$ kJ
C (graphite) $+ O_2(g) \rightarrow CO_2(g)$ $\Delta H = -393.5$ kJ
$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ $\Delta H = -571.7$ kJ 5
[Ans: Standard heat of formation of CH_4 is -74.9 kJ mol^{-1}] **[Q.N. 23, 2054]**

Unit 6: Chemical Thermodynamics

Very Short Questions

(All questions are of equal value, 2 marks each.)

1. How would you predict the spontaneity of a system in term of free-energy change? 2 **[Q.N.6, 2072'C']**
2. Predict the criteria of spontaneity in light of free-energy change. **2 [Q.N.6, Supp. 2071]**
3. Mention the proper conditions of a chemical reaction to become spontaneous if its ΔH and ΔS are positive. 2 **[Q.N. 6, Set 'C' 2071]**
4. Predict the criteria of spontaneity in the light of entropy change. 2 **[Q.N. 6, Set 'D' 2071]**
5. Distinguish spontaneous and non spontaneous process giving an example of each. 1+1 **[Q.N.6, 2070 'Supp']**
6. What is meant by spontaneous process ? Write an example for it. **[Q.N. 5, 2070 'C']**
7. How would you predict the spontaneity using the relation $T\Delta S_{total} = -\Delta G_{sys}$ **[Q.N. 6, 2070 'D']**
8. What is meant by spontaneous process? Give an example for it. **[Q.N. 6, Supp. 2069]**
9. Define Gibbs free-energy change. Write the mathematical relation to predict the spontaneity. **[Q.N. 5, Set 'A' 2069]**
10. Name the two criteria which must be met for a process to be spontaneous regardless of the temperature. **[Q.N.15, 2068]**
11. Define thermodynamic efficiency of heat engine. How is second law of thermodynamics stated in the light of this term ? **[Q.N.14, 2063]**
12. Define the terms :
(i) Standard free energy of a reaction. **[Q.N. 16(ii), 2062]**
13. In order for a reaction to occur spontaneously, what is the criterion ? **[Q.N. 14, 2061]**
14. What is entropy ? State the effect of increased temperature on the entropy of a substance. **[Q.N. 17, 2060]**
15. How is free energy change of a reaction related to enthalpy change and entropy change? **[Q.N. 17, 2059]**
16. What is the physical concept of entropy? **[Q.N. 17, 2057]**

Short Questions

(All questions are of equal value, 5 marks each.)

1. Define Gibbs Free energy. How is spontancity of a reaction predicted in light of free energy change, enthalpy change and entropy change? **[Q.N. 26, Set 'B' 2069]**
2. What is meant by free-energy change ? Write the relation between entropy change and enthalpy change. How does this relation help in predicting the spontaneity of a reaction ? **[Q.N. 26, 2067]**
3. What is free energy change ? How is it related with enthalpy change and entropy change ? How would you predict whether a reaction is spontaneous, non spontaneous and equilibrium in term of free energy change. **[Q.N.26, 2065]**
4. Define Gibb's free energy. How is the feasibility of exothermic and endothermic reactions predicted in the light of free energy change and entropy change ? **[Q.N. 24, 2064]**
5. State and explain second law of thermodynamics. How does free energy change depend on the equilibrium constant ? **[Q.N. 27, 2061]**