Board of Studies: Chemistry

Class: TYBSc (Chemistry)

Subject Code: CHEM3501

Subject: Physical Chemistry

Semester: V

QUESTION BANK

Unit 1: Investigation of Molecular Structure

A) Multiple Choice Questions:

1. 'Refractive index' is equal to
   a) speed of light in material /speed of light in vacuum
   b) speed of light in material/speed of light in air
   c) speed of light in vacuum/speed of light in material
   d) speed of light in vacuum/speed of light in air

2. Light bends in all materials at
   a) same angle
   b) different angles
   c) nearly same angles
   d) opposite angles

3. Snell's law relates _____.
   a) Light relfection
   b) Light refraction
   c) Light transmission
   d) Light Absorption

4. The unit of molar refraction _____.
   a) cm^3mol^{-1}
   b) $cm^{-3}mol^{-1}$
   c) $cmmol^{-1}$
   d) $cm^{-1}mol$

5. If the water molecule is linear
   a) it would have a very high boiling point
   b) it would be highly reactive
   c) its dipole moment would be zero
   d) it would be highly ionic

6. When the centre of gravity of the nuclei in a molecule is exactly at the same point as that of the electrons, then it is a
   a) Polar molecule
   b) Normal molecule
   c) Non-polar molecule

d) Simple molecule

7. For non-polar molecules, molar polarization is
   a) Deformability
   b) Induced molar polarization
   c) Polarizability
   d) Dipole moment

8. The plot of total molar polarization (P_T) versus inverse of absolute temperature (1/T) of the system in case of non-polar molecule is
   a) Parallel to 1/T axis
   b) Parallel to P_T axis
   c) Passing through origin
   d) With positive intercept on P_T axis

9. The dipole molecule of CCl_4 molecule is
   a) Zero
   b) One
   c) Two
   d) Four

10. Zero dipole moment of dinitrobenzene which indicates that dinitrobenzene is
    a) o-dinitrobenzene
    b) m-dinitrobenzene
    c) p-dinitrobenzene
    d) 1,1-dinitrobenzene

11. The total energy associated with the molecule is considered as
    a) Internal energy
    b) Translational energy
    c) Rotational energy
    d) Translational plus internal energy

12. the electronic transition will give rise to spectra in
    a) The visible or UV region
    b) The microwave region
    c) The infrared region
    d) In radio wave region

13. The intensity of spectral lines does not depends on
    a) Transition probability
    b) Population of energy state
    c) Concentration and path length
    d) Temperature

14. The population of atoms or molecules at the given energy state is governed by
    a) Planck’s distribution law
    b) Boltzmann distribution law
    c) Maxwell distribution law
    d) Einstein distribution law

15. The wavelength range in nm of microwave radiation is
    a) 10^5-10^7 nm
    b) 10^4-10^6 nm
    c) 10^3-10^5 nm
    d) 10^3-10^7 nm
16. The interaction of IR radiation with molecule brings about change in
    a) Rotational motion only
    b) Vibrational motion only
    c) Rotational and vibrational motions
    d) Spin of electron

17. Intensities of stokes lines is
    a) Equal to antistokes lines
    b) Greater than antistokes lines
    c) Less than antistokes lines
    d) Equal to Rayleigh line

18. Homonuclear diatomic molecules are often found to be
    a) Microwave active
    b) IR active
    c) Uv active
    d) Raman active

19. The selection rule for rotational transition is
    a) $\Delta J = \pm 2$
    b) $\Delta J = \pm 1$
    c) $\Delta J = 0$
    d) $\Delta v = \pm 1$

20. The line at the incident frequency is called
    a) Stokes line
    b) Antistokes line
    c) Rayleigh line
    d) Raman line

B) One sentence answer questions:

1. State Snell's law.
2. Calculate frequency of uv radiation of wavelength 200 nm.
3. Define polarizability of molecule.
4. What is the unit of molar refraction?
5. Define dipole moment.
6. What is the unit of dipole moment?
7. What is the unit of molar polarization?
8. What is the selection rule for rotational transition?
9. What is zero-point energy?
10. What is the selection rule for vibrational transition?
11. Why we get pure rotational spectra?
12. Why pure vibrational spectra cannot be obtained?
13. What do you mean by Rayleigh scattering?

14. What is Raman scattering?
15. What are stokes lines?
16. What are antistokes lines?

C) Write short notes on:

1. Molar polarization
2. Orientation polarization
3. Induced polarization
4. Dipole moment
5. Microwave spectroscopy
6. Isotopes and microwave spectroscopy
7. Vibrational spectroscopy
8. Raman spectra

D) Short answer questions:

1. Distinguish between polar and non-polar molecules.
2. What is the effect of temperature on molar polarization of non-polar molecules.
3. What do you mean by ionic character of compound?
4. What is meant by molar refraction?
5. What are additive properties?/
6. Write the equation for rotational constant.
7. Dipole moment of BF3 is zero. why?
8. Why methane molecule is microwave inactive?
9. Why stokes lines are intense than relative antistokes lines?
10. Why CO2 molecule is microwave inactive but IR active?
11. What is optical exaltation?
12. What do you mean by zero point energy?
13. What is Rayleigh scattering?
14. Why homonuclear diatomic molecules are raman active?
15. Why pure vibrational spectra cannot be obtained?
16. What do you mean by raman effect?

E) Long answer questions:

1. Explain the term molar refraction. How is useful for elucidation of molecular structure?
2. Define dipole moment. Give a method for determining the dipole moment of molecule.
3. How is dipole moment is measured by vapour temperature method?
4. Discuss the applications of dipole moment measurements in elucidation of molecular structure.
5. What are the induced and orientation polarization of polar and non-polar molecules?
6. Discuss the electronic, vibrational and rotational energy levels of diatomic molecule with energy level diagram.
7. Raman spectra have more advantages than rotational and vibrational spectra. Explain.
8. Explain rotational spectra of diatomic molecule.
9. Distinguish between Raman spectra and infrared spectra.
10. Derive an expression for the energy of the transition from $J \rightarrow J+1$ level in the rotational spectrum of simple diatomic molecule.
11. What are Rayleigh and Raman scatterins? What are stokes and antistokes lines?
12. What are merits and demerits of microwave spectra?

13. Discuss the theory of Raman effect.
14. Derive the expressin for tha wave number of line in vibration spectra. Draw the energy level diagram for vibration of the diatomic molecule.

F) Problems:

1. Molar refractions for CH3CH2CH2CH3, CH3CH2OH and CH3OH are 20.6, 12.9 and 8.3 ml $mole^{-1}$ respectively. Calculate the molar refraction for CH3CH2CH2CH2OH.
2. The dielectric constant of CH4 (g) at 0°C and at one atmosphere is 1.00094. Assuming methane to behave as an ideal gas, calculate induced molar polarization and polarizability of the substance.
3. The molar polarization of silicobromoform is 45.98 cm^3 mol^{-1} at 25 °C. if the polarizability of the molecule is 1.31 x 10^{-23} , calculate the dipole moment of the molecule.
4. The compound nitrobenzene has a dipole moment 3.80 D. Estimate the dipole moment of m-dinitrobenzene.
5. Calculate frequency, wave number and energy for typical radiation of wavelength 200 nm.
6. The rotational spectrum of HF has lines 41.9 cm^{-1} apart. Calculate the moment of inertia and bond length in HF.
7. HBr has a bond length 1.4 Å. Calculate the reduced mass, moment of inertia, and the rotational constant. What would be the spacing of spectral lines?
8. The force constant of the bond in CO molecule is 1.902 x 10^6 dynes per cm and reduced mass is 1.138 x 10^{-23} g. compare the frequency of vibration of the CO molecule.
9. Calculate the percentage ionic character of HBr from the following data. Dipole moment of HBr = 0.79 D, bond length in HBr = 1.42 x 10^{-8} cm.
10. The density of acetic acid is 1.054 g cm^{-3} and the refractive index for Na-D line is 1.3722 at 20°C. Calculate the molar refraction of acetic acid.

Unit 2: Electrolytic Conductance

A) Multiple Choice Questions:

1. Specific conductance is the conductance of
   (a) one centimetre cube of solution of an electrolyte
   (b) one centimetre cube of the solid electrolyte
   (c) one gram of a solution of an electrolyte
   (d) one gram of the solid electrolyte

2. The unit of specific conductance is
   (a) ohm. cm (b) ohm cm^{-1}
   (c) ohm^{-1} cm (d) ohm^{-1} cm^{-1}

3. The equivalent conductance of a solution of an electrolyte
   (a) increases with dilution (b) decreases with dilution
   (c) do not vary with dilution (d) always equal to one

4. The SI unit of equivalent conductance is
   (a) Siemens m^2 eqvt (b) $ohm^{-1}cm^{-1}$ $eqvt^{-1}$
   (c) ohm^{-1} cm^2 $eqvt^{-1}$ (d) $ohm^{-1}cm^{-2}$ $eqvt^{-1}$

5. With rise in temperature the conductance of a solution of an electrolyte
   (a) decreases (b) increases

(c) remains constant (d)becomes zero

6. The cell constant is the ratio of
   (a) distance between electrodes to area of electrode
   (b) area of electrode to distance between electrodes
   (c) specific conductance to area of electrode
   (d) specific conductance to distance between electrodes

7. The specific conductance of a 0.01 M solution of KCl is 1.4×10^{-3} ohm $^{-1}$cm $^{-1}$ at 298 K. Its equivalent conductance is
   (a) 0.14 (b) 1.4 (c) 14.0 (d) 140

8. Plots of λ vs $\sqrt{c}$ in case of strong electrolytes are
   (a) linear with negative slope (b) linear with positive slope
   (c) parallel to $\sqrt{c}$ axis (d) linear passing through origin

9. The specific conductance of NaCl solution at 291 K is 0.0124 ohm^{-1}m ^{2} eqvt $^{-1}$and the resistance of the cell containing this solution at the same temperature is 50.0 ohm. The cell constant will be
   (a) 0.31 (b) 0.124 (c) 0.62 (d) 0.000248

10. The equivalent conductance of decinormal solution of acetic acid at 298K is 80 and at infinite dilution is 400 Siemens. The percentage dissociation of acetic acid is
   (a) 10 % (b) 20 % (c) 100 % (d)50 %

B) One sentence answer questions:

1. What do you mean by electrolyte?
2. What is effect of concentration of electrolyte on specific conductance and equivalent conductance of electrolyte solution?
3. Show graphically, how equivalent conductance varies with $\sqrt{c}$ for weak electrolyte.
4. What is effect of temperature on electrolytic conductance?
5. What will be degree of ionization of N/1000 acetic acid solution if its equivalent conductance is 50 mhos.cm^2 and the value of equivalent conductance at infinite dilution is 350mhos.cm^2.
6. Calculate the specific conductance of a solution whose observed resistance is 210 ohms, placed in a cell with cell constant 1.049 cm $^{-1}$.
7. What do you mean by infinite dilution solution?
8. Explain the term transport number of ion.
9. What is conductometric titration? Give one example of it.
10. What will be the relation between activity and concentration of a solution?

C) Short answer questions:

1. Define or Explain the following –
   a) Equivalent conductance b) Cell constant c) Specific conductance
   d) Transport number of ions e) activity f) activity coefficient g) Ionic mobility h) Fugacity
   i) Strong electrolyte j) degree of dissociation k) molar conductance.
2. Why alternating current is used in the conductance measurements?
3. What do you mean by equivalent conductance at infinite dilution?
4. Explain the difference between molecular conductance and equivalent conductance of a solution. What ae the units of these two terms?

5. "On progressive dilution, specific conductance of an electrolyte decreases but molar conductance increases" discuss.
6. What is relationship between specific conductance and equivalent conductance?

7. State Kohlrausch's law of independent migration of ions.
8. What do you mean by conductivity water? How is it prepared?
9. Define the term- Electrolyte. Explain the different types of electrolytes with examples.
10. Write short notes on -
    a) Ohm's law b) Cell constant c) Kohlrausch's law d) Asymmetric effect e) Relaxation effect f) electrophoretic effect g) Activity and activity coefficient h) Absolute velocity of ions i) Ionic product of water j) Conductometric titration. k) degree of dissociation of weak electrolyte.

D) Long answer questions:

1. Explain the terms- cell constant, Specific conductance and equivalent conductance. How these terms are determined experimentally?
2. Explain the effect of dilution on specific conductance and equivalent conductance.
3. State and explain Kohlrausch's law of independent migration of ions. How it is useful in determining the equivalent conductance of an electrolyte at infinite dilution.
4. Explain 'Debye- Huckel Theory' of interionic attraction.
5. What do you mean by specific resistivity, specific conductivity and equivalent conductivity? Give the mathematical expression for each term.
6. Explain the terms- activity and activity coefficient. Discuss a method to determine activity coefficient.
7. Give the postulates of Debye- Huckel Theory of strong electrolyte. Explain in detail- Relaxation effect and Electrophoretic effect.
8. State and explain the applications of Kohlrausch's law of independent migration of ions.
9. Explain Wheatstone bridge method for the determination of unknown resistance of electrolyte solution with suitable diagram. Why alternating current is used in conductance measurements?
10. Discuss in brief the moving boundary method for determination of transport number of cation.
11. Explain in detail the various applications of conductance measurements.
12. What do you mean by conductometric titrations? Explain the different types of conductometric titrations with examples.

E) Problems:

1. 0.5 N solution of a salt surrounding two plates of electrodes, 1.0 cm apart and 0.25 cm 2 in area, was found to offer a resistance of 475 ohms. Calculate the equivalent conductance of the solution.
2. The resistance of a conductivity cell filled with 0.02 N solution of an electrolyte is 100 ohms at 25°C. Calculate specific conductance and equivalent conductance if the cell constant is 2.06 cm^{-1}.
3. At 25°C the equivalent conductance of 0.1 N acetic acid is 5.2 $cm^2ohm^{-1}eq^{-1}$. If the λ_∞ for acetic acid is 390.7 $cm^2ohm^{-1}eq^{-1}$. Calculate the dissociation constant of acetic acid at 25°C.
4. At 25°C the equivalent conductance at infinite dilution of CH_3COONa, HCl and NaCl are 90, 425.15 and 124.9 $ohm^{-1}cm^2$. Calculate equivalent conductance at infinite dilution of CH_3COOH. If equivalent conductance of 0.001 N CH_3COOH is 9.23, calculate degree of dissociation of acetic acid at 25°C.
5. The resistance of N/50 solution of KCl at 25°C is 400 ohms. If the specific conductance of the solution at 25°C is 0.002756 $ohm^{-1}cm^{-1}$ and resistance of 0.01N solution of acetic acid at 25°C is 815 ohms, calculate equivalent conductance of acetic acid.

Unit 3: Photochemistry

A) Multiple Choice Questions:

1. A photochemical reaction is occurring by absorption of …….
   (a) chemical energy (b) UV and visible radiation
   (c) heat energy (d) infrared radiation
2. In photochemical reaction, the absorption of light takes place in …….
   (a) primary processes only (b) secondary processes only
   (c) both primary and secondary processes (d) all processes
3. The wavelength range of UV and visible region of EM spectrum is ….
   (a) 10 to 100 nm (b) 900 to 1000 nm
   (c) 200 to 800 nm (d) 100 to 200 nm
4. For the reaction which obeys Einstein law,
   (a) $\Phi < 1$ (b) $\Phi > 1$
   (c) $\Phi = \lambda$ (d) $\Phi = 1$
5. The energy associated with a photon is represented by ….
   (a) $E = h \lambda$ (b) $E = h \upsilon$
   (c) $E = h \varphi$ (d) $E = h c^2$
6. One Einstein is the energy associated with ……
   (a) one photon (b) one molecule
   (c) Avogadro number of photons (d) 100 photons
7. A substance which can both absorbs and transfer radiant energy for activation of the reactant molecule is called as
   (a) an ionizer (b) a photosensitizer
   (c) a activator (d) a catalyst
8. The number of molecules reacted or formed per photon of light absorbed is called as
   (a) yield of the reaction (b) quantum efficiency
   (c) quantum yield (d) quantum productivity
9. The substance that when exposed to light radiations of short wavelength emit light of longer wavelength are called
   (a) photosensitized substances (b) phosphorescent substances
   (c) fluorescent substances (d) photoluminescent substances
10. The light emitted in a chemiluminescent reaction is also called
    (a) cold light (b) hot light
    (c) bright light (d) faint light

B) One sentence answer questions:

1. What is photochemistry?
2. Give an example of photochemical reaction.
3. What do you mean by one Einstein of energy?
4. Define-Quantum efficiency of the reaction.
5. What is photosensitizer? Give one example.

C) Short answer questions:

1. Define or Explain the following –
   a) Photochemistry b) Photochemical equation c) Quantum yield
   d)Grothus-Draper law e) Stark-Einstein law f) Photosynthesis
2. Distinguish between photochemical reaction and thermal reaction.
3. What do you mean by one Einstein of energy? How is it related to wavelength?
4. Define the term- Quantum yield. Explain the experimental method to determine it.
5. Write a note on- a) Photosynthesis b) Fluorescence,
   c) Phosphorescence d) Chemiluminescence.
6. What are primary and secondary photochemical reactions?

D) Long answer questions:

1. State and explain the Stark-Einstein law of photochemical equivalence.
2. Write the mathematical expression for quantum yield. Discuss the reasons for high and low quantum yield with the help of hydrogen-halogen reaction.
3. What do you mean by photochemical reactions? Explain the photochemical decomposition of HI.
4. What is photosensitization and quenching. Discuss the mechanism of photosensitization and quenching by taking suitable example.
5. Explain in detail the measurement of quantum yield by using uranyl oxalate actinometer.

E)Problems:

1. Calculate the energy of the photon corresponding to wavelength 4.8×10^{-7} m.
2. Calculate the energy of an Einstein of radiation having wavelength of 253 nm.
3. A system absorbs 2×10^{16} quanta of radiation per second. When it is irradiated for 15 minutes, found that 3.0×10^{-4} mole of the reactant has reacted. Calculate the quantum yield of the reaction.
4. For a photochemical reaction, $H_2 + Cl_2 \rightarrow 2\ HCl$, the quantum yield is 1.0×10^{4} at a wavelength of 600 nm. Calculate the number of moles of HCl produced per joule of radiant energy absorbed.
5. The quantum yield of the reaction, $2HI \rightarrow H_2 + I_2$, is 2. Calculate the number of photons absorbed in an experiment in which 0.01 mol of HI are decomposed.

Unit 4: Colloids

A) Multiple Choice Questions:

1. An emulsion is a colloidal system consisting of
   a) Two liquids
   b) Tw solids
   c) One gas and one liquid
   d) Two gases
2. Milk is an example of
   a) Sol
   b) Gel
   c) Foam
   d) Emulsion
3. Smoke is a dispersion of
   a) Solid in gas
   b) Gas in solid
   c) Gas in gas

d) Liquid in gas

4. A colloidal system in which a solid is a dispersed in a liquid is called
   a) Foam
   b) Sol
   c) Gel
   d) Emulsion
5. The presence of colloidal particles of dust in air imparts blue colour to the sky. This is due to
   a) Absorption of light
   b) Scattering of light
   c) Reflection of light
   d) None of these
6. Brownian movement is an ----- property of the colloidal sol.
   a) Electrical
   b) Kinetic
   c) Optical
   d) Colligative
7. Fog is colloidal system of
   a) Gas in liquid
   b) Liquid in gas
   c) Gas in gas
   d) Gas in solid
8. Lyophobic colloids are
   a) Reversible
   b) Irreversible
   c) Protective
   d) Water loving
9. Which one of the following forms a colloidal solution in water?
   a) NaCl
   b) Glucose
   c) Starch
   d) KCl
10. A tendency to take up a large quantity of water leads to increase in the volume of the gel, this property is known as
    a) Hydration
    b) Swelling or imbibition
    c) Syneresis
    d) Thixotropy

B) One sentence answer questions:

1. What do you mean by dispersed phase?
2. What do you mean by dispersion medium?
3. What are colloids?
4. Define the term lyophilic colloids.
5. Define the term lyophobic colloids.
6. What are sols?
7. What are gels?
8. What are emulsions?
9. Define emulsifier.
10. What do you mean by surfactants?

C) Write short notes on:

1. Colloidal system
2. Sol
3. Gel
4. Emulsion
5. Surfactants
6. Tyndall effect
7. Brownian motion
8. Lyophilic sol
9. Lyophobic sol
10. Types of colloidal systems

D) Short answer questions:

1. Explain colloidal system based on particle size.
2. Explain lyophilic colloids.
3. Explain lyophobic colloids.
4. Explain Tyndall effect.
5. Explain Brownian movement.
6. Explain the classification of sols.
7. What are gels? How are they classified?
8. What are emulsions? How are they classified?
9. Explain the term emulsifier.
10. Explain the properties of gels.

E) Long answer questions:

1. What are sols? How are they prepared?
2. What are gels? How are they prepared?
3. What are emulsions? How are they prepared?
4. Distinguish between lyophilic sols and lyophobic sols.
5. What is the size range of colloidal particles? Distinguish between true solution, colloidal solution and suspension on the basis of size, electrical and kinetic properties.
6. Distinguish between emulsion and gel.
7. State different methods for the preparation of sols. Describe in detail mechanical dispersion method.
8. Give the properties and applications of gels.
9. Give the properties and applications of emulsions.
10. What do you mean by dispersed phase and dispersion medium? On the basis of these explain different types of colloidal systems.