

MCQ on General Chemistry-I, General Chemistry-II and Physical Chemistry

AUTHOR

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GENERAL CHEMISTRY-I

UNIT-I

Atomic structure and Periodic trends

History of atom (J.J.Thomson, Rutherford);
Moseley's Experiment and Atomic number,
Atomic Spectra; Black-Body Radiation and
Planck's quantum theory - Bohr's model of atom;
The Franck-Hertz Experiment; Interpretation of
Spectrum; Photoelectric effect, Compton effect;
Dual nature of Matter- DeBroglie wavelength-
Davisson and Germer experiment Heisenberg's
Uncertainty Principle; Electronic Configuration
of Atoms and ions - Hund's rule, Pauli's exclusion
principle and Aufbau principle; Numerical
problems involving the core concepts.

UNIT-II

Introduction to Quantum mechanics Classical mechanics,

Wave mechanical model of atom, distinction
between a Bohr orbit and orbital; Postulates of
quantum mechanics; probability interpretation of
wave functions, formulation of Schrodinger wave

equation (derivation not needed) - Probability
and electron density-visualizing the orbitals -
probability density and significance of Ψ and Ψ^2 .

Modern Periodic Table

Cause of periodicity; Features of the periodic
table; classification of elements - Periodic trends
for atomic size- Atomic radii, Ionic, crystal and
Covalent radii; ionization energy, electron
affinity, electro negativity-electro negativity
scales, applications of electro negativity.

Problems involving the core concepts

UNIT-III: Structure and bonding - I **Ionic bond**

Lewis dot structure of ionic compounds;
properties of ionic compounds; Energy involved
in ionic compounds; Born Haber cycle - lattice
energies, Madelung constant; relative effect of
lattice energy and solvation energy; Ion
polarisation - polarising power and polarizability;
Fajans' rules - effects of polarisation on
properties of compounds; problems involving the
core concepts.

Covalent bond

Shapes of orbitals, overlap of orbitals - σ and π bonds; directed valency - hybridization; VSEPR theory - shapes of molecules of the type AB₂, AB₃ and AB₄. Partial ionic character of covalent bond - dipole moment, application to molecules of the type A₂, AB and AB₂. Percentage ionic character - numerical problems based on calculation of percentage ionic character.

UNIT-IV: Structure and bonding - II

VB theory application to hydrogen molecule; concept of resonance - resonance structures of some inorganic species - CO₂, NO₂, CO₃²⁻, NO₃⁻; limitations of VBT; MO theory - bonding, antibonding and nonbonding orbitals, bond order; MO diagrams of H₂, O₂, O₂⁺, N₂, HF, CO.

Magnetic characteristics, comparison of VB and MO theories.

Coordinate bond: Definition, Formation of BF₃, NH₃ - properties

Band theory - mechanism of conduction in solids;
conductors, insulator, semiconductor - types,
applications of semiconductors

Weak Chemical Forces - Vander Waals forces,
ion-dipole forces, dipole-dipole interactions,
induced dipole interactions, Instantaneous dipole-
induced dipole interactions. Repulsive forces;
Hydrogen bonding and its types.

**UNIT-V: Basic concepts in Organic Chemistry
and Electronic effects**

Types of bond cleavage - heterolytic and
homolytic; reagents and substrates; types of
reagents - electrophiles, nucleophiles, free
radicals; reaction intermediates - carbanions,
carbocations, carbenes, arynes and nitrynes.

Inductive effect - reactivity of alkyl halides,
acidity of halo acids, basicity of amines;
inductomeric and electromeric effects.

Resonance - resonance energy, conditions for
resonance - acidity of phenols, basicity of
aromatic amines, stability of carbonium ions,
carbanions and free radicals.

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Hyperconjugation - stability of alkenes, bond
length, orienting effect of methyl group,
dipole moment of aldehydes and nitromethane



UNIT-I

1 Marks

1. Who proposed the "plum pudding" model of the atom?
 - a. J.J. Thomson
 - b. Ernest Rutherford
 - c. Niels Bohr
 - d. John Dalton
2. Which experiment led to the discovery of the electron?
 - a. Cathode Ray Tube experiment
 - b. Oil drop experiment
 - c. Alpha particle scattering experiment
 - d. Photoelectric effect experiment
3. The nucleus of an atom was discovered by:
 - a. J.J. Thomson
 - b. Ernest Rutherford
 - c. Niels Bohr
 - d. James Clerk Maxwell
4. What is the charge of an electron?
 - a. Positive
 - b. Negative
 - c. Neutral
 - d. Variable
5. Which scientist's model of the atom includes electrons orbiting the nucleus in specific energy levels?
 - a. J.J. Thomson
 - b. Ernest Rutherford

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- c. Niels Bohr d. Dmitri Mendeleev

6. Who conducted the gold foil experiment that led to the discovery of the atomic nucleus?

- a. J.J. Thomson b. Ernest Rutherford
c. Niels Bohr d. Werner Heisenberg

7. What is the fundamental particle responsible for determining the identity of an element?

- a. Proton b. Neutron
c. Electron d. Positron

8. Moseley's experiment helped to establish a relationship between:

- a. Atomic mass and atomic number
b. Atomic mass and electron configuration
c. Atomic number and nuclear charge
d. Atomic number and wavelength of X-rays

9. What did Moseley's experiment contribute to the understanding of the periodic table?

- a. Arrangement of elements by atomic mass
b. Arrangement of elements by atomic number
c. Arrangement of elements by electron configuration
d. Arrangement of elements by isotopic mass

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10. The modern periodic table is organized based on:

- a. Atomic mass b. Atomic number
- c. Electron configuration d. Ionization energy

11. Who proposed the quantum theory to explain black-body radiation? **

- a. Albert Einstein b. Max Planck
- c. Niels Bohr d. Werner Heisenberg

12. The quantization of energy in electromagnetic radiation is explained by:

- a. Newton's laws b. Bohr's model
- c. Planck's quantum d. Avogadro's hypothesis

13. Bohr's model of the atom successfully explained the spectrum of which element?

- a. Hydrogen b. Helium
- c. Oxygen d. Carbon

14. In Bohr's model, electrons orbit the nucleus in specific:

- a. Radii b. Velocities
- c. Energy levels d. Spin orientations

15. What is the main idea behind the Franck-Hertz experiment?

- a. Determining atomic masses

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- b. Measuring the speed of light
- c. Demonstrating the quantization of energy levels
- d. Studying electron collisions with atoms

16. The Franck-Hertz experiment provided evidence for:

- a. Quantized energy levels in atoms
- b. Wave-particle duality
- c. Photoelectric effect
- d. Quantum entanglement

17. Which phenomenon is responsible for the discrete lines observed in atomic spectra?

- a. Ionization energy
- b. Quantum tunneling
- c. Electron diffraction
- d. Quantized energy levels

18. The spectral lines of hydrogen can be explained by the transitions of electrons between:

- a. Energy levels
- b. Spin orientations
- c. Radii
- d. Velocities

19. What does the term "black-body radiation" refer to?

- a. Radiation from black holes
- b. Radiation from burning objects
- c. Idealized radiation from a perfect absorber and emitter

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a. $\left(p = \frac{h}{\lambda}\right)$ b. $\left(p = \lambda^2\right)$

c. $\left(p = \frac{1}{h\lambda}\right)$ d. $\left(p = h\lambda\right)$

25. The Davisson and Germer experiment provided experimental evidence for the:

- a. Photoelectric effect
- b. Wave-particle duality of electrons
- c. Compton effect
- d. Heisenberg's Uncertainty Principle

26. The Compton effect is related to the:

- a. Absorption of electron
- b. Scattering of light
- c. Diffraction of X-rays
- d. Reflection of photon

27. According to Heisenberg's Uncertainty Principle, it is impossible to simultaneously and precisely know the:

- a. Position and momentum of a particle
- b. Energy and time of a process
- c. Spin and angular momentum of an electron
- d. Charge and mass of a particle

28. Which equation represents the relationship between the energy (E) and frequency (ν) of a photon?

a. $\left(E = h\nu\right)$ b. $\left(E = \frac{h}{\nu}\right)$

c. $\left(E = hc\right)$ d. $\left(E = \frac{c}{\lambda}\right)$

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29. In the context of the photoelectric effect, which of the following is true?

- a. Electrons are emitted immediately when exposed to any light
- b. The photoelectric current is independent of the frequency of light
- c. Electrons are emitted with a delay, regardless of light intensity
- d. The intensity of light determines the number of emitted electrons

30. Which physical quantity remains conserved during a Compton scattering process?

- a. Energy
- b. Momentum
- c. Angular momentum
- d. Charge

31. Which principle states that electrons fill the lowest energy orbitals first before moving to higher energy levels?

- a. Hund's Rule
- b. Pauli's Exclusion Principle
- c. Aufbau Principle
- d. Heisenberg's Uncertainty Principle

32. According to Pauli's Exclusion Principle, no two electrons in an atom can have the same:

- a. Mass
- b. Charge
- c. Spin
- d. Energy level

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33. Hund's Rule states that electrons occupy orbitals of the same energy in a way that maximizes their:

- a. Charge
- b. Spin
- c. Mass
- d. Stability

34. In the Aufbau Principle, electrons fill orbitals starting from the one with the:

- a. Highest energy
- b. Lowest energy
- c. Maximum charge
- d. Maximum spin

35. How many electrons can occupy a single orbital, according to the Pauli Exclusion Principle?

- a. 1
- b. 2
- c. 3
- d. 4

36. Which subatomic particles are governed by the Pauli Exclusion Principle?

- a. Protons
- b. Electrons
- c. Neutrons
- d. Positrons

37. In the electron configuration notation, what does the superscript represent?

- a. Principal quantum number
- b. Azimuthal quantum number
- c. Spin quantum number
- d. Number of electrons in the orbital

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38. What is the maximum number of electrons that can occupy the p orbital?

- a. 2 b. 4
- c. 6 d. 8

39. Which of the following represents a violation of Hund's Rule?

- a. $1s^2$ b. $2s^2 2p^6 3s^2$
- c. $2s^2 2p^5$ d. $3s^2 3p^6 4s^1$

40. If an atom has the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6$, which element does it represent?

- a. Oxygen b. Nitrogen
- c. Carbon d. Neon

Answers

1.a, 2.a, 3.b, 4.b, 5.c, 6.b, 7.a, 8.d, 9.b, 10.b, 11.b, 12.c, 13.a, 14.c, 15.d, 16.a, 17.d, 18.a, 19.c, 20.b, 21.b, 22.c, 23.c, 24.a, 25.b, 26.b, 27.a, 28.a, 29.c, 30.b, 31.c, 32.c, 33.b, 34.b, 35.b, 36.b, 37.d, 38.c, 39.c, 40.d.

5 Marks

1. Explain the contributions of J.J. Thomson and Ernest Rutherford to the history of the atom.

How did their experiments lead to the development of the atomic model?

2. Describe Moseley's experiment and its significance in understanding the structure of the atom. How did Moseley's work contribute to the concept of atomic number?
3. Explain Niels Bohr's model of the atom. How does this model account for the observed line spectra of elements?
4. Discuss the limitations and advancements brought about by Bohr's atomic model.
5. Define the photoelectric effect and how it challenged classical wave theory. Discuss how Einstein's explanation and the concept of photons resolved the photoelectric effect
6. Explain the significance of the photoelectric effect in understanding the dual nature of matter.
7. Discuss the Davisson and Germer experiment and its significance in the development of quantum mechanics.
8. How did their work provide experimental evidence for the wave nature of electrons?
9. Explain Werner Heisenberg's Uncertainty Principle. How does it challenge classical ideas about the precision of simultaneously measuring certain pairs of properties?

10. Discuss the implications of the Uncertainty Principle in understanding the behavior of subatomic particles.
11. Explain the electronic configuration of atoms and ions. Discuss Hund's Rule and its role in determining the arrangement of electrons in orbitals.
12. Provide examples to illustrate the application of Hund's Rule.
13. Discuss Pauli's Exclusion Principle and its significance in understanding the behavior of electrons.
14. Explain the Aufbau Principle and how it guides the filling of electron orbitals in atoms. Provide examples to illustrate the application of these principles.
15. Apply the principles of electronic configuration (Aufbau Principle, Pauli's Exclusion Principle, Hund's Rule)

10 Marks

1. Describe J.J. Thomson's model of the atom, emphasizing the key features and contributions.
2. Discuss the details of Rutherford's famous gold foil experiment. What were the

observations, and how did they lead to a new understanding of the atomic structure?

3. Explain Moseley's experiment and its significance in the development of the atomic theory. Discuss how Moseley's work contributed to the concept of atomic number.
4. Explain the concept of black-body radiation and its challenges as per classical physics.
5. Describe Bohr's model of the atom, emphasizing the postulates and its success in explaining certain features of the hydrogen spectrum.
6. Discuss the photoelectric effect and its significance in understanding the particle-like behavior of light. Explain the Compton effect and how it provided experimental evidence for the particle nature of photons.
7. Explain the concept of De Broglie wavelength and its significance in quantum mechanics.
8. Discuss how the De Broglie wavelength is related to the dual nature of matter.
9. State Heisenberg's Uncertainty Principle and provide a qualitative explanation. Discuss the mathematical representation of the Uncertainty Principle.
10. Provide examples illustrating the application of Hund's rule, Pauli's

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exclusion principle, and the Aufbau principle in determining the electronic configuration of specific elements or ions.



UNIT-II

1 Marks

1. Which model of the atom incorporates both particle and wave-like properties of electrons?
a. Bohr Model b. Wave Mechanical Model
c. Classical Model d. Quantum Model
2. In classical mechanics, electrons are often treated as:
a. Particles with definite trajectories
b. Waves with continuous motion
c. Particles with fixed positions
d. Waves with quantized energy
3. According to the wave mechanical model, what is the probability density function used to describe the position of an electron in an atom?
a. Wavefunction b. Quantum number
c. Electron configuration d. Orbit
4. How does the concept of quantized energy levels in the Bohr model differ from the wave mechanical model?
a. Bohr model allows continuous energy levels, while wave mechanical model has quantized levels

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- b. Wave mechanical model allows continuous energy levels, while Bohr model has quantized levels
- c. Both models have identical concepts of energy levels
- d. Neither model considers energy levels
5. What term is used to describe the region around the nucleus where there is a high probability of finding an electron?
- a. Orbit b. Shell
- c. Orbital d. Path
6. The Bohr model describes electrons as moving in fixed paths called:
- a. Orbitals b. Orbits
- c. Shells d. Subshells
7. Which of the following is a major limitation of the Bohr model when compared to the wave mechanical model?
- a. It cannot explain the stability of atoms
- b. It cannot explain the emission spectrum of hydrogen
- c. It does not consider quantized energy levels
- d. It cannot describe the behavior of electrons in multi-electron atoms

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8. How does an orbital differ from a Bohr orbit?
- a. Bohr orbits have definite shapes, while orbitals do not
 - b. Orbitals describe the probability of finding an electron, while Bohr orbits depict definite paths
 - c. Orbitals have quantized energy levels, while Bohr orbits do not
 - d. Both represent the same concept
9. In the wave mechanical model, what does the principal quantum number (n) represent?
- a. Size of the orbital b. Shape of the orbital
 - c. Spin of the electron d. Orientation of the orbit
10. Which of the following statements is true regarding the behavior of electrons in the wave mechanical model?
- a. Electrons follow precise trajectories around the nucleus.
 - b. The exact position and momentum of an electron can be simultaneously known.
 - c. Electrons exhibit both particle and wave-like behavior.
 - d. Electrons occupy specific orbits without any uncertainty.
11. Which of the following is a fundamental postulate of quantum mechanics?

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- a. Deterministic nature of particles
- b. Continuous trajectories of particles
- c. Quantization of energy levels
- d. Absolute predictability of particle properties

12. According to quantum mechanics, the state of a system is described by:

- a. Classical variables only
- b. Wavefunctions
- c. Only observable quantities
- d. Definite trajectories

13. The probability interpretation of wave functions suggests that the square of the wave function amplitude gives the probability of finding:

- a. Momentum of a particle
- b. Spin of a particle
- c. Particle at a specific position
- d. Particle's mass

14. What is the mathematical representation of a wave function denoted by ψ ?

- | | |
|-----------------|---------------------|
| a. Energy | b. Momentum |
| c. Wavefunction | d. Angular momentum |

15. According to the probability interpretation, what does it mean if the square of the wave function amplitude is large at a particular position?

- a. High probability of finding the particle at that position
- b. Low probability of finding the particle at that position
- c. The particle is in definite motion
- d. The particle's velocity is known

16. The uncertainty principle, a key concept in quantum mechanics, is attributed to which physicist?

- a. Max Planck
- b. Werner Heisenberg
- c. Louis de Broglie
- d. Erwin Schrödinger

17. Which of the following statements is consistent with the probability interpretation of wave functions?

- a. The wave function directly provides the precise position of a particle.
- b. The square of the wave function amplitude represents the probability density of a particle.
- c. Wave functions only describe the momentum of a particle.
- d. Probability has no role in quantum mechanics.

18. Quantum mechanics postulates that certain physical properties are quantized. What does "quantized" mean in this context?

- a. Continuous and unbounded
- b. Discrete and specific values
- c. Random and unpredictable
- d. Inversely proportional

19. Which postulate of quantum mechanics asserts that certain pairs of properties, like position and momentum, cannot be precisely known simultaneously?

- a. Probability postulate
- b. Uncertainty principle
- c. Wave-particle duality
- d. Superposition principle

20. What is the significance of the probability amplitude in quantum mechanics?

- a. It represents the particle's velocity.
- b. It provides information about the particle's charge.
- c. It determines the particle's energy.
- d. It contributes to the probability of finding the particle at a specific position.

21. What does the Schrödinger wave equation describe in quantum mechanics?

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- a. Particle's trajectory in space
- b. Probability distribution of a particle's position
- c. Momentum of a particle
- d. Electron charge distribution

22. Which fundamental constant appears in the Schrödinger wave equation?

- a. (h) (Planck's constant)
- b. (c) (speed of light)
- c. (G) (gravitational constant)
- d. (e) (elementary charge)

23. The Schrödinger equation is a key tool for describing the behavior of:

- a. Classical particles only
- b. Electrons in quantum systems
- c. Photons in electromagnetic fields
- d. Subatomic particles in nuclear reactions

24. What does the term "probability density" refer to in the context of the Schrödinger equation?

- a. The likelihood of an electron having a certain velocity
- b. The likelihood of an electron being in a specific orbital
- c. The probability of an electron's charge distribution

d. The probability of an electron's mass distribution

25. In the Schrödinger equation, what does the symbol Ψ represent?

- a. Probability density b. Electron charge
- c. Velocity of the electron d. Angular momentum

26. Which term is associated with the region where the probability density of finding an electron is significant in an orbital?

- a. Nodal plane b. Orbital boundary
- c. Electron cloud d. Principal quantum number

27. The visualization of orbitals often involves representing areas where the probability density is higher as:

- a. Dark regions b. Light regions
- c. Colored regions d. Transparent regions

28. What is the shape of an s orbital in three-dimensional space?

- a. Spherical b. Prolate spheroid
- c. Dumbbell-shaped d. Tetrahedral

29. In visualizing orbitals, the term "nodal plane" refers to:

- a. The region of highest probability density

- b. A plane where the probability of finding an electron is zero
- c. The outer boundary of an orbital
- d. The region where the electron has maximum energy

30. Which quantum number is primarily responsible for determining the shape of an orbital?

- a. Principal quantum number (n)
- b. Azimuthal quantum number (l)
- c. Magnetic quantum number (m)
- d. Spin quantum number (s)

Answers

1.b, 2.a, 3.a, 4.b, 5.c, 6.b, 7.d, 8.b, 9.a, 10.c, 11.c, 12.b, 13.c, 14.c, 15.a, 16.b, 17.b, 18.b, 19.b, 20.d, 21.b, 22.a, 23.b, 24.b, 25.a, 26.c, 27.b, 28.a, 29.b, 30.b.

5 Marks

1. Compare classical mechanics with the wave mechanical model of the atom. Highlight the key differences in their approaches to describing the behavior of electrons.

2. Discuss how the wave mechanical model overcame the limitations of classical mechanics in understanding atomic structure.
3. Differentiate between a Bohr orbit and an orbital. Discuss the limitations of Bohr's model and how the concept of orbitals in the wave mechanical model addresses these limitations.
4. Explain the postulates of quantum mechanics. Discuss how these postulates laid the foundation for the development of modern quantum theory. Discuss the significance of the wave function (Ψ) and its square (Ψ^2).
5. Provide insights into the formulation of the Schrödinger wave equation and its role in describing the behavior of particles.
6. Discuss the concept of probability density in quantum mechanics. How are orbitals visualized based on probability density?
7. Explain the significance of Ψ and Ψ^2 in understanding the distribution of electrons in an atom.
8. Features of the periodic table; classification of elements - Periodic trends for atomic size- Atomic radii, Ionic,
9. Discuss the key features of the periodic table. Explain how elements are organized in the

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modern periodic table and the significance of periods and groups.

10. Describe the classification of elements in the periodic table. Discuss the basis for the classification and explain the significance of periods and groups in predicting the properties of elements.
11. Explain the concept of atomic size and atomic radii in the periodic table. Discuss the trends in atomic size across periods and down groups.
12. Describe the trends in ionic radii across the periodic table. Explain the factors influencing the size of cations and anions.
13. Discuss how the size of ions relates to their positions in the periodic table.
14. Define ionization energy and discuss the trends in ionization energy across periods and down groups in the periodic table.

10 Marks

1. Briefly explain the classical model of the atom and its limitations.
2. Discuss the key features that make the wave mechanical model a more accurate representation of atomic behavior.

3. Discuss the differences between Bohr orbits and orbitals in terms of their conceptualization and accuracy in describing electron behavior.
4. Explain how the probability interpretation challenges classical determinism and contributes to the understanding of electron behavior.
5. Discuss the concept of visualizing orbitals in terms of electron probability density. Explore how the Schrödinger equation contributes to the development of three-dimensional visualizations of orbitals.
6. Outline the key features of the periodic table, including periods, groups, and the arrangement of elements based on atomic number.
7. Explain the basis for the classification of elements into groups and periods on the periodic table.
8. Explain ionization energy and discuss the periodic trend for ionization energy across the periodic table.
9. Introduce electronegativity scales (e.g., Pauling scale) and their significance. Discuss practical applications of electronegativity in understanding chemical bonding and predicting molecular properties.
10. Present a set of problems involving the core concepts of the periodic table, including atomic size, ionization energy, electron affinity, and

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electronegativity. Require students to solve these problems, applying their knowledge of periodic trends and electronic structure.



UNIT-III

1 Marks

1. What does the Lewis dot structure represent for ionic compounds?
 - a. Arrangement of protons
 - b. Electron distribution in atoms
 - c. Nuclear charge
 - d. Molecular weight
2. Which of the following is a property commonly observed in ionic compounds?
 - a. Low melting and boiling points
 - b. Conductivity in the solid state
 - c. Covalent bonding
 - d. Low solubility in water
3. What type of energy is involved in the formation of ionic compounds?
 - a. Kinetic energy
 - b. Nuclear energy
 - c. Potential energy
 - d. Electrical energy
4. In the Born-Haber cycle, what does the Madelung constant account for?
 - a. Kinetic energy of ions
 - b. Size of ions in the crystal lattice
 - c. Arrangement of ions in the crystal lattice

d. Ionization energy of the compound

5. What is the primary factor influencing lattice energies in ionic compounds?

- a. Atomic size of cations
- b. Charge of ions
- c. Number of lone pairs
- d. Electronegativity of anions

6. In the context of the relative effect of lattice energy and solvation energy, which factor determines solubility?

- a. Lattice energy
- b. Solvation energy
- c. Combined kinetic energy
- d. Potential energy

7. Which term refers to the ability of an ion to distort the electron cloud of its neighboring ion?

- a. Ionization energy
- b. Ion polarizability
- c. Lattice energy
- d. Solvation energy

8. In the Born-Haber cycle, what is the role of the Madelung constant in the calculation of lattice energy?

- a. It represents the charge of ions.
- b. It adjusts for the size of ions in the crystal lattice.
- c. It accounts for the arrangement of ions.
- d. It determines the solubility of the compound.

9. Which of the following has a significant effect on the degree of ionic character in a covalent bond?

- a. Electronegativity difference
- b. Atomic mass
- c. Number of lone pair
- d. Metallic character

10. What is the purpose of the Born-Haber cycle in the context of ionic compounds?

- a. To calculate the atomic size of ions
- b. To predict the shape of molecules
- c. To determine the percentage ionic character
- d. To calculate the energy changes involved in the formation of ionic compounds

11. What is ion polarization in the context of chemical bonding?***

- a. The rearrangement of electrons in an ionic bond
- b. The distortion of electron clouds in an ion
- c. The transfer of electrons between ions
- d. The interaction between two ions

12. Which term refers to the ability of an ion to distort the electron cloud of its neighboring ion?

- a. Ionization energy
- b. Ion polarizability
- c. Lattice energy
- d. Solvation energy

13. What is the effect of increased size and charge of an ion on ion polarizability?

- a. Decreased ion polarizability
- b. No effect on ion polarizability
- c. Increased ion polarizability
- d. Increased ionization energy

14. Which of the following ions is likely to have a higher polarizing power?

- a. Li^+
- b. Na^+
- c. Mg^{2+}
- d. Al^{3+}

15. What does the term "polarizing power" refer to in Fajans' rules?

- a. The ability of an ion to attract electrons
- b. The ability of an ion to distort the electron cloud of another ion
- c. The degree of ionization of an element
- d. The charge-to-size ratio of an ion

16. According to Fajans' rules, what effect does the presence of small, highly charged ions have on covalent character?

- a. Increases covalent character
- b. Decreases covalent character
- c. No effect on covalent character
- d. Increases ionic character

17. Which of the following compounds is likely to exhibit more covalent character according to Fajans' rules?

- a. NaCl b. MgCl_2
- c. AlCl_3 d. SiCl_4

18. In Fajans' rules, which ion parameter is considered to have a dominant effect on the extent of polarization?

- a. Ionic radius b. Charge
- c. Electron affinity d. Ionization energy

19. Which factor is considered in Fajans' rules to enhance ionic character in compounds?

- a. Large ionic radius
- b. High charge on the cation
- c. High ionization energy
- d. Low polarizability

20. According to Fajans' rules, which compound is expected to have the highest degree of ionic character?

- a. KI b. CsI
- c. NaI d. LiI

21. What happens to the polarizing power of an ion as its charge increases?

- a. Increases b. Decreases

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- c. Remains constant d. No effect

22. Which of the following compounds is expected to show the least covalent character based on Fajans' rules?

- a. RbBr b. SrBr₂
c. CaBr₂ d. MgBr₂

23. In Fajans' rules, which ion parameter is considered to have a significant effect on the extent of polarization?

- a. Ionic radius b. Electron affinity
c. Charge d. Ionization energy

24. According to Fajans' rules, what effect does the presence of a polarizable anion have on covalent character?

- a. Increases covalent character
b. Decreases covalent character
c. No effect on covalent character
d. Increases ionic character

25. Which compound is likely to exhibit the highest degree of ionic character based on Fajans' rules?

- a. KF b. RbF
c. CsF d. LiF

26. What is the primary factor considered in Fajans' rules to determine the degree of polarization in an ionic compound?

- a. Size of ions
- b. Electronegativity
- c. Bond length
- d. Ionization energy

27. Which of the following compounds is expected to show more covalent character based on Fajans' rules?

- a. CaO
- b. SrO
- c. BaO
- d. MgO

28. In Fajans' rules, what effect does the presence of a small cation have on covalent character?

- a. Increases covalent character
- b. Decreases covalent character
- c. No effect on covalent character
- d. Increases ionic character

29. What is the concept of directed valency concerned with?

- a. Orientation of electrons in an atom
- b. Arrangement of orbitals in a molecule
- c. The direction in which a bond is formed
- d. Molecular geometry

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30. What is the term for the specific regions in an atom where electrons are likely to be found?

- a. Orbitals b. Nodes
- c. Shells d. Nuclei

31. Which type of bond involves the head-on overlap of orbitals?

- a. π bond b. δ bond
- c. σ bond d. ϕ bond

32. In the context of molecular shapes, what does VSEPR stand for?

- a. Variable Shape Electron Pair Repulsion
- b. Valence Shell Electron Pair Repulsion
- c. Vibrant Shape Electron Pair Repulsion
- d. Viscous Shape Electron Pair Repulsion

33. What is the geometry of a molecule with the molecular formula AB_2 according to VSEPR theory?

- a. Linear b. Trigonal planar
- c. Tetrahedral d. Bent

34. Which of the following is a molecular shape predicted by VSEPR theory for the molecule AB_3 ?

- a. Linear b. Trigonal planar
- c. Tetrahedral d. Bent

35. What is the concept of directed valency concerned with?

- a. Orientation of electrons in an atom
- b. Arrangement of orbitals in a molecule
- c. The direction in which a bond is formed
- d. Molecular geometry

36. Which process involves the mixing of atomic orbitals to form hybrid orbitals?

- a. Orbital overlap
- b. Hybridization
- c. Ionization
- d. Polarization

37. In the context of hybridization, what does the term " sp^3 " represent?

- a. A specific type of molecular bond
- b. The number of hybrid orbitals formed
- c. The shape of the molecule
- d. A type of sigma bond

38. What is the molecular geometry of a molecule with the formula AB_4E according to VSEPR theory?

- a. Tetrahedral
- b. Trigonal planar
- c. Octahedral
- d. Linear

39. In the formation of a π bond, what type of orbital overlap occurs?

- a. Head-on overlap
- b. Side-to-side overlap

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- c. Overlap along the axis d. Orbital mixing

40. Which molecule is expected to exhibit the trigonal pyramidal shape according to VSEPR theory?

- a. CH_4 b. NH_3
c. H_2O d. CO_2

41. What is the concept of "valence shell electron pair repulsion" used to predict in VSEPR theory?

- a. Bond strength b. Molecular shapes
c. Orbital overlap d. Electron configuration

42. In the context of molecular shapes, what does VSEPR theory predict for the molecule AB_4 ?

- a. Linear b. Trigonal planar
c. Tetrahedral d. Bent

43. What is the shape of a molecule with the molecular formula AB_2E according to VSEPR theory?

- a. Linear b. Bent
c. Trigonal planar d. T-shaped

44. Which type of hybridization is associated with the formation of four equivalent sp^3 hybrid orbitals?

- a. sp hybridization b. sp^2 hybridization

- c. sp^3 hybridization d. dsp^3 hybridization

45. Which of the following molecules is expected to have a linear shape according to VSEPR theory?

- a. CO_2 b. H_2O
c. NH_3 d. CH_4

46. What is the term for the concept of overlapping orbitals along the internuclear axis to form a sigma (σ) bond?

- a. Orbital mixing b. π bonding
c. Head-on overlap d. Side-to-side overlap

47. Which molecule is predicted to have a tetrahedral shape according to VSEPR theory?

- a. BF_3 b. CO_2
c. CH_4 d. NH_3

48. In the context of molecular shapes, what is the geometry of a molecule with the molecular formula AB_3 according to VSEPR theory?

- a. Tetrahedral b. Trigonal bipyramidal
c. Octahedral d. Linear

49. What is the concept of directed valency concerned with?

- a. Orientation of electrons in an atom

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- b. Arrangement of orbitals in a molecule
- c. The direction in which a bond is formed
- d. Molecular geometry

50. What is the term for the measure of the separation of positive and negative charges in a molecule?

- a. Dipole moment
- b. Ionic character
- c. Polarization
- d. Covalent radius

51. In a covalent bond, when does a molecule exhibit a dipole moment?

- a. The atoms have different sizes.
- b. The atoms have similar electronegativities.
- c. The atoms have different electronegativities.
- d. The atoms have the same size.

52. Which type of molecule is expected to have the highest dipole moment?

- a. AB_3
- b. AB_4
- c. AB_2
- d. AB_5

53. What does a dipole moment of zero in a molecule imply?

- a. The molecule is nonpolar.
- b. The molecule is ionic.
- c. The molecule has a high percentage of ionic character.

d. The molecule is symmetrical.

54. Which molecule is likely to have the highest percentage of ionic character?

- a. HCl
- b. HI
- c. HF
- d. HBr

55. What is the dipole moment of a molecule with two atoms of the same element?

- a. Zero
- b. Nonzero
- c. Indeterminate
- d. Infinity

56. In a molecule of the type AB_2 , what is the expected molecular geometry if the dipole moment is nonzero?

- a. Linear
- b. Trigonal planar
- c. Tetrahedral
- d. Bent

57. For molecules of the type AB_2 , what factor contributes to the dipole moment?

- a. Symmetry of the molecule
- b. The electronegativity of atom A
- c. The electronegativity of atom B
- d. The size of atom B

58. Which molecule is likely to have a dipole moment if the bond is polar?

- a. O_2
- b. N_2

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c. F_2

d. Cl_2

59. In a molecule of the type A_2 , what is the expected molecular geometry if the dipole moment is nonzero?

a. Linear

b. Diatomic

c. Tetrahedral

d. Bent

60. Which of the following compounds is expected to have the highest percentage of ionic character?

a. LiF

b. NaCl

c. KBr

d. RbI

61. What is the primary factor influencing the dipole moment of a bond?

a. Bond length

b. Molecular weight

c. Electronegativity difference

d. Bond energy

62. Which molecule is expected to have a higher dipole moment if all other factors are equal?

a. HCl

b. HBr

c. HI

d. HF

63. For molecules of the type AB_2 , when is the dipole moment zero?

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- a. When A and B have different electronegativities
- b. When A and B have the same electronegativity
- c. When A is more electronegative than B
- d. When A is less electronegative than B

64. In a molecule of the type AB_2 , what is the expected molecular geometry if the dipole moment is zero?**

- a. Linear
- b. Trigonal planar
- c. Tetrahedral
- d. Bent

65. What is the dipole moment of a molecule with three atoms arranged in a straight line (linear geometry)?

- a. Zero
- b. Nonzero
- c. Indeterminate
- d. Infinity

66. For molecules of the type AB_2 , what factor contributes to the dipole moment?

- a. Symmetry of the molecule
- b. The electronegativity of atom A
- c. The electronegativity of atom B
- d. The size of atom B

67. Which molecule is expected to have a higher dipole moment if the bond is polar?

- a. HCl
- b. HI

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c. HBr

d. HF

68. In a molecule of the type A_2 , what is the expected molecular geometry if the dipole moment is nonzero?

a. Linear

b. Diatomic

c. Tetrahedral

d. Bent

69. What does a dipole moment of zero in a molecule imply?

a. The molecule is nonpolar.

b. The molecule is ionic.

c. The molecule has a high percentage of ionic character.

d. The molecule is symmetrical.

Answers

1.b, 2.b, 3.c, 4.c, 5.b, 6.b, 7.b, 8.c, 9.a, 10.d, 11.b,
12.b, 13.c, 14.d, 15.a, 16.a, 17.d, 18.b, 19.b, 20.d,
21.a, 22.d, 23.a, 24.a, 25.d, 26.a, 27.d, 28.a, 29.c,
30.a, 31.c, 32.b, 33.a, 34.b, 35.c, 36.b, 37.b, 38.c,
39.b, 40.b, 41.b, 42.c, 43.b, 44.c, 45.a, 46.c, 47.c,
48.b, 49.c, 50.a, 51.c, 52.b, 53.a, 54.b, 55.a, 56.d,
57.b, 58.c, 59.b, 60.d, 61.c, 62.d, 63.b, 64.a, 65.a,
66.c, 67.d, 68.b, 69.a.

5 Marks

1. Explain the concept of Lewis dot structures for ionic compounds. Provide examples and discuss how these structures illustrate the arrangement of electrons in ionic bonds.
2. Discuss the properties of ionic compounds. Highlight characteristics such as high melting and boiling points, electrical conductivity, and solubility.
3. Explain the energy involved in the formation of ionic compounds. Introduce the Born-Haber cycle and discuss the factors affecting lattice energies.
4. Discuss the relative effects of lattice energy and solvation energy on the dissolution of ionic compounds.
5. Explain how these energies influence the solubility of ionic compounds in different solvents.
6. Define ion polarization and discuss its significance in ionic compounds. Explain Fajans' rules and how ion polarization affects the properties of compounds.
7. Provide examples to illustrate the impact of ion polarization on chemical behavior.
8. Explain the shapes of different atomic orbitals and how they contribute to the formation of σ

and π bonds. Provide examples to illustrate the overlap of orbitals in the context of covalent bonding

9. Discuss the concept of directed valency and its role in hybridization. Explain how hybridization leads to the formation of hybrid orbitals. Provide examples to illustrate the hybridization of atoms in molecules.
10. Describe the VSEPR (Valence Shell Electron Pair Repulsion) theory and its application to predict the shapes of molecules. Discuss the shapes of molecules of the type AB_2 , AB_3 , and AB_4 using VSEPR theory. Provide examples to illustrate molecular shapes.
11. Define dipole moment and explain its significance in determining the partial ionic character of a covalent bond. Apply the concept to molecules of the type A_2 , AB , and AB_2 . Provide examples to demonstrate the calculation of dipole moments.
12. Explain the concept of percentage ionic character in covalent bonds. Provide numerical problems based on the calculation of percentage ionic character and demonstrate how to determine the degree of ionic character in a given bond.

10 Marks

1. Discuss the general properties of ionic compounds, including their high melting points, electrical conductivity in molten or dissolved state, and brittleness.
2. Define and explain the Born-Haber cycle. Discuss how it is used to calculate lattice energies in ionic compounds.
3. Explain ion polarization, polarizing power, and polarizability in the context of ionic compounds.
4. Introduce Fajans' rules and discuss their effects on the properties of compounds.
5. Define lattice energy and solvation energy. Discuss their relative importance in the stability of ionic compounds.
6. Present a problem involving the calculation of lattice energy or solvation energy and ask students to solve it, demonstrating their understanding of the concepts.
7. Define VSEPR theory and explain its basic principles in predicting the shapes of molecules.
8. Consider three molecules of the type AB₂, AB₃, and AB₄, where A is the central atom and B represents surrounding atoms.

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9. State the possible molecular geometry for a molecule of the type AB_2 according to VSEPR theory.
10. Determine the expected molecular geometry for a molecule of the type AB_4 according to VSEPR theory.



UNIT-IV

1 Marks

1. In VB theory, what is the key concept used to describe the bonding in the hydrogen molecule (H_2)?
 - a. Atomic orbitals overlap to form hybrid orbitals
 - b. Molecular orbitals overlap to form covalent bonds
 - c. Electronegativity difference
 - d. Ionization energy
2. Which of the following is a limitation of Valence Bond Theory (VBT)?
 - a. It cannot explain the concept of resonance.
 - b. It does not consider the shape of molecules.
 - c. It cannot explain the paramagnetic behavior of certain molecules.
 - d. It cannot predict bond angles accurately.
3. In resonance structures of inorganic species like NO_3^- , how are the electrons distributed among different atoms?
 - a. Electrons are localized on a single atom.
 - b. Electrons are equally shared between all atoms.
 - c. Electrons are delocalized among multiple atoms.

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d. Electrons are transferred between atoms.

4. Which of the following molecules exhibits resonance structures?

- a. H_2 b. CO_2
- c. N_2 d. HF

5. What is the bond order of a molecule calculated from Molecular Orbital (MO) theory?

- a. The number of sigma bonds
- b. The number of pi bonds
- c. The difference between bonding and antibonding electrons divided by 2
- d. The number of lone pairs

6. In MO theory, what type of orbital is formed when atomic orbitals combine in-phase?

- a. Bonding orbital b. Antibonding orbital
- c. Nonbonding orbital d. Hybrid orbital

7. Which of the following is an antibonding orbital in MO theory?

- a. σ^* (sigma-star) orbital b. π (pi) orbital
- c. σ (sigma) orbital d. δ (delta) orbital

8. In MO theory, what does a positive bond order indicate for a molecule?

- a. Stability b. Instability
- c. Nonpolarity d. Paramagnetism

9. Which molecule is expected to have the highest bond order according to MO theory?

- a. O_2 b. O_2^+
- c. O_2^- d. O_3

10. In the MO diagram of H_2 , which molecular orbital is lower in energy?

- a. Bonding orbital (σ) b. Antibonding orbital (σ^*)
- c. Nonbonding orbital d. Hybrid orbital

11. What property of a substance is primarily associated with its magnetic characteristics?

- a. Electronegativity b. Atomic radius
- c. Spin of electrons d. Ionization energy

12. In magnetic characteristics, which term describes a substance that is attracted to a magnetic field?

- a. Diamagnetic b. Paramagnetic
- c. Ferromagnetic d. Antiferromagnetic

13. How do electrons contribute to the magnetic behavior of a substance?

- a. By their mass b. By their charge
- c. By their spin d. By their energy levels

14. Which of the following is a comparison point between Valence Bond (VB) and Molecular Orbital (MO) theories?

- a. VB theory considers only electrons in pi orbitals.
- b. MO theory predicts bond angles accurately.
- c. VB theory involves the overlap of atomic orbitals.
- d. MO theory cannot explain the paramagnetic behavior of molecules.

15. In the context of coordination compounds, what is the term for a bond formed when a metal atom donates a pair of electrons to a nonmetal atom?

- a. Covalent bond
- b. Ionic bond
- c. Coordinate bond
- d. Hydrogen bond

16. Which molecule is an example of the formation of a coordinate bond in BF_3 ?

- a. F_2
- b. BF_3
- c. NH_3
- d. H_2O

17. What is the definition of a coordinate bond?

- a. A bond formed by the sharing of electrons between atoms.
- b. A bond formed by the complete transfer of electrons from one atom to another.

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- c. A bond formed when electrons are shared equally between atoms.
- d. A bond formed when one atom donates both electrons in the bond.

18. Which of the following properties is associated with a molecule containing a coordinate bond?

- a. High boiling point
- b. Nonpolarity
- c. Low melting point
- d. Presence of formal charges

19. In the formation of a coordinate bond in NH_3 , which atom donates a pair of electrons?

- a. Nitrogen (N)
- b. Hydrogen (H)
- c. Boron (B)
- d. Fluorine (F)

20. Which term is used to describe the property of a substance to form a coordinate bond?

- a. Covalency
- b. Lewis acidity
- c. Electron affinity
- d. Polarizability

21. What is the primary mechanism of conduction in solids, according to Band Theory?

- a. Movement of ions
- b. Flow of electrons
- c. Vibrations of molecule
- d. Diffusion of gases

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22. Which of the following is a characteristic of a good conductor?

- a. Wide energy band gap
- b. Partially filled valence band
- c. Full valence band and empty conduction band
- d. Narrow energy band gap

23. What type of material is an insulator?

- a. Material with a completely filled valence band
- b. Material with a partially filled conduction band
- c. Material with a small energy band gap
- d. Material with a narrow energy band gap

24. Which of the following is a semiconductor?

- a. Copper (Cu)
- b. Silicon (Si)
- c. Aluminum (Al)
- d. Gold (Au)

25. What determines the conductivity of a semiconductor?

- a. Presence of free electrons
- b. Energy band gap
- c. Temperature
- d. Presence of ions

26. What type of material is a good conductor of electricity at high temperatures but behaves as a semiconductor at low temperatures?

- a. Insulator
- b. Superconductor

c. Metal

d. Semiconductor

27. Which application is commonly associated with semiconductors?

a. Power lines

b. Lighting fixtures

c. Microelectronics

d. Household insulation

28. What type of forces are responsible for Vander Waals forces between molecules?

a. Covalent forces

b. Ionic forces

c. Dipole-dipole forces

d. Metallic forces

29. In ion-dipole forces, what is the nature of the interaction between ions and polar molecules?

a. Attraction between like charges

b. Repulsion between like charges

c. Attraction between opposite charges

d. Repulsion between opposite charges

30. Which force is responsible for the interaction between temporary dipoles in nonpolar molecules?

a. Vander Waals forces

b. Hydrogen bonding

c. Ion-dipole forces

d. Metallic bonding

31. Which type of intermolecular force is present between molecules with permanent dipoles?

a. Vander Waals forces

b. Hydrogen bonding

c. Dipole-dipole interaction

d. Ionic bonding

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32. What is the primary cause of induced dipole interactions between nonpolar molecules?

- a. Permanent dipoles
- b. Electric charge
- c. Fluctuations in electron distribution
- d. Hydrogen bonding

33. What term is used to describe the temporary dipole moment induced in a nonpolar molecule by the presence of a neighboring dipole?

- a. Instantaneous dipole
- b. Induced dipole
- c. Permanent dipole
- d. Repulsive dipole

34. Which force is responsible for London dispersion forces between molecules?

- a. Induced dipole interactions
- b. Hydrogen bonding
- c. Dipole-dipole interactions
- d. Ionic bonding

35. What is the primary repulsive force between molecules that prevents them from collapsing into each other?

- a. Coulombic repulsion
- b. Dipole-dipole repulsion
- c. Induced dipole repulsion
- d. Vander Waals repulsion

36. Which intermolecular force is a special case of dipole-dipole interactions and involves hydrogen as one of the atoms?

- a. Vander Waals forces
- b. Hydrogen bonding
- c. Induced dipole interactions
- d. Covalent bonding

37. In hydrogen bonding, what type of atom is usually bonded to hydrogen to form the hydrogen bond?

- a. Oxygen (O)
- b. Nitrogen (N)
- c. Carbon (C)
- d. Fluorine (F)

38. Which of the following molecules is capable of forming hydrogen bonds?

- a. CH_4
- b. H_2O
- c. CO_2
- d. N_2

39. What is the primary factor that determines the strength of hydrogen bonding?

- a. The size of the molecules involved
- b. The electronegativity of the atoms involved
- c. The number of electrons in the molecules
- d. The molecular weight of the molecules

40. Which type of intermolecular force is the strongest among the following?

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- a. London dispersion forces
- b. Dipole-dipole interactions
- c. Hydrogen bonding
- d. Induced dipole interactions

Answers

1.b, 2.a, 3.c, 4.b, 5.c, 6.a, 7.a, 8.a, 9.b, 10.a, 11.c,
12.b, 13.c, 14.c, 15.c, 16.c, 17.d, 18.a, 19.a, 20.b,
21.b, 22.c, 23.a, 24.b, 25.a, 26.b, 27.c, 28.c, 29.c,
30.a, 31.c, 32.c, 33.a, 34.a, 35.a, 36.b, 37.a, 38.b,
39.b, 40.c.

5 Marks

1. Discuss the application of Valence Bond Theory to the hydrogen molecule (H_2). Include the concept of orbital overlap and how it leads to the formation of a covalent bond.
2. Explain the limitations of Valence Bond Theory (VBT) in describing the bonding in molecules. Provide examples to illustrate these limitations
3. Define the concept of resonance and explain how it is applied to inorganic species such as CO_2 , NO_2 , CO_3^{2-} , and NO_3^- . Provide resonance structures for each of these species.

4. Discuss the significance of resonance in understanding the structure and properties of molecules. How does the concept of resonance contribute to a more accurate representation of the electronic structure?*
5. Explain the basic principles of Molecular Orbital (MO) Theory, including the concepts of bonding, antibonding, and nonbonding orbitals. How does MO theory differ from Valence Bond Theory in describing the electronic structure of molecules?
6. Draw Molecular Orbital diagrams for H_2 , O_2 , O_2^+ , N_2 , HF , and CO . Discuss the bond order, stability, and magnetic characteristics predicted by MO theory for each molecule
7. Compare the predictions of magnetic characteristics in molecules using Valence Bond Theory (VBT) and Molecular Orbital (MO) Theory. Discuss how each theory explains the magnetic behavior of different types of molecules.
8. Examine the strengths and weaknesses of each theory in predicting magnetic properties, providing specific examples to support your discussion
9. Discuss how Valence Bond Theory (VBT) and Molecular Orbital (MO) Theory can be integrated to provide a more comprehensive understanding of the electronic structure of molecules.

10. Explain the concept of Band Theory in the context of solids. How does Band Theory elucidate the mechanism of conduction in different types of solids?
11. Discuss the distinctions between conductors, insulators, and semiconductors based on Band Theory. Provide examples of each type and highlight their specific characteristics.
12. Classify semiconductors into different types and discuss the factors that determine their conductivity. Explain the role of energy bands in semiconductors.
13. Explore the applications of semiconductors in various electronic devices. Provide specific examples and discuss the significance of semiconductors in modern technology.
14. Elaborate on the nature and origin of Vander Waals forces between molecules. Provide examples to illustrate the different types of Vander Waals forces.
15. Explain the concept of ion-dipole forces and discuss how they contribute to intermolecular interactions. Provide examples to demonstrate the significance of ion-dipole forces in chemistry.

16. Discuss the characteristics of dipole-dipole interactions and their role in determining the properties of polar molecules. Provide examples to illustrate the impact of dipole-dipole interactions.

10 Marks

1. Explain the application of Valence Bond Theory (VBT) to the hydrogen molecule (H_2). Include a detailed discussion on how the theory describes the formation of the covalent bond in H_2 .
2. Discuss the limitations of Valence Bond Theory in explaining the electronic structure of molecules. Provide specific examples to illustrate these limitations.
3. Define the concept of resonance and explain its application to inorganic species such as CO_2 , NO_2 , CO_3^{2-} , and NO_3^- . Provide resonance structures for each of these species.
4. Accurate representation of the electronic structure of molecules. Provide examples to illustrate the significance of resonance in understanding the properties of these species.
5. Provide a comprehensive explanation of Molecular Orbital (MO) Theory, covering the concepts of bonding, antibonding, and

nonbonding orbitals. Discuss how MO theory differs from Valence Bond Theory.

6. Draw Molecular Orbital diagrams for H_2 , O_2 , O_2^+ , N_2 , HF , and CO . Analyze the bond order, stability, and magnetic characteristics predicted by MO theory for each molecule.

7. Discuss how Valence Bond Theory (VBT) and Molecular Orbital (MO) Theory predict and explain the magnetic characteristics of different types of molecules. Provide examples to support your discussion.

8. Evaluate the strengths and weaknesses of each theory in describing the magnetic properties of molecules. Highlight any cases where the two theories complement each other.

9. Define the term "coordinate bond" and explain how it differs from other types of chemical bonds. Provide examples of molecules with coordinate bonds.

10. Discuss the formation of BF_3 and NH_3 , emphasizing the role of coordinate bonds. Examine the properties of these molecules and explain how the presence of coordinate bonds influences their behavior.

11. Explain the Band Theory in the context of solids. How does it describe the mechanism of conduction in different types of solids, including conductors, insulators, and semiconductors?

12. Discuss the distinctions between conductors, insulators, and semiconductors based on Band Theory. Provide examples to illustrate the properties and applications of each type.
13. Classify semiconductors into different types and discuss the factors that determine their conductivity. Explain the role of energy bands in semiconductors.**
14. Explore the applications of semiconductors in various electronic devices. Provide specific examples and discuss the significance of semiconductors in modern technology.
15. Provide a detailed explanation of Vander Waals forces, including dispersion forces and dipole-dipole interactions. Discuss how these forces contribute to intermolecular interactions.
16. Explain the concept of ion-dipole forces and discuss their role in determining the properties of substances. Provide examples to illustrate the significance of ion-dipole forces in chemistry.
17. Discuss the characteristics of dipole-dipole interactions and their role in determining the properties of polar molecules. Provide examples to illustrate the impact of dipole-dipole interactions.

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18. Explain the concept of induced dipole interactions and how they contribute to intermolecular forces. Provide examples to highlight the significance of induced dipole interactions in different substances.

19. Explore repulsive forces in the context of intermolecular interactions. Discuss how these forces prevent the collapse of molecules and influence the physical properties of substances.



UNIT-V

1 Marks

1. What is the primary difference between heterolytic and homolytic bond cleavage?
 - a. Homolytic cleavage results in unequal sharing of electrons, while heterolytic cleavage results in equal sharing.
 - b. Homolytic cleavage results in equal sharing of electrons, while heterolytic cleavage results in unequal sharing.
 - c. Homolytic cleavage involves the breaking of two bonds, while heterolytic cleavage involves the breaking of one bond.
 - d. Homolytic cleavage always produces ions, while heterolytic cleavage produces radicals.
2. Which term refers to species that donate electron pairs during a chemical reaction?
 - a. Electrophiles
 - b. Nucleophiles
 - c. Free radicals
 - d. Carbanions
3. In a reaction intermediate, which species carries a positive charge?
 - a. Carbanion
 - b. Carbocation
 - c. Carbenes
 - d. Arynes

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4. What type of bond cleavage is associated with the formation of free radicals?

- a. Homolytic b. Heterolytic
- c. Radicalytic d. Inolytic

5. Which of the following is an example of an electrophile?

- a. Cl^- b. CH_3Br
- c. $\text{OH}^\cdot$ (hydroxyl radical) d. H^+

6. What is the inductive effect responsible for in the reactivity of alkyl halides?

- a. Increasing acidity b. Increasing basicity
- c. Electron withdrawal d. Electron donation

7. Which term describes the phenomenon where the electron cloud of a sigma bond is shifted towards a more electronegative atom?

- a. Electromeric effect b. Inductomeric effect
- c. Resonance effect d. Hyperconjugation

8. In the acidity of haloacids, what factor contributes to increased acidity?

- a. Presence of electron-withdrawing groups
- b. Presence of electron-donating groups
- c. Size of the halogen atom
- d. Number of halogen atoms

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9. Which species is an example of a nucleophile?

- a. H^+
- b. Br^-
- c. $\text{CH}_3\cdot$ (methyl radical)
- d. NO_2^+

10. What type of species is formed by the removal of a leaving group from a substrate during a reaction?

- a. Electrophile
- b. Nucleophile
- c. Carbanion
- d. Carbocation

11. What is resonance energy in the context of molecular resonance?

- a. Energy released during a resonance reaction
- b. Energy required for resonance stabilization
- c. The difference in energy between the actual and resonance hybrid structures
- d. The energy needed to break a resonance bond

12. Which of the following conditions is necessary for resonance to occur in a molecule?

- a. Presence of a single bond
- b. Presence of multiple bonds
- c. High electronegativity of atoms
- d. Low molecular weight

13. In the context of phenols, how does resonance affect acidity?

- a. Increases acidity

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- b. Decreases acidity
- c. No effect on acidity
- d. Converts phenols into base

14. What is the major factor determining the basicity of aromatic amines?

- a. Size of the amine group
- b. Presence of resonance structures
- c. Electronegativity of the amine atom
- d. Number of substituents

15. In the stability of carbonium ions, how does resonance contribute?

- a. Increases stability
- b. Decreases stability
- c. No effect on stability
- d. Converts carbonium ions into radicals

16. How does resonance affect the stability of carbanions?

- a. Increases stability
- b. Decreases stability
- c. No effect on stability
- d. Converts carbanions into radicals

17. Which of the following species is known for its ability to exhibit resonance?

- a. Alkanes
- b. Alkenes

- c. Aromatic compounds d. Alkynes

18. What role does resonance play in the stability of free radicals?

- a. Increases stability
- b. Decreases stability
- c. No effect on stability
- d. Converts free radicals into ions

19. In the context of resonance, which atom is often involved in donating or accepting electrons?

- a. Hydrogen (H) b. Carbon (C)
- c. Nitrogen (N) d. Oxygen (O)

20. Which statement accurately describes the impact of resonance on a molecule?

- a. Resonance destabilizes molecules.
- b. Resonance contributes to the overall instability of a molecule.
- c. Resonance helps distribute charge and stabilize molecules.
- d. Resonance only occurs in highly reactive species.

21. How does hyperconjugation contribute to the stability of alkenes?***

- a. It increases the bond length.
- b. It decreases the bond length.

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- c. It increases the dipole moment.
- d. It stabilizes the alkene by delocalizing electrons through sigma bonds.

22. What is the effect of hyperconjugation on the bond length of a molecule?*

- a. Increases the bond length
- b. Decreases the bond length
- c. No effect on the bond length
- d. Causes the bond length to become variable

23. How does the presence of a methyl group affect the orientation of a substituent in a molecule due to hyperconjugation?

- a. It repels the substituent.
- b. It attracts the substituent.
- c. It has no effect on the orientation.
- d. It causes the substituent to be randomly oriented.

24. Which compound is expected to have a higher dipole moment due to hyperconjugation?

- a. Formaldehyde (CH_2O)
- b. Acetaldehyde (CH_3CHO)
- c. Acetone (CH_3COCH_3)
- d. Methanol (CH_3OH)

25. In the context of hyperconjugation, which compound is expected to exhibit a higher stability among alkenes?

- a. Butene ($\text{CH}_3\text{CH}=\text{CHCH}_3$)
- b. Isobutene ($\text{CH}_2=\text{C}(\text{CH}_3)_2$)
- c. 1,3-Butadiene ($\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$)
- d. Cyclohexene (C_6H_{10})

Answers

1.b, 2.b, 3.b, 4.a, 5.d, 6.c, 7.b, 8.a, 9.b, 10.d, 11.c,
12.b, 13.a, 14.b, 15.a, 16.a, 17.c, 18.b, 19.d, 20.c,
21.d, 22.b, 23.b, 24.b, 25.b,

5 Marks

1. Differentiate between heterolytic and homolytic bond cleavage, providing examples for each. Discuss the types of reaction intermediates formed during these cleavage processes, including carbanions, carbocations, carbenes, arynes, and nitrynes.
2. Explain the significance of understanding different types of bond cleavage in predicting reaction mechanisms and designing synthetic routes.
3. Discuss the role of reagents in chemical reactions, emphasizing their influence on bond

cleavage. Provide examples of reagents that induce heterolytic and homolytic cleavage.

4. Explore the importance of substrate selection in reactions, considering how the nature of the substrate influences the type of bond cleavage that occurs.
5. Define and differentiate between electrophiles, nucleophiles, and free radicals. Provide examples of each type of reagent and explain their roles in chemical reactions.
6. Discuss the factors that determine whether a species acts as an electrophile, nucleophile, or free radical in a given reaction.
7. Explain the formation and stability of carbanions, carbocations, carbenes, arynes, and nitynes as reaction intermediates. Provide examples of reactions involving each intermediate and discuss their significance in organic chemistry.
8. Define the inductive effect and discuss its role in the reactivity of alkyl halides. Explain how the inductive effect influences the stability of intermediates formed during bond cleavage.
9. Explore the impact of the inductive effect on the acidity of halo acids. Provide examples to illustrate how inductive effects influence the relative acidity of different halo acids.

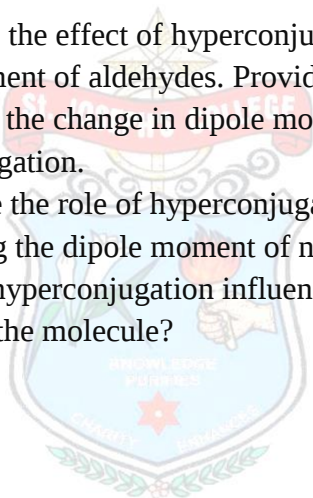
10. Define resonance energy and explain its significance in the stability of molecules. Provide an example to illustrate the concept.
11. Discuss the conditions under which resonance occurs in a molecule. How does the presence of multiple resonance structures affect the stability of a molecule?
12. Explore the relationship between resonance and the acidity of phenols. How does resonance contribute to the enhanced acidity of phenols?
13. Discuss the influence of resonance on the basicity of aromatic amines. Provide examples to support your explanation.
14. Examine how resonance impacts the stability of carbonium ions. Provide examples of carbonium ions stabilized by resonance.
15. Discuss the role of resonance in stabilizing carbanions and free radicals. Provide examples of species where resonance enhances stability.
16. Explain how hyperconjugation contributes to the stability of alkenes. Provide examples to illustrate the concept.
17. Discuss the impact of hyperconjugation on bond length. How does it affect the overall geometry of molecules?
18. Elaborate on the orienting effect of a methyl group in the context of hyperconjugation. How does the presence of a methyl group influence the

reactivity and orientation of a substituent in a molecule?

10 Marks

1. Define resonance energy and explain its significance in the stability of molecules. Provide examples to illustrate the concept.
2. Discuss the conditions under which resonance occurs in a molecule. How does the presence of multiple resonance structures affect the stability of a molecule?
3. Explore the relationship between resonance and the acidity of phenols. How does resonance contribute to the enhanced acidity of phenols?
4. Discuss the influence of resonance on the basicity of aromatic amines. Provide examples to support your explanation.
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6. Discuss the role of resonance in stabilizing carbanions and free radicals. Provide examples of species where resonance enhances stability.
7. Explain how hyperconjugation contributes to the stability of alkenes. Provide examples to illustrate the concept.

8. Discuss the impact of hyperconjugation on bond length. How does it affect the overall geometry of molecules?
9. Elaborate on the orienting effect of a methyl group in the context of hyperconjugation. How does the presence of a methyl group influence the reactivity and orientation of a substituent in a molecule?
10. Discuss the effect of hyperconjugation on the dipole moment of aldehydes. Provide examples to illustrate the change in dipole moment due to hyperconjugation.
11. Explore the role of hyperconjugation in determining the dipole moment of nitromethane. How does hyperconjugation influence the overall polarity of the molecule?



GENERAL CHEMISTRY - II

UNIT-I

Acids, bases and Ionic equilibria Concepts of Acids and Bases - Arrhenius concept, Bronsted-Lowry concept, Lewis concept; Relative strengths of acids, bases and dissociation constant; ionic product of water, pH scale, pH of solutions; Degree of dissociation, common ion effect, factors affecting degree of dissociation.

Buffer solutions - types, mechanism of buffer action in acid and basic buffer, Henderson - Hasselbach equation.

Salt hydrolysis - salts of weak acids and strong bases, weak bases and strong acids, weak acids and weak bases - hydrolysis constant, degree of hydrolysis and relation between hydrolysis constant and degree of hydrolysis; Solubility product - determination and applications; numerical problems involving the core concepts.

UNIT-II Chemistry of s - Block Elements

Hydrogen:

Position of hydrogen in the periodic table. Alkali metals: Comparative study of the elements with respect to oxides, hydroxides, halides, carbonates

and bicarbonates. Diagonal relationship of Li with Mg. Preparation, properties and uses of NaOH, Na_2CO_3 , KBr, KClO_3 alkaline earth metals. Anomalous behaviour of Be.

Chemistry of p- Block Elements (Group 13 & 14)

Preparation and structure of diborane and borazine - Chemistry of borax - Extraction of Al and its uses - Alloys of Al. Comparison of carbon with silicon - Carbon-di-sulphide - Preparation, properties, structure and uses - Per carbonates, per monocarbonates and per dicarbonates.

UNIT-III Chemistry of p- Block Elements (Group 15-18)

General characteristics of elements of Group - 15; Chemistry of $\text{H}_2\text{N}-\text{NH}_2$ and NH_2OH .

Chemistry of PH_3 , PCl_3 and PCl_5 - Oxy acids of phosphorous H_3PO_3 and H_3PO_4 .

General properties of elements of Group - 16 -

Structure and allotropy of elements - chemistry of ozone - Classification and properties of oxides - oxides of sulphur and selenium - Oxy acids of sulphur (Caro's and Marshall's acids).

Chemistry of Halogens: General characteristics of halogen with reference to electro-negativity, electron affinity, oxidation states and oxidizing power. Peculiarities of fluorine. Halogen acids (HF, HCl, HBr and HI), oxides and oxy acids (HClO₄). Inter-halogen compounds (ICl, ClF₃, BrF₅ and IF₇).

Noble gases: Position in the periodic table. Preparation, properties and structure of XeF₂, XeF₄ and XeOF₄.

UNIT-IV

Hydrocarbon Chemistry-I

Alkenes

Nomenclature, general methods of preparation - Mechanism of β - elimination reactions - E1 and E2 mechanism - Hofmann and Saytzeff rules. Reactions of alkenes - addition reactions - mechanisms - Markownikoff's rule, Kharasch effect, oxidation reactions - hydroxylation, epoxidation, ozonolysis.

Alkadienes

Nomenclature - classification - isolated, conjugated and cumulated dienes; stability of conjugated dienes; mechanism of electrophilic

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addition to conjugated dienes - 1, 2 and 1, 4
additions; free radical addition to conjugated
dienes - Diels-Alder reactions.

Alkynes

Nomenclature; general methods of preparation,
properties and reactions; acidic nature of terminal
alkynes and acetylene, polymerisation and
isomerisation

Cycloalkanes:

Nomenclature, Relative stability of cycloalkanes,
Bayer's strain theory and its limitations.
Conformational analysis of cyclohexane.
Geometrical isomerism in cyclohexanes.

UNIT-V

Hydrocarbon Chemistry – II

Benzene: Source, structure of benzene, stability
of benzene ring, molecular orbital picture of
benzene, aromaticity, Huckel's $(4n+2)$ rule and
its applications. Electrophilic substitution
reactions - General mechanism of aromatic
electrophilic substitution - nitration, sulphonation,
halogenation, Friedel-Craft's alkylation and
acylation.

Polynuclear Aromatic hydrocarbons:

Naphthalene - nomenclature, Haworth synthesis; physical properties, reactions - electrophilic substitution reaction, nitration, sulphonation, halogenation, Friedel - Crafts acylation and alkylation. Anthracene - synthesis by Elbs reaction, Diels - Alder reaction and Haworth synthesis; physical properties; reactions - Diels - Alder reaction, preferential substitution at C-9 and C-10; uses.



UNIT-1

1 Marks

1. What is the fundamental difference between Arrhenius, Bronsted-Lowry, and Lewis concepts of acids and bases?
 - a. Arrhenius focuses on proton transfer, Bronsted-Lowry on electron pair transfer, and Lewis on both.
 - b. Arrhenius focuses on electron pair transfer, Bronsted-Lowry on proton transfer, and Lewis on both.
 - c. Arrhenius and Bronsted-Lowry focus on proton transfer, while Lewis focuses on electron pair transfer.
 - d. Arrhenius and Lewis focus on proton transfer, while Bronsted-Lowry focuses on electron pair transfer.
2. Which of the following is a Lewis acid?
 - a. HCl
 - b. H₂O
 - c. BF₃
 - d. NH₃
3. What does the pH scale measure?
 - a. Concentration of hydrogen ions in a solution
 - b. Concentration of hydroxide ions in a solution

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c. Concentration of both hydrogen and hydroxide ions in a solution

d. Degree of dissociation of acids

4. Which of the following solutions is basic?

a. pH = 7

b. pH = 1

c. pH = 14

d. pH = 9

5: What is the common ion effect?

a. Increase in the concentration of ions due to the addition of a common ion

b. Decrease in the concentration of ions due to the addition of a common ion

c. Increase in the pH of a solution

d. Decrease in the pH of a solution

6. Which factor does not affect the degree of dissociation of an acid?

a. Concentration of the acid b. Temperature

c. Presence of a catalyst d. Nature of the acid

7. What is the formula for the dissociation constant (K_a) for a weak acid?

a. $\frac{[H_3O^+][OH^-]}{[HA]}$

b. $\frac{[H^+][A^-]}{[HA]}$

c. $\frac{[H^+][OH^-]}{[H_2O]}$

d. $\frac{[A^-]}{[HA]}$

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8 .Which type of buffer is formed by a weak acid and its salt?***

- a. Acidic buffer
- b. Basic buffer
- c. Amphiprotic buffer
- d. Neutral buffer

9. What is the mechanism of buffer action in an acidic buffer solution?

- a. Hydrolysis of the salt
- b. Reaction between the weak acid and strong base
- c. Reaction between the weak acid and weak base
- d. Ionization of the weak acid

10. Which of the following is a characteristic of a good buffer solution?

- a. High concentration of the weak acid or base
- b. Low concentration of the weak acid or base
- c. Resists changes in pH upon addition of small amounts of acid or base
- d. Strong electrolyte nature

11. What does the Henderson-Hasselbalch equation describe?

- a. The relationship between the concentration of ions and the temperature of a solution.
- b. The relationship between the pH of a buffer solution, the pK_a of the weak acid, and the

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concentration ratio of the conjugate base to the weak acid.

- c. The ionization constant of water in a buffer solution.
- d. The rate of a chemical reaction in a buffer solution.

12. In the Henderson-Hasselbalch equation, what does 'pKa' represent?

- a. The concentration of the weak acid.
- b. The pH of the solution.
- c. The ionization constant of water.
- d. The negative logarithm of the acid dissociation constant (K_a) of the weak acid.

13. Which of the following is the Henderson-Hasselbalch equation for a weak acid (HA) and its conjugate base (A^-)?

- a. $pH = pK_a + \log([HA]/[A^-])$
- b. $pH = pK_a - \log([HA]/[A^-])$
- c. $pH = \log([HA]/[A^-])$
- d. $pH = \log([A^-]/[HA])$

14. What is the primary factor that determines the effectiveness of a buffer solution according to the Henderson-Hasselbalch equation?

- a. Concentration of the weak acid.
- b. Concentration of the conjugate base.

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- c. Ratio of the concentration of the weak acid to the conjugate base.
- d. pH of the solution.

15. Which of the following salt solutions is likely to undergo hydrolysis?

- a. Sodium chloride (NaCl)
- b. Potassium nitrate (KNO_3)
- c. Calcium sulfate (CaSO_4)
- d. Ammonium chloride (NH_4Cl)

16. What is the hydrolysis constant (K_h) a measure of in salt hydrolysis?

- a. The concentration of hydroxide ions in the solution.
- b. The degree of dissociation of the salt.
- c. The pH of the solution.
- d. The concentration of hydrogen ions in the solution.

17. Which type of salt undergoes hydrolysis to produce an acidic solution?

- a. Salts of weak acids and strong bases.
- b. Salts of strong acids and strong bases.
- c. Salts of strong acids and weak bases.
- d. Salts of weak acids and weak bases.

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18. What is the hydrolysis constant expression for a salt of a weak acid (HA) and a strong base (BOH)?

- a. $K_h = [HA][BOH]$ b. $K_h = [H^+][OH^-]$
c. $K_h = [A^-][H^+]$ d. $K_h = [OH^-][A^-]/[BOH]$

19. Which of the following salts is likely to form a basic solution upon hydrolysis?

- a. Sodium acetate ($NaCH_3COO$)
b. Ammonium bromide (NH_4Br)
c. Potassium sulfate (K_2SO_4)
d. Calcium nitrate ($Ca(NO_3)_2$)

20. In the context of salt hydrolysis, what is the significance of the hydrolysis constant (K_h) being greater than 1?

- a. The solution is neutral.
b. The solution is basic.
c. The solution is acidic.
d. The solution is not undergoing hydrolysis.

21. What does the term "degree of hydrolysis" refer to in chemical reactions?

- a. The extent to which a salt dissolves in water.
b. The percentage of a substance that undergoes hydrolysis in a reaction.
c. The concentration of hydroxide ions in a solution.

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d. The ratio of the concentrations of the products to the reactants in a hydrolysis reaction.

22. How is the degree of hydrolysis (α) related to the hydrolysis constant (K_h)?

a. $\alpha = \sqrt{K_h}$

b. $\alpha = \frac{1}{K_h}$

c. $\alpha = \frac{K_h}{1 + K_h}$

d. $\alpha = K_h^2$

23. In the context of hydrolysis, what does a higher value of the hydrolysis constant (K_h) indicate?

a. Greater degree of hydrolysis.

b. Lower degree of hydrolysis.

c. Neutral solution.

d. No hydrolysis.

24. What is the solubility product (K_{sp}) a measure of?

a. The concentration of solute in a saturated solution.

b. The rate of dissolution of a solute.

c. The molar mass of a solute.

d. The acidity of a solution.

25. How is the solubility product (K_{sp}) calculated for a sparingly soluble salt AB_2 ?

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- a. $(K_{sp} = [A]^2[B]^2)$ b. $(K_{sp} = [A][B])$
c. $(K_{sp} = [A]^2[B])$ d. $(K_{sp} = [A][B]^2)$

26. What is the significance of the ion product (Q) in relation to the solubility product (K_{sp})?

- a. If $(Q < K_{sp})$, the solution is unsaturated.
b. If $(Q = K_{sp})$, the solution is supersaturated.
c. If $(Q > K_{sp})$, the solution is saturated.
d. Both a and c.

27. Which of the following statements about solubility product (K_{sp}) is true?

- a. K_{sp} is dependent on temperature.
b. K_{sp} is a constant for all salts.
c. K_{sp} is higher for more soluble salts.
d. K_{sp} is inversely proportional to molar mass.

28. What is the common ion effect in the context of solubility product?

- a. The decrease in solubility of a salt in the presence of a common ion.
b. The increase in solubility of a salt in the presence of a common ion.
c. The change in color of a solution due to the addition of a common ion.
d. The neutralization of a common ion.

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29. In which of the following situations would you expect the highest solubility for a salt?

- a. Low temperature and low pressure.
- b. High temperature and low pressure.
- c. Low temperature and high pressure.
- d. High temperature and high pressure.

30. If the ion product (Q) is equal to the solubility product (K_{sp}), what is the state of the solution?

- a. Saturated.
- b. Unsaturated.
- c. Supersaturated.
- d. Insaturated.

Answers

1.c, 2.c, 3.a, 4.d, 5.b, 6.a, 7.b, 8.a, 9.a, 10.c, 11.b, 12.d, 13.a, 14.c, 15.d, 16.b, 17.a, 18.d, 19.a, 20.b, 21.b, 22.c, 23.a, 24.a, 25.a, 26.d, 27.a, 28.a, 29.d, 30.a.

5 Marks

1. Define the Arrhenius, Bronsted-Lowry, and Lewis concepts of acids and bases. Provide one example for each concept.
2. Explain the relative strengths of acids and bases. How does the dissociation constant (K_a) or (K_b) relate to the strength of weak acids and bases?

3. Discuss the ionic product of water (K_w), the pH scale, and how to calculate the pH of a solution. Provide an example to illustrate.
4. Define the degree of dissociation (α) and explain its significance, particularly for weak acids and bases. What is the common ion effect, and how does it affect the dissociation of weak electrolytes?
5. Describe the types of buffer solutions and the mechanism of buffer action for both acidic and basic buffers. Provide a hypothetical scenario to illustrate the buffer action.
6. Provide a detailed explanation of the Henderson-Hasselbalch equation. How does this equation relate the pH of a solution to the pK_a of a weak acid and the ratio of its conjugate base to the weak acid? Illustrate with an example.
7. Discuss the concept of salt hydrolysis, focusing on salts derived from weak acids and strong bases, weak bases and strong acids, and weak acids and weak bases. Provide examples for each type of salt hydrolysis.
8. Explain the relationship between the hydrolysis constant (K_h) and the degree of hydrolysis.
9. How does the degree of hydrolysis influence the pH of a solution undergoing hydrolysis?

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Provide a mathematical expression to represent this relationship.

10. Define the solubility product (K_{sp}) and discuss its significance .

11. Determining the solubility of a sparingly soluble salt. How can one experimentally determine the solubility product of a salt, and what factors affect it?

10 Marks

1. Define and explain the Arrhenius, Bronsted-Lowry, and Lewis concepts of acids and bases. Provide examples for each concept and discuss their significance in understanding acid-base behavior.

2. Compare and contrast the strengths of acids and bases based on the Arrhenius concept, highlighting the differences between strong and weak acids, as well as strong and weak bases.

3. Define the dissociation constant (K_a) for acids, (K_b) for bases) and explain how it quantifies the extent of ionization of weak acids and bases. Provide relevant equations and examples.

4. Discuss the ionic product of water (K_w), its significance, and its relation to the pH scale.

5. Explain how the pH scale is used to quantify the acidity or basicity of a solution.
6. Define the degree of dissociation and explain how it measures the extent to which a substance ionizes in a solution. Discuss the factors that influence the degree of dissociation.
7. Explain the common ion effect and how it affects the dissociation of weak electrolytes in a solution. Provide examples to illustrate the common ion effect.
8. Discuss the types of buffer solutions, focusing on both acidic and basic buffers. Explain the key characteristics that define each type.
9. Provide a detailed explanation of the mechanism of buffer action in acidic buffers. How does the presence of a weak acid and its conjugate base help resist changes in pH when an acid or base is added?
10. Define the Henderson-Hasselbalch equation and explain its significance in calculating the pH of a buffer solution. Provide a step-by-step derivation of the Henderson-Hasselbalch equation and illustrate its application with an example involving a weak acid and its conjugate base.
11. Define the solubility product (K_{sp}) and explain its significance in determining the solubility of a sparingly soluble salt.

UNIT-II

1 Marks

1. Where is hydrogen positioned in the periodic table?

- a. Group 1
- b. Group 2
- c. Group 17
- d. Group 18

2. Which of the following is a characteristic of alkali metals' oxides?

- a. Basic
- b. Acidic
- c. Neutral
- d. Amphoteric

3. Among alkali metals, which element forms the most stable hydroxide?

- a. Lithium
- b. Sodium
- c. Potassium
- d. Rubidium

4. What type of halides do alkali metals generally form?

- a. Covalent
- b. Ionic
- c. Metallic
- d. Molecular

5. Which alkali metal carbonate is insoluble in water?

- a. Lithium carbonate
- b. Sodium carbonate
- c. Potassium carbonate
- d. Rubidium carbonate

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6. What is the common feature of carbonates of alkali metals?

- a. Soluble in water b. Insoluble in water
- c. Volatile d. Colored

7. Which of the following is a bicarbonate formed by an alkali metal?

- a. NaOH b. KOH
- c. NaHCO₃ d. K₂CO₃

8. How does the reactivity of alkali metals change down the group?

- a. Increases b. Decreases
- c. Remains constant d. Unpredictable

9. Which alkali metal halide is commonly used in table salt?

- a. Lithium chloride b. Sodium chloride
- c. Potassium chloride d. Rubidium chloride

10. What is the valency of hydrogen?

- a. 1 b. 2
- c. 3 d. 4

11. Which pair of elements exhibits a diagonal relationship?

- a. Li and Na b. Li and K
- c. Li and Mg d. Li and Ca

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12. What is a characteristic feature of the diagonal relationship between Li and Mg?
- Similar atomic size
 - Similar electronegativity
 - Similar ionization energy
 - Similar metallic character
13. Which of the following is a common property of both Li and Mg compounds?
- Solubility in water
 - Insolubility in water
 - Formation of colored compounds
 - Volatility
14. What is the chemical formula of sodium hydroxide?
- NaO
 - NaOH
 - Na₂O
 - Na₂OH
15. What is the primary use of sodium hydroxide (NaOH)?
- Baking
 - Fertilizer production
 - Soap and detergent manufacturing
 - Water purification

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16. Which alkaline earth metal is commonly associated with the preparation of slaked lime (calcium hydroxide)?

- a. Magnesium
- b. Calcium
- c. Barium
- d. Strontium

17. What is the chemical formula of potassium bromide?

- a. KBr
- b. K_2Br
- c. KB
- d. KBr_2

18. Which alkaline earth metal is known for its use in fireworks due to the vivid colors it imparts?

- a. Magnesium
- b. Calcium
- c. Barium
- d. Strontium

19. What is the primary use of sodium carbonate (washing soda)?

- a. Cooking ingredient
- b. Water softening
- c. Agriculture fertilizer
- d. Glass manufacturing

20. Which compound is commonly used as an oxidizing agent and is produced by the reaction of potassium chloride with chlorine?

- a. $KClO_3$
- b. KCl
- c. K_2O
- d. K_2CO_3

21. What is the chemical formula of diborane?

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- a. B_2H_6
- b. BH_3
- c. B_3H_8
- d. B_4H_{10}

22. What type of bonding is present in diborane?

- a. Ionic
- b. Covalent
- c. Metallic
- d. Van der Waals

23. What is the chemical formula of borazine?

- a. B_2H_6
- b. BH_3
- c. $B_3N_3H_6$
- d. B_4H_{10}

24. Borax is a sodium borate compound. What is its chemical formula?

- a. $NaBO_2$
- b. $Na_2B_4O_7 \cdot 10H_2O$
- c. $Na_2B_6O_{10}$
- d. $NaBH_4$

25. What is the primary use of borax?

- a. Food preservative
- b. Antifreeze
- c. Laundry detergent
- d. Insecticide

26. In the extraction of aluminum (Al), which compound is used as the starting material?

- a. Alumina (Al_2O_3)
- b. Aluminum chloride ($AlCl_3$)
- c. Aluminum sulfate ($Al_2(SO_4)_3$)
- d. Aluminum oxide (AlO)

27. What is the primary use of aluminum alloys?

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- a. Electrical insulation
- b. Structural materials in construction
- c. Water purification
- d. Medicinal applications

28. In comparison to carbon, what is a characteristic property of silicon?

- a. Forms strong double bonds
- b. Acts as a good reducing agent
- c. Can form multiple bonds with other elements
- d. Has a tendency to form long chains

29. Which of the following is a common use of carbon disulfide?

- a. Food additive
- b. Solvent in the extraction of fats and oils
- c. Medical antiseptic
- d. Fire extinguisher

30. What is the chemical formula of carbon disulfide?

- a. CS₂
- b. C₂S
- c. CO₂
- d. CS

31. In comparison to carbon, what is a characteristic property of silicon?

- a. Forms strong double bonds
- b. Acts as a good reducing agent

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- c. Can form multiple bonds with other elements
- d. Exhibits strong acidity

32. What is the chemical formula of carbon disulfide?

- a. CS₂
- b. C₂S
- c. CO₂
- d. CS

33. What is the general formula for percarbonates?

- a. M₂CO₃
- b. MCO₃
- c. M₂(CO₃)₂
- d. M(CO₄)₂

34. Which of the following is a property associated with percarbonates?

- a. High solubility in water
- b. Decomposition upon heating
- c. Low reactivity with acids
- d. Non-reactivity with metals

35. What is the structure of a monocarbonate ion (MCO₃⁻)?

- a. Linear
- b. Trigonal planar
- c. Tetrahedral
- d. Octahedral

36. Which metal is commonly associated with the preparation of perdicarbonates?

- a. Sodium (Na)
- b. Potassium (K)
- c. Calcium (Ca)
- d. Magnesium (Mg)

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37. What is a characteristic property of perdicarbonates?

- a. Stability at high temperatures
- b. Strong reducing nature
- c. Release of oxygen upon decomposition
- d. Insolubility in water

38. What is the primary use of percarbonates?

- a. Food preservation
- b. Bleaching agent
- c. Fuel in rocket propulsion
- d. Pharmaceutical applications

39. Which of the following is a common use of carbon disulfide?

- a. Food additive
- b. Solvent in the extraction of fats and oils
- c. Medical antiseptic
- d. Fire extinguisher

40. What is the chemical formula of perdicarbonate ion?

- a. CO_3^{2-}
- b. $\text{C}_2\text{O}_6^{2-}$
- c. CO_4^{2-}
- d. $\text{C}_2\text{O}_7^{2-}$

Answers

1.d, 2.a, 3.c, 4.b, 5.a, 6.a, 7.c, 8.a, 9.b, 10.a, 11.c,
12.d, 13.b, 14.b, 15.c, 16.b, 17.a, 18.c, 19.d, 20.a,
21.a, 22.b, 23.c, 24.b, 25.c, 26.a, 27.b, 28.c, 29.b,
30.a, 31.c, 32.a, 33.d, 34.b, 35.a, 36.b, 37.c, 38.b,
39.b, 40.d.

5 Marks

1. Discuss the position of hydrogen in the periodic table, highlighting its unique characteristics.
2. Conduct a comparative study of alkali metals concerning their oxides, hydroxides, halides, carbonates, and bicarbonates, emphasizing trends down the group.
3. Explain the diagonal relationship between lithium (Li) and magnesium (Mg), discussing the similarities and differences in their properties.
4. Provide a detailed account of the preparation, properties, and uses of sodium hydroxide (NaOH), sodium carbonate (Na_2CO_3), potassium bromide (KBr), and potassium chlorate (KClO_3).
5. Explore the chemistry of alkaline earth metals, focusing on their extraction methods, properties, and significant uses.

6. Investigate the anomalous behavior of beryllium (Be), considering its position in the periodic table and distinctive properties compared to other alkaline earth metals.
7. Discuss the preparation and structure of diborane (B_2H_6) and borazine ($B_3N_3H_6$), highlighting their significance.
8. Examine the chemistry of borax, including its chemical formula, properties, and notable applications.
9. Provide an overview of the extraction of aluminum (Al) and discuss its various uses, particularly focusing on alloys.
10. Compare the properties of carbon and silicon, emphasizing their differences and similarities in bonding and reactivity. Additionally, discuss the significance of carbon disulfide (CS_2) in chemical processes.

10 Marks

1. Discuss the position of hydrogen in the periodic table, considering its electronic configuration, isotopes, and its anomalous placement in the alkali metal group.
2. Conduct an in-depth comparative study of alkali metals (Li, Na, K, Rb, Cs) concerning their oxides, hydroxides, halides, carbonates, and

bicarbonates. Explain the trends observed down the group and their implications on reactivity.

3. Explain the concept of diagonal relationships in chemistry, focusing specifically on the diagonal relationship between lithium (Li) and magnesium (Mg). Discuss similarities in properties and their significance.

4. Provide a comprehensive analysis of the preparation, properties, and uses of sodium hydroxide (NaOH), sodium carbonate (Na₂CO₃), potassium bromide (KBr), and potassium chlorate (KClO₃).

5. Explore the chemistry of alkaline earth metals (Be, Mg, Ca, Sr, Ba), covering their extraction methods, properties, and important applications. Discuss any anomalies in the behavior of beryllium.

6. Investigate the anomalous behavior of beryllium (Be) in terms of its electronic configuration, bonding, and physical properties. Discuss how these anomalies differ from the rest of the alkaline earth metals.

7. Discuss the chemistry of p-block elements in Groups 13 and 14, highlighting their general characteristics, trends, and notable compounds.

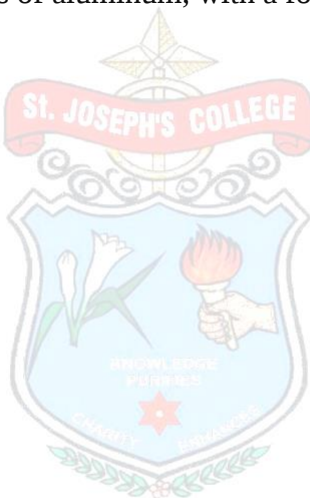
8. Explain the preparation and structure of diborane (B₂H₆) and borazine (B₃N₃H₆).

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Discuss their unique bonding characteristics and potential applications.

9. Provide a detailed account of the chemistry of borax, covering its structure, properties, and various applications in different industries.

10. Examine the extraction process of aluminum (Al), including the Bayer process, and discuss the diverse uses of aluminum, with a focus on its alloys.



UNIT-III

1 Marks

1. Which group do elements like nitrogen, phosphorus, arsenic, antimony, and bismuth belong to?
a. Group 14 b. Group 15
c. Group 16 d. Group 17
2. What is the chemical formula for hydrazine?
a. H_2O_2 b. $\text{H}_2\text{N}-\text{NH}_2$
c. HNO_3 d. H_2SO_4
3. Which of the following compounds is NOT a hydrazine derivative?
a. Hydrazine hydrate ($\text{H}_2\text{N}-\text{NH}_2$)
b. Hydroxylamine (NH_2OH)
c. Phosphine (PH_3)
d. Phosphorous pentachloride (PCl_5)
4. What is the structure of phosphorous pentachloride (PCl_5)?
a. Trigonal planar b. Tetrahedral
c. Octahedral d. Square pyramidal
5. Which of the following is an oxyacid of phosphorous?

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- a. H_2SO_4 b. H_3PO_3
c. HNO_3 d. HClO_4

6. What is the common oxidation state of phosphorus in H_3PO_4 (phosphoric acid)?

- a. +1 b. +3
c. +5 d. +7

7. Elements of Group 16 are commonly known as:

- a. Halogens b. Alkali metals
c. Chalcogens d. Noble gases

8. Which of the following allotropes of sulfur has a puckered ring structure?*

- a. Rhombic sulphur b. Monoclinic sulfur
c. Amorphous sulphur d. Cyclo-sulfur (cyclo-S₈)

9. Ozone (O_3) is a triatomic molecule. What is its molecular shape?

- a. Linear b. Bent (V-shaped)
c. Trigonal planar d. Tetrahedral

10. Caro's acid (H_2SO_5) is an example of which type of oxyacid of sulfur?

- a. Sulfurous acid b. Perchloric acid
c. Persulfuric acid d. Peracetic acid

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11. Which of the following halogens has the highest electronegativity?

- a. Fluorine b. Chlorine
- c. Bromine d. Iodine

12. What is a peculiar property of fluorine compared to other halogens?

- a. Low electron affinity b. Low reactivity
- c. Small atomic size d. High electronegativity

13. Halogen acids include HF, HCl, HBr, and HI. Which one is the strongest acid among them?

- a. HF b. HCl
- c. HBr d. HI

14. What is the common oxidation state of halogens in their compounds?

- a. +1 b. -1
- c. 0 d. Varies depending on the halogen

15. Which of the following halogens exhibits positive oxidation states in its compounds?

- a. Fluorine b. Chlorine
- c. Bromine d. Iodine

16. The oxyacid HClO_4 is known as:

- a. Chlorous acid b. Perchloric acid
- c. Hypochlorous acid d. Chloric acid

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17. What is the shape of the inter-halogen compound ICl (iodine monochloride)?

- a. Linear
- b. Trigonal planar
- c. T-shaped
- d. Square pyramidal

18. ClF₃ is an example of an inter-halogen compound. What is its molecular geometry?

- a. Linear
- b. Trigonal planar
- c. T-shaped
- d. Tetrahedral

19. BrF₅ is an inter-halogen compound. What is its hybridization state of the central atom?

- a. sp
- b. sp²
- c. sp³
- d. sp³d²

20. Which of the following inter-halogen compounds is known for having seven fluorine atoms bonded to one iodine atom?

- a. ICl
- b. ClF₃
- c. BrF₅
- d. IF₇

21. Where are noble gases located in the periodic table?

- a. Group 1
- b. Group 14
- c. Group 18
- d. Group 17

22. Which noble gas is commonly used in the study of organometallic compounds?

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- a. Helium
- b. Neon
- c. Argon
- d. Xenon

23. What is the general electronic configuration of noble gases?

- a. ns^2np^4
- b. ns^2np^5
- c. ns^2np^6
- d. ns^2np^3

24. Which noble gas is known for forming compounds with high electronegative elements?

- a. Helium
- b. Neon
- c. Argon
- d. Xenon

25. What is the structure of XeF_2 (xenon difluoride)?

- a. Linear
- b. Trigonal planar
- c. T-shaped
- d. Square planar

26. XeF_4 (xenon tetrafluoride) has a molecular shape of:

- a. Linear
- b. Square planar
- c. Square pyramidal
- d. Octahedral

27. What is the hybridization state of xenon in $XeOF_4$?

- a. sp
- b. sp^2
- c. sp^3
- d. sp^3d^2

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28. What is the common oxidation state of xenon in its compounds?

- a. +2
- b. +4
- c. +6
- d. +8

29. Which noble gas compound is known for its square pyramidal geometry?

- a. XeF_2
- b. XeF_4
- c. XeOF_4
- d. XeF_6

30. In XeF_2 , how many lone pairs of electrons are present around the xenon atom?

- a. 0
- b. 1
- c. 2
- d. 3

Answers

1.b, 2.b, 3.c, 4.d, 5.b, 6.c, 7.c, 8.d, 9.b, 10.c, 11.a, 12.d, 13.a, 14.b, 15.d, 16.b, 17.c, 18.d, 19.d, 20.d, 21.c, 22.d, 23.c, 24.d, 25.c, 26.b, 27.d, 28.c, 29.d, 30.c.

5 Marks

1. Discuss the general characteristics of Group 15 elements, highlighting key trends in electron affinity, oxidation states, and oxidizing power. Provide examples to support your explanation.

2. Explore the chemistry of hydrazine ($\text{H}_2\text{N}-\text{NH}_2$) and hydroxylamine (NH_2OH), discussing their preparation methods, properties, and significant applications.
3. Examine the chemistry of phosphorus compounds, focusing on the preparation, properties, and reactions of PH_3 , PCl_3 , and PCl_5 . Highlight any peculiarities observed in their behavior.
4. Compare the oxy acids of phosphorus, H_3PO_3 and H_3PO_4 , detailing their structures, preparation methods, and applications.
5. Investigate the general properties of Group 16 elements, emphasizing the structure and allotropy of sulfur and selenium. Provide examples of allotropes and their significance.
6. Analyze the chemistry of ozone (O_3), discussing its structure, properties, and role in the atmosphere. Explain its classification and the importance of the ozone layer.
7. Classify and explain the properties of oxides of sulfur and selenium, emphasizing their roles in environmental processes.
8. Discuss the structure, general characteristics, and applications of halogens, focusing on electronegativity, electron affinity, oxidation states, and oxidizing power.

9. Explore the peculiarities of fluorine compared to other halogens, addressing its unique characteristics and reactivity.
10. Examine the chemistry of inter-halogen compounds (ICl , ClF_3 , BrF_5 , and IF_7), providing insights into their structures, preparation, and notable properties.

10 Marks

1. Explain the general characteristics of Group 15 elements, discussing trends in atomic size, electronegativity, and ionization energy. Provide examples and applications of these elements in chemical processes.
2. Investigate the chemistry of hydrazine ($\text{H}_2\text{N}-\text{NH}_2$) and hydroxylamine (NH_2OH), elaborating on their preparation methods, chemical properties, and industrial applications. Compare and contrast their reactivity.
3. Analyze the chemistry of phosphorus, with a focus on phosphine (PH_3), phosphorus trichloride (PCl_3), and phosphorus pentachloride (PCl_5).
4. Compare and contrast the oxy acids of phosphorus, H_3PO_3 and H_3PO_4 , discussing their structures, preparation, and roles in various

chemical processes. Explore the significance of these acids in industrial applications.

5. Examine the general properties of Group 16 elements, elucidating on the structure and allotropy of sulfur and selenium. Discuss the role of these elements in different oxidation states and their impact on the environment.

6. Investigate the chemistry of ozone (O_3), focusing on its structure, properties, and functions in the Earth's atmosphere. Discuss the classification of ozone and its importance in environmental chemistry.

7. Classify and elaborate on the properties of oxides of sulfur and selenium, discussing their roles in chemical processes and environmental impact. Compare and contrast their behavior in various conditions.

8. Explore the general characteristics of halogens, emphasizing electronegativity, electron affinity, oxidation states, and oxidizing power. Discuss the peculiarities of fluorine and its significance in chemical reactions.

9. Analyze the properties of halogen acids (HF , HCl , HBr , and HI), oxides, and oxy acids ($HClO_4$). Discuss their preparation methods, chemical properties, and applications in different industries.

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10. Examine the chemistry of inter-halogen compounds (ICl , ClF_3 , BrF_5 , and IF_7), providing detailed insights into their structures, preparation methods, and chemical reactivity.



UNIT -IV

1 Marks

1. What is the general method of preparation for alkenes?
 - a. Dehydration of alcohols
 - b. Oxidation of aldehydes
 - c. Reduction of alkynes
 - d. Halogenation of alkanes
2. Which mechanism is associated with the elimination reaction where the leaving group and a proton are removed in a single step, resulting in the formation of an alkene?
 - a. E1 mechanism
 - b. E2 mechanism
 - c. SN1 mechanism
 - d. SN2 mechanism
3. According to the Saytzeff rule, in elimination reactions, the major product is the one where the double bond is formed on the carbon with:
 - a. More hydrogen atom
 - b. Fewer hydrogen atom
 - c. A halogen substituent
 - d. A methyl substituent
4. Which rule predicts the major product in alkene elimination reactions based on the stability of the alkene formed?
 - a. Saytzeff rule
 - b. Markownikoff's rule

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c. E1 rule

d. E2 rule

5. The Kharasch effect is associated with:

a. Halogenation of alkanes

b. Epoxidation of alkenes

c. Ozonolysis of alkenes

d. Halogenation of alkenes in the presence of peroxides

6. In alkene addition reactions, which rule predicts the major product based on the stability of the intermediate carbocation?

a. Saytzeff rule

b. Markownikoff's rule

c. E1 rule

d. E2 rule

7. Which reaction involves the addition of hydroxyl groups to the carbon atoms of a double bond in an alkene?

a. Hydroxylation

b. Epoxidation

c. Ozonolysis

d. Halogenation

8. What is the product of the epoxidation of an alkene?

a. Aldehyde

b. Ketone

c. Epoxide

d. Alcohol

9. Ozonolysis of alkenes involves the cleavage of the double bond with the formation of

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- a. Peroxides
- b. Carboxylic acids
- c. Aldehydes or ketones
- d. Alcohols

10. What type of oxidation reaction converts an alkene into a vicinal diol?

- a. Hydroxylation
- b. Epoxidation
- c. Ozonolysis
- d. Halogenation

11. How are dienes classified based on their arrangement of double bonds?

- a. Isolated, conjugated, cumulated
- b. Cyclic, acyclic, heterocyclic
- c. Saturated, unsaturated, aromatic
- d. Aliphatic, aromatic, alicyclic

12. Which type of diene possesses alternating single and double bonds along the carbon chain?

- a. Isolated diene
- b. Conjugated diene
- c. Cumulated diene
- d. Heterocyclic diene

13. The stability of conjugated dienes is attributed to:

- a. Increased steric hindrance
- b. Resonance stabilization
- c. Decreased electron delocalization
- d. Enhanced reactivity

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14. In electrophilic addition to conjugated dienes, what is the result of 1,2 addition?

- a. Formation of a carbocation
- b. Formation of a double bond
- c. Formation of a triple bond
- d. Rearrangement of atoms

15. What is the major product of 1,4 addition in electrophilic addition to conjugated dienes?

- a. Formation of a carbocation
- b. Formation of a double bond
- c. Formation of a triple bond
- d. Rearrangement of atoms

16. Free radical addition to conjugated dienes is commonly associated with:

- a. Diels-Alder reaction
- b. Bromination
- c. Ozonolysis
- d. Halogenation

17. The Diels-Alder reaction involves the cycloaddition of:

- a. A diene & dienophile
- b. Two dienes
- c. Two dienophiles
- d. A diene and a radical

18. In the Diels-Alder reaction, what is the nature of the newly formed ring?

- a. Saturated
- b. Unsaturated
- c. Aromatic
- d. Heterocyclic

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19. Which of the following is an example of a dienophile in the Diels-Alder reaction?

- a. Ethylene (C_2H_4) b. Benzene (C_6H_6)
c. Maleic anhydride ($C_4H_2O_3$) d. Methane (CH_4)

20. The Diels-Alder reaction is known for its ability to form:

- a. Alkenes b. Alkynes
c. Aromatic compounds d. Six-membered rings

21. What is the IUPAC name for the compound $CH\equiv CH$?

- a. Ethylene b. Ethane
c. Acetylene d. Methane

22. How is acetylene (C_2H_2) generally prepared in the laboratory?

- a. Dehydration of alcohols
b. Dehydrohalogenation of vicinal dihalides
c. Dehydrogenation of alkanes
d. Partial reduction of alkynes

23. What is a characteristic property of terminal alkynes, contributing to their acidic nature?

- a. High boiling point b. Low pK_a value
c. Low reactivity d. High solubility in water

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24. Which process involves the combination of monomers to form a long-chain structure in the case of alkynes?

- a. Hydrolysis b. Esterification
- c. Polymerization d. Isomerization

25. In Bayer's strain theory, the strain in cyclopropane is attributed to:

- a. Angle strain b. Torsional strain
- c. Steric strain d. Conformational strain

26. According to Bayer's strain theory, which cycloalkane is expected to be the most stable?

- a. Cyclopropane b. Cyclobutane
- c. Cyclopentane d. Cyclohexane

27. What is a limitation of Bayer's strain theory in explaining the stability of cycloalkanes?

- a. It neglects torsional strain.
- b. It overlooks steric interactions.
- c. It cannot explain ring inversion.
- d. It fails to consider angle strain.

28. In cyclohexane, what is the most stable conformation due to the minimum steric hindrance between hydrogen atoms?

- a. Chair conformation
- b. Boat conformation

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- c. Twist-boat conformation
- d. Planar conformation

29. Geometrical isomerism in cyclohexanes is associated with:

- a. Rotation around a single bond
- b. Restricted rotation around a double bond
- c. Ring inversion
- d. Axial and equatorial positions

30. What type of isomerism arises when different substituents are attached to the same carbon atoms in a cyclohexane ring?

- a. Conformational isomerism
- b. Geometrical isomerism
- c. Structural isomerism
- d. Optical isomerism

Answers

1.a, 2.b, 3.a, 4.a, 5.d, 6.b, 7.a, 8.c, 9.c, 10.a, 11.a,
12.b, 13.b, 14.b, 15.a, 16.b, 17.a, 18.a, 19.c, 20.d,
21.c, 22.b, 23.b, 24.c, 25.a, 26.d, 27.a, 28.a, 29.d,
30.b.

5 Marks

1. Discuss the nomenclature of alkadienes, highlighting the distinctions between isolated, conjugated, and cumulated dienes. Provide examples to illustrate each classification.
2. Explain the stability of conjugated dienes and discuss the mechanism of electrophilic addition to conjugated dienes. Highlight the importance of resonance in the stabilization of conjugated dienes.
3. Compare and contrast the E1 and E2 mechanisms in β -elimination reactions. Provide examples to illustrate each mechanism and discuss the factors influencing the choice between E1 and E2 pathways.
4. Explore the reactions of alkenes, focusing on addition reactions. Discuss the mechanisms involved in Markownikoff's rule, the Kharasch effect, and oxidation reactions, including hydroxylation, epoxidation, and ozonolysis.
5. Elaborate on the nomenclature of alkynes and discuss the general methods of their preparation. Highlight the properties and reactions of terminal alkynes and acetylene, emphasizing their acidic nature.
6. Provide an overview of the classification of alkadienes into isolated, conjugated, and

cumulated dienes. Discuss the stability factors influencing each type and provide examples to illustrate their structures.

7. Investigate the mechanism of free radical addition to conjugated dienes, emphasizing the role of radicals in this process. Discuss the relevance of Diels-Alder reactions in the synthesis of complex organic compounds.

8. Discuss the nomenclature of cycloalkanes and delve into the relative stability of cycloalkanes. Explain Bayer's strain theory and its limitations in explaining the stability of cycloalkanes.

9. Perform a conformational analysis of cyclohexane, discussing its various conformations and identifying the most stable conformation. Explain the factors influencing the stability of different conformations.

10. Explore the concept of geometrical isomerism in cyclohexanes. Provide examples to illustrate the occurrence of geometrical isomers and discuss the factors influencing their formation in cyclohexane molecules.

10 Marks

1. Provide a comprehensive discussion on the nomenclature of alkenes and alkynes, outlining the general methods of their preparation. Include

relevant examples to illustrate the naming conventions and preparation techniques.

2. Explore the mechanisms of β -elimination reactions, differentiating between E1 and E2 mechanisms. Discuss the factors influencing the choice between E1 and E2 reactions and provide examples to support your explanation.

3. Delve into the reactions of alkenes, focusing on addition reactions. Explain the mechanisms involved in Markownikoff's rule, the Kharasch effect, and oxidation reactions, including hydroxylation, epoxidation, and ozonolysis.

4. Conduct a detailed analysis of alkadienes, covering their nomenclature and classification into isolated, conjugated, and cumulated dienes. Discuss the stability of conjugated dienes and elaborate on the mechanism of electrophilic addition

5. Discuss the nomenclature of alkynes and outline the general methods of their preparation. Examine the properties and reactions of terminal alkynes and acetylene, emphasizing their acidic nature.

6. Explore the polymerization and isomerization of acetylene, providing insights into the processes involved and the resulting products. Discuss the industrial applications of acetylene polymerization.

7. Conduct a thorough examination of cycloalkanes, covering their nomenclature and the relative stability of different cycloalkanes. Explain Bayer's strain theory and its limitations in explaining cycloalkane stability.
8. Perform a detailed conformational analysis of cyclohexane, discussing its various conformations and identifying the most stable conformation. Explore the factors influencing the stability of different conformations.
9. Discuss the concept of geometrical isomerism in cyclohexanes, providing examples to illustrate the occurrence of geometrical isomers.
10. Analyze the factors influencing the formation of geometrical isomers in cyclohexane molecules. Integrate the knowledge from alkenes, alkadienes, alkynes, and cycloalkanes to propose a multi-step synthesis of a complex organic compound.

UNIT-V

1 Marks

1. What is the source of benzene in the petrochemical industry?

- a. Coal tar b. Natural gas
- c. Petroleum d. Wood tar

2. What is the molecular formula of benzene?

- a. C₄H₈ b. C₅H₁₀
- c. C₆H₆ d. C₇H₁₄

3. The stability of the benzene ring is due to:

- a. High reactivity b. Aromaticity
- c. Low boiling point d. Non-planarity

4. According to Huckel's ($4n+2$) rule, how many π electrons does a compound need to be aromatic?

- a. 2 b. 4
- c. 6 d. 8

5. What is the molecular orbital picture of benzene?

- a. It has three σ bonds and three π bonds.
- b. It has six σ bonds and no π bonds.
- c. It has six σ bonds and six π bonds.
- d. It has three σ bonds and six π bonds.

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6. Which of the following electrophilic substitution reactions involves the introduction of a nitro group into the benzene ring?

- a. Halogenation b. Sulphonation
- c. Nitration d. Friedel-Craft's acylation

7. In the general mechanism of aromatic electrophilic substitution, what role does the catalyst play?

- a. It stabilizes the electrophile
- b. It generates the electrophile
- c. It stabilizes the benzene ring
- d. It acts as a reducing agent

8. What electrophilic substitution reaction involves the introduction of an alkyl group into the benzene ring?

- a. Nitration
- b. Halogenation
- c. Friedel-Craft's alkylation
- d. Friedel-Craft's acylation

9. Which of the following reactions introduces an acyl group into the benzene ring?

- a. Nitration b. Halogenation
- c. Friedel-Craft's alkylation d. Friedel-Craft's

10. What is the role of a Lewis acid in Friedel-Craft's alkylation and acylation reactions?

- a. It acts as an electrophile
- b. It generates a nucleophile
- c. It stabilizes the benzene ring
- d. It increases the reaction rate

11. What is the correct nomenclature for the following polynuclear aromatic hydrocarbon?

- a. Naphthalene
- b. Anthracene
- c. Biphenyl
- d. Phenanthrene

12. How is naphthalene synthesized through the Haworth synthesis?

- a. By Diels-Alder reaction
- b. By Elbs reaction
- c. By Diels-Alder and Haworth synthesis
- d. By the cyclization of a diene and a dienophile

13. Which of the following reactions is NOT a typical electrophilic substitution reaction of naphthalene?

- a. Nitration
- b. Sulphonation
- c. Halogenation
- d. Friedel-Crafts alkylation

14. Anthracene is synthesized through the Elbs reaction, Diels-Alder reaction, and Haworth

synthesis. What is the primary purpose of the Diels-Alder reaction in anthracene synthesis?

- a. Introduction of substituents at C-9 and C-10
- b. Formation of a double bond between C-9 and C-10
- c. Preferential substitution at C-9 and C-10
- d. Formation of a triple bond

15. What is the correct order of reactivity of naphthalene towards electrophilic substitution reactions (from most reactive to least reactive)?

- a. Nitration > Sulphonation > Halogenation
- b. Halogenation > Nitration > Sulphonation
- c. Sulphonation > Nitration > Halogenation
- d. Halogenation > Sulphonation > Nitration

16. In the Haworth synthesis of naphthalene, what type of reaction is involved?

- a. Nucleophilic substitution
- b. Electrophilic substitution
- c. Cyclization
- d. Rearrangement

17. What is the preferential substitution pattern observed in the reactions of anthracene?

- a. C-1 and C-2
- b. C-4 and C-5

- c. C-9 and C-10 d. C-2 and C-3

18. Besides its use in chemical synthesis, what is another notable application of anthracene?

- a. Fuel additive b. Antiseptic
c. Fluorescent dye d. Lubricant

19. What is the correct IUPAC nomenclature for the following compound?

- a. Naphthalene b. Anthracene
c. Biphenyl d. Phenanthrene

20. How is naphthalene synthesized through the Haworth synthesis?

- a. By Diels-Alder reaction
b. By Elbs reaction
c. By Diels-Alder and Haworth synthesis
d. By the cyclization of a diene and a dienophile

21. Which of the following is NOT a typical electrophilic substitution reaction of naphthalene?

- a. Nitration b. Sulphonation
c. Halogenation d. Friedel-Crafts alkylation

22. Anthracene is synthesized through the Elbs reaction, Diels-Alder reaction, and Haworth synthesis. What is the primary purpose of the Diels-Alder reaction in anthracene synthesis?

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- a. Introduction of substituents at C-9 and C-10
- b. Formation of a double bond between C-9 and C-10
- c. Preferential substitution at C-9 and C-10
- d. Formation of a triple bond

23. What is the correct order of reactivity of naphthalene towards electrophilic substitution reactions (from most reactive to least reactive)?

- a. Nitration > Sulphonation > Halogenation
- b. Halogenation > Nitration > Sulphonation
- c. Sulphonation > Nitration > Halogenation
- d. Halogenation > Sulphonation > Nitration

24. In the Haworth synthesis of naphthalene, what type of reaction is involved?

- a. Nucleophilic substitution
- b. Electrophilic substitution
- c. Cyclization
- d. Rearrangement

25. What is the preferential substitution pattern observed in the reactions of anthracene?

- a. C-1 and C-2
- b. C-4 and C-5
- c. C-9 and C-10
- d. C-2 and C-3

26. Besides its use in chemical synthesis, what is another notable application of anthracene?

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- a. Fuel additive b. Antiseptic
c. Fluorescent dye d. Lubricant

27. What reaction is involved in the preferential substitution at C-9 and C-10 in anthracene?

- a. Electrophilic substitution
b. Nucleophilic substitution
c. Radical substitution
d. Addition reaction

28. What is one significant use of polynuclear aromatic hydrocarbons like anthracene?

- a. Food preservative b. Antacid
c. Antiseptic d. Fluorescent materials

Answers

1.c, 2.c, 3.b, 4.c, 5.c, 6.c, 7.b, 8.c, 9.d, 10.a, 11.a,
12.c, 13.d, 14.b, 15.b, 16.c, 17.c, 18.c, 19.a, 20.c,
21.d, 22.b, 23.b, 24.c, 25.c, 26.c, 27.a, 28.d.

5 Marks

1. Discuss the sources of benzene in the industrial context and elaborate on its molecular structure. How does the stability of the benzene ring differ from that of aliphatic compounds?

2. Explain the molecular orbital picture of benzene, emphasizing the concept of aromaticity and how it aligns with Huckel's $(4n+2)$ rule. Provide examples to illustrate the application of Huckel's rule in aromatic compounds.
3. Explore the general mechanism of electrophilic substitution reactions in aromatic compounds. Discuss the key steps involved and how this mechanism is applicable to reactions such as nitration, sulphonation, halogenation, Friedel-Craft's alkylation, and acylation.
4. Provide a detailed account of the nomenclature and Haworth synthesis of naphthalene. Discuss its physical properties and reactions, focusing on electrophilic substitution reactions such as nitration, sulphonation, halogenation, Friedel-Craft's acylation, and alkylation.
5. Investigate the synthesis of anthracene through the Elbs reaction, Diels-Alder reaction, and Haworth synthesis. Highlight the physical properties of anthracene and delve into its reactions, emphasizing the Diels-Alder reaction and the preferential substitution at C-9 and C-10.
6. Discuss the preferential substitution at C-9 and C-10 in anthracene, elucidating the factors that influence this pattern. Additionally, explore the industrial and practical uses of anthracene.

7. Compare and contrast the electrophilic substitution reactions of benzene, naphthalene, and anthracene. Highlight any similarities or differences in their reactivity and the types of products formed.
8. Explain the Haworth synthesis of naphthalene, providing a step-by-step mechanism. Discuss the conditions under which this synthesis is favorable and any limitations associated with the process.
9. Evaluate the role of Friedel-Craft's acylation and alkylation in the synthesis of polynuclear aromatic hydrocarbons. Discuss the selectivity and regiochemistry observed in these reactions.
10. Illustrate the applications of Huckel's $(4n+2)$ rule in predicting the aromaticity of various compounds, including benzene and other polynuclear aromatic hydrocarbons.

10 Marks

1. Discuss the historical sources and methods of industrial production of benzene. Elaborate on the molecular structure of benzene and the concept of resonance, highlighting how it contributes to the stability of the benzene ring.
2. Provide a comprehensive overview of the molecular orbital picture of benzene, emphasizing the concept of aromaticity. Explain

Huckel's ($4n+2$) rule and its applications in predicting the aromatic nature of compounds.

3. Explore the general mechanism of electrophilic substitution reactions in aromatic compounds.

Using specific examples, detail the steps involved in nitration, sulphonation, halogenation, Friedel-Craft's alkylation, and acylation. Discuss the factors influencing the regioselectivity of these reactions.

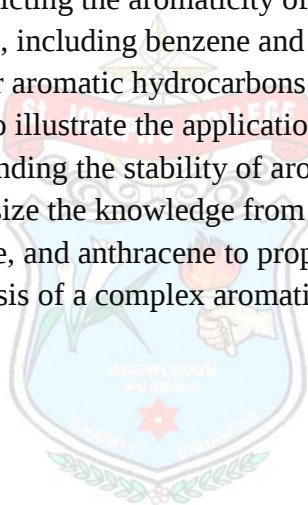
4. Investigate the nomenclature and Haworth synthesis of naphthalene. Discuss the physical properties of naphthalene and its reactions, with a focus on electrophilic substitution reactions.

5. Analyze the synthesis of anthracene through the Elbs reaction, Diels-Alder reaction, and Haworth synthesis. Detail the physical properties of anthracene and its reactions, especially the Diels-Alder reaction and the preferential substitution at C-9 and C-10.

6. Discuss the industrial and practical applications of anthracene. Explore its uses in various fields and evaluate its significance in both academic and industrial contexts.

7. Compare and contrast the electrophilic substitution reactions of benzene, naphthalene, and anthracene. Highlight any similarities or differences in their reactivity and the types of products formed.

8. Evaluate the role of Friedel-Craft's acylation and alkylation in the synthesis of polynuclear aromatic hydrocarbons. Discuss the selectivity and regiochemistry observed in these reactions and how these processes contribute to the overall synthesis of complex aromatic compounds.
9. Discuss the significance of Huckel's $(4n+2)$ rule in predicting the aromaticity of various compounds, including benzene and other polynuclear aromatic hydrocarbons. Provide examples to illustrate the application of this rule in understanding the stability of aromatic systems.
10. Synthesize the knowledge from benzene, naphthalene, and anthracene to propose a multi-step synthesis of a complex aromatic compound.



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B. Sc. CHEMISTRY
SEMESTER V
PHYSICAL CHEMISTRY

UNIT-I Chemical Equilibrium

2.1 Thermodynamic derivation of equilibrium constants- K_p , and K_c - Relations between K_p , and K_c - Standard free energy change-Derivation of van't Hoff reaction isotherm DeDonder's treatment of chemical equilibria-concept of chemical affinity (no derivation)-Temperature dependence of equilibrium constant van't Hoff isochore-Pressure dependence of equilibrium constant. 1.2 Adsorption- Physical and chemical adsorption- Types of adsorption isotherms-Freundlich adsorption isotherm-Derivation of Langmuir adsorption isotherm (BET isotherm (postulates only) BET equation (statement).

UNIT-II Chemical Kinetics-I

2.1 Derivation of rate constant of a second order reaction-when the reactants are taken at different initial concentrations-when the reactants are taken at the same initial concentrations Determination of the rate constant of a II order reaction-Derivation of rate constant of a third order reaction-when the

reactants are taken at the same initial concentrations. Derivation of half-life periods for second and third order reactions having equal initial concentration of reactants.

2.2 Methods of determining the order of reaction- Experimental methods in the study of kinetics volumetry, manometry, polarimetry and colorimetry.

2.3 Effect of temperature on reaction rates- Derivation of Arrhenius equation-concept of activation energy determination of Arrhenius frequency factor and energy of activation.

UNIT-III Chemical Kinetics-II

3.1 Collision theory (CT) of reaction rates- Derivation of rate constant of a bimolecular reaction from collision theory-Failures of collision theory.

3.2 Lindemann theory of Unimolecular reactions.

3.3 Theory of Absolute Reaction Rates (ARRT) - Thermodynamic derivation of rate constant for a bimolecular reaction based on ARRT- comparison between ARRT and CT. Significance of free energy of activation and entropy of activation.

UNIT-IV Electrochemistry – I

- 4.1 Metallic and electrolytic conductance –
Definitions of specific, equivalent and molar
conductance – Relations between them –
measurement of conductance and cell constant.
- 4.2 Variation of conductance with dilution –
Qualitative explanation – Strong and weak
electrolytes Migrations of ions – transport number
– determination by Hittorf and moving boundary
methods – Kohlrausch's law – applications –
calculation of equivalent conductance for weak
electrolytes and determination of transport number.
- 4.3 Ionic mobilities and Ionic conductance.
Diffusion and ionic mobility- molar ionic
conductance and viscosity- Walden rule.
- 4.4 Applications of conductance measurements –
Degree of dissociation of weak electrolytes –
Determination of ionic product of water –
Determination of solubility of sparingly soluble
salts – conductometric titrations

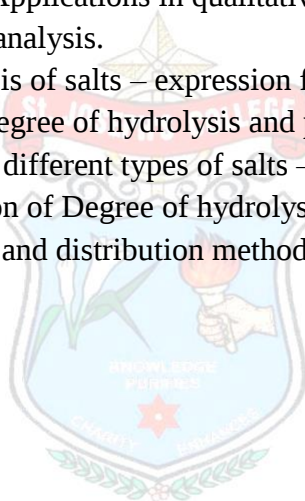
UNIT – V Theory of strong electrolytes

- 5.1 Debye – Huckel – Onsager theory –
verification of Onsager equation – Wien and
Debye – Falkenhagen effect.

5.2 Activity and activity co-efficients of strong electrolytes – ionic strength. Ostwald's dilution law – determination of dissociation constants – Ionic product of water – pH value.

5.3 Buffer solution – Henderson equations – uses of Buffers including living systems – common ion effect – solubility product principle – relation to solubility – Applications in qualitative and quantitative analysis.

5.4 Hydrolysis of salts – expression for hydrolysis constant – Degree of hydrolysis and pH of salt solutions for different types of salts – Determination of Degree of hydrolysis – conductance and distribution methods.



UNIT-I

1 Marks

1. What is the primary focus of the thermodynamic derivation of equilibrium constants K_p and K_c ?
 - a) Heat transfer in reactions
 - b) Kinetic parameters
 - c) Reaction spontaneity
 - d) Equilibrium concentrations
2. Which of the following represents the relationship between K_p and K_c for a given reaction?
 - a) $K_p = K_c$
 - b) $K_p = K_c RT$
 - c) $K_p = K_c (1 - \Delta n)$
 - d) $K_p = K_c + \Delta n RT$
3. What does the standard free energy change (ΔG°) represent in the context of chemical reactions?
 - a) Activation energy
 - b) Gibbs free energy at standard conditions
 - c) Enthalpy change at standard conditions
 - d) Rate constant

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4. Which of the following is the correct derivation of the van't Hoff reaction isotherm?

a) $\left(\frac{d(\ln K)}{dT} \right) = \frac{\Delta H}{RT^2}$

b) $\left(\frac{d(\ln K)}{dT} \right) = \frac{\Delta H}{RT}$

c) $\left(\frac{d(\ln K)}{dT} \right) = \frac{\Delta S}{R}$

d) $\left(\frac{d(\ln K)}{dT} \right) = \frac{\Delta G}{RT^2}$

5. DeDonder's treatment of chemical equilibria is primarily associated with:

- a) Thermodynamics b) Quantum mechanics
c) Kinetics d) Statistical mechanics

6. What is the concept of chemical affinity related to in the context of chemical equilibria?

- a) Activation energy b) Reaction spontaneity
c) Reaction rate d) Equilibrium constant

7. Which of the following is true regarding the temperature dependence of the equilibrium constant (K)?

- a) K increases with temperature for endothermic reactions
b) K is independent of temperature

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- c) K decreases with temperature for exothermic reactions
- d) K is not affected by temperature changes

8. The relation between Gibbs free energy change (ΔG) and equilibrium constant (K) is given by:

- a) $\Delta G = -RT \ln K$
- b) $\Delta G = RT \ln K$
- c) $\Delta G = -RT/K$
- d) $\Delta G = RT/K$

9. What is the significance of Δn in the context of equilibrium constants?

- a) Change in enthalpy
- b) Change in entropy
- c) Change in the number of moles of gas
- d) Change in Gibbs free energy

10. According to the van't Hoff reaction isotherm, how does the equilibrium constant (K) change with temperature?

- a) K is constant with temperature
- b) K increases with temperature for exothermic reactions
- c) K decreases with temperature for endothermic reactions
- d) K is inversely proportional to temperature

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11. What is the van't Hoff isochore primarily concerned with?

- a) Temperature changes
- b) Pressure changes
- c) Volume changes
- d) Concentration changes

12. The pressure dependence of the equilibrium constant is described by which equation?

- a) Boyle's Law
- b) Charles's Law
- c) van't Hoff equation
- d) Le Chatelier's principle

13. Adsorption can be categorized into which two main types?

- a) Physical and chemical adsorption
- b) Exothermic and endothermic adsorption
- c) Fast and slow adsorption
- d) Reversible and irreversible adsorption

14. Which of the following is NOT a type of adsorption isotherm?

- a) Freundlich adsorption isotherm
- b) Langmuir adsorption isotherm
- c) Boyle's adsorption isotherm
- d) BET adsorption isotherm

15. The Freundlich adsorption isotherm is expressed as:

- a) $(P = aV)$
- b) $(\theta = KP^n)$
- c) $(P = K\theta^n)$
- d) $(V = KT)$

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16. What does the Langmuir adsorption isotherm describe?

- a) Multilayer adsorption b) Monolayer adsorption
- c) Reverse adsorption d) Irreversible adsorption

17. The BET isotherm is primarily associated with:

- a) Physical adsorption b) Multilayer adsorption
- c) Chemical adsorption d) Monolayer adsorption

18. Which of the following is an assumption or postulate of the BET isotherm?

- a) Adsorption occurs on a single layer
- b) Adsorption is irreversible
- c) Adsorption is independent of temperature
- d) Adsorption is independent of pressure

19. The BET equation is used to describe the adsorption of:

- a) Gases on solids b) Liquids on solids
- c) Gases on liquids d) Liquids on liquids

20. In the BET equation, what does the term $\frac{C}{P}$ represent?

- a) Monolayer capacity b) Pressure
- c) Temperature d) Surface area

Answers

1.d, 2.c, 3.b, 4.a, 5.a, 6.b, 7.a, 8.a, 9.c, 10.b, 11.c,
12.c, 13.a, 14.c, 15.c, 16.b, 17.b, 18.a, 19.a, 20.a.

5 Marks

1. Explain the thermodynamic derivation of equilibrium constants, K_p , and K_c . Highlight the key steps and concepts involved in obtaining these expressions.
2. Elaborate on the relations between K_p and K_c for a given chemical reaction. Provide examples to illustrate how these constants are interrelated and the conditions under which they may be equal or differ significantly.
3. Discuss the significance of the standard free energy change (ΔG°) in the context of chemical reactions. Include the conditions under which a reaction is spontaneous or non-spontaneous based on ΔG° .
4. Provide a detailed derivation of the van't Hoff reaction isotherm. Highlight the key assumptions and mathematical expressions involved in understanding the temperature dependence of the equilibrium constant.

5. Explain DeDonder's treatment of chemical equilibria. Discuss the key principles and insights that DeDonder introduced to enhance our understanding of chemical equilibrium from a thermodynamic perspective.
6. Define and explain the concept of chemical affinity. While avoiding mathematical derivations, discuss how chemical affinity is related to the spontaneity of reactions and their tendency to reach equilibrium.
7. Explore the temperature dependence of equilibrium constants. Discuss how changes in temperature impact the position of equilibrium and the magnitude of equilibrium constants, providing examples to support your explanation.
8. Describe the van't Hoff isochore and its significance in thermodynamics. Highlight any practical applications or implications of considering isochoric processes in the study of chemical systems.
9. Elaborate on the pressure dependence of equilibrium constants. Discuss the van't Hoff equation and how it relates changes in pressure to alterations in the equilibrium constant. Provide examples to illustrate this relationship.
10. Provide an in-depth discussion on adsorption, covering physical and chemical adsorption. Explain the types of adsorption isotherms,

focusing on the Freundlich adsorption isotherm. Include the conditions under which it is applicable and its significance in understanding adsorption phenomena.

10 Marks

1. In detail, derive the expressions for equilibrium constants, K_p , and K_c , from a thermodynamic perspective. Explain the significance of each term in these expressions and how they relate to the state of chemical equilibrium.
2. Explore and discuss the various relations between K_p and K_c . Provide a comprehensive analysis of the factors that influence the relationship between these equilibrium constants
3. Investigate the concept of standard free energy change (ΔG°) and its role in determining the spontaneity of chemical reactions.
4. Perform a detailed derivation of the van't Hoff reaction isotherm. Include the fundamental assumptions, mathematical steps, and the physical interpretation of the resulting equation.
5. Provide an extensive overview of DeDonder's treatment of chemical equilibria. Explore the key principles, methodologies, and any novel insights that DeDonder introduced to enhance the

understanding of chemical equilibrium within the framework of thermodynamics

6. Define and elaborate on the concept of chemical affinity. Discuss how chemical affinity is related to thermodynamic functions and how it influences the progress of reactions towards equilibrium. Provide illustrative examples to support your discussion.

7. Analyze the temperature dependence of equilibrium constants. Explore the theoretical basis for this dependence and discuss how changes in temperature affect the position of equilibrium.

8. Examine the van't Hoff isochore in detail. Discuss its significance in thermodynamics, focusing on how it differs from other thermodynamic processes.

9. Investigate the pressure dependence of equilibrium constants, with a particular focus on the van't Hoff equation.

10. Provide a comprehensive discussion on adsorption, covering both physical and chemical adsorption. Explore the different types of adsorption isotherms, with a detailed focus on the Freundlich adsorption isotherm.

UNIT-II

1 Marks

1. What is the focus of the derivation of the rate constant for a second-order reaction when reactants are taken at different initial concentrations?

- a) Initial concentration dependence
- b) Temperature dependence
- c) Time dependence
- d) Pressure dependence

2. In a second-order reaction, when reactants are taken at the same initial concentrations, the rate constant is influenced by:

- a) Temperature only
- b) Concentration only
- c) Both temperature and concentration
- d) Pressure only

3. How is the rate constant of a second-order reaction determined?

- a) Experimentally
- b) Theoretically
- c) Both a and b
- d) Indirectly

4. The derivation of the rate constant for a third-order reaction, when reactants are taken at the same initial concentrations, primarily depends on:

- a) Initial concentration b) Time
- c) Temperature d) Pressure

5. What is the main focus when deriving the half-life periods for second and third-order reactions with equal initial concentrations of reactants?

- a) Temperature dependence
- b) Time dependence
- c) Concentration dependence
- d) Pressure dependence

6. In a second-order reaction, if the initial concentration of reactants is doubled, how does the rate constant change?

- a) It is halved b) It is doubled
- c) It remains the same d) It is quadrupled

7. For a third-order reaction, if the initial concentration of reactants is tripled, how does the rate constant change?

- a) It is tripled b) It is halved
- c) It remains the same d) It is squared

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8. How is the rate constant of a second-order reaction typically represented in terms of the initial concentrations of reactants?

- a) $k = \frac{1}{[A]}$ b) $k = [A]^2$
c) $k = \frac{1}{[A]^2}$ d) $k = [A]$

9. What is the overall order of a reaction if the sum of the exponents in the rate law expression is 3?

- a) Zero order b) First order
c) Second order d) Third order

10. In the context of reaction kinetics, what does the term "half-life" represent?

- a) The time taken for the reaction to complete
b) The time taken for the reactant concentration to reduce by half
c) The time taken for the product concentration to reach half of its maximum value
d) The time taken for the rate constant to halve

11. Which of the following methods is NOT commonly used in the study of kinetics for determining the order of a reaction?

- a) Volumetry b) Manometry
c) Gravimetry d) Colorimetry

12. What experimental technique involves measuring the volume changes during a reaction to determine reaction kinetics?

- a) Volumetry b) Manometry
- c) Polarimetry d) Colorimetry

13. In manometry, what is being measured to study reaction kinetics?

- a) Pressure b) Volume
- c) Temperature d) Color intensity

14. Which experimental method involves measuring the rotation of plane-polarized light to study reaction kinetics?

- a) Volumetry b) Manometry
- c) Polarimetry d) Colorimetry

15. Colorimetry is based on the measurement of:

- a) Pressure b) Volume
- c) Color intensity d) Temperature

16. How does temperature affect reaction rates?

- a) It has no effect on reaction rates
- b) Reaction rates increase with temperature
- c) Reaction rates decrease with temperature
- d) Temperature only affects the order of reactions

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17. The Arrhenius equation relates the rate constant (k) to which of the following factors?

- a) Temperature b) Concentration
- c) Pressure d) Time

18. What is the concept represented by the activation energy in the Arrhenius equation?

- a) Energy released during the reaction
- b) Energy required to initiate the reaction
- c) Energy change during the reaction
- d) Energy stored in the reactants

19. Which parameter is determined by plotting $\ln(k)$ against $1/T$ in the Arrhenius equation?

- a) Activation energy
- b) Arrhenius frequency factor
- c) Rate constant (k)
- d) Temperature

20. How is the Arrhenius frequency factor determined experimentally?

- a) By measuring temperature changes
- b) By conducting colorimetric assays
- c) By studying reaction stoichiometry
- d) By fitting experimental data to the Arrhenius equation

Answers

1.a, 2.c, 3.c, 4.a, 5.c, 6.b, 7.c, 8.b, 9.d, 10.b, 11.c,
12.a, 13.a, 14.c, 15.c, 16.b, 17.a, 18.b, 19.a, 20.d.

5 Marks

1. Explain the derivation of the rate constant for a second-order reaction when the reactants are taken at different initial concentrations.
2. Discuss the derivation of the rate constant for a second-order reaction when the reactants are taken at the same initial concentrations. Highlight the similarities and differences compared to the case with different initial concentrations.
3. Outline the experimental methods used for determining the rate constant of a second-order reaction. Highlight the procedures involved and how these may vary when the initial concentrations of reactants are different versus the same.
4. Provide a detailed derivation of the rate constant for a third-order reaction when the reactants are taken at the same initial concentrations. Discuss the mathematical steps involved and the resulting expression for the rate constant.

5. Explore the derivation of half-life periods for second and third-order reactions when the initial concentrations of reactants are equal. Discuss the expressions for the half-life periods and the insights gained from these derivations.

6. Explain the experimental methods used to determine the order of a reaction in kinetics.

Discuss the principles and applications of volumetry, manometry, polarimetry, and colorimetry in identifying and verifying reaction orders.

7. Discuss the impact of temperature on reaction rates. Explain the theoretical foundations and experimental observations regarding how temperature influences the kinetics of chemical reactions.

8. Provide a step-by-step derivation of the Arrhenius equation. Discuss the key assumptions and mathematical expressions involved in expressing the temperature dependence of reaction rates.

9. Define the concept of activation energy within the context of the Arrhenius equation. Discuss the significance of activation energy in understanding the energy barriers that reactions must overcome.

10. Explain the experimental methods used to determine the Arrhenius frequency factor and

energy of activation. Discuss the techniques, measurements, and analyses involved in obtaining these parameters and their importance in characterizing reaction kinetics.

10 Marks

1. Provide a detailed analysis of the derivation of the rate constant for a second-order reaction, considering scenarios where reactants are taken at different and the same initial concentrations.
2. Discuss the various experimental methods used for determining the rate constant of a second-order reaction. Compare and contrast the approaches when reactants are taken at different and the same initial concentrations. .
3. Conduct a thorough derivation of the rate constant for a third-order reaction when the reactants are taken at the same initial concentrations. Highlight the mathematical intricacies, assumptions, and insights gained from this derivation.
4. Explore the derivation of half-life periods for second and third-order reactions, specifically when the initial concentrations of reactants are equal. Discuss the expressions for the half-life period.

5. Provide a detailed explanation of the experimental methods employed in the study of kinetics for determining the order of a reaction. Focus on volumetry, manometry, polarimetry, and colorimetry, elucidating their principles, applications, and limitations.
6. Discuss the comprehensive effect of temperature on reaction rates. Explore the theoretical foundations, experimental observations, and mathematical relationships that describe the temperature dependence of reaction kinetics.
7. Conduct a step-by-step derivation of the Arrhenius equation. Clarify the assumptions made, mathematical steps involved, and the resulting expression.
8. Provide an in-depth discussion of the concept of activation energy within the context of the Arrhenius equation. Explore the physical interpretation of activation energy and its role in determining the rate of reaction.
9. Delve into the experimental methods used to determine the Arrhenius frequency factor. Discuss the procedures, techniques, and data analysis involved in obtaining this parameter.
10. Conduct a comprehensive analysis of the experimental determination of the energy of activation.

UNIT-III

1 Marks

1. What is the primary focus of Collision Theory in the context of reaction rates?

- a) Thermodynamics b) Quantum mechanics
- c) Kinetics d) Electrochemistry

2. In Collision Theory, the rate constant for a bimolecular reaction is derived from:

- a) Quantum principles
- b) Thermodynamic principles
- c) Statistical considerations
- d) Electrochemical principles

3. What is the essential assumption of Collision Theory regarding the reaction mechanism?

- a) Reactions occur in a single step
- b) Reactions involve multiple steps
- c) Reactants collide with specific orientation
- d) Reactants collide without specificity

4. The rate constant for a bimolecular reaction derived from Collision Theory is dependent on:

- a) Temperature only b) Concentration only
- c) Both a and b d) Pressure only

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5. Which of the following is a limitation or failure of Collision Theory?
- a) It cannot explain reaction mechanisms
 - b) It assumes all collisions lead to successful reactions
 - c) It is not applicable to bimolecular reactions
 - d) It neglects the role of temperature
6. According to Collision Theory, what is the critical factor for a successful reaction between two molecules?
- a) Temperature
 - b) Pressure
 - c) Collision energy
 - d) Concentration
7. The rate constant derived from Collision Theory is proportional to:
- a) Temperature
 - b) Pressure
 - c) Concentration
 - d) Activation energy
8. What type of reactions does Collision Theory primarily focus on?
- a) Unimolecular reactions
 - b) Bimolecular reactions
 - c) Termolecular reactions
 - d) Zeroth-order reactions
9. What assumption in Collision Theory leads to its failure in certain cases?

- a) Constant collision energy
- b) Successful collision in every encounter
- c) Independent collisions of reactants
- d) Homogeneous reaction medium

10. In Collision Theory, what factor is not considered when determining the rate constant?

- a) Reactant concentrations
- b) Activation energy
- c) Temperature
- d) Molecular orientation during collisions

11. What is the primary focus of Lindemann's theory in the context of reaction rates?

- a) Bimolecular reactions
- b) Unimolecular reactions
- c) Termolecular reactions
- d) Homogeneous reactions

12. According to Lindemann's theory, what is the critical factor influencing the rate of unimolecular reactions?

- a) Activation energy b) Reactant concentrations
- c) Molecular collisions d) Temperature

13. Lindemann's theory primarily applies to which type of reactions?

- a) Reversible reactions

- b) Bimolecular reactions
- c) Unimolecular reactions
- d) Zeroth-order reactions

14. What assumption does Lindemann's theory make regarding the mechanism of unimolecular reactions?

- a) Single-step mechanism
- b) Multiple-step mechanism
- c) No specific mechanism assumed
- d) Homogeneous mechanism

15. In Lindemann's theory, what is the relationship between the rate constant and the frequency of molecular collisions?

- a) Linear
- b) Inverse
- c) Exponential
- d) Logarithmic

16. What does ARR stand for in the Theory of Absolute Reaction Rates (ARRT)?

- a) Activation Rate Ratio
- b) Absolute Rate Reaction
- c) Arrhenius Rate Ratio
- d) Absolute Reaction Rates

17. The Theory of Absolute Reaction Rates (ARRT) focuses on the thermodynamic

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derivation of the rate constant for which type of reaction?

- a) Unimolecular b) Bimolecular
- c) Termolecular d) Zeroth-order

18. What is the fundamental principle underlying the thermodynamic derivation of the rate constant in ARRT?

- a) Conservation of energy
- b) Conservation of mass
- c) Equilibrium constant
- d) Transition state theory

19. According to ARRT, what thermodynamic parameters are crucial for determining the rate constant of a bimolecular reaction?

- a) Enthalpy and entropy
- b) Internal energy and pressure
- c) Temperature and Gibbs free energy
- d) Activation energy and frequency factor

20. What distinguishes ARRT from collision theories like Lindemann's theory?

- a) Treatment of reaction mechanism
- b) Consideration of molecular collisions
- c) Focus on activation energy
- d) Emphasis on reactant concentrations

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21. What does ARRT stand for in the context of reaction kinetics?

- a) Absolute Reaction Rate Theory
- b) Advanced Reaction Rate Technique
- c) Arrhenius Rate Reduction Theory
- d) Absolute Rate Reaction Treatment

22. In the context of comparison, what does CT stand for?

- a) Collision Theory b) Conservation Theory
- c) Critical Theory d) Catalysis Theory

23. How does ARRT differ from CT in terms of their treatment of reaction mechanisms?

- a) ARRT considers reaction mechanisms, while CT does not.
- b) CT considers reaction mechanisms, while ARRT does not.
- c) Both ARRT and CT treat reaction mechanisms in the same way.
- d) Neither ARRT nor CT considers reaction mechanisms.

24. What is the primary focus of CT in explaining reaction rates?

- a) Thermodynamic parameters
- b) Kinetic parameters
- c) Reaction mechanisms

d) Quantum states of reactants

25. In ARRT, what thermodynamic parameters are crucial for determining the rate constant of a reaction?

- a) Temperature and Gibbs free energy
- b) Enthalpy and entropy
- c) Internal energy and pressure
- d) Activation energy and frequency factor

26. How does ARRT treat the effect of molecular collisions on reaction rates compared to CT?

- a) ARRT emphasizes molecular collisions more than CT.
- b) CT emphasizes molecular collisions more than ARRT.
- c) Both ARRT and CT treat molecular collisions in the same way.
- d) Neither ARRT nor CT considers molecular collisions.

27. What distinguishes the significance of the free energy of activation in ARRT and CT?

- a) ARRT focuses on the free energy of activation, while CT does not.
- b) CT focuses on the free energy of activation, while ARRT does not.

- c) Both ARRT and CT emphasize the free energy of activation equally.
- d) Neither ARRT nor CT considers the free energy of activation.

28. What does entropy of activation measure in the context of reaction kinetics?

- a) Energy required for activation
- b) Disorder in the transition state
- c) Activation energy distribution
- d) Kinetic energy of reactants

29. In CT, how is the entropy of activation typically related to the mechanism of a reaction?

- a) It is inversely related to the mechanism complexity.
- b) It is directly related to the mechanism complexity.
- c) It is unrelated to the mechanism of a reaction.
- d) It determines the overall rate of the reaction.

30. What information does the entropy of activation provide about the transition state in ARRT?

- a) It quantifies the disorder in the transition state.
- b) It measures the overall kinetic energy of the reactants.

- c) It determines the frequency of molecular collisions.
- d) It indicates the specific mechanism of the reaction.

Answers

1.c, 2.c, 3.d, 4.c, 5.b, 6.c, 7.c, 8.b, 9.b, 10.d, 11.b,
12.a, 13.c, 14.c, 15.a, 16.d, 17.b, 18.a, 19.c, 20.a,
21.a, 22.a, 23.a, 24.b, 25.a, 26.a, 27.a, 28.b, 29.b,
30.a.

5 Marks

1. Explain the key principles of Collision Theory (CT) in the context of reaction rates. Provide a detailed derivation of the rate constant for a bimolecular reaction based on CT.
2. Outline the fundamental concepts of Lindemann's theory as it pertains to the rates of unimolecular reactions. Discuss the critical factors considered by Lindemann in explaining the kinetics of these reactions.
3. Provide a comprehensive overview of the Theory of Absolute Reaction Rates (ARRT) with a focus on the thermodynamic derivation of the rate constant for a bimolecular reaction.

4. Conduct a detailed comparison between the Theory of Absolute Reaction Rates (ARRT) and Collision Theory (CT). Discuss how these theories differ in their treatment of reaction mechanisms.
5. Explore the significance of the free energy of activation and entropy of activation in the context of reaction kinetics. Explain how these parameters are crucial in understanding the energetics and transition states of chemical reactions.
6. Derive the rate constant for a bimolecular reaction using Collision Theory. Discuss the assumptions made during the derivation and explain the physical meaning of each term in the resulting expression.
7. Elaborate on the failures or limitations of Collision Theory. Discuss specific scenarios or types of reactions where CT may not accurately predict reaction rates. Provide insights into alternative theories that address these limitations.
8. Discuss how Lindemann's theory provides mechanistic insights into the rates of unimolecular reactions. Explain the role of molecular collisions and activation energy in Lindemann's framework, and highlight any experimental evidence supporting the theory.

9. Explain the thermodynamic basis underlying the Theory of Absolute Reaction Rates (ARRT) in the derivation of the rate constant for a bimolecular reaction.
10. Provide real-world examples where the free energy of activation and entropy of activation play a critical role in understanding and predicting reaction rates.

10 Marks

1. Provide an in-depth analysis of Collision Theory (CT), covering its foundational principles, assumptions, and the step-by-step derivation of the rate constant for a bimolecular reaction.
2. . Discuss specific cases or types of reactions where CT falls short in predicting reaction rates. Explore the reasons behind these limitations
3. Provide a comprehensive overview of Lindemann's theory of unimolecular reactions. Illustrate the role of activation energy and molecular collisions in Lindemann's theory.
4. Explain in detail the thermodynamic derivation of the rate constant for a bimolecular reaction in the Theory of Absolute Reaction Rates (ARRT).
5. Discuss the theoretical foundations, treatment of reaction mechanisms, and application domains

of each theory. Highlight scenarios where one theory outperforms the other and discuss their complementarity.

6. Explore the significance of the free energy of activation in reaction kinetics. Discuss how this parameter reflects the energy barrier that reactions must overcome and its implications for the overall rate of chemical reactions.

7. Explain how entropy influences the transition state and the overall reaction rate. Discuss the role of disorder in the activation process and provide examples to illustrate its importance in understanding reaction kinetics.

8. Discuss specific experiments and observations that align with Lindemann's predictions. Highlight cases where experimental data validate the assumptions and principles of Lindemann's theory.

9. Discuss the practical applications of both the Theory of Absolute Reaction Rates (ARRT) and Collision Theory (CT) in various chemical systems.

10. Explore recent advances in reaction rate theories, including developments beyond CT, Lindemann's theory, and ARRT.

UNIT-IV

1 Marks

1. What does specific conductance (κ) measure?
 - a) The conductivity of a solution
 - b) The conductance of a specific electrolyte
 - c) The conductivity per unit volume
 - d) The conductance per unit mass
2. Which of the following conductance terms is independent of concentration?
 - a) Specific conductance (κ)
 - b) Equivalent conductance (Λ)
 - c) Molar conductance (Λ_m)
 - d) All of the above
3. What is the relationship between specific conductance (κ), equivalent conductance (Λ), and concentration (C)?

a) $\kappa = \Lambda \times C$	b) $\Lambda = \kappa \times C$
c) $C = \kappa \times \Lambda$	d) $\kappa = \Lambda/C$
4. How is molar conductance (Λ_m) related to equivalent conductance (Λ) and the number of equivalents (n) in a solution?

a) $\Lambda_m = \Lambda \times n$	b) $\Lambda = \Lambda_m \times n$
c) $n = \Lambda_m \times \Lambda$	d) $\Lambda_m = \Lambda/n$

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5. What is the unit of conductance?

- a) S/m b) $S \cdot m^2/mol$
c) $S \cdot cm/mol$ d) ohm

6. How is the cell constant (G) defined in the context of conductance measurements?

- a) $G = l/A$ b) $G = A/l$
c) $G = l \times A$ d) $G = \sqrt{(l/A)}$

7. What happens to the conductance of a solution as it is diluted?

- a) Increases b) Decreases
c) Remains constant d) Depends on the nature

7. What is the qualitative explanation for the variation of conductance with dilution for strong electrolytes?

- a) Increased dissociation
b) Decreased dissociation
c) Change in temperature
d) Change in pressure

9. For weak electrolytes, how does conductance vary with dilution?

- a) Increases sharply b) Decreases sharply
c) Remains constant d) Follows a logarithmic

10. Which type of electrolyte exhibits nearly constant conductance with dilution?

- a) Strong electrolyte
- b) Weak electrolyte
- c) Nonelectrolyte
- d) Electrolyte concentration does not affect conductance

11. How does the conductance of a strong electrolyte typically vary with dilution?

- a) Increases
- b) Decreases
- c) Remains constant
- d) Depends on the nature

12. For weak electrolytes, what is the general trend in conductance as the solution is diluted?

- a) Increases sharply
- b) Decreases sharply
- c) Remains constant
- d) Follows a logarithmic

13. How is the transport number of ions defined in the context of electrolytes?

- a) The number of ions in a solution
- b) The ratio of the charge of a specific ion to the total charge in the solution
- c) The number of moles of ions
- d) The total charge in the solution

14. How is the transport number of ions determined by the Hittorf method?

- a) By measuring the speed of ions during electrolysis
- b) By measuring the voltage across the electrolyte
- c) By measuring the concentration of ions in the solution
- d) By measuring the temperature change during electrolysis

15. What does Kohlrausch's law state regarding the equivalent conductance of electrolytes?

- a) The equivalent conductance is constant with dilution for all electrolytes.
- b) The equivalent conductance is directly proportional to the concentration of the electrolyte.
- c) The equivalent conductance is inversely proportional to the concentration of the electrolyte.
- d) The equivalent conductance is constant only for strong electrolytes.

16. How does Kohlrausch's law contribute to the determination of equivalent conductance for weak electrolytes?

- a) It provides a mathematical model for calculating equivalent conductance.

- b) It allows direct measurement of equivalent conductance.
- c) It defines the relationship between conductivity and concentration.
- d) It is not applicable to weak electrolytes.

17. What is the key application of Kohlrausch's law in the study of electrolytes?

- a) Determination of molar mass of electrolytes
- b) Calculation of transport numbers
- c) Measurement of equivalent conductance for strong electrolytes
- d) Analysis of the conductance of mixed electrolyte solutions

18. How is the transport number determined by the moving boundary method?

- a) By measuring the speed of ions during electrolysis
- b) By measuring the voltage across the electrolyte
- c) By measuring the concentration of ions in the solution
- d) By measuring the movement of ions in a solution under the influence of an electric field

19. What is the primary information provided by the transport number in electrolyte solutions?

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- a) The concentration of ions
- b) The speed of ions
- c) The charge carried by each type of ion
- d) The total conductance of the solution

20. Why is the determination of transport numbers important in the study of electrolytes?

- a) It helps calculate the density of ions in a solution.
- b) It provides insights into the mechanism of ion migration.
- c) It determines the overall conductivity of a solution.
- d) It is not significant in the study of electrolytes.

21. What is the relationship between diffusion and ionic mobility?

- a) Directly proportional
- b) Inversely proportional
- c) No relationship
- d) Logarithmic relationship

22. What does molar ionic conductance measure?

- a) The rate of diffusion of ions
- b) The conductance of a specific electrolyte
- c) The total conductance of a solution
- d) The conductance per mole of ions

23. Which rule relates molar ionic conductance and viscosity?

- a) Faraday's law b) Walden's rule
- c) Arrhenius law d) Kohlrausch's law

24. How is Walden's rule defined in the context of molar ionic conductance and viscosity?

- a) The molar ionic conductance is directly proportional to viscosity.
- b) The molar ionic conductance is inversely proportional to viscosity.
- c) The molar ionic conductance is logarithmically related to viscosity.
- d) The molar ionic conductance is unrelated to viscosity.

25. What is the primary information provided by conductance measurements in applications?

- a) Rate of diffusion of ions
- b) Concentration of ions
- c) Electrical conductivity of a solution
- d) Charge carried by ions

26. How are conductance measurements used to determine the degree of dissociation of weak electrolytes?

- a) By measuring the viscosity of the solution
- b) By measuring the rate of diffusion of ions

- c) By analyzing the change in conductance with dilution
- d) By measuring the total conductance of the solution

27. What is determined through conductance measurements for the ionic product of water?

- a) pH of the solution
- b) Solubility product constant
- c) Electrical conductivity of water
- d) Concentration of ions in water

28. How are conductance measurements utilized in the determination of the solubility of sparingly soluble salts?

- a) By measuring the electrical conductivity of the salt solution
- b) By analyzing the viscosity of the salt solution
- c) By measuring the total charge carried by the salt ions
- d) By measuring the rate of diffusion of ions in the salt solution

29. In conductometric titrations, what property is monitored to determine the endpoint of the titration?

- a) pH of the solution
- b) Temperature of the solution

- c) Electrical conductivity of the solution
- d) Color change of the indicator

30. How does conductance change during a conductometric titration as the titrant is added to the solution?

- a) Increases sharply at the endpoint
- b) Decreases sharply at the endpoint
- c) Remains constant at the endpoint
- d) Experiences a logarithmic change at the endpoint

Answers

1.c, 2.a, 3.b, 4.a, 5.c, 6.a, 7.a, 8.a, 9.b, 10.b, 11.a, 12.b, 13.b, 14.a, 15.a, 16.a, 17.d, 18.d, 19.c, 20.b, 21.a, 22.d, 23.b, 24.a, 25.b, 26.c, 27.d, 28.a, 29.c, 30.a.

5 Marks

1. Explain the definitions of specific, equivalent, and molar conductance. Provide the mathematical relations between these conductance terms.
2. Discuss the qualitative explanation for the variation of conductance with dilution, focusing on both strong and weak electrolytes.

3. Describe the migration of ions and the concept of transport numbers. Explain how transport numbers are determined using both the Hittorf method and the moving boundary method.
4. Provide an overview of Kohlrausch's law and its applications. How does Kohlrausch's law contribute to the understanding of conductance in solutions? Discuss the calculation of equivalent conductance for weak electrolytes using Kohlrausch's law and its application in determining transport numbers.
5. Define ionic mobilities and discuss their significance in the context of diffusion. Explain the relationship between molar ionic conductance and viscosity according to Walden's rule. How does Walden's rule provide insights into the behavior of ions in solution?
6. Explore various applications of conductance measurements. Discuss how conductance measurements are used to determine the degree of dissociation of weak electrolytes. Explain their role in determining the ionic product of water and how conductance measurements aid in the determination of solubility for sparingly soluble salts.
7. Elaborate on the principle and procedure of conductometric titrations. How does the electrical

conductivity change during a conductometric titration?

8. Analyze the relationship between conductance and the degree of dissociation for weak electrolytes. How does the conductance behavior provide insights into the extent of dissociation? Illustrate with examples.
9. Discuss the significance of determining the ionic product of water. How is it experimentally determined through conductance measurements? Explain the implications of variations in the ionic product of water for different types of solutions.
10. Explain how conductance measurements contribute to the determination of the solubility of sparingly soluble salts. Discuss the principles and experimental considerations involved in using conductance to quantify the solubility of these salts.

10 Marks

1. Provide comprehensive definitions for specific, equivalent, and molar conductance. Discuss the mathematical relations between these conductance terms.
2. Explain the qualitative variation of conductance with dilution, considering both strong and weak electrolytes. Discuss how the

behavior of conductance differs between strong and weak electrolytes as the solution is diluted.

3. Define ion migration and transport numbers. Describe the determination of transport numbers using both the Hittorf method and the moving boundary method.

4. Explore Kohlrausch's law and its applications in detail. Discuss how Kohlrausch's law aids in understanding conductance in solutions. .

5. Define ionic mobilities and discuss their relevance to diffusion. Explain the relationship between molar ionic conductance and viscosity.

6. Explain their role in determining the ionic product of water and how conductance measurements aid in determining solubility for sparingly soluble salts.

7. How does electrical conductivity change during a conductometric titration? Discuss practical considerations and advantages associated with the use of conductometric titrations in analytical chemistry.

8. Analyze the relationship between conductance and the degree of dissociation for weak electrolytes.

9. Explain the implications of variations in the ionic product of water for different types of solutions.

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10. Explain how conductance measurements contribute to the determination of the solubility of sparingly soluble salts. Discuss the principles and experimental considerations involved in using conductance to quantify the solubility of these salts.



UNIT-V

1 Marks

1. What does the Debye-Huckel-Onsager theory primarily address in electrolyte solutions?
 - a) Conductivity of strong electrolytes
 - b) Activity and activity coefficients of strong electrolytes
 - c) Equilibrium constants for weak electrolytes
 - d) pH values in acidic solutions

2. Which of the following effects is associated with Wein and Debye-Falkenhagen in electrolyte solutions?
 - a) Debye-Huckel effect
 - b) Onsager equation effect
 - c) Ostwald's dilution effect
 - d) Wein and Debye-Falkenhagen effect

3. What is the primary focus of the Debye-Huckel-Onsager theory regarding electrolyte solutions?
 - a) Verification of Onsager equation
 - b) Ionic strength determination
 - c) Activity coefficients of weak electrolytes
 - d) pH value calculations

4. Which equation is verified by the Debye-Huckel-Onsager theory?

- a) Debye-Huckel equation
- b) Ostwald's dilution law
- c) Onsager equation
- d) Nernst equation

5. What does the Debye-Falkenhagen effect describe in electrolyte solutions?

- a) Conductance variation with dilution
- b) Temperature dependence of conductivity
- c) Changes in activity coefficients with concentration
- d) Behavior of weak electrolytes in solution

6. In Ostwald's dilution law, what is assumed to be constant during dilution of a strong electrolyte?

- a) Activity coefficient
- b) Ionic strength
- c) Degree of dissociation
- d) Temperature

7. What is the primary parameter associated with ionic strength in electrolyte solutions?

- a) Activity coefficient
- b) Conductivity
- c) Concentration of ions
- d) Dissociation constant

8. According to Ostwald's dilution law, how does the degree of dissociation change with dilution for weak electrolytes?

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- a) Increases b) Decreases
c) Remains constant d) Depends on temperature

9. What does the determination of the ionic product of water involve?

- a) pH measurements
b) Conductance measurements
c) Dissociation constant calculations
d) Equilibrium constant measurements

10. What is the main parameter controlled by the pH value in aqueous solutions?

- a) Ionic strength
b) Activity coefficient
c) Hydrogen ion concentration
d) Dissociation constant

11. What is the primary purpose of a buffer solution?

- a) Enhancing conductivity
b) Maintaining a constant pH
c) Accelerating reaction rates
d) Increasing solubility

12. Which equation is commonly used to describe the pH of a buffer solution?

- a) Nernst equation b) Henderson equation
c) Arrhenius equation d) Van't Hoff equation

13. In the Henderson equation, what does "pKa" represent?

- a) Acid dissociation constant
- b) Buffer capacity
- c) pH of the solution
- d) Concentration of the buffer components

14. What is a common application of buffer solutions in living systems?

- a) Water purification
- b) Energy production
- c) pH regulation in blood
- d) Accelerating chemical reactions

15. How does the common ion effect influence the pH of a buffer solution?

- a) Increases pH
- b) Decreases pH
- c) Has no effect on pH
- d) Changes the color of the solution

16. What principle is associated with the solubility product in qualitative analysis?

- a) Arrhenius principle
- b) Le Chatelier's principle
- c) Solubility product principle
- d) Nernst principle

17. How is the solubility product related to the solubility of a substance in a solution?

- a) Directly proportional
- b) Inversely proportional
- c) Logarithmically related
- d) No relationship

18. What is the primary application of the solubility product principle in qualitative analysis?

- a) Determining the pH of a solution
- b) Identifying the presence of ions in a solution
- c) Accelerating chemical reactions
- d) Measuring conductivity

19. In quantitative analysis, how is the solubility product utilized?

- a) To calculate buffer capacity
- b) To determine the pH of a solution
- c) To calculate the concentration of ions in a solution
- d) To measure conductivity

20. What is the general significance of buffer solutions in both qualitative and quantitative analysis?

- a) Enhancing reaction rates
- b) Maintaining constant pH conditions
- c) Measuring conductivity

d) Accelerating chemical reactions

21. What is the primary process involved in the hydrolysis of salts?

- a) Dissolution in water
- b) Ionization in solution
- c) Reaction with acids
- d) Reaction with water to produce ions

22. How is the hydrolysis constant (K_h) defined for a salt undergoing hydrolysis?

- a) The rate of hydrolysis
- b) The equilibrium constant for hydrolysis
- c) The concentration of ions in solution
- d) The pH change during hydrolysis

23. What does the degree of hydrolysis represent in the context of salt hydrolysis?

- a) The rate of hydrolysis
- b) The amount of salt dissolved
- c) The fraction of salt molecules hydrolyzed
- d) The concentration of hydrogen ions

24. How is the pH of salt solutions affected by the degree of hydrolysis?

- a) It remains constant
- b) It increases
- c) It decreases
- d) It depends on the salt

25. What types of salts are more likely to produce acidic solutions upon hydrolysis?

- a) Salts of strong acids and strong bases
- b) Salts of weak acids and strong bases
- c) Salts of strong acids and weak bases
- d) Salts of weak acids and weak bases

26. How is the degree of hydrolysis determined experimentally using conductance measurements?

- a) By measuring the speed of ions during hydrolysis
- b) By measuring the voltage across the solution
- c) By analyzing the change in conductance with dilution
- d) By measuring the concentration of ions in solution

27. What method can be employed to determine the degree of hydrolysis based on the distribution of ions between two solvents?

- a) Conductance method b) Distribution method
- c) pH method d) Titration method

28. Which ions play a crucial role in the pH determination of salt solutions undergoing hydrolysis?

- a) Hydroxide ions b) Hydrogen ions
- c) Oxide ions d) Nitrate ions

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29. In salt hydrolysis, what factor contributes to a salt solution having a neutral pH?

- a) Equal concentrations of hydroxide and hydrogen ions
- b) Excess hydroxide ions
- c) Excess hydrogen ions
- d) Absence of ions

30. How does the concentration of the conjugate acid and conjugate base influence the pH of a salt solution undergoing hydrolysis?***

- a) It has no effect on pH
- b) Higher concentration of the conjugate acid lowers pH
- c) Higher concentration of the conjugate base lowers pH
- d) It increases pH

Answers

1.b, 2.d, 3.c, 4.c, 5.a, 6.c, 7.c, 8.a, 9.b, 10.c, 11.b,
12.b, 13.a, 14.c, 15.c, 16.c, 17.a, 18.b, 19.c, 20.b,
21.d, 22.b, 23.c, 24.c, 25.c, 26.c, 27.b, 28.b, 29.a,
30.b.

5 Marks

1. Explain the Debye-Huckel-Onsager theory, including the verification of the Onsager equation. Discuss the Wein and Debye-Falkenhagen effect and its significance in electrolyte solutions.
2. Explain Ostwald's dilution law and its application in determining dissociation constants. How is the Ionic product of water related to pH value?
3. Describe the characteristics of a buffer solution. Explain the common ion effect and its influence on buffer behavior. How is the solubility product principle related to the behavior of buffers and their relation to solubility?
4. Explain the degree of hydrolysis and its impact on the pH of salt solutions for different types of salts. Discuss the determination of the degree of hydrolysis using conductance and distribution methods.
5. Discuss the role of buffers in qualitative and quantitative analysis. Provide examples of how these principles are utilized in analytical chemistry. How does the common ion effect impact the determination of ions in a solution?
6. Explain the interconnections between Debye-Huckel-Onsager theory, activity coefficients, buffer solutions, and hydrolysis of salts. Discuss

how these concepts contribute to a comprehensive understanding of electrolyte behavior in solutions.

7. Provide specific examples of biological processes where buffers play a crucial role. How do buffers contribute to maintaining homeostasis in biological systems?

8. Discuss the practical aspects of conducting experiments related to buffer solutions and salt hydrolysis. What considerations should be taken into account in the experimental determination of these parameters?

9. Explain how pH is determined experimentally and its significance in solution chemistry. Discuss the relationship between the ionic product of water and pH. How are these parameters interconnected in the context of aqueous solutions?

10. Provide examples of how understanding Debye-Huckel-Onsager theory, activity coefficients, buffers, and salt hydrolysis is essential in various industrial processes and quality control.

10 Marks

1. Explain the Debye-Huckel-Onsager theory, detailing the theoretical foundations and the role

of each component. Discuss the experimental verification of the Onsager equation.

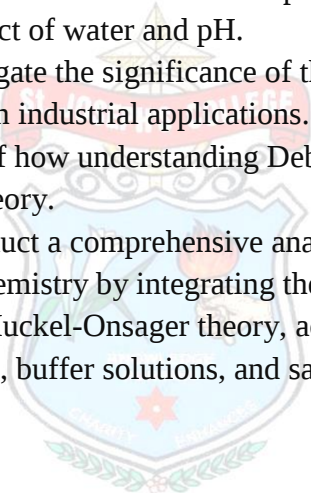
2. Define activity and activity coefficients of strong electrolytes. Explore the concept of ionic strength and its relationship with activity coefficients. Discuss the connection between ionic product of water and pH values in solutions.

3. Provide a comprehensive overview of buffer solutions, including the Henderson equation. Discuss the various uses of buffers, especially in living systems. Analyze the common ion effect and its influence on the behavior of buffer solutions.

4. Derive the expression for the hydrolysis constant and explain its significance. Describe the degree of hydrolysis and its impact on the pH of salt solutions for different types of salts.

5. Explore the interdisciplinary connections between Debye-Huckel-Onsager theory, activity coefficients, buffer solutions, and hydrolysis of salts.

6. Examine the importance of buffers in living systems, providing specific examples from biological processes. Discuss how buffer solutions contribute to maintaining pH homeostasis in biological systems. Explore the role of buffers in cellular processes and physiological functions.

7. Detail the experimental techniques employed in determining activity coefficients and ionic strength in solutions. Discuss practical considerations in experimental setups for studying buffer solutions and salt hydrolysis.
 8. Explain the experimental methods for determining pH and its significance in solution chemistry. Discuss the relationship between the ionic product of water and pH.
 9. Investigate the significance of the covered principles in industrial applications. Provide examples of how understanding Debye-Huckel-Onsager theory.
 10. Conduct a comprehensive analysis of solution chemistry by integrating the principles of Debye-Huckel-Onsager theory, activity coefficients, buffer solutions, and salt hydrolysis.
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ABOUT THE AUTHOR

Mrs.C.MYTHILI was born in 1985 in Paramathi Velur (Namakkal Dt.), TamilNadu and she currently working as an Assistant Professor in the Department of Chemistry, St.Joseph's College of Arts and Science for Women, Hosur. She has completed her D.Pharm in Swamy Vivekanandha College of Pharmacy, Tiruchencode, M.Sc studied in Vivekanandha College of Arts and Science, Tiruchencode, M.Phil degree in Kandasamy Kandar's College, Paramathi-Velur, Namakkal District and B.Ed., in Ponkaliamman College of Education. She has published 2 National & International conference Proceedings. Her areas of interest include Inorganic Chemistry and Pharmaceutical Chemistry.

