+3 Sem-I(NEP)
CHE-C-1(P-1)R/B Major

Dec,2025
Major Elective Chemistry

Full Marks: 100 **Time:3 Hours**

Q.No.1 All are compulsory **[10x1 = 10]**

I. Which spectral series of hydrogen lies entirely in the ultraviolet region?

a) Balmer b) Paschen c) Brackett d) Lyman

II. Nodes where $\psi = 0$ but $\psi^2 \neq 0$ are called —?

III. The angular momentum of an electron in Bohr's atom is quantized in units of?

IV. Down a group, atomic radius increases mainly due to —?

V. Which property best predicts the nature of bonding between two elements?

a) Atomic radius b) Ionization energy c) Electronegativity difference d) Electron affinity

VI. First ionization energy generally increases across a period because of

a) increasing atomic size b) decreasing nuclear charge

c) increasing effective nuclear charge d) increasing shielding effect

VII. Which ion has greater polarizing power: Na^+ or Al^{3+}?

VIII. Which parameter corrects for ion–ion repulsion in the Born–Landé equation?

IX. The correct order of repulsion in VSEPR theory is:

a) BP–BP > LP–BP > LP–LP

b) LP–LP > BP–BP > LP–BP

c) LP–LP > LP–BP > BP–BP

d) BP–LP > BP–BP > LP–LP

X. The hybridization of the central atom in ICl_2^- is:

a) sp b) sp^2 c) sp^3d d) sp^3d^2

Q.No. 2 All are compulsory **[9x2 = 18]**

I. What is degeneracy of orbitals? Illustrate with hydrogen atom.

II. What is the physical significance of normalization of wave function?

III. Explain why Rutherford's atomic model is unstable according to classical physics.

IV. Why is van der Waals radius larger than covalent radius?

V. Why does fluorine have lower electron affinity than chlorine?

VI. What is Madelung constant and why is it dimensionless?

VII. Distinguish between polarizing power and polarizability.

VIII. Explain why the bond angle in NH_3 is less than that in CH_4.

IX. Why is BeH_2 linear while H_2O is bent, although both involve two bond pairs?

Q.No.3 Answer any 8 out of 10 questions **[8x5 = 40]**

I. Derive Heisenberg's Uncertainty Principle and discuss its implications on the concept of electron orbits.

II. Explain radial probability distribution curves for s-orbitals and discuss their significance.

III. Explain the four quantum numbers. How do they arise from Schrödinger equation and what restrictions apply to them?

IV. Define ionization energy. Discuss factors affecting ionization energy and explain its periodic variation.

V. Explain Pauling's and Mulliken's scales of electronegativity and compare them.

VI. Discuss the applications of electronegativity in predicting bond type, polarity, and chemical reactivity.

VII. Discuss lattice energy and the factors affecting it. Correlate lattice energy with melting point and solubility.

VIII. Explain solvation energy and its role in determining solubility of ionic compounds. Why are some ionic solids insoluble in water despite high lattice energy?

IX. Explain VSEPR theory and discuss its application in predicting the shapes of NH_3, H_2O, PCl_5 and ClF_3.

X. With suitable MO energy-level diagrams, explain the bonding in N_2 and O_2. Account for their magnetic properties and bond orders.

Q.No. 4 Answer any 4 out of 5 questions **[4x8 = 40]**

I. Discuss the postulates of wave mechanics. Derive Schrödinger's wave equation for hydrogen atom and explain the significance of ψ and ψ^2.

II. Explain quantum numbers and their significance. Discuss Pauli's Exclusion Principle, Hund's rule of maximum spin multiplicity, and Aufbau principle with suitable examples and limitations.

III. Discuss different types of atomic radii (covalent, van der Waals) and ionic radii. Explain their periodic variations and factors influencing them.

IV. Explain the types of ionic packing and voids in crystal lattices. Discuss tetrahedral and octahedral voids and their occupation in NaCl, CsCl, and ZnS crystal structures.

V. Explain the concept of ionic character in covalent compounds. Discuss the role of electronegativity, dipole moment and polarization effects in determining bond nature, with suitable examples.

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DECEMBER,2025

FUNDAMENTAL ORGANIC CHEMISTRY

Marks: 100 **Time: 3 hr**

The figures in the right-hand margin indicate marks

1. Answer all questions. **[10x1=10]**

(a) Which of the following statement is correct about resonance?

(i) Displacement of σ electron is involved.

(ii) The resonance structures should not have almost equal energy.

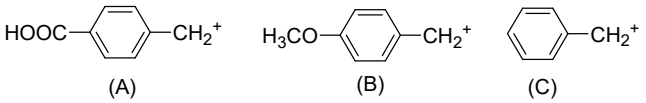
(iii) The position of constituent atoms remains same in all contributing structures.

(iv) The contributing structures may not have same number of unpaired electrons.

(b) Which of the following is an electrophile?

(i) $H_2C=CH_2$ (ii) OH^- (iii) H_2O (iv) $AlCl_3$

(c) The stability order of the following species are given by



(A) (B) (C)

(i) A > B > C (ii) B > C > A (iii) A < B > C (iv) A < B < C

(d) Which of the following is optically active?

(i) Isopropanol (ii) 1-Butanol (iii) 2-Butanol (iv) 3-pentanol

(e) Alkenes react with cold alkaline $KMnO_4$ to give _____

(i) trans diol (ii) cis diol (iii) epoxide (iv) Ketone

(f) Toluene undergoes

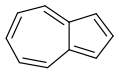
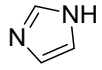
(i) Electrophilic addition reaction (ii) Electrophilic substitution reaction

(iii) Nucleophilic addition reaction (iv) Nucleophilic substitution reaction

(g) Two optically active compounds, which are not mirror image of each other are called

(i) Enantiomers (ii) Epimers (iii) Mesomers (iv) Diastereomers

(h) Which of the following is not an aromatic compound?

(i)  (ii) 

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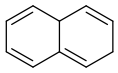
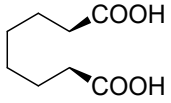
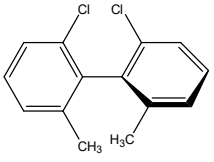
(iv) 

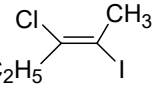
(i) Anti-Markownikoff's rule occurs in presence of

(i) HBr (ii) peroxides (iii) Sn/HCl (iv) Aqueous KOH

(j) Which of the following compound is optically active?

(i)  (ii) 

(iii) 

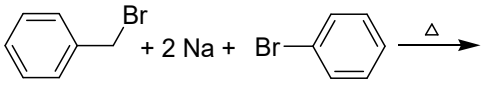
(iv) 

2. Answer all questions. **[9x2=18]**

(a) Which is stronger acid between acetic acid and chloroacetic acid? Explain why?

(b) Write the structure of carbene.

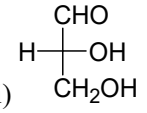
(c) Complete the following reaction.



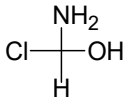
(d) Define meso compounds with a suitable example.

(e) Aniline is a weaker base than ammonia. Explain.

(f) Write the configuration of the compounds with R/S notation.



(i)



(ii)

(g) What is Markownikoff's rule? Give one example.

(h) Comment on the optical activity of a racemic mixture.

(i) Toluene is more reactive towards benzene towards the bromination. Explain why?

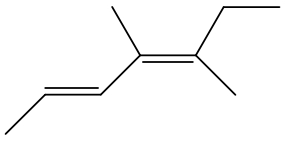
3. Answer any eight questions. **[8x5=40]**

(a) What are carbanions? Explain the structure, generation and stability of carbanions.

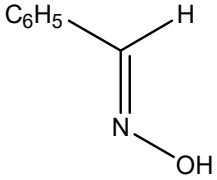
(b) Write a note on CIP rules.

(c) State and explain Corey-House reaction with mechanism.

(d) What is geometrical isomerism. Give the configuration of the following compounds.



(i)



(ii)

(e) What is conformational isomerism? Explain the stability of different conformers with an example.

(f) Distinguish between resonance and hyperconjugation.

(g) What is Kharasch effect? Explain the effect of organic peroxide in addition reaction of alkenes.

(h) Explain the acidic properties of acetylenic hydrogen and give a reaction involving terminal acetylenic hydrogen.

(i) Explain the nitration of toluene with mechanism.

(j) State and explain oxymercuration-demercuration reaction with mechanism.

4. Answer **any four** questions. **[4x8=32]**

(a) What is Saytzeff and Hofmann eliminations? Explain with example.

(b) Write the conformational analysis of cyclohexane. Explain the stabilities of the conformations with potential energy diagram.

(c) Explain S_N1 reaction mechanism. Explain the factors influencing S_N1 reaction.

(d) Discuss the hydroboration-oxidation reaction of an unsymmetrical alkene with mechanism.

(e) Explain the directing effect of various functional group in the aromatic electrophilic reaction.

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+3 Sem-I(NEP)
CHE-C-2(P-1)R/B Minor

Dec,2025

Atomic Structure, Periodicity of elements and Chemical Bonding

Q.No.1 All are compulsory **[10x1 = 10]**

I. State Pauli's exclusion principle.

II. Which quantum number determines the size of an orbital?

a) n b) l c) m d) s

III. The dual nature of matter was proposed by

a) Bohr b) de Broglie c) Heisenberg d) Planck

IV. Which scale of electronegativity is based on electron density ratio?

V. Electronegativity values according to Pauling scale are based on

a) Atomic size b) Bond energy

c) Ionization energy only d) Electron affinity only

VI. Which of the following has the largest atomic radius?

a) Na b) Mg c) Al d) Si

VII. The Born–Haber cycle is used to calculate

a) Bond length b) Lattice energy

c) Ionization energy d) Electron affinity

VIII. What is solvation energy?

IX. Name the theory that explains paramagnetism of oxygen.

X. Which molecule has zero dipole moment?

a) NH_3 b) H_2O c) CO_2 d) SO_2

Q.No.2 All are compulsory **[9x2 = 18]**

I. Explain the de Broglie hypothesis.

II. State Heisenberg's Uncertainty Principle and its significance.

III. Explain the significance of wave function (ψ) and ψ^2.

IV. Define ionization energy and state its periodic trend.

V. What is electron affinity?

VI. Define polarizing power of a cation

VII. State two limitations of the radius ratio rule.

VIII. State the basic postulates of VSEPR theory.

IX. Why does NH_3 have a pyramidal shape while CH_4 is tetrahedral?

Q.No.3 Answer any 8 out of 10 questions **[8x5 = 40]**

I. State and explain Heisenberg's Uncertainty Principle and discuss its significance in atomic structure.

II. Explain the four quantum numbers and discuss their physical significance.

III. Discuss the shapes of s and p orbitals with suitable diagrams.

IV. Explain Pauling's and Mulliken's scales of electronegativity.

V. Define ionization energy and explain the factors affecting it. Discuss its periodic variation.

VI. Describe the salient features of the long form of the periodic table and explain the basis of classification of elements.

VII. Define lattice energy and explain the factors influencing its magnitude.

VIII. Describe the Born–Haber cycle for the formation of an ionic compound and explain its applications.

IX. Explain the basic postulates of Valence Bond Theory using the Heitler–London approach.

X. Discuss molecular orbital diagrams of N_2 and CO.

Q.No. 4 Answer any 4 out of 5 questions **[4x8 = 32]**

I. Describe Bohr's atomic model in detail. Explain the origin of the hydrogen spectrum and discuss the limitations of Bohr's theory.

II. Explain the postulates of wave mechanics. Derive Schrödinger's wave equation for the hydrogen atom and discuss the significance of ψ and ψ^2.

III. Discuss various types of atomic radii and ionic radii. Explain the factors affecting them and their periodic variations with suitable examples.

IV. Explain the nature of ionic bonding in detail. Discuss lattice energy, factors affecting it, and its importance in determining properties of ionic solids.

V. Discuss the concept of ionic character in covalent compounds. Explain dipole moment, electronegativity difference, and methods for calculating percentage ionic character.

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DECEMBER, 2025

Environmental Chemistry

Full Marks : 100 **Time : 3 hrs**

Answer all the parts

Figures in the right hand margin indicate marks

Time – 3 hour **Full Marks-100**

PART - I

1. Answer all questions. **[10x1]**

a) Which layer of the atmosphere is responsible for absorbing ultraviolet radiation from the Sun?

i) Stratosphere ii) Mesosphere iii) Thermosphere iv) Troposphere

b) The gas mainly responsible for the greenhouse effect is

i) O_2 ii) N_2 iii) CO_2 iv) Ar

c) Which gas is essential for aquatic life?

d) Gas mainly responsible for ozone layer depletion is _____?

e) Environment-friendly chemistry is called _____ Chemistry.

i) Physical ii) Green iii) Analytical iv) Polymer

f) Acid rain is mainly caused by

i) CO and CO_2 ii) SO_2 and NO_2 iii) O_3 and CH_4 iv) NH_3 and H_2S

g) Radioactive pollution is associated with which power plant?

h) The major constituent of Earth's atmosphere is

i) Oxygen ii) Nitrogen iii) Carbon dioxide iv) Argon

i) Which of the following is a non-biodegradable pollutant?

i) Paper ii) Food waste iii) Plastic iv) Cotton

j) The major pollutant released from thermal power plants is

i) Carbon monoxide ii) Fly ash iii) Methane iv) Ozone

PART –II

2. Answer all questions within 50 words. **[9x2]**

a. Define heat budget of the earth.

b. What do you mean by Pesticides ? Give any two examples.

c. Define photochemical smog.

d. What do you mean by macro-nutrients in soil?

e. What is the role of ozone layer?

f. What is BOD? State its significance.

g. What is radioactive waste?

h. How do nuclear power plants contribute to environment pollution?

i. Define environmental toxicology.

j. What is biodegradability?

PART – III

3. Answers <u>any eight</u> questions from the following in 250 words: [8x5]

a. Discuss different types of aquatic pollution.

b. Explain the hydrological cycle.

c. Describe the purification and treatment of drinking water.

d. Discuss soil pollution caused by fertilizers and pesticides.

e. Describe greenhouse effect and global warming.

f. Explain causes and effects of acid rain.

g. Discuss pollution caused by thermal power plants.

h. Discuss principles of decomposition of organic wastes.

i. Explain the vertical temperature profile of the atmosphere.

j. Write down difference between macro and micro nutrients in soil.

PART – IV

4. Answer any four questions from the following in 800 words: [4x8]

a. Explain different types of aquatic pollution and their impact on water quality.

b. Describe industrial pollution with reference to paper and pulp industry.

c. Discuss pollution problems associated with thermal and nuclear power plants, including management and disposal of fly ash and radioactive wastes

d. What is pollution? Explain the analytical methods for measuring air pollutions.

e. Write short notes on – (any two)

i) Photochemical smog
ii) ozone depletion
iii) Soil composition and nutrients

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