

63 (FY)SEM-1/MAJ/CHMMAJ1014

2025

CHEMISTRAY

Paper: CHMMAJ1014

(Fundamentals of Chemistry)

Full Marks: 50

Pass Marks: 20

Time: Two hours

*The figures in the margin indicate full marks for the questions*

1. Choose the correct answer:

1x6=6

i) Which orbital is filled before 3d according to the Aufbau principle?

- a) 3p
- b) 4s
- c) 4p
- d) 5s

ii) Which factor increases ionization enthalpy?

- a) Increase in atomic radius
- b) Increase in nuclear charge
- c) Increase in shielding effect
- d) Decrease in effective nuclear charge

(Turn Over)

- iii) Fischer projection is mainly used to represent:
- a) Conformational isomers
  - b) Optical isomers
  - c) Structural isomers
  - d) Position isomers
- iv) The most stable carbene is generally:
- a) Singlet carbene
  - b) Carbocation
  - c) Triplet carbene
  - d) Carbanion
- v) Tautomerism involves the migration of:
- a) Alkyl group
  - b) Electron cloud
  - c) Proton and shift of double bond
  - d) Hydroxyl group only
- vi) In Slater's rules, electrons in the same shell contribute to shielding by a factor of approximately:
- a) 0.85
  - b) 0.35
  - c) 1.00
  - d) 0.70

(Contd.)

2. Answer the following questions (any six): 2x6=12

- (a) Explain the physical significance of  $\sigma^2$ .
- (b) What is meant by crystal radius? Mention one method used to determine it.
- (c) How does shielding affect the effective nuclear charge according to Slater's rules?
- (d) Distinguish between +M and -M effects with one example each.
- (e) How is Maxwell's distribution used to evaluate molecular speeds?
- (f) What is the physical significance of van der Waals constants a and b?
- (g) What information do virial coefficients provide about real gases?

3. Answer the following questions (any four): 3x4=12

- (a) Explain how magnetic and spin quantum numbers influence electron distribution.
- (b) Why does cis-2-butene have a higher boiling point than trans-2-butene? Explain.
- (c) Assign E or Z configuration to 2-bromo-2-butene using C.I.P. rules.

*(Turn Over)*

(d) Why is compressibility factor nearly unity at the Boyle temperature over a wide pressure range?

(e) How do intermolecular forces affect the P-V relationship of real gases?

4. Answer the following questions (any four): 5x4=20

(a) Calculate the RMS velocity of hydrogen gas at 298 K.  
Given:  $R=8.314 \text{ J mol}^{-1} \text{ K}^{-1}$  Molar mass of  $\text{H} = 2 \text{ g mol}^{-1}$ .

(b) An electron is confined in a one-dimensional box of length 1 nm. Calculate the energy of the electron in the first quantum state.

(c) Explain the sawhorse projection method. Draw sawhorse projections for eclipsed and staggered conformations of ethane and explaining their relative stability.

(d) Derive expressions for collision frequency and discuss the factors affecting it.

(e) State the postulates of kinetic theory of gases and derive the kinetic gas equation.

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