2023

Time - 3 hours

Full Marks - 60

*Answer **all groups** as per instructions.*
Figures in the right hand margin indicate marks.

GROUP – A

1. Answer all questions and fill in the blanks as required. [1 × 8

(a) The + and – signs of the lobes of the orbitals represent _____ of the wave function.

(b) How many nodes are there in 3p orbital ?

(c) Which is the strongest covalent bond between s–s, s–p and p–p bonds ?

(d) Between VBT and MOT, which theory suggests the concept of hybridisation ?

(e) Which one of the following does not show microwave spectra :

H_2O, HCl, CO, CO_2

(f) What is the number of vibrational degrees of freedom of a linear molecule containing 'n' number of atoms ?

(g) Which has higher energy between an excited singlet state and corresponding triplet state ?

(h) Full form of LCAO is _____.

GROUP – B

2. Answer any eight of the following questions within two to three sentences each. [1½ × 8

(a) What do you understand by a free particle ?

(b) Write Schrodinger wave equation for one electron system in spherical polar coordinates.

(c) Name three types of operators used in quantum mechanics.

(d) Arrange the following in order of increasing stability giving reasons : N_2 , N_2^- , N_2^+ .

(e) Name three rules which are obeyed during filling up of electrons in molecular orbitals.

(f) Write the mathematical expression for Hooke's law and indicate the meanings of the notations used.

(g) Explain Raman Scattering.

(h) What are hot bands ?

(i) Explain photosensitised reaction giving example.

(j) What is quenching ? Distinguish between internal quenching and external quenching.

GROUP – C

3. Answer any eight of the following questions within 75 words each. [2 × 8

(a) Explain quantization of energy and zero point energy.

(b) State and explain Heisenberg's uncertainty principle.

(c) What are the principles of LCAO for formation of MO ?

(d) How are BMOs different from ABMOs ?

(e) Give examples of localised and non-localised molecular orbitals.

(f) What is Born-Oppenheimer approximation ?

(g) Distinguish between Stokes and anti-Stokes lines.

(h) What do you understand by spin-forbidden and symmetry-forbidden transitions ?

(i) What is chemiluminescene ? Give examples where it is observed.

(j) State Grotthuss-Draper's law and Stark-Einstein law of photochemistry.

GROUP – D

*Answer **all** questions.*

4. Discuss rigid rotator model of rotation of diatomic molecules. [6

OR

Explain commutation rule and hence give quantitative description of angular momentum. [1 + 5

5. Explain with the help of Walsh diagram why H_2O is bent but BeH_2 is linear. [6

OR

Make a comparative discussion on VB treatment and LCAO-MO treatment of H_2 molecule. [6

6. Write a note on P, Q, R branches. [6

OR

Explain : [3 × 2

(i) Anharmonicity and Morse potential

(ii) Rule of mutual exclusion

7. Explain Franck-Condon principle of electronic transitions. [6

OR

Write notes on : [3 × 2

(i) Actinometry

(ii) High and low quantum yield