

2023-24

Time - 3 hours

Full Marks - 60

Answer all groups as per instructions.

Figures in the right hand margin indicate marks.

*Candidates are required to answer
in their own words as far as practicable.*

GROUP - A

1. Fill in the blanks. (all) [1 × 8]
- (a) The spacing between any two successive energy levels in rotational energy levels is _____ cm^{-1} .
- (b) Zero point energy of simple Harmonic oscillator is _____ Joule.
- (c) Bond order of O_2^{2-} is _____.
- (d) Electronic transition from first triplet excited state to ground state is called _____.
- (e) The value of operator \hat{P}_x is _____.
- (f) The selection rule for 'P' branch line in vibrational-rotational spectrum is _____.

[2]

- (g) Degeneracy of a particle present in a 3-dimensional cubic box having energy $\frac{5h^2}{8ma^2}$ is _____.
- (h) Electronic spectroscopy comes in _____ region of electromagnetic spectrum.

GROUP - B

2. Answer any eight of the following within two or three sentences each. [1½ × 8]
- (a) What is the condition of normalisation of a wave function ?
- (b) State "Frank-Condon principle".
- (c) Write down the molecular orbital electronic configuration of N_2^+ and write its magnetic behaviour.
- (d) What is force constant and write its unit ?
- (e) Define Hermitian operator with example.
- (f) Define Fluorescence.
- (g) State Hooke's law and give its equation.
- (h) Predict the relative stability of O_2^+ , O_2^- and O_2^{2-} .

[3]

- (i) Define Non-bonding molecular orbital.
- (j) Among H_2 and HCl , which molecule is rotational active and why ?

GROUP - C

3. Answer any eight of the following within 75 words each. [2 × 8]
- (a) What is photosensitised reaction ? Give an example.
- (b) What are the conditions of acceptability of a wave-function ?
- (c) Draw the molecular orbital diagram of F_2 molecule.
- (d) Define 'Hot-band'.
- (e) Write a note on 'Chemiluminescence'.
- (f) Calculate the value of $[\hat{P}_X, \hat{X}]$.
- (g) State and explain "Rule of Mutual Exclusion principle" with suitable example.
- (h) Distinguish Bonding molecular orbital and Antibonding molecular orbital.
- (i) Write any two postulates of quantum mechanics.
- (j) Calculate the number of vibrational degrees of freedom of H_2O , NH_3 and CO_2 molecule.

[4]

GROUP - D

4. Answer any four of the following within 500 words each. [6 × 4]
- (a) Set up and solve the Schrodinger wave equation for a particle present in an one dimensional box of length 'a' and normalise the wave function. [4 + 2]
- (b) Write notes on : [3 × 2]
- (i) Quantum yield
- (ii) Lambert's law of photochemistry
- (c) Discuss the LCAO-MO treatment of formation of H_2^+ ion.
- (d) Give an explanatory account of 'Vibrational-Rotational' spectroscopy.
- (e) Derive the differential rate of formulation of HBr from H_2 and Br_2 photochemically.
- (f) Write notes on : [3 × 2]
- (i) Isotopic substitution
- (b) Intensities of spectral line
- (g) Draw and explain the molecular orbital diagram of H_2O molecule.