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| Bon Secours College for Women Nationally Accredited with “A” Grade by NAAC (Affiliated to Bharathidasan University, Trichy-24) Recognized by UGC Under Section 2(f) & 12 (B)    Vilar Bypass, Thanjavur-613 006. |

**DEPARTMENT OF PHYSICS**

**ATOMIC AND MOLECULAR PHYSICS**

**UNIT I**

**2 marks**

1. State Hund’s rule.
2. What is Hyperfine structure?
3. What is periodic table?
4. Explain the sepectroscopic terms and the selection rules for fine structure.
5. Define pauli’s exclusion principle.
6. What is selection rule?

**5 marks**

1. Explain Ls and jj coupling briefly.
2. Write short notes on hyperfine structure.
3. Explain the stark effect of hydrogen.
4. Explain the Michelson Interferometer.
5. Discuss the atomic quantum numbers with its allowed values and its function.
6. Draw and discuss the z-component of an orbital angular momentum vector having a value L=1 and L=2.
7. Explain electron spin-orbit coupling.
8. What are the factors that affect the intensity of spectral lines?
9. Explain Hund’s rule in brief manner.
10. Explain how atomic states are representated in L-S and j-j coupling schemes.
11. List the salient features of alkali spectra.
12. Describe the stern and Gerlach experiment and indicate the importance of results obtained.
13. What are different series of alkali spectra? Give their wave numbers.
14. Give the construction and working of Stern –Gerlach experiment.

**10 marks**

1. Explain the spectra of alkali atoms.
2. Explain Pauli’s exclusion principle as applied to electrons in atoms. Describe how this principle assists in the interpretation of the periodic system of the elements.
3. Find the spin orbit interaction energy. Determine the doublet five structure separations due to spin orbit interaction.
4. List the salient features of alkali spectra. How are they explained?
5. Explain the arrangements of elements in the periodic table and also obtain Hyperfine structure.
6. Discuss in detail the various coupling schemes for many electron systems.
7. Distinguish between Zeeman and Stark effect with neat level diagram discusses the Zeeman Effect on transitions between 2S and 2P states.

**UNIT II**

**2 marks**

1. Explain Paschen-Back effect.
2. Sketch the molecular orbital formation of Benzene.
3. What is Zeeman Effect?
4. What do you mean by bonding and antibonding MO’s?
5. What is stark effect?
6. Give the importance of Born-oppenheimer approximation.

**5marks**

1. Explain the quantum theory of Paschen Back effect.
2. Discuss in detail the normal and an anomalous Zeeman Effect.
3. Explain central field approximation.
4. Discuss Born oppenheimer approximation.
5. Outline molecular orbital theory.
6. Explain Paschen-Back effect.
7. Explain briefly the Thomas-Fermi model.
8. Explain how you will apply LCAO approximation to the molecular orbital of C2H6.
9. Explain in detail the Huckel’s molecular approximation. Discuss its application related to butadiene
10. Explain Zeeman Oppenheimer approximation.

**10 marks**

1. Describe the application of Huckel’s molecular approximation to butadiene and benzene.
2. Explain the concept of exchange degeneracy. Outline the Heitler-London wave functions for hydrogen molecule. What are the singlet and triplet states of hydrogen?
3. Describe the application of Huckel’s molecular approximation to butadiene and butadiene.
4. Explain how you will apply LCAO approximation for molecular orbitals of CH4, C2H6 and C2H4.
5. Outline the Heitler-London wave functions for hydrogen molecule. Derive an expression for energy of the singlet and triplet states of hydrogen.

**UNIT III**

**2 marks**

1. Give the difference between microwave and IR spectroscopy.
2. What are hot bands?
3. Distinguish between a rigid rotator and a non rigid rotator.
4. Sketch a symmetric top molecule.
5. Sketch the molecular orbital formation of Benzene.
6. Explain the difference between symmetric top and asymmetric top molecular.

**5 marks**

1. What is the effect of isotopic substitution on pure rotational spectra?
2. Discuss infrared method of linear and symmetric top molecules.
3. Explain the potential energy of simple polyatomic molecule.
4. How will you evaluate molecular constants from vibrational spectral data?
5. Obtain the energy levels of a rigid rotator.
6. Discuss the effects of isotopes on the rotational spectrum of diatomic molecules.
7. Explain the effect of isotopic substitution on the rotational spectra of diatomic molecule.
8. Explain the vibrational –rotational energy levels of symmetric top molecules.
9. State and explain Franck-Condon principle.
10. Show that the Raman shift is twice the frequency of rotation of the molecule.
11. Obtain the expression for the rotational energy levels of a diatomic molecule, taking it as a rigid rotator.
12. Explain with examples, the characteristic group frequencies in the interpretation of the vibrational spectra.

**10marks**

1. Discuss with theory the microwave rotational spectra of symmetric top molecules?
2. Describe the experimental techniques and instrumentation involved in the infrared spectroscopy.
3. Discuss with an example the pure rotational spectrum of a polyatomic molecule using symmetric top model.
4. Describe the experimental techniques and instrumentation involved in the IR spectroscopy.
5. The HCI molecule absorbs radiation γ =2890 cm-1. Calculate the force constant and population difference between the energy levels.
6. Describe the vibrational-rotational energy levels of linear polyatomic molecules.
7. Discuss in detail a diatomic vibrating rotator and obtain its energy levels and the spectrum arising from them.
8. Explain the energy levels of diatomic vibrating rotator. Find expression for the transition frequencies for P and R branches and discuss the nature of the spectra.

**UNIT IV**

**2marks**

1. Why antistokes lines are less intense Mass Stokes lines?
2. What are Fortrat parabolae?
3. Define dissociation energy.
4. Write the selection rules for Raman spectroscopy.
5. What is Raman Effect?
6. Write a note on dissociation energy in electronic spectra of molecular.

**5marks**

1. Give the quantum theory of Raman Effect.
2. State and explain Frank-Condon principle.
3. Explain Raman Effect.
4. Write a note on Hund’s rule.
5. Give the energy level and selection rule for the pure rotational Raman spectra of diatomic molecules.
6. Explain dissociation energy.
7. Discuss the influence of rotation on the spectra of polyatomic molecules.
8. Compare the rotational spectra top and linear symmetric top and asymmetric top molecules.

**10marks**

1. Discuss rotational five structures of electronic vibration transitions. Explain why the bands are degraded towards red or violet.
2. Discuss the theory of Raman Effect.
3. Discuss in detail the electronic spectra of diatomic molecule.
4. Explain fully the quantum theory of Raman Effect. Also explain why laser in preferred as a Raman sources.
5. Discuss, with necessary theory, the main features of rotational and vibration Raman spectra of diatomic molecules.
6. The spectroscopic bond dissociation energy of 35CI 16O radical is 1.9 eV. Calculate the equilibrium bond dissociation energy of CIO, if the fundamental vibrational frequency is 780 cm-1.
7. Discuss the Franck-Condon principle. Explain why the structure of infra red bands is degraded towards the red.
8. The exciting line in an experiment is 5460 Å and the Stokes line is at 5520 Å. Find the wavelength of the anti stokes line.
9. Discuss in detail the electronic spectra diatomic molecule.
10. Discuss the electronic spectroscopy for diatomic molecular. Explain the fine structure of electronic vibration transition.

**UNIT V**

**2marks**

1. State Bloch Theorem.
2. What is of factor?
3. Why electron spin resonance is called electron paramagnetic resonance?
4. Define coupling constant in NMR.
5. Define Chemical shift.
6. What is Electron paramagnetic spectroscopy?

**5marks**

1. Gove the theory of NMR spectroscopy.
2. Explain the basic principle of ESR and obtain the resonance condition.
3. Write a note on Bloch equation.
4. Explain chemical shift and coupling constant in NMR spectroscopy.
5. Explain spin-spin coupling in NMR studies.
6. Write a note on Hyperfine splitting of ESR spectrum.
7. Explain the principles of NMR and obtain the resonance condition.
8. Explain the formation of Hyperfine structure in ESR.
9. Explain the principle of ESR.

**10marks**

1. Derive the Bloch equations in NMR. Explain spin-lattice and spin-spin relaxation times.
2. Explain the principle of ESR and give its theory. Mention some important application of ESR.
3. Explain the theory of NMR spectroscopy. Explain spin lattice relaxation.
4. Describe the working of a typical ESR spectrometer. Give the application of ESR with special reference to hyperfine structure.
5. Discuss the theory and instrumentation ESR spectroscopy.
6. Explain the principle and instrumentation FTNMR spectroscopy.
7. Describe the theory, working principle and applications of ESR Spectrometer.
8. Derive Bloch equations in magnetic resonance.
9. Explain in detail the tree radical studies and biological application in ESR Spectroscopy.