



Registration Number:

Date & Session

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BENGALURU -27

B.Sc. (PHYSICS) – V SEMESTER

SEMESTER EXAMINATION: OCTOBER 2023

(Examination conducted in November/December 2023)

PH 5223: ELEMENTS OF ATOMIC AND MOLECULAR PHYSICS

(For current batch students only)

Time: 2 Hours

Max Marks: 60

This paper contains 2 printed pages and 3 parts

PART-A

Answer any **FOUR** questions:

[4X8=32]

1. With necessary theory, describe Stern-Gerlach experiment and mention its importance. [8]
2. What is Zeeman effect? Give the quantum mechanical explanation of normal Zeeman effect. [8]
3. Obtain an expression for the rotational energy levels of diatomic molecule and show that pure rotational spectral lines are equally spaced. [8]
4. a) Explain the L-S coupling. Give the expression for spin orbit interaction energy. [5]
b) Give the details of different regions of molecular spectra. [3]
5. What is Compton effect? Derive an expression for Compton shift and wavelength of scattered photon. [8]
6. a) Describe linear, symmetric top and asymmetric top molecules? [4]
b) What is a black body? Discuss the black body spectrum. [4]

PART-B

Answer any **FOUR** questions:

[4X5 = 20]

Planck's Constant = 6.626×10^{-34} Js. Mass of electron = 9.1×10^{-31} kg,
Charge of electron = 1.6×10^{-19} C

7. The first line of Balmer series of hydrogen has a wavelength 6563\AA . Calculate the wavelength of the second line.
8. Find the possible orientations of total angular momentum vector \vec{j} corresponding to $j = 3/2$ with respect to a magnetic field along Z-axis and sketch them.
9. Calculate Lande's g factor and total magnetic moment for $^2D_{3/2}$ state.

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10. The force constant of CO bond is 187 N/m. Find the frequency of vibration of CO molecule and the spacing between vibrational levels. Mass of C atom is 1.99×10^{-26} kg and of O atom is 2.66×10^{-26} kg.
11. In an experiment to study the Raman effect using mercury green radiation of wavelength 546.1 nm, a Stokes line of wavelength 554.3 nm was observed. Find the Raman shift and the wavelength corresponding to anti-Stokes line.
12. Calculate the average energy of an oscillator of frequency 6×10^{13} Hz at a temperature 1800 K based on Planck's hypothesis. Boltzmann constant = 1.38×10^{-23} J/K.

PART-C

Answer any **FOUR** questions with proper justification.

[4X2 = 8]

13. Why is Sodium D line a doublet?
14. What is the significance of selection rule?
15. "An electronic transition takes place so rapidly that a vibrating molecule does not change its internuclear distance appreciably during the transition" Is the statement true or false? Comment.
16. Why all molecules do not show rotational spectra?
17. When a metal is heated it appears red first and then blue. Give reason.
18. Differentiate between Mie scattering and Rayleigh scattering.