

**FOURTH SEMESTER M.Sc. DEGREE (REGULAR) EXAMINATION
MARCH 2021**

(CBCSS)

Physics

PHY 4C 12—ATOMIC AND MOLECULAR SPECTROSCOPY

(2019 Syllabus Year)

Time : Three Hours

Maximum : 30 Weightage

General Instructions

1. In cases where choices are provided, students can attend **all** questions in each section.
2. The minimum number of questions to be attended from the Section / Part shall remain the same.
3. There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.

Section A

(8 Short questions answerable within 7½ minutes)

Answer **all** questions, each carry weightage 1.

1. Explain spin-orbit coupling.
2. Iron could not be heated with a Microwave oven. But microwave oven can be used to heat food materials. Why ?
3. Explain Born -Oppenheimer approximation.
4. What is Inverse Raman effect ?
5. Explain briefly the information one can get from vibrational analysis of electronic spectra.
6. Explain the factors responsible for the hyperfine structure in ESR spectra.
7. What is isomer shift ? Explain with an example.
8. Explain Larmour precession. What is Larmour frequency ?

(8 × 1 = 8 weightage).

Section B

(4 essay questions answerable within 30 minutes)

Answer **any two** questions, each carry weightage 5.

9. Discuss the theory of Zeeman effect and Explain Stark effect on one electron system.
10. Explain the basic principle of Non-linear Raman effect and Hyper Raman effect.

Turn over

11. (a) Discuss Franck Condon Principle.
 (b) Explain fortrrat parabola, dissociation and pre dissociation energy.
12. Explain in detail :
 (a) Relaxation process in NMR.
 (b) Theory of Chemical shift with an example.

(2 × 5 = 10 weightage)

Section C

(7 problems answerable within 15 minutes)

Answer any **four** questions, each carry weightage 3.

13. Electron spin resonance is observed for atomic hydrogen with an instrument operating at 9.5GHz. If the g value for the electron in the hydrogen atom is 2.0026, what is the magnetic field ? Bohr magnetron $\mu_B = 9.274 \times 10^{-24} \text{ J/K}$.
14. A Mossbauer nucleus Fe^{57} makes the transition from the excited state of energy 14.4 keV to the ground state. What is its recoil velocity ?
15. The band origin of a transition in C_2 is observed at 19378 cm^{-1} while the rotational fine structure indicates that the rotational constants in excited and ground states are respectively $B' = 1.7527 \text{ cm}^{-1}$ and $B'' = 1.6326 \text{ cm}^{-1}$. Estimate the position of the band head.
16. The first Stokes line in the rotational Raman Spectrum of $\text{N}^{14}\text{N}^{15}$ is observed at 11.5416 cm^{-1} . What is its B value ? Calculate its bond length.
17. Given that the spacing between the vibrational levels of a CO molecule is 8.45×10^{-2} electron volt and the reduced mass is $1.14 \times 10^{-24} \text{ kg}$. Calculate the value of the force constant k of the bond in a CO molecule.
18. Calculate the wavelength separation between the two component lines which observed in the normal Zeeman effect. The magnetic field used is 0.4 weber/m^2 specific charge $= 1.76 \times 10^{11} \text{ Ckg}^{-1}$ and $\lambda = 6000 \text{ \AA}$.
19. What is the average period of rotation of HCl molecule if it is in the $j = 1$ state? The internuclear distance of HCl is 0.1274 nm . Given the mass of hydrogen and Chlorine atom are $1.673 \times 10^{-27} \text{ kg}$ and $58.06 \times 10^{-27} \text{ kg}$ respectively.

(4 × 3 = 12 weightage)