MANIPAL
ACADEMY of HIGHER EDUCATION

Reg. No.										

DEPARTMENT OF SCIENCES, III SEMESTER M.Sc. (Physics)
END SEMESTER EXAMINATIONS, DEC. 2020

ATOMIC AND MOLECULAR PHYSICS [PHY 5101]

(REVISED CREDIT SYSTEM - 2017)

Time: 3 Hours Date: 29.12.2020 MAX. MARKS: 50

Note: (i) Answer **ALL** questions

(ii) Draw diagrams and write equations wherever necessary

1. (a) Explain the theory of the Normal Zeeman Effect.
   (b) Explain factors that contribute to the broadening of spectral lines.
   (c) What causes the fine structure of spectral lines. [5+3+2]

2. (a) Draw the energy levels and the allowed electron spin resonance (ESR) transitions for the hydrogen atom.
   (b) What is chemical shift during resonance absorption. Explain with an example.
   (c) An NMR instrument operates at 30.256 M Hz; what fields are required to bring ^{1}H and ^{13}C nuclei to resonance at this frequency? Given: $g_N = 5.585$; $\mu_N = 5.05 \times 10^{-27}$ JT^{-1}.
   [4+2+4]

3. (a) What is the isotope effect in rotational spectra and how does isotope shift allow precise determination of the atomic weight of atoms.
   (b) Homonuclear diatomic molecules do not show vibrational spectra. Why?
   (c) The fundamental and first overtone transitions of CO are centred at 2143.3cm^{-1} and 4260.0 cm^{-1}. Calculate the equilibrium oscillation frequency, the anharmonicity constant and force constant of the molecule. The reduced mass of CO molecule is 1.1385×10^{-26} kg. [4+2+4]

4. (a) Explain the quantum theory of Raman scattering.

   (b) How do you correlate Raman and IR active vibrations in a molecule.

   (c) The bond length of the N_2 molecule is 1.097×10^{-10} m. What would be the positions of the first three rotational Raman lines of N_2? Given: $^{14}N = 23.25 \times 10^{-27}$ kg. [4+2+4]

5. (a) What is the basic principle of photoelectron spectroscopy (PES)? What are the uses of XPS and UPS spectroscopy?

   (b) What are the essential conditions required to get Mossbauer spectra?

   (c) The value of $\bar{\nu}_e$ and $\bar{\nu}_e x_e$ for the upper and lower states of a molecule are 439 cm^{-1}, 28 cm^{-1}; 563 cm^{-1}, 18 cm^{-1} respectively. If the electronic energy difference is 37,206 cm^{-1}, calculate the wavenumbers of the (0,0) and (1,0) transitions. [4+2+4]