Reg. No ..... Name .....

MSc DEGREE END SEMESTER EXAMINATION - MARCH 2020

SEMESTER 4 : PHYSICS

COURSE : **16P4PHYT13 : ATOMIC AND MOLECULAR PHYSICS**

(For Regular - 2018 Admission and Supplementary - 2017, 2016 Admissions)

Time : Three Hours Max. Marks: 75

Section A
Answer All the Following (1 Mark each)

1. The aluminium atom has two 3s electrons and one 3p electron outside the filled inner shells. The term symbol of its ground state is
   a) $^2P_{1/2}$ b) $^2S_{1/2}$ c) $^2P_{3/2}$ d) $^2S_{1/2}$
2. In rotation vibration spectra of diatomic molecules, the lines corresponding to ΔJ = -1 is called
   a) R Branch b) Q Branch c) P Branch d) None of these
3. In molecules, the rotational transitions occur by absorption of energy of the order of
   a) 5eV b) 0.5eV c) 0.005eV d) 500eV
4. In a Raman scattering experiment, light of frequency ν from a laser is scattered by a diatomic molecule having moment of inertia I. The typical Raman shifted frequency depend on

   a. ν and I b) only ν c) only I d) neither on I or ν

5. The nuclear magneton is defined by
   (a) $\mu_N = \frac{e\hbar}{2m_p}$
   (b) $L\mu_N = \frac{e\hbar}{2m_e}$
   (c) $\mu_N = \frac{eh}{2m_p}$
   (d) $L\mu_N = \frac{e}{2hm_e}$

(1 x 5 = 5)

Section B
Answer any 7 (2 Marks each)

6. Show that no two electrons in an atom can have the same quantum state.
7. List the reasons for hyperfine structure in atomic spectra.
8. CO give spectrum in the microwave region where as CO_2 doesn't. Why?
9. Explain the consequences of the breakdown of Born – Oppenheimer approximation in IR spectra of molecules.
10. Explain parallel and perpendicular vibrations of molecules.
11. Discuss the conditions under which band heads are degraded towards violet or red in electronic spectrum.
12. What is the effect of nuclear spin on the Raman spectra of molecules?
13. Explain the principle of NMR.
14. What is meant by spin lattice relaxation?
15. Explain the factors affecting the hyperfine structure in ESR spectra.

(2 x 7 = 14)

Section C
Answer any 4 (5 Marks each)

16. Obtain doublet separation in F state due to spin-orbit interaction.
17. The spin orbit interaction splits certain transition into two lines with wavelengths 5890A^{o} and 5896A^{o}. Calculate the effective magnetic induction experienced by the valance electron.
18. The fundamental band of HCl is centered at 2886cm^{-1}. Assuming the internuclear distance to be 1.276A^{O}, calculate the wave number of first two lines in each of the P and R branches of the spectrum.
19. Explain the quantum theory of Raman Effect.
20. Explain any two non linear Raman effects.
21. An NMR signal for a compound is found to be 180 Hz downward from TMS peak using a spectrometer operating at 60 MHz. Calculate its chemical shift in ppm.

(5 x 4 = 20)

Section D
Answer any 3 (12 Marks each)

22.1. Obtain the expression for interaction energy in jj coupling. Illustrate the splitting in an '*pd*' system.

OR

2. Explain the details of hyperfine structure of spectral lines. What are the reasons for the broadening of spectral lines?

23.1. Explain the Born – Oppenheimer approximation. Hence deduce the theory of a diatomic vibrating rotator.

OR

2. Explain the rotation vibration spectra of a polyatomic linear molecule having parallel vibrations.

24.1. Explain the conditions for a molecule to be Raman active. Hence explain the Raman Activity in vibrations of CO_2 molecule.

OR

2. What are the applications of NMR, ESR and Mossbauer spectroscopy?

(12 x 3 = 36)