Reg. No ..... Name ..... **21P4004**

**M. Sc DEGREE END SEMESTER EXAMINATION - APRIL 2021**

**SEMESTER 4 : PHYSICS**

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

*(For Regular - 2019 Admission & Supplementary 2018/2017/2016 Admissions)*

Time : Three Hours Max. Marks: 75

**PART A**

**Answer All (1 marks each)**

1. For two electron system if $l_1 = 2$ and $l_2 = 1$, the value of J according to LS coupling will be
   a) 3,2,1 b) 4,3,2,1,0 c) 1,2,3,4 d) 4,3,2
2. The common wave number difference in the two successive rotational lines is
   a) $h/4\pi^2Ic$ b) $h/8\pi^2Ic$ c) $hc/8\pi^2I$ d) $h^2/8I$
3. The force constant of $H_2$ is 510Nm-1 and dissociation energy is 4.5eV. If it vibrates harmonically, the vibrational quantum number corresponding to dissociation energy is
   a) 8 b) 9 c) 10 d) 7
4. The separation between first stokes and corresponding anti stokes lines of the rotational Raman spectrum in terms of rotational constant B is
   a) 2B b) 4B c) 6B d) 8B
5. The selection rule for EPR spectroscopy is
   a) $\Delta m_s = \pm 1$ , $\Delta m_l = 0$ b) $\Delta m_s \neq 0$, $\Delta m_l = 0$
   c) $\Delta m_s > 1$, $\Delta m_l = 1$ d) $\Delta m_s = \pm 1$ , $\Delta m_l \neq 1$

**(1 x 5 = 5)**

**PART B**

**Answer any 7 (2 marks each)**

6. How hyper fine structure is obtained in atomic spectra?
7. State and prove Lande's interval rule.
8. What will be the change in the rotational constant, if hydrogen is replaced by deuterium in hydrogen molecule?
9. Explain the effect of non rigidity on the rotational spectra of molecules
10. Explain the effect of anharmonicity on the vibrational spectra of molecules
11. Distinguish between Raman Scattering and Rayleigh scattering.
12. What is a polarizability ellipsoid? How is it constructed?
13. What is meant by relaxation process in resonance spectroscopy?
14. Draw and label the nuclear energy levels of a spin ½ system in an external magnetic field.
15. List the applications of Mossbauer technique.

**(2 x 7 = 14)**

**PART C**

**Answer any 4 (5 marks each)**

16. Draw the vector diagram for *L S* coupling in a *pd* electron system
17. Explain how doublet separation changes with n, l and z
18. Discuss the consequences of breakdown of Born – oppenheimer approximation on the IR spectrum of molecules.
19. With the help of a diagram explain Fortrat parabola.
20. Write short notes on dissociation, dissociation energy and pre dissociation.
21. Briefly outline the technique of Mossbauer spectroscopy.

**(5 x 4 = 20)**

## PART D

**Answer any 3 (12 marks each)**

22.1. Describe spin orbit interaction. Explain the doublet formation of sodium D lines on the basis of spin orbit interaction.

**OR**

2. Explain quantum mechanical considerations of the hydrogen atom and the emergence of the quantum numbers *n, l*, and $m_l$

23.1. Describe the microwave spectra of a polyatomic linear molecule.

**OR**

2. Explain the rotation vibration spectra of a polyatomic symmetric top molecule having perpendicular vibrations.

24.1. Give quantum theory of Raman Effect. Explain how size, shape and orientation of polarizability ellipsoid changes when $H_2O$ molecule vibrates.

**OR**

2. Discuss chemical shift, electric quadrupole and magnetic hyperfine interactions in Mossbauer spectroscopy.

**(12 x 3 = 36)**