**TM154550C** **Reg. No:……...….....**

**Name:...…….....**

**M. Sc. DEGREE (C.S.S.) EXAMINATION, MARCH 2017**
**SEMESTER IV – CORE (PHYSICS)**
**PH4C11TM - ATOMIC AND MOLECULAR PHYSICS**

**Time: Three Hours** **Maximum Marks: 75**

## PART A

**I. Answer any five questions. Each question carries 3 marks.**

1. State Lande interval rule.
2. What is Paschen Back effect?
3. Briefly explain the effect of isotopic substitution in rotational spectrum.
4. Explain the transitions and frequencies observed in an anharmonic oscillator.
5. Explain rotational fine structure in Raman spectra.
6. Give the classical theory of Raman scattering.
7. Explain recoilless emission and absorption of gamma rays.

**(5x3=15)**

## PART B

**II. Answer any six questions. Each question carries 5 marks.**

8. Explain normal Zeeman effect. Draw the normal Zeeman pattern of Sodium D line.
9. Explain Stark effect in hydrogen atom.
10. The fundamental band for HCl is centred at $2886cm^{-1}$. Assuming that internuclear distance is $1.276A^0$, calculate the wave number of first two lines of each of P and R branches of HCl.
11. The rotational spectrum of $^{79}Br^{19}F$ shows a series of equidistant line $0.71433cm^{-1}$ apart. Calculate the rotational constant and bond length of the molecule.
12. The band origin of a transition in $C_2$ is observed at 19,338 $cm^{-1}$ while the rotational fine structure indicates that the rotational constants in excited and ground states are respectively B' = $1.7527cm^{-1}$ and B'' = $1.6326cm^{-1}$. Estimate the position of band head.
13. Explain the principle of PARS. Draw the block diagram of the experimental setup used for the observation of PARS and explain its working.
14. With which type of spectroscopy would one observe the pure rotation spectrum of $H_2$? If the bond length of $H_2$ is 0.07417 nm, what would be the spacing of the lines in the spectrum?
15. Explain hyperfine splitting in ESR. The ESR spectrum of hydrogen atom slided at 9.3GHz shows one line at 3570 Gauss and other at 3330 Gauss. Calculate the hyperfine splitting constant.
16. What is Magnetic hyperfine interaction? Calculate the Doppler velocity corresponding to the natural linewidth of the γ ray emission line from 23.9 keV excited state of $^{119}Sn$ nucleus having a half life of $1.9\times10^{-8}$s.

**(6x5=30)**

## PART C

**III. Answer any two questions. Each question carries 15 marks.**

17. Explain LS and jj coupling. Derive interaction energy in LS coupling. Also find the possible configurations of pd electrons and draw the energy distribution of the same.
18. Explain the rotational spectrum of rigid diatomic molecule and hence bring out the changes in the spectrum when bond becomes elastic.
19. Write on Vibrational Raman spectra. Explain the Raman activity of vibrations of $CO_2$ and $H_2O$ molecules.
20. Explain the basic principle of NMR. Also describe CW and FT NMR spectrometer.

**(2x15=30)**