**ST.JOSEPH’S COLLEGE (AUTONOMOUS), BANGALORE-27**

**DATE: 23-10-2019**

M.Sc. – II SEMESTER

**SUPPLEMENTARY EXAMINATION: OCTOBER 2019**

**PH 7315 : Atomic and Molecular Physics**

**Time : 2½ hrs**  **Max. Marks: 70**

**(Attach the question paper with the answer booklet)**

**PART-A**

Answer any **five** of the following: (5X10=50)

1. a) Discuss the different factors that contribute to broadening of spectral lines.

   b) Draw the Anomalous Zeeman pattern for D1 and D2 lines of sodium and give their         frequencies.                       (4+6)

2. a) What is the condition for vibration of a molecule to be Raman active? Explain mutual          exclusion principle with an example.

   b) Describe the effect of anharmonicity on the vibrational spectra of diatomic molecules.         Draw the Morse potential curve.                                                                             (3+7)

3. a) State and explain Frank Condon principle. Discuss the intensity distribution in the             vibrational structure of the electronic transitions of a diatomic molecule.

    b) Why diatomic molecules such as CO, HF will show a rotational spectrum where as N2          and O2 will not. Outline the effect of isotopic substitution on the rotational spectra of         molecules.                                                                                                                 (6+4)

4. a) For an atom of nuclear spin I=3. Draw an energy level diagram and the involved         hyperfine components of the transition 2 D3/2 to 2 P1/2

  b) With a neat diagram explain ESR spectrometer. Explain why an ESR spectrum is         usually recorded in the first derivative mode. (5+5)

5. a) Can all atoms give NMR signals? Give reason. Explain the concept of shielding and         deshielding with an example.

    b) Explain Isomer shift with reference to Mössbauer spectra. Mention the applications of          Mössbauer Effect. (5+5)

6. a) Give the principle of NQR.

    b) Discuss the NQR transitions for axially symmetric systems with (i) half integral spin (I =        3/2) and (ii) integral spin (I =1). (4+6)

7. a) Give the Laue theory of X-ray diffraction.

 b) Define the terms: Atomic scattering factor and Structure factor. (8+2)

**PART-B**

Answer any **four** of the following: (5X4=20)

8. What magnetic field will give the normal Zeeman Effect lines at 636.4055 nm,      636.4209 nm and 636.4363 nm?

9. The ground state electron configuration of carbon is 1s2 2s2 2p2. Find the spectral terms      for this state via L-S coupling scheme and identify that which is lowest in energy

10. The first line in the rotation spectrum of carbon monoxide has a frequency of 3.8424 cm-1       Calculate the rotational constant, moment of inertia and hence the bond length in carbon       monoxide. Masses of carbon and oxygen are 19.92168 x10-27 kg and 26.56136 x10-27 kg       respectively.

11. How many hyperfine components will there be in the ESR spectrum of a system having       an unpaired electron interacting with three equivalent protons. Draw the corresponding       energy level diagram.

12. Calculate the Doppler velocity corresponding to the natural line width of the γ– ray         emission line from 23.9 keV excited state of 119Sn nucleus having a half life of       1.9 x 10-8 s.

13. Calculate the ratio of the population of the two nuclear spin states for protons in a        magnetic field of 4T at 27 OC, g N = 5.585.

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