LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – PHYSICS

THIRD SEMESTER – NOVEMBER 2015

PH 3815 - SPECTROSCOPY

Date : 05/11/2015   Dept. No.   Max. : 100 Marks
Time : 09:00-12:00

PART A

Answer **all** questions: **(2×10=20 marks)**

1. Diatomic molecules such as CO, HF will show a rotational spectrum whereas N_2, O_2, H_2,… will not. Why?
2. The bond length of HF molecule is 0.0927 nm. Calculate the moment of inertia of the HF molecule.
3. How many normal modes of vibrations are possible for
   (a) HBr   (b) NO_2 (c) C_2H_4 (d) C_6H_6
4. Explain in brief the rule of mutual exclusion.
5. What is predissociation?
6. A free electron is placed in a magnetic field of strength 1.3 T. Calculate the resonance frequency if g = 2.0023 and $\mu_B = 9.274 \times 10^{-24}$ JT^{-1}.
7. What is chemical shift in NMR Spectroscopy?
8. An excited $^{57}Fe^*$ nucleus, recoiling at 10^2 ms^{-1} emits   - radiation with frequency 3.5×10^{18} Hz. Calculate the Doppler shift of the   - ray frequency.
9. Give any two applications of SEM.
10. Write the working concept of an atomic force microscope (AFM).

PART B

Answer **any four** questions: **(4×7.5=30 marks)**

11. (a) Explain with example, the effect of isotopic substitution on the pure rotational spectra of a diatomic molecule.

   (b) The first rotational line of $^{12}C^{16}O$ is observed at 3.84235 cm^{-1} and that of $^{13}C^{16}O$ at 3.673377 cm^{-1}. Calculate the atomic weight of ^{13}C, assuming the mass of ^{16}O to be 15.9949 amu.

12. (a) Explain the polarizability ellipsoid. On the basis of polarizability, outline the vibrational Raman effect of H_2O

   (b) The first rotational Raman line of H_2 appears at 346 cm^{-1} from the exciting line. Calculate the bond length of H_2 molecule.

13. Explain with diagrams the formation of molecular orbitals for different combination of s and p_x atomic orbitals.

14. Write a note on dissociation energy and derive an expression for equilibrium dissociation energy.

15. Explain the interaction between nuclear spin and magnetic field.

16. Outline the principle of Auger Electron Spectroscopy (AES).

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PART C

Answer **any four** questions: **(4×12.5=50 marks)**

17. Explain with necessary theory the spectrum of a linear diatomic molecule of rigid type. Outline the correction for non – rigid rotor.

18. Explain the theory of pure rotational Raman spectra of
    (i) Linear molecule (ii) Symmetric top molecule

19. (a) Explain the vibration spectrum of a diatomic molecule. Deduce the effect of anharmonicity.

    (b) The fundamental and first overtone transitions of $^{14}N^{16}O$ are centered at 1876.06 cm^{-1} and 3724.20 cm^{-1}. Evaluate the equilibrium vibration frequency, the anharmonicity constant, zero point energy and the force constant of the molecule.

20. Write the principle of ESR and explain the working of an ESR Spectrometer.

21. Explain the principle of Mossbauer Spectroscopy using the decay scheme of ^{57}Co into ^{57}Fe. With a diagram, explain the working of a Mossbauer Spectrometer.

22. Explain the principle and instrumentation of Photoelectron Spectroscopy.

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