C 3534 (Pages : 2) Name.....

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE EXAMINATION, JUNE 2016

(CUCSS)

Physics

PHY 4C 12 – ATOMIC AND MOLECULAR SPECTROSCOPY

(2012 Admission onwards)

Time : Three Hours Maximum : 36 Weightage

Section A

Answer **all** *questions.*

Each question carries 1 *weightage.*

1. Write a note on space quantisation.
2. Explain Hund's rule with examples.
3. What are the salient features of rotational spectra?
4. Outline the effect of isotopic substitution on the rotational spectra of a molecule.
5. Diatomic molecule do not show vibrational spectra. Justify the statement.
6. State the conditions to be satisfied for a vibration to be Raman active considering the normal vibrations of CO_2 molecules as example.
7. Explain inverse Raman scattering.
8. Write a note on Franck-Condon principle.
9. Explain Fortrat diagram.
10. What is chemical shift? Explain it with an example.
11. Deduce the condition for NMR.
12. With the help of a block diagram, explain Mossbauer spectrometer.

(12 × 1 = 12 weightage)

Section B

Answer any **two** *questions.*

Each question carries 6 *weightage.*

13. (a) Derive an expression for Lande's splitting factor and explain the anamalous Zeeman effect of sodium doublet lines D_1 and D_2 with its help.

    (b) State rules of Zeeman components.

14. Discuss in detail the construction and working of a Microwave spectrometer.

Turn over

15. Describe with necessary theory how structure of diatomic and triatomic molecules can be determined by combining Raman and Infrared spectroscopy.

16. Explain the different relaxation processes from nuclei and derive Block equations.

(2 × 6 = 12 weightage)

Section C

Answer any **four** *questions.*

Each question carries 3 *weightage.*

17. In an atom obeying 2-S coupling the components of a normal triplet state have separations 20 cm^{-1} and 40cm^{-1} between adjacent components. There is a higher state for which the separations are 22 cm^{-1} and 33 cm^{-1} respectively. Determine the terms for the two states and show the allowed transitions on an energy level diagram.

18. In the intra-red spectrum of HCl molecule the first line falls at 20.8 cm^{-1}. Calculate the moment of inertia reduced mass and the bond length of molecule.

19. A Raman line is observed at 4768.5 Å when acetylene was irradiated by 4358.3 Å radiations. Calculate the equilibrium vibrational frequency that causes their shift.

20. The rotational lines of a band system of electronic vibration spectra is given by $\bar{\upsilon} = (24{,}762 + 25\ m - 2.1\ m^2)\ cm^{-1}$ $m = \pm 1, \pm 2, ...$ Deduce the values of B, B" and the position of the band head. Comment on the inter nuclear distance of the two states and on the degradation of the band system.

21. The band origin of a transition in C_2 is observed at 19378 cm^{-1}, while the rotational fine structure indicates that the rotational constants in excited and ground states are, respectively, $B^1 = 1.7527\ cm^{-1}$ and $B^{11} = 1.6326\ cm^{-1}$. Estimate the position of the band head. Which state has the larger internuclear distance?

22. Consider the ESR spectrum of the free radicle CH_3 observed in a magnetic field of 0.34 T (i) If **g** = 2.0023 for free electron, find the frequency at which resonance is obtained ; (ii) How many hyperfine components are observes? (iii) Represent the transitions in an energy level diagram. Given $\mu_B = 9.274 \times 10^{-24}\ JT^{-1}$.

(4 × 3 = 12 weightage)