

C 82501

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Name.....

Reg. No.....

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FOURTH SEMESTER M.Sc. DEGREE EXAMINATION, JUNE 2015

(CUCSS)

Physics

PHY 4C 12—ATOMIC AND MOLECULAR SPECTROSCOPY

(2012 Admissions)

Time : Three Hours

Maximum : 36 Weightage

Section A

Answer all questions, each has weightage 1.

1. Explain singlet and triplet states with examples.
2. Distinguish between Paschen-Back, normal and anomalous Zeeman effect.
3. How will you classify the notation of a three dimensional molecule based on the relative values of principal moment of inertia ?
4. What are the salient features of vibrational-rotational spectra ?
5. Briefly outline the advantages of FTIR spectroscopy over the conventional procedure.
6. Illustrate mutual exclusion principle with example.
7. What is hyper-Raman effect ?
8. What is Fortrat parabola ?
9. Distinguish between ν' and ν'' progression. Explain why the wave number separation of bands in ν'' progression decreases towards longer wave length whereas that in ν' progression decreases towards shorter wavelengths.
10. Deduce the condition for NMR.
11. What is chemical shift ? Explain it with an example.
12. Outline the principle of ESR.

(12 × 1 = 12 weightage)

Section B

Answer any two questions, each has weightage 6.

13. (a) Discuss in detail rotational spectra of a diatomic molecule, considering it as a non-rigid rotator.
(b) How will you account the isotope effect in the above spectrum ?
14. With the help of a schematic diagram, describe the construction and working of a Raman spectrometer.

Turn over

15. (a) Discuss in detail the rotational fine structure of electronic vibrational transitions.
 (b) Explain conditions under which the band heads are degraded towards violet and red in the electronic spectra.
16. Explain the different relaxation processes for nuclei and derive Bloch equations.

(2 × 6 = 12 weightage)

Section C

Answer any four questions, each has weightage 3.

17. Suppose that the separation between two components of normal Zeeman pattern is 4×10^{10} cycles/sec. What should be the value of magnetic field B so that their lines may be resolved by a spectrometer capable of resolving lines separated by 0.05 \AA .
18. The spin-orbit effect splits the $3P \rightarrow 3S$ transitions into two lines, 5885 \AA corresponding to ${}^2P_{3/2} \rightarrow {}^2S_{1/2}$ and 5890 \AA corresponding to $2p_{1/2} \rightarrow 2s_{1/2}$. Calculate, by using then wavelength, the effective magnetic induction experienced by an outer electron in the sodium atom as a result of its orbital motion.
19. The force constant of the bond in CO molecule is 1870 N/m and its reduced mass is 1.4×10^{-26} . Calculate the frequency of vibration of the molecule and the spacing between its vibrational energy levels in eV.
20. 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. ${}^1\text{H} = 1.673 \times 10^{-27} \text{ kg}$.
21. The frequency separation between protons in C_6H_6 and TMS is 510.5 Hz when the field is 1.6 T . What is the chemical shift? (Given $g_N = 5.585$).
22. For ${}^{39}\text{K}$ nucleus $I = \frac{3}{2}$ and $g_I = 0.2606$:
- (a) Draw all possible energy levels in a magnetic field.
- (b) Calculate the transition frequency from one of these orientations to an adjacent one in a magnetic field of 0.1 T (0.2 MHz).

(4 × 3 = 12 weightage)