G 2416 (Pages : 2) Reg. No.....

Name.....

M.Sc. DEGREE (CSS) EXAMINATION, JUNE 2015

Fourth Semester

Faculty of Science

Branch : II – Physics – A – Pure Physics

PH 4C 11 – ATOMIC AND MOLECULAR PHYSICS

[2012 Admission onwards – Regular/Supplementary]

(Common for all)

Time : Three Hours Maximum Weight : 30

Part A

Answer any **six** *questions.*
Weight 1 *each.*

1. How hyperfine structure is obtained in atomic spectra?
2. Explain Frank-Condon principle.
3. With the help of a diagram, explain Fortrat parabola.
4. Write a note on the relaxation process in NMR.
5. What is resonance Raman scattering?
6. How does the intensity of lines vary in rotational spectra?
7. What is chemical isomer shift?
8. What are hot bands in IR spectra?
9. Obtain the Lande of factor for an S-electron.
10. Why anti-stokes lines are less intense than stokes lines?

(6 × 1 = 6)

Part B

Answer any **four** *questions.*
Weight 2 *each.*

11. The term symbol for an atomic state is $^2P_{3/2}$. What are the values of L, S and J for this state? What is the g value? What type of Zeeman effect this atom will give?
12. The harmonic vibrational frequency of HCl^{35} molecule is 2991 cm^{-1}. Calculate the same for its deuterated analogue.
13. When H_2 molecule is irradiated with 435.8 nm mercury line, the Raman stokes vibrational line appear at 18551.05 cm^{-1}. Find the wave number of antistokes line ; the force constant and zero point energy. Atomic weight of hydrogen = 1.008 and Avogadros number = 6.023×20^{23}.

Turn over

14. A free electron gives resonance of a frequency of 19.0 GHz when the magnetic field is 1.02 T. Determine the frequency at which the resonance will occur if the magnetic field is 4.08 T.

15. The fundamental and first overtone transition of $^{14}N^{16}O$ are centred at 1876.06 cm^{-1} and 3724.20 cm^{-1} respectively. Evaluate the equilibrium vibration frequency, the anharmonicity constant, zero point energy and the force constant of the molecules.

16. Calculate the Doppler velocity corresponding to the natural line width of the γ-ray emission from 14.4 keV excited stated of ^{57}Fe nucleus having a half life of 9.8×10^{-8} n.

(4 × 2 = 8)

Part C

Answer **all** *questions.*

Weight 4 each.

17. (a) Discuss LS and *jj* coupling schemes. Taking an *sp* configuration show that the number of spectral terms arising out of these schemes is the same.

Or

(b) Explain the theory of a diatomic vibrating rotator. Obtain the equation for energy levels.

18. (a) What is dissociation energy and show this is obtained from experimental molecular spectroscopy?

(b) Explain principle of Fourier Transform Infra Red Spectroscopy.

Or

Give the principle of ESR and explain the origin of hyperfine structure in ESR. Draw a neat block diagram for the experimental setup of EST and describe how ESR signals are detected.

19. (a) Give the theory of Raman effect. What are the advantages of lasers in the study of Raman effect.

(b) Explain how Raman spectrum gives information on molecular structure.

Or

Explain how the rotational fine structure of electronic vibration spectra allows one to determine the internuclear distance of the electronic states.

20. Explain the Bloch equations and the steady state solutions in the case of NMR.

Or

(a) Explain recoilless emission and absorption of gamma rays.

(b) Explain the important applications of Mossbauer effect.

(4 × 4 = 16)