2017

M.Sc.

3rd Semester Examination

PHYSICS

PAPER – PHS-302 (Gr. – A + B)

Full Marks : 50

Time : 2 Hours

(Molecular Spectroscopy and Laser Physics – PHS 302A)

Answer Q1 and any one from Q2 and Q3

1. Answer any five bits: 5X2 = 10

(a) What do you mean by an asymmetric top molecule? Write an example.

(b) The fundamental bond of CO is centred at 2143.3 cm^{-1} and the first overtone 2459.7 cm^{-1}. Calculate the equilibrium frequency of the molecule.

(c) Write down the implication of Born-Oppenheimer approximation in molecular spectroscopy.

(d) What do you mean by band head in molecular electronic spectroscopy?

(e) What is Frank-Condon principle? Write its advantage in molecular spectroscopy.

(f) At what temperature are the rates of spontaneous and stimulated emission are equal for wavelength λ=500nm?

(g) The intensity J=0 to J=1is often not most intense rotational line. Why?

(Turn Over)

(h) Which of the two molecules H_2O and D_2O will have smaller separation of lines in rotational spectra?

2. (a) What is a three level laser system? (2)

(b) Obtaining the rate equations of each of the energy levels, find the expression of population inversion in the system. (3+2)

(c) Obtain also the expression of its threshold power. (2)

(d) Give an example of three-level laser. (1)

3. (a) Give the theory and obtain an expression for energies of various vibrational levels of diatomic molecule. Show that the energy levels are equally spaced. (4+1)

(b) The first three vibrational lines of vibration spectrum of HCl molecule have wave number 2886cm^{-1}, 5668cm^{-1} and 8347cm^{-1}. Find the anharmonicity coefficient and the force constant. Show that the vibration spectrum lies in IR region. (2+2+1)

(Nuclear Physics I – PHS 302B)
Answer Q1 and any one from Q2 and Q3

1. Answer any five bits: 5X2 = 10

(a) Show that electric quadruple moment of a nucleus vanishes for spin $I = 0$ and $I = 1/2$.

(b) Graphically show the transitions of the following odd-A isobaric nuclei with parabolic presentation: ${}^{77}_{32}Ge \xrightarrow{\beta^-} {}^{77}_{33}As \xrightarrow{\beta^-} {}^{77}_{34}Se\ (Stable)$ and ${}^{77}_{36}Kr \xrightarrow{\beta^+} {}^{77}_{35}Br \xrightarrow{\beta^+} {}^{77}_{34}Se$

(*Continued*)

(c) Write down the expression for the α-disintegration energy and show that most of the disintegration energy is carried away by the α-particles for heavy nuclei.

(d) Write down the expressions for Q-values of β^+ and electron-capture decays.

(e) What are the factors that control γ-emission and internal conversion?

(f) Find the multipole character of γ-radiations emitted in the following transitions: (i) $\frac{3}{2}^+ \rightarrow \frac{1}{2}^+$ (ii)$1^- \rightarrow 0^+$.

(g) Explain the mass parabolas for isobaric nuclei.

(h) What is nuclear isomerism? Explain with example.

2. (a) Following Gamow's theory of α-decay, obtain an expression for the decay constant λ in terms of the kinetic energy of α-particle. (8)

(b) If the α-particles are emitted from states other than ground state (i.e. $l \neq 0$) then how the probability of α-decay will be affected? (2)

3. (a) Write down the Rabi method for the determination of magnetic moment of lithium nuclei. (6)

(b) State Pauli's hypothesis of β-decay. (2)

(c) Graphically show the energy spectra of β^+ and β^- particles in β-decay. (2)

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