2018

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) Which one of the following molecules does not exhibit a rotational spectrum and why? H_2, CO, HCl, HBr

(b) In the rotational spectrum of $^{12}C^{16}O$ absorption lines are observed at a constant separation of 3.84236 cm^{-1}. Calculate angular velocity in radian per second in $j = 1$ level.

(c) Find the ratio of the rates of spontaneous and stimulated emissions at $T=10^3$ K for visible radiation of frequency 5×10^{14} Hz.

(d) What do you mean by Quality factor of a laser resonator?

(e) Discuss the non existence of two level lasing systems?

(f) State Frank-Condon principle for intensity distribution of lines in molecular spectra.

(g) Draw the energy level diagram of Ruby laser.

(Turn Over)

(h) Why a spherical symmetric molecule is microwave inactive? Give an example of such molecule.

2. (a) Discuss rotational spectra of a diatomic molecule treated as a non-rigid rotator. (4)

(b) What do you mean by zero-point energy ?And derive this for a diatomic molecule. (3)

(c) The fundamental and first overtone transition of $^{14}N^{6}O$ are centered at 1876.06 cm^{-1} and 3724.20 cm^{-1} respectively. Evaluate the equilibrium vibration frequency and anharmonic constant. (3)

3. (a) A He- Ne laser has a coherence length of 10m. What is the coherence time? What is population inversion? (1+1)

(b) What is a four-level laser system? Obtaining the rate equations of each of the energy levels, find the expression of population inversion in the system. (1+5)

(c) Why four-level laser is more efficient than three-level laser? (2)

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

1. Answer any five bits: 5X2 = 10

(a) What is Kurie plot? What is its significance?

(b) Present diagrammatically the mechanism of α-decay.

(*Continued*)

(c) Explain the nuclear shape when its electric quadrupole moment (Q) becomes Q = 0, Q > 0 and Q < 0.

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

(e) Write down the selection rules for allowed Gamow-Teller transition.

(f) Write down the principle of double focusing mass spectrograph.

(g) Using the semi-empirical mass formula show that the most stable isobar for a nucleus having odd A is given by $Z = \frac{A}{0.015A^{2/3}+2}$

(h) Determine the stable nucleus that has radius is equal to 1/3 that ^{189}Os.

2. (a) Following Fermi's theory of beta-decay, find out the probability of electron (beta) emission per unit time in the momentum range P_e and $P_e + dP_e$. (7)

(b) Show that the slope of the electron energy spectrum for allowed decays is zero near $T_e = Q$ if $m_\nu = 0$ but becomes infinite if $m_\nu \neq 0$. (3)

3. (a) What is Mossbauer effect? Write down the experimental evidence of Mossbauer effect. (2+1)

(b) Write down the selection rules for gamma-emission. (2)

(c) An even-Z, even-N nucleus has the following sequence of levels above its 0^+ ground state: 2^+ (89 keV), 4^+ (288 keV), 6^+ (585 keV), 0^+ (1050 keV), 2^+ (1129 keV). Draw an energy level diagram and show all reasonably probable γ transitions and their dominant multipole assignments. (5)

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Internal Assessment-10