Third Semester Examination-2018

M.Sc. PHYSICS

Paper Code:PHS-302

Full Marks : 40 **Time: 2 Hours**

Use Separate scripts for Group A& Group B

Group A

(Molecular Spectroscopy & Laser Physics)

Answer question number 1 and any one questions from the rest.

1. Answer any five of the following questions $(2\times 5 = 10)$

a) State Born-Oppenheimer Approximation.

Write down an analytical expression for vibrational coarse structure spectrum.

b) What is symmetric top molecule? Can an asymmetric top molecule shows rotational spectrum?

c) Write down the selection rules and expression for the energy shift (ΔE) for the rotational fine structure involving P branch and R branch lines.

d) The force constant of HCl molecule is 4.8×10^5dyne/cm. Find the energy required to increase the nuclear separation by 1 Angstrom.

e) The value of w_e and $w_e x$are 1580.36 and 12.073 cm respectively for the ground state of molecular oxygen. Calculate the zero point energy.

f) Explain what is Hot Bond?

g) What is Fortrat Parabola?

h) Explain what is meant by Q switching.

2. i) Calculate the moment of inertia of a linear polyatomic molecule. (4)

ii) State the conditions for a molecule to exhibit

(a) Rotational, (b) Vibrational and (c) Electronic transition. (2)

iii) How anharmonicity affects the pattern of the allowed vibrational energy levels. (2)

iv) Calculate the separation between the Vibrational energy levels of an Anharmonic Oscillator for (2)

a) $v = 0 \rightarrow v = 1$

b) $v = 0 \rightarrow v = 2$

c) $v = 0 \rightarrow v = 3$

3.a) With proper justification, obtain the rate of equation of a four level laser. Hence derive threshold pumping power of the four level one.

(3.5 + 3.5)

b) Explain the mechanism of CO_2 laser. (3)

Group B

(Nuclear Physics-I)

Answer question number 4 and any one questions from the rest.

4. Answer any five of the following questions $(2 \times 5 = 10)$

   a) α-particles having kinetic energy 8.776 MeV is subjected to a magnetic field of 1T. What is the radius of curvature of the track?

   b) *For* γradiation of 100 keV energy from the nuclei A = 56 with average life of excited state 10^{-10}sec. Is resonance fluorescence possible (Neglect Doppler broadening).

   c) Estimate the mass of neutrino from the free decay of neutron to proton. The maximum kinetic energy of β decay is 782.32 keV. Given $m_n = 939.5657$ MeV, $m_p = 938.2723$ MeV, $m_e = 0.511$ MeV.

   d) What is internal conversion?

   e) ^{34}Cldecays positron to ^{34}S. Derive the maximum positron energy. Difference in masses of the neutral atoms of ^{34}Cl and ^{34}S is 5.52 MeV/c^2

   f) Compute the disintegration energy of the reaction
   $Pu^{239} \rightarrow \alpha + U^{235}$
   Given the energy of emitted α particles is 5.144 MeV.

   g) What is the energy required to remove the last tightly bound neutron fromCa_{20}^{40}?

   h) What is Mossbauer effect[7]?

5. a) Show that in β ray spectrum, the most intense energy occurs at $E = \frac{E_{max}}{5}$. (4)

   b)For a α decay, derive the Gamow's formula of transmission co-efficient. (6)

6. a) Write the working formula and show the experimental set-up for the measurement of nuclear magnetic moment using Rabi method. Rabi obtained resonance of Li^7 (I=3/2) in a steady magnetic field of 0.3385 T and at frequency if oscillator at 5.585 MHz. Calculate the magnetic moment of Li^7 (5+2)

b) Derive the nuclear quadrupole moment of a prolate spheroid shaped nucleus of atomic number Z with semi axises a and b. (3)

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