2017

M.Sc. 3rd Semester Examination

PHYSICS

PAPER—PHS-302

Full Marks : 40

Time : 2 Hours

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Illustrate the answers wherever necessary.

Use separate Answer-scripts for Group-A & Group-B

Group-A

[Marks : 20]

Answer Q. No. *1* and any *one* from the rest.

1. Answer any *four* bits : $2\frac{1}{2} \times 4$

(a) What is the average period of rotation of HCl molecule if it is in the J = 1 state ? The internuclear distance of HCl is 0.1274 nm. The mass of hydrogen and chlorine atoms are 1.673×10^{-27} kg and 58.06×10^{-27} kg respectively.

(b) The 2886 cm^{-1} fundamental bond of HCl can be shown to fit in the empirical relation $\nu = 2885.90 + 20.577m - 0.3034\ m^2$. Calculate the value of Be (Rotational constant in the vibrational state v), given $a_e = 0.3312\ cm^{-1}$.

(c) Clearly distinguish dissociation of molecule by excitation into (i) a stable upper state and (ii) a continious upper state.

(d) Discuss the method of measuring the interatomic separations of a tri-atomic linear molecule by isotopic sulstitution method.

(e) Write Franck condon principle in molecular electronic spectroscopy. What is its physical significance ?

(f) The oxygen atom of CO molecule is changed by its another isotope. Do the frequencies of the microwave lines change ? Justify your answer.

2. (a) With proper justification obtain the expression of rate equation of a four level laser. Hence derive the expression of threshold pumping power of the four level one. Write an example of four level laser.

(b) Discuss the method of obtaining a mode locked laser. (3+3+1)+3

3. (a) Find the rotational fine structure of a vibration-electronic transition for a diatomic molecule.

(b) Show how an electronically excited molecule can loose energy through phosphoresence.

(c) What is Hot band ? 7+2+1

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Group-B

[Marks : 20]

Answer Q. No. *1* and any *one* from the rest.

1. Answer any *five* bits : 2×5

(a) A detector is used to count the number of γ-rays emitted by a radioactive source. If the number of counts recorded is 1000 in 20 seconds. Calculate the error in the counting rate per second.

(b) Classify the following transitions :

$$^{6}He \rightarrow {}^{6}Li + e^{-} + \nu \left(0^{+} \rightarrow 1^{+}\right)$$

$$^{17}F \rightarrow {}^{17}O + e^{+} + \nu \left(\frac{5^{+}}{2} \rightarrow 5/2^{+}\right)$$

(c) If the β-ray spectrum is represented by

$$N(E)dE \alpha \sqrt{E}(E_{max} - E)^{2} dE$$

Show that the most intense energy occurs at $E = E_{max}/5$.

(d) Plot graphically to compare energy losses by a charged particle through ionization and radiation.

(e) Examine the possibilities of isomeric transition between nuclei $^{7}_{4}Be$ and $^{7}_{3}Li$.

(The isotopic masses are :

$$^{7}_{3}Li = 7.0116004u \; ; \; ^{7}_{4}Be = 7.016929u\,)$$

(f) Show that the classical cross-section for elastic scattering of point particles from an infinitely massive sphere (hard sphere) of radius R is isotropic.

(g) Show that electron-positron pair cannot be created by an isolated photon.

2. (a) Using the semi-empirical binding energy formula, find the atomic number of the most stable nucleus for the given mass number A. Hence explain which is the most stable among $_2He^6$, $_4Be^6$ and $_3Li^6$.

(b) Chlorine-33 decays by positron emission with a maximum energy of 4.3 Mev. Calculate the radius of the nucleus from this.

(c) Find the value of the quadrupole moment of a system in which a proton is circling a spherical nucleus of equal value of Z and N. 4+4+2

3. (a) How magnetic moment of nuclei is determined experimentally ?

(b) ^{14}C disintegrates by β-emission with an end point energy of 0.155 Mev. The β-particle with an energy of 0.025 Mev is emitted in a direction at 135° to the direction of motion of the recoil nucleus. Calculate the momenta of all the three particles involved in this disintegrations.

(c) What is difference is the atomic and nuclear resonance fluorescences ? 4+4+2
