

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 B_e (Rotational constant in the vibrational state v), given $\alpha_e = 0.3312 \text{ cm}^{-1}$.

(Turn Over)

- (c) Clearly distinguish dissociation of molecule by excitation into (i) a stable upper state and (ii) a continuous upper state.
- (d) Discuss the method of measuring the interatomic separations of a tri-atomic linear molecule by isotopic substitution 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
-

Group-B

{ Marks : 20 }

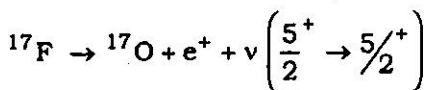
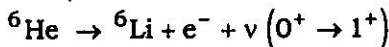
Answer Q. No. 1 and any one from the rest.

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 :



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

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

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

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

(e) Examine the possibilities of isomeric transition between nuclei ${}^7_4\text{Be}$ and ${}^7_3\text{Li}$.

(The isotopic masses are :

$${}^7_3\text{Li} = 7.0116004\text{u} ; {}^7_4\text{Be} = 7.016929\text{u}$$

- (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 ${}_2\text{He}^6$, ${}_4\text{Be}^6$ and ${}_3\text{Li}^6$.
- (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) ${}^{14}\text{C}$ 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