PG/IIIS/PHS-302/18

M.Sc. 3rd Semester Examination, 2018

PHYSICS

PAPER —PHS-302

Full Marks : 40

Time : 2 hours

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

The figures in the right hand margin indicate marks

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

Illustrate the answers wherever necessary

Use separate Groups for Gr.-A and Gr.-B

GROUP—A

[*Marks* : 20]

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

   (*a*) The average spacing between successive rotational lines of carbon monoxide molecule

is 3·8626 cm^{-1}. Determine the transition which gives the most intense spectral line at temperature 300 K.

(*b*) A molecule has undergone an electronic transition into an excited state. Explain with neat diagrams the re-emission of energy by an excited molecule through fluroscence and phosphorescence.

(*c*) The fundamental band for DCl^{35} is centered at 2011·00 cm^{-1}. Assume that the internuclear distance is constant at 1·288 Å. Calculate the wave number of first line of each of *P* and *R* branches of DCl^{35}.

(*d*) What are symmetric top molecules ? When they are called prolate and when they are oblate types ? Write examples for each of them.

(*e*) With proper diagram discuss deslandres table and its importance in molecular spectroscopy. What are progressions of lines ?

(*f*) Discuss the electro-optic method of obtaining a *Q*-switched laser. What is its advantage in application world ?

2. Discuss rotational fine structure of electronic vibrational transitions assuming $B' < B''$. B'' and B' are rotational constants corresponding to lower electronic state and upper electronic state respectively. What happens to the spectra when $B' > B''$. What is Fortrat diagram ? What is Frank Condon principle and Explain intensity variation in progression series of valuational electronic spectra ? 4 + 2 + 2 + 2

3. What is a three level laser system obtaining the rate equations of each of the energy levels, find the expression of population inversion in the system. Obtain also the expression of population inversion in the system. Obtain also the expression of its threshold power. Give an example of three level laser. 2 + (3 + 2) + 2 + 1

GROUP–B

[*Marks* : 20]

1. Answer any *five* : 2×5

(*a*) A nucleus with mass no. 238 undergoes alpha emission. Find the ratio of energy shared between the alpha particle and the daughter nucleus.

(*b*) $^{7}_{4}\mathrm{Be} \rightarrow ^{7}_{3}\mathrm{Li} + e^{+}$

$^{7}_{4}\mathrm{Be} + e^{-} \rightarrow ^{7}_{3}\mathrm{Li}$

Justify whether both decays are possible (given atomic mass difference between $^{7}_{4}\mathrm{Be}$ and $^{7}_{3}\mathrm{Li}$ is 0·846 Mev)

(*c*) Some isobaric nuclear families are represented by one mass parabola while some others are represented by two mass parabolas. Explain.

(*d*) What do you mean by double focussing mass-spectrograph ?

(*e*) Calculate the spin and parity of $_{17}Cl^{38}$.

(*f*) Draw a schematic experimental set up for the detection of neutrino.

(*g*) Can a nucleus undergo $0^+ \rightarrow 0^+$ electromagnetic transition ? Justify your answer.

(*h*) Explain non-conservation of parity in β-decay with simbolic (by spin and linear momenta) presentation by products nucleus and particles of the following β-decay :

$$_{27}Co^{60}_{33} \rightarrow_{28} Ni^{60}_{32} + \beta^- + \overline{\gamma}_e$$

2. (*a*) Draw the potential barrier faced by an alpha particle while it is emitted from a nucleus.

(*b*) Assuming the barrier transmission coefficient for a rectangular barrier, find an expression for the decay constant for the above mentioned barrier [Q. 2(*a*)].

(*c*) Find the type of gamma radiation for the following transitions with given nuclear spin-parity values :

(*i*) $\frac{1}{2}^{+} \rightarrow \frac{3}{2}^{+}$

(*ii*) $1^{-} \rightarrow 0^{+}$ 1 + 6 + 3

3. (*a*) Show that the maximum energy shift that can be observed for a body whose quadrupole moment is Q can be written as

$$\Delta U = \frac{1}{8} eQ \left(\frac{\partial^2 \phi}{\partial z^2} \right) \cdot \frac{2I - 1}{I + 1}$$

where ϕ is the electric potential. 3

(*b*) $^{212}_{83}Bi$ decay with a half-life of 60·5 min. by emitting 5 groups of α-particles with energies 6·08 Mev, 6·04 Mev, 5·76 Mev, 5·62 Mev and 5.60 Mev.

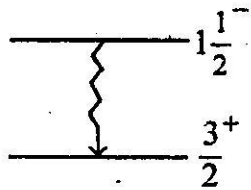
(*i*) Calculate the α-disintegration energies.

(*ii*) What is the daughter nucleus ?

(*iii*) Sketch its level scheme. 4

(*c*) Find the multipole character of α-radiation emitted in the following transitions with given spin-parity values as shown below : 3

(*i*)



(*ii*)