6/H–24 (viii) (Syllabus–2015)

2 0 2 1

(July)

PHYSICS

(Honours)

(Atomic and Molecular Spectroscopy, Nuclear Physics)

[PHY08(T)]

Marks : 56

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer Question No. **1** and *any* **four** from the rest

1. *(a)* Calculate the kinetic energy of the -particle emitted by the decay of $_{86}Rn^{222}$. Given mass of $_{86}Rn^{222}$ 222 017531 a.m.u. Mass of polonium nucleus 218 008930 a.m.u. Mass of -particle 4 002603 a.m.u. 3

   (b) A substance shows a Raman line at 4567 Å when exciting line 4358 Å is used. Deduce the positions of Stokes and anti-Stokes lines for the same substance when the exciting line 4047 Å is used. 3

(c) Calculate the wavelength separation between the two component lines which are observed in the normal Zeeman effect. The magnetic field used is 0·4 weber/m^2, the specific charge 1 76 10^{11} coulombs/kg and 6000 Å. 3

(d) Explain which of the following reactions are allowed or forbidden under conservation of charge, conservation of baryon number and conservation of strangeness : 3

   (i) n °

   (ii) p °   °

   (iii) p °   °

2. *(a)* What is Zeeman effect? Distinguish between normal and anomalous Zeeman effects. Give the quantum mechanical explanation of the anomalous Zeeman effect with suitable energy-level diagram. 1+2+5=8

   (b) Explain the fine structure of alkali spectra. 3

3. *(a)* How is Raman effect explained on the basis of quantum theory? Explain the origin of Stokes and anti-Stokes lines in Raman spectrum. 3+3=6

   (b) State and explain Franck-Condon principle. 5

(3)

4. *(a)* Describe Rutherford's experiment on artificial transmutation and write the relevant nuclear reaction. 5+2=7

(b) Explain Fermi's theory of -decay. 4

5. *(a)* State the laws of conservation of charge and baryon number. 4

(b) What are primary cosmic rays? Discuss the effect of earth's magnetic field on cosmic rays. 3+4=7

6. *(a)* Write short notes on the following : 2+2=4

(i) Atomic Emission Spectroscopy (AES)

(ii) Atomic Absorption Spectroscopy (AAS)

(b) Explain what is Larmor's precession. 4

(c) Calculate the Landé *g*-factor for $^3P_1$ level of an atom. 3

7. *(a)* Discuss rotational fine structure of electronic vibrational transitions. What is Fortrat diagram? 7+2=9

(b) How does a neutrino differ from an anti-neutrino? 2

(4)

8. *(a)* Describe the Stern-Gerlach experiment. 6

(b) Explain the salient features of nuclear shell model. What are the magic numbers? 3+2=5

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