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(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 α -particle emitted by the decay of ${}_{86}\text{Rn}^{222}$. Given mass of ${}_{86}\text{Rn}^{222}$ 222 017531 a.m.u. Mass of polonium nucleus 218 008930 a.m.u. Mass of α -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/m², 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) $n \rightarrow p + e + \bar{\nu}_e$
- (ii) $p \rightarrow n + e + \nu_e$
- (iii) $p \rightarrow n + \pi^0 + \pi^0$

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

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4. (a) Describe Rutherford's experiment on artificial transmutation and write the relevant nuclear reaction. 5+2=7
- (b) Explain Fermi's theory of β -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

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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
