

2026

Physics (Core)

Paper Code : PY-CE-6334

Paper Name : Atomic and Nuclear Physics

Time : 2 hours

Full Marks : 50

The figures in the margin indicate full marks for the questions.

1. Answer the following questions : 1×4=4
 - a) What is the experimental confirmation of Stern-Gerlach experiment ?
 - b) Zeeman effect is the splitting of spectral line in the presence of _____. (Fill in the blank)
 - c) Define nuclear binding energy.
 - d) What is radioactive decay ?
2. Answer the following questions : 2×3=6
 - a) Find the precessional frequency of an electron orbit when placed in a magnetic field of 6 Tesla.
Given : $(e = 1.6 \times 10^{-19} \text{ C}, m = 9.1 \times 10^{-31} \text{ kg})$
 - b) What is Lande g-factor ? What is the value of g-factor of an atom with single electron in $d_{3/2}$ state.
 - c) Assuming the unit nuclear radius to be $R_0 \sim 10^{-15} \text{ m}$ and mass of a nucleon to be $m \sim 10^{-27} \text{ kg}$, find the approximate value of the mass density of the nucleus.
3. Answer the following questions (any two) : 5×2=10
 - a) i) If the potential difference between anode and cathode is 25kV, what is the cut-off wavelength and the cut-off frequency of the emitted X-rays ? $(c = 3 \times 10^8 \text{ m/s}, h = 6.6 \times 10^{-34} \text{ JS})$ 2

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- ii) Using vector atom model, determine the possible values of an f-electron ($l=3$). 3
- b) Describe and explain L-S and J-J coupling with vector diagram. 5
- c) Write a short note on Vector atom model. 5
- d) Write short note on the liquid drop model of nucleus. 5
4. Answer the following questions (*any three*) : 10×3=30
- a) What are positive rays ? Discuss Thomson's method for positive rays. What are its draw back ? 2+6+2=10
- b) What is Zeeman effect ? Draw a neat diagram to illustrate the Zeeman splitting of D_1 and D_2 lines for sodium light. Distinguish between normal and anomalous Zeeman effect. Find the expression for Zeeman shift. 2+3+2+3=10
- c) i) Describe Stern-Gerlach experiment and explain how it verifies the vector atom model. 4+3=7
- ii) Calculate the values of l , s and j for a d electron in a one-electron atomic system. 3
- d) i) Write the Weiz sacker's mass formula and explain each term involved. What is mass parabola ? 4+2=6
- ii) Find the most stable nuclei for $A=25, 43, 77$. 4
- e) What is β decay ? What were the problems associated with decay and its continuous spetrum ? How Pauli solved the problems ? A sample has 2.1 kg of po^{210} . If the decay constant of the material is $6 \times 10^{-8} s^{-1}$,then what is the activity of the sample ? 2+3+3+2=10
- f) Explain Gamow's theory of α decay. How is Geiger-Nuttal law derived from it ? What is the velocity and kinetic energy of the daughter nucleus formed in the decay (of energy 4.19 MeV) of the parent nucleus U^{238} ? 3+3+2+2=10

