2023

(May/June)

PHYSICS

(Elective)

(Special Theory of Relativity, Quantum Mechanics—I, Atomic Physics—I, Nuclear Physics—I and Solid State Physics—I)

[PHY–04 (T)]

Marks : 56

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer *any* **eight** questions

1. Describe the Michelson-Morley experiment and discuss the various interpretations given to the negative result obtained therefrom. 7

2. *(a)* Deduce Einstein mass-energy relation $E = mc^2$ and give its physical significance. 3+1=4

(b) Derive the formula $E^2 = m_0^2c^4 + p^2c^2$ where the symbols have their usual meanings. Hence obtain relativistic relation between kinetic energy and momentum of a particle. 2+1=3

3. (a) Mention any two of the failures of classical physics which led to the development of quantum theory. 2

(b) State Heisenberg uncertainty principle. Illustrate this principle by a single-slit electron diffraction experiment. 1+4=5

4. Solve the Schrödinger equation for a particle enclosed in a one-dimensional box of side L and obtain its energy values. Draw a graph of its first three wave functions. Discuss the probability of finding the particle at different points in the box when it is in different states. 4+1+2=7

5. Describe Thomson's method for the determination of e/m of an electron. Why is the measurement of this ratio important? 6+1=7

6. (a) Discuss, with a neat diagram, the construction of Bainbridge mass spectrograph. 3

(b) Name the quantum numbers that help to specify the energy state of the electron in an atom. Give their significance. 2+2=4

7. (a) Briefly describe how X-rays are produced in the Coolidge tube. 3

(b) What are characteristic X-rays? Distinguish between continuous X-ray and characteristic X-ray emission spectra. 1+3=4

8. What is natural radioactivity? Give a brief account of the nature and properties of the radiations emitted in a radioactive decay. 1+6=7

9. What are cosmic rays? Discuss the altitude effect and latitude effect of cosmic rays. 1+6=7

10. (a) What do you mean by a chain reaction in nuclear fission? Explain controlled and uncontrolled chain reactions. 1+2=3

(b) Show that there is a critical size of the fissionable material in order that the chain reaction may be sustained. 4

11. Define coordination number. Compute the same for simple cubic, b.c.c. and f.c.c. lattices. Also prove that the distances between the nearest neighbours are a, $\frac{a\sqrt{3}}{2}$ and $\frac{a}{\sqrt{2}}$ respectively. 1+3+3=7

12. *(a)* What is superconductivity? Discuss the experimental evidence of the occurrence of superconductivity in metals and alloys. 1+3=4

(b) Distinguish between type-I and type-II superconductors. 3

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