Total No. of Printed Pages—4

4 SEM TDC PHYH (CBCS) C 9

2024

(May/June)

PHYSICS

(Core)

Paper : C–9

(Elements of Modern Physics)

Full Marks : 53
Pass Marks : 21

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option : 1×5=5

(a) The minimum energy required to remove an electron from the surface of a given metal is called

(i) stopping potential

(ii) work function

(iii) kinetic energy

(iv) None of the above

(b) Electrons cannot exist within the nuclei of atoms is understood from

(i) Heisenberg's uncertainty principle

(ii) de Broglie's hypothesis

(iii) Bohr's atomic model

(iv) None of the above

(c) The total probability of finding a particle must be

(i) infinity

(ii) unity

(iii) zero

(iv) None of the above

(d) Which of the following is true for nuclear force?

(i) They obey the inverse square law of distance

(ii) They are short range force

(iii) They are electromagnetic force

(iv) They are dependent of nature of charges

(e) Which of the following is used as a moderator in a nuclear reactor?

(i) Plutonium

(ii) Uranium

(iii) Cadmium

(iv) Heavy water

2. Answer the following questions : 2×5=10

(a) State and write the mathematical expression for Planck's law of blackbody radiation.

(b) How can we determine the time of existence and range of a virtual particle using Heisenberg's uncertainty principle?

(c) Briefly discuss the linear superposition principle.

(d) Define and write the mathematical expression for the binding energy of a nucleus.

(e) How did Pauli predict the emission of a neutrino from a nucleus?

3. (a) Explain why it is impossible for an electron to be present inside the nucleus of an atom. 3

(b) Briefly discuss the process of nuclear fission with examples. 3

(c) Briefly discuss the creation of neutrino and antineutrino in the β-decay process with examples. 3

4. (a) Show that the half-life of a radioactive substance is inversely proportional to the decay constant. 4

Or

Show that the group velocity of a wave packet is equal to the particle velocity.

(b) Briefly discuss the construction and working of an He-Ne laser. 4

5. *(a)* Briefly describe the confinement of a quantum dot in an infinitely rigid box. Find the value of N for the wave function of a particle of mass m moving along X-axis between $x = -\frac{\pi}{2}$ to $x = +\frac{\pi}{2}$ is given by $\psi = N \sin^2 x$. 2+4=6

(b) Explain Compton scattering and obtain an expression for the Compton shift. 6

(c) Explain the quantum mechanical tunnelling for a particle across a rectangular potential barrier and obtain the expression for transmission coefficient. 5

6. Write a short note on any *one* of the following : 4

(a) Nuclear shell model

(b) Davisson-Germer experiment

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