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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

(2)

- (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

(3)

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
