

Total number of printed pages-5

3 (Sem-4/CBCS) PHY HC 2

2021

PHYSICS

(Honours)

Paper : PHY-HC-4026

(Elements of Modern Physics)

Full Marks : 60

Time : Three hours

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

GROUP-A

1. Choose the correct option : 5

(i) The momentum of a photon of energy E is :

(a) E/c

(b) E^2/c

Contd.

- (c) c/E^2
- (d) Ec
- (ii) The Schrödinger equation contains :
- (a) First-order time derivative
- (b) First-order space derivative
- (c) Second-order time derivative
- (d) Third-order time derivative
- (iii) What is the transmission coefficient for a particle incident on a step potential with energy greater than step height ?
- (a) 1
- (b) <1
- (c) 0
- (d) infinite
- (iv) Which combinations of radioactive emissions will not change the mass number of radioactive nuclei ?
- (a) Alpha and beta decays
- (b) Alpha and gamma decays
- (c) Beta and gamma decays
- (d) Alpha, beta and gamma decays

(v) What process creates energy in the Sun ?

(a) Fission

(b) Gamma emission

(c) Fusion

(d) Electro-magnetic interaction

2. Answer the following question : $2 \times 5 = 10$

(a) Find the de Broglie wavelength of an electron having kinetic energy of 1 Mev.

(b) What is the physical significance of a wave function ?

(c) What is tunneling in Quantum mechanics ? Give *one* example.

(d) Show that nuclear density is independent of mass number.

(e) If the loss in mass during a fission is 0.01 gm, how much energy in Mev will be produced ?

3. Answer **any three** questions from the following : $5 \times 3 = 15$

- (a) Derive Heisenberg's Uncertainty principle from wave packets.
- (b) Explain normalization of a wave function. How is normalization expressed mathematically ?
- (c) Define Commutator. Show that position and momentum operator do not commute.
- (d) Explain the process of gamma emission.
- (e) Explain the working of nuclear reactor.

GROUP-B

4. Answer **any three** questions from the following : $10 \times 3 = 30$

- (a) What are phase velocity and group velocity ? Deduce the expression of phase velocity and group velocity and hence derive the relation between these two velocities. $2+3+3+2$

- (b) Solve the Schrödinger equation for a free particle in a one-dimensional infinitely rigid box and obtain the eigenfunctions and corresponding eigenvalues. 6+4
- (c) Express the binding energy of a nucleus according to the semi-empirical mass formula and explain each term involved in the expression. 10
- (d) Explain the nature of beta particle spectrum. How Pauli's neutrino hypothesis able to explain the conservation laws of energy and linear momentum ? 4+6
- (e) Explain the terms — optical pumping and population inversion. Explain the three- level pumping LASERS and mention *two* drawbacks of this type of LASERS. 2+2+4+2