

**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 ?

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- (a) Alpha and beta decays
- (b) Alpha and gamma decays
- (c) Beta and gamma decays
- (d) Alpha, beta and gamma decays

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(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  $0.01 \text{ gm}$ , how much energy in  $\text{Mev}$  will be produced ?

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*Contd.*

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.  $2+3+3+2$

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(b) Solve the Schrödinger equation for a free particle in a one-dimensional infinitely rigid box and obtain the eigenfunctions and corresponding eigenvalues.  $6+4$

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(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.  $2+2+4+2$

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