



B.Sc./4th Sem (H)/PHYS/24(CBCS)

2024

4th Semester Examination

PHYSICS (Honours)

Paper : C 9-T

[Elements of Modern Physics]

[CBCS]

Full Marks : 40

Time : Two Hours

The figures in the margin indicate full marks.

Candidates are required to give their answers

in their own words as far as practicable.

Group - A

Answer any *five* questions : $2 \times 5 = 10$

1. What is the conclusion of double slits experiment with electrons?
2. What is ultraviolet catastrophe?
3. Explain how the time energy uncertainty principle can be used to estimate the lifetime of virtual particles.
4. Are all the particles at rest at 0 K according to quantum mechanics?
5. What was the reason behind Pauli's neutrino hypothesis?

P.T.O.

(2)

6. What is the difference between spontaneous and stimulated emission?
7. Calculate the wavelength in nm of electrons which have been accelerated from rest through a potential difference of 54V.
8. Define packing fraction.

Group - B

Answer any *four* of the following : $5 \times 4 = 20$

9. The state of a free particle is described by the following wave function.

$$\phi(x) = 0 \text{ for } x < -3a$$

$$= c \text{ for } -3a < x < a$$

$$= 0 \text{ for } x > a$$

- (a) Determine c using the normalization condition. 2
- (b) Find the probability of finding the particle in the interval $[0, a]$. 3
10. What is the source of binding energy in a nucleus? What are the important features of binding energy/nucleon vs. mass number curve? 2+3
11. A thermal neutron has a speed v at temperature $T = 300\text{K}$.

(3)

- (a) Calculate its de Broglie wavelength. State whether a beam of these neutrons could be diffracted by a crystal, and why? 2+1
- (b) Use Heisenberg's Uncertainty principle to estimate the kinetic energy (in MeV) of a nucleon bound within a nucleus of radius 10^{-15}m . 2
12. (a) Check whether in operator $\frac{d}{dx}$ is hermitian or not.
- (b) Consider a one dimensional particle which is confined within the region $0 \leq x \leq a$ and whose wavefunction is $\psi(x, t) = \sin(\pi x / a) \exp(-i\omega t)$. Find the potential $V(x)$. 2+3
13. Explain nuclear fission and fusion from binding energy curve.
14. Describe the liquid drop model of nucleus. What are the features that it can not explain? 4+1

Group - C

Answer any *one* of the following : $10 \times 1 = 10$

15. Consider a particle of mass m moving freely between $x = 0$ and $x = a$ inside an infinite square well potential
- (a) Find the ground and the 1st excited state of energy and the wavefunction.

P.T.O.

(b) Calculate the expectation values of $\langle x \rangle_1$, $\langle p \rangle_1$ and

$$\langle x^2 \rangle_1, \langle p^2 \rangle_1.$$

(c) Calculate the uncertainty product $\Delta x \Delta p$. 5+4+1

16. Discuss the working principle of ruby laser. Why He Ne laser is better than Ruby laser? Can you make laser with any material? 6+2+2
-