

2024/TDC (CBCS)/EVEN/SEM/  
PHSHCC-402T/091

TDC (CBCS) Even Semester Exam., 2024

PHYSICS

( 4th Semester )

Course No. : PSHHCC-402T

( Elements of Modern Physics )

Full Marks : 50

Pass Marks : 20

Time : 3 hours

The figures in the margin indicate full marks  
for the questions

UNIT—I

1. Answer any *two* questions : 2×2=4

(a) What is Planck's quantum hypothesis?

(b) Show that de Broglie waves are produced due to motion of the particle.

(c) Show that the wavelength of electron of mass  $m$ , accelerated through a potential difference ( $V$ ) is given by

$$\lambda = \frac{h}{\sqrt{2meV}}$$

24J/722

( Turn Over )



( 2 )

2. Answer either (a) or (b) : 6
- (a) Describe Davisson and Germer experiment in detail with necessary diagram. 6
- (b) An electron and a photon each has a wavelength of 2 Å. Calculate their momenta and total energies. 2+4=6

UNIT—II

3. Answer any two questions : 2×2=4
- (a) Write the physical significance of Heisenberg's uncertainty principle.
- (b) Why are uncertainties inescapable in quantum mechanics?
- (c) Justify that the concept of Bohr orbit violates uncertainty relation.
4. Answer either (a) or (b) : 6
- (a) Find the expression of radius of Bohr orbit and ground-state energy of hydrogen atom using uncertainty relation. 3+3=6
- (b) (i) Show that electron cannot reside within a nucleus. 3½

24J/722

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( 3 )

- (ii) The uncertainty in the velocity of a particle is equal to its velocity. If  $\Delta P \Delta x = \hbar$ , then show that the uncertainty in its location is its de Broglie wavelength. 2½

UNIT—III

5. Answer any two questions : 2×2=4
- (a) Write any four properties of wave function.
- (b) What is probability current density? Write its symbol.
- (c) Write down the one-dimensional time-independent Schrödinger equation for a particle of mass  $m$ . Also write the same equation for a free particle.
6. Answer either (a) or (b) : 6
- (a) Deduce orthogonality condition of wave functions. 6
- (b) (i) For the wave function  $\psi(x) = Ae^{-i\kappa x}$ , find the probability current density. 2
- (ii) Show that if a particle is in a stationary state at a given time, it will always remain in a stationary state. 4

24J/722

( Turn Over )

( 4 )

UNIT—IV

7. Answer any *two* questions :  $2 \times 2 = 4$

- (a) Write down the symbol and expression of Hamiltonian operator.
- (b) Write down the time-dependent Schrödinger equation for a particle of mass  $m$  in one-dimension and in three-dimension.
- (c) What will be the value of potential function on the wall of the box and inside the box for a particle residing within an infinitely rigid box of length  $L$ ?

8. Answer *either* (a) or (b) : 6

- (a) For a particle placed in an infinitely rigid box of length  $L$ , find the expression of normalized wave function. Also show that energy of the particle is quantized.  $4+2=6$

- (b) Show that for a particle whose energy is more than the height of the potential step ( $V_0$ )  $R + T = 1$ , where symbols have their own meaning. 6

24J/722

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( 5 )

UNIT—V

9. Answer any *two* questions :  $2 \times 2 = 4$

- (a) What is half life? How is it related to disintegration constant?
- (b) Define mass defect and binding energy.
- (c) Mention the differences between spontaneous and stimulated emission.

10. Answer *either* (a) or (b) : 6

- (a) Discuss construction and working of ruby laser. 6
- (b) Explain the process of nuclear fission and fusion with necessary reactions.  $3+3=6$

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24J—320/722

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