MCQ's Wave Mechanics

L1

Q.1. Which of the following is the correct expression for the group velocity?

(a) ϒ. λ

(b) ω/k

(c) Δω/Δk

(d) Δk/Δw

Ans . C

L1

Q.2. Unit of Planck's constant is

(a) J

(b) s

(c) J/s

(d) J . s

Ans . D

L1

Q.3. Phase velocity (v_p) = group velocity (v_g) suggests that,

(a) Particle velocity = phase velocity = speed of light

(b) Particle velocity < velocity of light

(c) Particle velocity > velocity of light

(d) there is no realtion between phase velocity and particle velocity

Ans . A

L1

Q.4. The relationship between group velocity(v_g) and particle velocity (v) is-

(a) $v_g < v$

(b) $v_g = v$

(c) $V_g > v$

(d) None of the above

Ans . B

L1

Q.5. The de Broglie expression for the momentum of particle is

(a) $p = h \lambda$

(b) $p = h / \lambda$

(c) $p = c/\lambda$

(d) $p = \lambda / h$

Ans . B

L1

Q.6. We do not observe matter waves in heavy particles because

(a) the wavelength associated is very large

(b) the wavelength associated is very small

(c) they travel with lesser velocity

(d) they doesn't have waves associated with it

Ans . B

L1

Q.7. Existence of matter wave was experimentally first demonstrated by

(a) Newton

(b) Planck

(c) Davisson & Germer

(d) de Broglie

Ans . C

L1

Q.8. The concept of matter wave was suggested by-

(a) de Broglie

(b) Heisenberg

(c) Schrodinger

(d) Laplace

Ans . A

L1

Q.9. The wavelength associated with an electron of energy E = 100 eV is equal to :

(a) 1.23 nm

(b) 123 nm

(c) 12.3 nm

(d) 24 nm

Ans . C

L3

Q.10. De-Broglie equation states the ________________ of Particles:

(a) dual nature

(b) particle nature

(c) wave nature

(d) none of these

Ans . A

L1

Q.11. De-Broglie wavelength of a body of mass m and kinetic energy E is given by (symbols have their usual meanings):

(a) $\lambda = \frac{h}{\sqrt{2mE}}$

(b) $\lambda = \frac{h}{2mE}$

(c) $\lambda = \frac{\sqrt{2mE}}{h}$

(d) $\lambda = \frac{h}{mE}$

Ans . A

L1

Q.12. The momentum of an electron that emits a wavelength of 2 Å will be:

(a) 6.4×10^{-36} kgm/sec

(b) 3.3×10^{-24} kgm/sec

(c) 3.3×10^{-34} kgm/sec

(d) none of these

Ans . B

L2

Q.13. If electrons, protons, alpha particle and cricket ball moving with same speed, then associated matter wave with .... have smallest wavelength.

(a) Electron

(b) proton

(c) alpha particle

(d) cricket ball

Ans . D

L2

Q.14. If the kinetic energy of a free electron doubles, its de Broglie wavelength changes by the factor of

(a) 2

(b) 1/2

(c) $\sqrt{2}$

(d) $1/\sqrt{2}$

Ans . D

L2

Q.15. In the Heisenberg uncertainty principle, which two measurable properties of a particle cannot be observed precisely at the same time?

(a) Size and speed

(b) Energy and torque

(c) Position and momentum

(d) Spin and color

Ans . C

L2

Q.16. The de Broglie wavelength associated with an electron accelerated by a potential of 400 V is approximately

(a) 0.03 nm

(b) 0.04 nm

(c) 0.12 nm

(d) 0.06 nm

Ans . D

L3

Q.17. According to the Heisenberg uncertainty principle it is impossible to determine precisely an object's position and its................ at the same time.

(a) energy

(b) momentum along the same direction

(c) momentum along the perpendicular direction

(d) angular momentum

Ans . C

L2

Q.18. Matter waves are not associated with ....

(a) electron revolving around nucleus

(b) bullet fired from gun

(c) light photons

(d) stationary particle

Ans . D

L2

Q.19. An electron and proton have the same de-Broglie wavelength, then the kinetic energy of the electron is-

(a) Zero

(b) Infinity

(c) Equal to the kinetic energy of the proton

(d) Greater than the kinetic energy of the proton

Ans . D

L2

Q.20. The wave variable of matter wave is

(a) Probability

(b) electric and magnetic field

(c) position of particle

(d) pressure

Ans . A

A

Q.21. Which of the following are the properties of well behaved wave function?

(a) Continuous

(b) Single valued

(c) Normalized

(d) All of above

Ans . D

L1

Q.22. Calculate the minimum uncertainty in the momentum of a He atom confined to 0.40 nm.

(a) 1.31×10^{-25} kg m/s

(b) 13.1×10^{-25} kg m/s

(c) 2.1×10^{-25} kg m/s

(d) 2.8×10^{-25} kg m/s

Ans . A

L3

Q.23. Which one of the following is incorrect statement-

(a) $\Delta E . \Delta t \geq h/(4\pi)$

(b) $\Delta p_x . \Delta x \geq h/(4\pi)$

(c) $\Delta L_\Theta . \Delta\Theta \geq h/(4\pi)$

(d) $\Delta p_x . \Delta y \geq h/(4\pi)$

Ans . D

L2

Q.24. Wave function Ψ (probability of finding particle) is

(a) a real quantity

(b) a complex quantity

(c) an observable quantity

(d) none of these

Ans . B

L1

Q.25. Which one of the the following is not a property of valid wave function?

(a) It should be Single valued

(b) wavefunction and its derivative should be continuous across the boundary

(c) it should be normalized

(d) it can be infinite

Ans . C

L2

Q.26. Mathematically, normalized wave function is expressed as-

(a) $\iiint_{-\infty}^{+\infty} \psi\,(x,t)^2 dv = 1$

(b) $\iiint_{-\infty}^{+\infty} \psi\,(x,t)^2 dv = 0$

(c) $\iiint_{-\infty}^{+\infty} \psi\,(x,t)\, dv = 1$

(d) $\iiint_{-\infty}^{+\infty} \psi\,(x,t)\, dv = 0$

Ans . A

L2

Q.27. The probability density is defined as

(a) ψ

(b) $|\psi|^2$

(c) $|\psi|^3$

(d) $\sqrt{\psi}$

Ans . B

L1

Q.28. The normalization condition say that the total probability of finding particle in space should be

(a) zero

(b) one

(c) infinite

(d) two

Ans . B

L2

Q.29. The probability density of a particle is

(a) negative.

(b) can be negative or positive.

(c) always positive

(d) Complex quantity

Ans . C

L2

Q.30. The square of absolute value of wave function is called

(a) current density

(b) probability density

(c) number of waves per unit area

(d) wave density

Ans . B

L1

Q.31. Which of the following is the correct expression for the one dimensional Schrödinger time independent wave function?

(a) $\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2}(\mathrm{E} - \mathrm{V})\psi = 0$

(b) $\frac{d^2\psi}{dx^2} + 2m\hbar^2(\mathrm{E} - \mathrm{V})\psi = 0$

(c) $\frac{d^2\psi}{dx^2} + \frac{\hbar^2}{2m}(\mathrm{E} - \mathrm{V})\psi = 0$

(d) $\frac{2m}{\hbar^2}\frac{d^2\psi}{dx^2} + 2m\hbar^2(\mathrm{E} - \mathrm{V})\psi = 0$

Ans . A

L2

Q.32. The operator ∇^2 is called as-

(a) Hamiltonian operator

(b) Laplacian operator

(c) Poisson operator

(d) vector operator

Ans . B

L1

Q.33. The operator corresponding to total energy is........

(a) $\hat{E} = i\hbar \frac{\partial}{\partial t}$

(b) $\hat{E} = \hbar \frac{\partial}{\partial t}$

(c) $\hat{E} = i\hbar^2 \frac{\partial}{\partial t}$

(d) none of above

Ans . A

L3

Q.34. The operator corresponding to kinetic energy is.........

(a) $E = \frac{-\hbar^2}{m} \nabla^2$

(b) $E = \frac{-\hbar^2}{2m} \nabla^2$

(c) $E = i \frac{-\hbar^2}{m} \nabla^2$

(d) $E = i\hbar\nabla^2$

Ans . B

L2

Q.35. For the free particle trapped in infinite potential well; probability of finding particle outside well is

(a) one

(b) zero

(c) sometimes zero sometimes one

(d) none of the above

Ans . B

L2

Q.36. For matter wave having angular frequency ω & wave number k the total energy (E) of the particle is expressed as-

(a) $\hbar$ k

(b) $\hbar$ ω/2

(c) $\hbar$ ω

(d) $\hbar$ k/2

Ans . B

B

Q.37. The allowed energy states for the free particle trapped in infinite potential well having length L, are expressed by equation-

(a) $E_n = \frac{hn^2}{8mL^2}$

(b) $E_n = \frac{hn}{8mL}$

(c) $E_n = \frac{hnL}{8m}$

(d) $E_n = \frac{n^2h^2}{8mL^2}$

Ans . D

L2

Q.38. If width of infinite potential box is reduced by factor 2, energy of particle will be

(a) Increased by 2 times

(b) Decreased by 2 times

(c) Increased by 4 times

(d) Decreased by 4 times

Ans . C

L2

Q.39. If width of infinite potential box is increased by factor 3, energy of particle will be

(a) Increased by 9 times

(b) Decreased by 3 times

(c) Increased by 3 times

(d) Decreased by 9 times

Ans . D

L2

Q.40. The wave function for a particle must be normalizable because:_

(a) the particle's charge must be conserved

(b) the particle's momentum must be conserved

(c) the particle must be present somewhere

(d) the particle's angular momentum must be conserved

Ans . C

L2

Q.41. What is the minimum Energy possessed by the free particle trapped in infinite potential well?

(a) Zero

(b) $E_n = \frac{h^2}{8mL^2}$

(c) $E_n = \frac{4h^2}{8mL^2}$

(d) $E_n = \frac{9h^2}{8mL^2}$

Ans . B

L3

Q.42. The wave function of the particle trapped in infinite potential well is given by equation

(a) $\psi_n = \sqrt{\frac{2}{L}} sin\left(\frac{n\pi x}{L}\right)$

(b) $\psi_n = \sqrt{\frac{L}{2}} sin\left(\frac{n\pi x}{L}\right)$

(c) $\psi_n = \sqrt{\frac{L}{2}} \sin(n\pi x)$

(d) $\psi_n = \sqrt{\frac{2}{L}}\sin(n\pi x)$

Ans . A

L2

Q.43. Calculate the Zero-point energy for a particle in an infinite potential well for an electron confined to a 1 nm atom.

(a) 3.5 X 10^{-20} J

(b) 4.0 X 10^{-20} J

(c) 6.0 X 10^{-20} J

(d) 5.0 X 10^{-20} J

Ans . C

L3

Q.44. An electron is in an infinite potential well that is 9.6- nm wide. The electron makes the transition from the n=14 to the n=11 state. The wavelength of the emitted photon is closest to:

(a) 3400 nm

(b) 4100 nm

(c) 2800 nm

(d) 4700 nm

Ans . B

L3

Q.45. The ground state energy level for a proton trapped in an infinite potential well of length 5 x 10^{-15} m is

(a) 0 MeV

(b) 4.1x10^{-8} MeV

(c) 8.2 MeV

(d) 32.3 MeV

Ans . C

L3

Q.46. In a finite Potential well, the potential energy outside the box is

(a) Zero

(b) Infinite

(c) finite and constant

(d) Variable

Ans . c

L2

Q.47. For a particle inside a box of finite potential well, the probability of finding particle outside the well is -

(a) always zero

(b) between zero to one

(c) infinite

(d) none of the above

Ans . a

L2

Q.48. The tunnel diode is an example of -

(a) particle trapped in infinite potential well

(b) particle trapped in finite potential well

(c) particle trapped in infinite as well as finite potential well

(d) None of the above

Ans . b

L3

Q.49. The quantum tunneling is observed in

(a) Scanning tunneling microscope

(b) tunnel diode

(c) alpha decay

(d) Scanning tunneling microscope, tunnel diode, alpha decay

Ans . d

L2

Q.50. Quantum Computing involves--------------------of qubits,

(a) Superposition

(b) Entanglement

(c) Superposition & entanglement

(d) De-coherence

Ans . C

L1

Q.51. Which of the following can be a wave function?

(a) tan x

(b) sin x

(c) cot x

(d) sec x

Ans. b

Q.52. Which of the following quantities is proportional to the probability density at a point?

a) the wavefunction

b) the square of the wave function

c) the de Broglie wavelength

d) the reciprocal of the de Broglie wavelength

Ans. b

Q.53. The total probability of finding the particle in space must be __________

a) zero

b) unity

c) infinity

d) double

Ans. b

Q.54. If Ψ1 and Ψ2 are two solutions of Schrodinger Wave equation then which of the following is also a solution?

a) Ψ1/Ψ2

b) Ψ1Ψ2

c) Ψ2/Ψ1

d) Ψ1 + Ψ2

Ans. d

Q.55. The values of Energy for which Schrodinger's steady state equation can be solved is called as ___________

a) Eigen Vectors

b) Eigen Values

c) Eigen Functions

d) Operators

Ans. b

Q.56. Which of the following is known as the Schrodinger's time dependent wave equation?

a) $E = h\nu$

b) E = mc2

c) $\lambda = h/p$

d) $H\psi = E\psi$

Ans. d

Q.57. In a finite Potential well, the potential energy outside the box is ___________

a) Zero

b) Infinite

c) Constant

d) Variable

Ans. c

Q.58. The wave function of a particle in a box is given by ___________

a) A sin(kx)

b) A cos(kx)

c) Asin(kx) + Bcos(kx)

d) A sin(kx) – B cos(kx)

Ans. c

Q.59. Tunnel effect is notably observed in the case of ___________

a) X-rays

b) Gamma rays

c) Alpha Particles

d) Beta Particles

Ans. c

Q.60. 4 MeV alpha particle crosses the 25 MeV potential barrier inside the nucleus due to

a) Tunnelling Effect

b) Compton Effect

c) Photoelectric effect

d) Uncertainty principle.

Ans. a