Unit 4: MCQs on Quantum Mechanics

Which of the following is the correct expression for the group velocity?
a) $\upsilon\lambda$
b) $d\omega/d\upsilon$
c) dE/dk
d) $dE/\hbar dk$
Answer: [d]

Planck's constant has unit s of
a) J
b) s
c) J/s
d) J.s
Answer: [d]

$v_p = v_g$ suggests that,
a) Particle is lagging behind the wave packet
b) Particle is travelling with the wave packet,
c) particle is travelling ahead of wave packet
d) Particle & wave packet have independent motion
Answer: [b]

The motion of a wave packet is similar to _____
a) Photons
b) Waves
c) Classical Particle
d) Quantum Particle
Answer: [c]

Which of the following is not a variable
a) Wavelength
b) Velocity
c) Planck's Constant
d) Location
Answer: [c]

The concept of matter wave was suggested by_____
a) Heisenberg
b) de Broglie
c) Schrodinger

Answer: [b]

if kinetic energy of electron doubles, its de-Broglie wavelength changes by a factor
a) 0.5
b) 2
c) 3
d) 0.707
Answer: [d]

What is the main point of the de Broglie equation?
a) the position of light cannot be precisely determined
b) matter has wave-like properties
c) matter only behaves like a particle
d) Einstein's theory of relativity was incorrect
Answer: [b]

Among the following particles, which one will be have smallest wavelength associated with it for same velocity
a) Proton
b) Electron
c) Alpha particle
d) Cricket ball
Answer: [d]

The de Broglie wavelength of an electron accelerated to a potential of 400 V is approximately
a) 0.03 nm
b) 0.04 nm
c) 0.12 nm
d)0.06 nm
Answer: [d]

The electron is accelerated from rest between two points which has potential of 20V and 40 V respectively. Associated De-Broglie wavelength is
a) 7.5 A^o
b) 2.75 A^o
c) 0.75 A^o
d) 2.75 m
Answer: [b]

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) $1/\sqrt{2}$

Answer: [d]

Which of the following is not a characteristic of wave function?

a) Continuous
b) Single valued
c) Differentiable
d) Physically Significant

Answer: [d]

Which two characteristics are variables in Heisenberg's uncertainty principle?

a) wavelength and distance
b) position and momentum
c) charge and displacement
d) atomic radius and frequency

Answer: [b]

Calculate the minimum uncertainty in the momentum of a ^{4}He atom confined to 0.40 nm.

a) 2.02 X 10^{-25} kg m/s
b) 2.53 X 10^{-25} kg m/s
c) 2.64 X 10^{-25} kg m/s
d) 2.89 X 10^{-25} kg m/s

Answer: [c]

The uncertainty in the location of a particle moving with velocity 7.28 X 10^7 m /s is two times its de-Broglie wavelength. What is the uncertainty in measuring the velocity?
a) 5.79 X 10^6 m/s
b) 6.12 X 10^6 m/s
c) 7.63 X 10^6 m/s
d) 8.45 X 10^6 m/s
Answer: [a]

Energy of a wave divided by its momentum gives _____
a) Group velocity
b) Classical Velocity
c) Phase Velocity
d) Wave velocity
Answer: [c]

Which of the following can be a wave function?
a) tan x
b) sin x
c) cot x
d) sec x
Answer: [b]

Wave function Ψ of a particle is
a) a real quantity
b) a complex quantity
c) an imaginary quantity
d) none of these
Answer: [b]

Which of the following is not a physical requirement for a wave valid wave function?
a) single valued;
b) continuous in a given region;
c) can be infinite;
d) none of these;
Answer: [c]

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
Answer: [b]

The total probability of finding the particle in space must be _____
a) zero
b) unity
c) infinity
d) double
Answer: [b]

The probability density of a particle is
a) negative.
b) can be negative or positive.
c) always positive
d) Complex quantity
Answer: [c]

The square of the magnitude of the wave function is called_____
a) current density
b) probability density
c) zero density
d) volume density
Answer: [b]

If Ψ is the wave function, the probability density function is given by _____
a) $|\Psi|$
b) $|\Psi|^2$
c) $|\Psi|^3$
d) $|\Psi|^4$
Answer: [b]

Which of the following is not a characteristic of wave function?
a) Continuous
b) Single valued
c) Differentiable
d) Physically Significant
Answer: [d]

Which of the following is the correct expression for the Schrödinger wave ?

a) $i\hbar(d\Psi/dt) = -i(\hbar/2m)\,\partial\Psi/\partial x + V\Psi$

b) $i\hbar(d\Psi/dt) = -i(\hbar/2m)\,\partial^2\Psi/\partial x^2 + V\Psi$

c) $i\hbar(d\Psi/dt) = -i(\hbar^2/2m)\,\partial\Psi/\partial x + V\Psi$

d) $i\hbar(d\Psi/dt) = -i(\hbar^2/2m)\,\partial^2\Psi/\partial x^2 + V\Psi$

Answer: [d]

Schrodinger's equation described the

a) procedure for splitting an atom

b) complement of the wave function

c) behaviour of "matter" waves

d) motion of light

Answer: [c]

If the particle moving in a _____ potential then the solution of the wave equation are described as a stationary states

a) time independent

b) time dependent

c) velocity dependent

d) velocity independent

Answer: [a]

The operator ∇^2 is called _____ operator
a) Hamiltonian
b) Laplacian
c) Poisson
d) vector
Answer: [b]

For a quantum wave particle, E = _____
a) $\hbar$ k
b) $\hbar$ ω
c) $\hbar$ ω/2
d) $\hbar$ k/2
Answer: [b]

The Schrodinger wave equation is _____
a) Linear
b) Quadratic
c) Differential equation
d) Derivable
Answer: [a]

If Ψ_1 and Ψ_2 are two solutions of Schrodinger Wave equation then which of the following is also a solution?
a) Ψ_1/Ψ_2
b) $\Psi_1\Psi_2$
c) Ψ_2/Ψ_1
d) $\Psi_1 + \Psi_2$
Answer: [d]

How is information extracted from a wave function?
a) Expectation value
b) Operators
c) Differential
d) Partial differential
Answer: [a]

Which function is considered independent of time to achieve the steady state form?
a) Ψ

b) $d\Psi/dt$
c) $d^2\Psi/dx^2$
d) V
Answer: [d]

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
Answer: [b]

For a box with infinitely hard walls, the potential is maximum at _____
a) L
b) 2L
c) L/2
d) 3L
Answer: [a]

Which of the following is known as the Schrodinger equation?
a) $E = h\nu$
b) $E = mc^2$
c) $\lambda = h/p$
d) $\mathbf{H}\psi = \mathbf{E}\psi$
Answer: [d]

The walls of a particle in a box are supposed to be _____
a) Small but infinitely hard
b) Infinitely large but soft
c) Soft and Small
d) Infinitely hard and infinitely large
Answer: [d]

The energy of a particle in a infinite potential box is _
a) Proportional to length of box
b) Inversely proportional to Square of length of box
c) Inversely proportional to length of box
d) None of these

Answer: [b]

. 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
Answer: [c]

. 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
Answer: [d]

. 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
Answer: [c]

. The wave function of the particle lies in which region?
a) $x > 0$
b) $x < 0$
c) $0 < X < L$
d) $x > L$
Answer: [c]

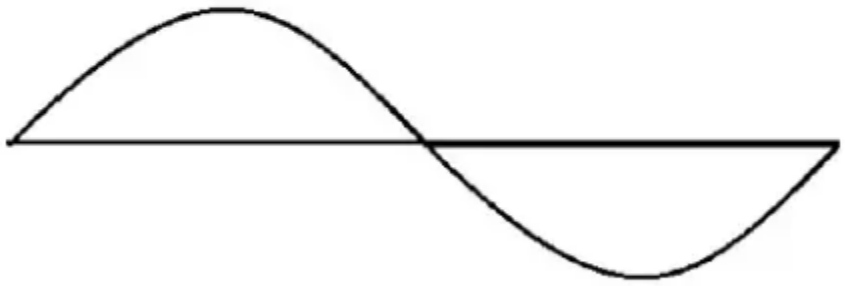
The Eigen value of a particle in a box is _____
a) L/2
b) 2/L
c) $\sqrt{(L/2)}$
d) $\sqrt{(2/L)}$
Answer: [d]

What is the minimum Energy possessed by the particle in a box?
a) Zero
b) $\pi^2\hbar^2/2mL^2$
c) $\pi^2\hbar^2/2mL$
d) $\pi^2\hbar/2mL$

Answer: [b]

The wave function of a particle in a box is given by _____
a) $\sqrt{(2/L)}\ \mathrm{Sin}(n\pi x/L)$
b) $\sqrt{(2/L)}\ \mathrm{Sin}(nx/L)$
c) $\sqrt{(2/L)}\ \mathrm{Sin}(x/L)$
d) $\sqrt{(2/L)}\ \mathrm{Sin}(\pi x/L)$
Answer: [a]

The wave function for which quantum state is shown in the figure?



a) 1
b) 2
c) 3
d) 4
Answer: [b]

Calculate the Zero-point energy for a particle in an infinite potential well for an electron confined to a 1 nm atom.
a) 3.5×10^{-20} J
b) 4.0×10^{-20} J
c) 6.0×10^{-20} J
d) 5.0×10^{-20} J
Answer: [c]

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
Answer: [b]

The ground state energy level for a proton trapped in an infinite potential well of length 5×10^{-15} m is
a) 0 MeV
b) 4.1×10^{-8} MeV
c) 8.2 MeV
d) 32.3 MeV
Answer: [c]

The transmission based on tunnel effect is that of a plane wave through a _____
a) Circular Barrier
b) Opaque Object
c) Rectangular Barrier
d) Infinitely small barrier
Answer: [c]

The particle has a finite, non-zero, potential for the region _____
a) $x > 0$
b) $x < 0$
c) $0 < X < a$
d) $x > a$
Answer: [c]

Tunnel effect is notably observed in the case of _____
a) X-rays
b) Gamma rays
c) Alpha Particles
d) Beta Particles
Answer: [c]

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.
Answer: [a]

The scanning tunnelling microscope works due to
a) Interference
b) Tunnelling effect shown by electrons
c) Diffraction of electrons
d) None of above
Answer: [b]

How does a scanning tunnelling microscope map a surface?
a) by measuring the size of each individual electron
b) by measuring the voltage created by electron transfer
c) by measuring the size of each atom of the surface
d) by measuring the current due to tunnelling electrons
Answer: [d]

Quantum Computing

Quantum Computing involves _____ of qubits,
a) Superposition
b) Entanglement

c) Superposition & entanglement
d) De-coherence
Answer: [c]

Qubits can be made of using,
a) Electron's spin & photon's polarization
b) Electron's motion
c) Photon's frequency
d) Photon's momentum
Answer: [a]

Qubits can hold,
a) Only 0 state
b) Only 1 state
c) Superposition of 0 & 1 state
d) None of above
Answer: [c]

High speed of quantum computing is possible due to _____ of qubits
a) Superposition
b) Entanglement
c) Superposition & entanglement
d) De-coherence
Answer: [c]

The difference between digital & quantum computing,
a) Strict discrete nature of 0 & 1 state in digital computing
b) Superposition of 0 & 1 in qubits
c) Entanglement of qubits
d) All of above
Answer: [d]

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"A thing of Quantum Physics is a Joy Forever" - Anonymous

Think Quantum! Think Quantum Computing !

Become a Quantum Computer Scientist/Engineer