MCQ on Group Velocity, Wave Packet

1. Which of the following is the correct expression for the group velocity?
   a) υλ
   b) dω/dυ
   c) dE/dk
   d) dE/ħdk
   Answer: [d]

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

3. $v_p = v_g$ 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]

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

MCQ on De Broglie Wavelength.

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

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

d) Laplace
Answer: [b]

7. 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]

8. 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]

9. 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]

10. 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]

11. 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]

12. 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]

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

14. 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]

15. Calculate the minimum uncertainty in the momentum of a ^4He atom confined to 0.40 nm.
    a) 2.02×10^{-25} kg m/s
    b) 2.53×10^{-25} kg m/s
    c) 2.64×10^{-25} kg m/s
    d) 2.89×10^{-25} kg m/s
    Answer: [c]

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

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

MCQ on Wave Function

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

19. 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]

20. 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]

21. 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]

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

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

24. 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]

25. 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]

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

Schrodinger's Time Independent Wave Equation

27. 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]

28. 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]

29. 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]

30. The operator ∇^2 is called_____ operator
a) Hamiltonian
b) Laplacian
c) Poisson
d) vector
Answer: [b]

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

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

33. 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]

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

35. 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]

36. 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]

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

38. 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]

MCQ on Particle In a Box

39. 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]

40. 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]

41. 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]

42. 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]

43. 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]

44. 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]

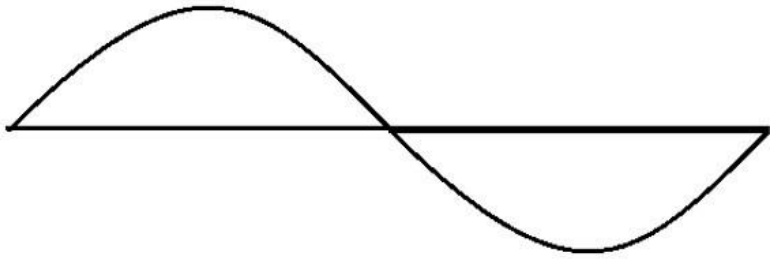
45. The Eigen value of a particle in a box is _____
    a) L/2
    b) 2/L
    c) $\sqrt{(L/2)}$
    d) $\sqrt{(2/L)}$
    Answer: [d]

46. 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]

47. 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]

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



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

49. 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]

50. 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]

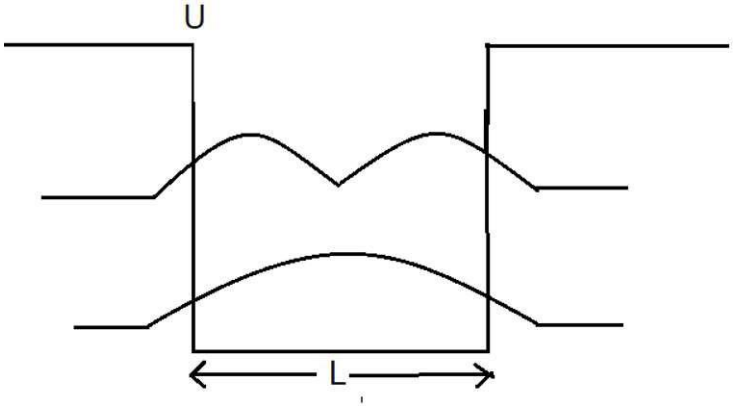
51. The ground state energy level for a proton trapped in an infinite potential well of length $5x10^{-15}$ m is
    a) 0 MeV
    b) $4.1x10^{-8}$ MeV
    c) 8.2 MeV
    d) 32.3 MeV
    Answer: [c]

MCQ on Finite Potential Well

52. In a finite Potential well, the potential energy outside the box is _____
    a) Zero
    b) Infinite
    c) Constant
    d) Variable
    Answer: [c]

53. 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)
    Answer: [c]

54. What does the following figure shows?



    a) Wave function for Infinite Potential Well
    b) Wave function for Finite Potential Well
    c) Probability Density function for Infinite Potential Well
    d) Probability Density function for Finite Potential Well
    Answer: [d]

55. For a particle inside a box of finite potential well, the particle is most stable at what position of x?
    a) $x > L$
    b) $x < 0$
    c) $0 < x < L$
    d) Not stable in any state
    Answer: [c]

MCQ on Tunnelling Effect

56. 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]

57. 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]

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

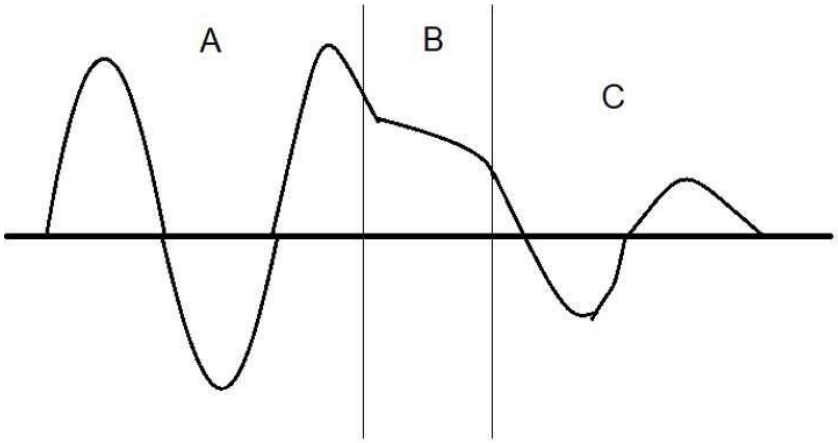
59. 4 MeV alpha particle crosses the 25 MeV potential barrier inside the nucleus due to
    a) Tunnelling Effect
    b) Compton Effect
    c) Photoelectric effect
    d) Uncertainty principle.
    Answer: [a]

60. The solution of Schrodinger wave equation for Tunnel effect is of the form _____
    a) $Ae^{ikx} + Be^{ikx}$
    b) $Ae^{ikx} - Be^{ikx}$
    c) $Ae^{ikx} + Be^{-ikx}$
    d) $Ae^{ikx} - Be^{-ikx}$

Answer: [c]

61. The particle with wave function $Ae^{kx} + Be^{-kx}$ represents_____
    a) Oscillating particle
    b) Moving Particle
    c) Probable Particle
    d) No such wave function
    Answer: [c]

62. In which of the following regions is E<V?



    a) A
    b) B
    c) C
    d) None of the regions
    Answer: [b]

63. What happens to a tunnel diode when the reverse bias effect goes beyond the valley point?
    a) it behaves as a normal diode
    b) it attains increased negative slope effects
    c) reverse saturation current increases
    d) becomes independent of temperature
    Answer: [a]

64. If ‘X’ corresponds to a tunnel diode and ‘Y’ to an avalanche diode, then_____
    a) X operates in reverse bias and Y operates in forward bias
    b) X operates in reverse bias and Y operates in reverse bias
    c) X operates in forward bias and Y operates in forward bias
    d) X operates in forward bias and Y operates in reverse bias
    Answer: [d]

65. Tunnel diode has a very fast operation in_____
    a) gamma frequency region
    b) ultraviolet frequency region
    c) microwave frequency region
    d) radio frequency region
    Answer: [c]

66. The depletion layer of tunnel diode is very small because _____
    a) its abrupt and has high dopants
    b) uses positive conductance property
    c) its used for high frequency ranges
    d) tunneling effect
    Answer: [a]

67. With interments of reverse bias, the tunnel current also increases because_____
    a) electrons move from valance band of p side to conduction band of n side
    b) fermi level of p side becomes higher than that of n side
    c) junction current decreases
    d) unequality of n and p band edge
    Answer: [a]

68. Tunnel diodes are made up of_____
    a) Germanium and silicon materials
    b) AlGaAs
    c) AlGaInP
    d) ZnTe
    Answer: [a]

69. The tunneling involves_____
    a) acceleration of electrons in p side
    b) movement of electrons from n side conduction band to p side valance band
    c) charge distribution management in both the bands
    d) positive slope characteristics of diode
    Answer: [b]

70. The range of tunnel diode voltage V_D, for which slope of its V-I characteristics is negative would be? (The V_P is the peak voltage and V_V is the valley voltage).
    a) $V_D > 0$
    b) $0 < V_D < V_p$
    c) $V_V > V_D > V_p$
    d) $V_V > V_D$
    Answer: [c]

71. The use of a scanning tunnelling microscope places a conducting tip
    a) 0.5 to 0.8 nm from the surface
    b) 0.4 to 0.7 nm from the surface
    c) 0.4 to 0.9 nm from the surface
    d) 0.3 to 0.5 nm from the surface
    Answer: [b]

72. In STM, Surface being imaged must be,
    a) Magnetic in nature
    b) Dielectric in nature
    c) Able to conduct electricity
    d) None of above
    Answer: [c]

73. 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]

74. 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]

75. Lateral resolution of STM is,
    a) 0.1 nm
    b) 1 nm
    c) 10 nm
    d) 0.01 nm
    Answer: [a]

MCQ on Quantum Computing

76. Quantum Computing involves_____of qubits,
    a) Superposition
    b) Entanglement

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

77. 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]

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

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

80. 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]