Chapter 1: MODERN PHYSICS

Multiple Choice Questions:

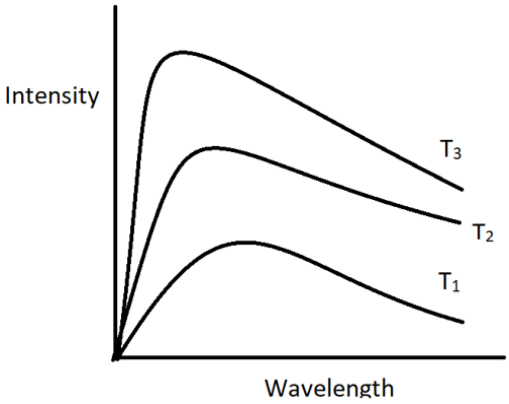
1. As the wavelength of the radiation decreases, the intensity of the black body radiations _____
   a) Increases
   b) Decreases
   c) First increases then decrease
   d) First decreases then increase
   Ans: (c)

2. 2. The radiations emitted by hot bodies are called as _____
   a) X-rays
   b) Black-body radiation
   c) Gamma radiations
   d) Visible light
   Ans: (b)

3. An iron rod is heated. The colors at different temperatures are noted. Which of the following colors shows that the iron rod is at the lowest temperature?
   a) Red
   b) Orange
   c) White
   d) Blue
   Ans: (a)

4. A black body is defined as a perfect absorber of radiations. It may or may not be a perfect emitter of radiations.
   a) True
   b) False
   Ans: (b)

5. From the figure, what's the relation between T_1, T_2, and T_3?



a) $T_1 > T_2 > T_3$
b) $T_3 > T_2 > T_2$
c) $T_3 > T_1 > T_2$
d) $T_2 > T_1 > T_3$
Ans: (b)

6. Electromagnetic wave theory of light could not explain Black Body radiations.
a) True
b) False
Ans: (a)

7. The unit of absorptive power is _____
a) T
b) Ts^{-1}
c) Ts
d) No unit
Ans: (d)

8. For an object other than a black body, it's emissivity, e is _____
a) 1
b) $0 < e < 1$
c) $e > 1$
d) $e = 0$
Ans: (b)

9. What relation between emissivity, e, and Absorptive Power, a, is given by Kirchhoff's law?
   a) e < a
   b) e > a
   c) e = a
   d) no specific relation
   Ans: (c)

10. Which of the following is the characteristic of a black body?
   a) A perfect absorber but an imperfect radiator
   b) A perfect radiator but an imperfect absorber
   c) A perfect radiator and a perfect absorber
   d) A perfect conductor

   Ans: (c)

11. The energy distribution is not uniform for any given temperature in a perfect black body.
   a) True
   b) False

   Ans: (a)

12. Rayleigh-Jean's law holds good for which of the following?
   a) Shorter wavelength
   b) Longer wavelength
   c) High temperature
   d) High energy

   Ans: (b)

13. Wien's displacement law holds good only for shorter wavelength.
   a) False
   b) True

   Ans: (b)

14. Which of the following does not affect the photon?
   a) Magnetic or electric field
   b) Light waves
   c) Gravity
   d) Current

   Ans: (a)

15. What is Compton shift?
    a) Shift in frequency
    b) Shift in charges
    c) Shift in radiation
    d) Shift in wavelength

    Ans: (d)

16. Compton shift depends on which of the following?
    a) Incident radiation
    b) Nature of scattering substance
    c) Angle of scattering
    d) Amplitude of frequency

    Ans: (c)

17. What is the relation between the interaction parameter, ‘b’, and atomic radius, R, for the Pair Production?
    a) $b > R$
    b) $b \approx R$
    c) $b < R$
    d) No relation between b and R

    An: (c)

18. For Pair Production phenomenon to occur the photon must have energy, greater than or equal to _____
    a) 0.51 MeV
    b) 1.02 MeV
    c) 0.32 MeV
    d) 0.85 MeV

    Ans: (b)

19. What kind of photon is required for the pair production phenomenon to occur?
    a) Visible Light Photon
    b) X-ray Photon
    c) γ-ray Photon
    d) UV Photon

    Ans: (c)

20. What are the rest mass energies for electron, E_e, and positron, E_P?
    a) E_e = 1.02 MeV, E_P = 1.02 MeV
    b) E_e = 0.51 MeV, E_P = 1.02 MeV
    c) E_e = 1.02 MeV, E_P = 0.51 MeV
    d) E_e = 0.51 MeV, E_P = 0.51 MeV

    Ans: (d)

21. Charge and momentum are conserved in Pair Production.
    a) True
    b) False

    Ans: (a)

22. A 3.0 MeV photon interacts with a lead nucleus in empty space. What would be the Kinetic Energy of the electron and positron pair?
    a) 2.01 MeV
    b) 1.5 MeV
    c) 1.45 MeV
    d) Electron-Positron pair won't be created

    Ans: (d)

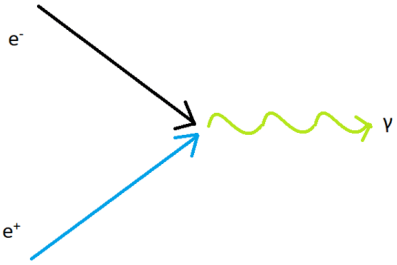
23. A photon of energy 4.1 MeV is incident on a lead nucleus, causing the creation of electron-positron pair. They travel perpendicular to the initial direction of the photon. The energy of the electron is _____
    a) 4.1 MeV
    b) 2.05 MeV
    c) 1.02 MeV
    d) 0.51 MeV

    Ans: (b)

24. Pair production does not occur in X-ray imaging.
    a) True
    b) False

    Ans: (a)

25. Which phenomenon is shown in the figure?



a) Pair Production
b) Photoelectric Effect
c) Compton effect
d) Pair annihilation

Ans: (d)

26. Ψ must be normalizable.
a) True
b) False

Ans: (a)

27. Which of the following is the correct expression for the total number of nodes without boundary conditions?
a) n – 1
b) l – 1
c) l + 1
d) n + 1

Ans: (a)

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

Ans: (b)

29. Which of the following is the correct expression for the Schrödinger wave function?

a) $\left[-\frac{\hbar^2}{2m}\frac{d^2\Psi}{dx^2}+U\right]\Psi = i\hbar\frac{d\Psi}{dt}$

b) $\left[\frac{\hbar^2}{2m}\frac{d^2\Psi}{dx^2}+U\right]\Psi = i\hbar\frac{d\Psi}{dt}$

c) $\left[\frac{\hbar^2}{2m}\frac{d^2\Psi}{dx^2}-U\right]\Psi = i\hbar\frac{d\Psi}{dt}$

d) $\left[-\frac{\hbar^2}{2m}\frac{d^2\Psi}{dx^2}+U\right]\Psi = -i\hbar\frac{d\Psi}{dt}$

Ans: (a)

30. For a quantum wave particle, E = _____

a) $\hbar$ k

b) $\hbar$ ω

c) $\hbar$ ω/2

d) $\hbar$ k/2

Ans: (b)

31. Schrodinger Wave equation can be derived from Principles of Quantum Mechanics.

a) True

b) False

Ans: (b)

32. Any wave function can be written as a linear combination of _____

a) Eigen Vectors

b) Eigen Values

c) Eigen Functions

d) Operators

Ans: (c)

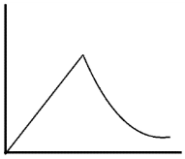
33. The Schrödinger is a differential equation.

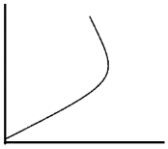
a) True

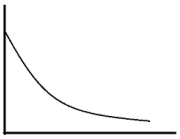
b) False

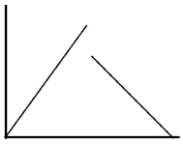
Ans: (b)

34. Which of the following can be a solution of Schrodinger equation?

a) 

b) 

c) 

d) 

Ans: (c)

35. In a finite Potential well, the potential energy outside the box is _____
    a) Zero
    b) Infinite
    c) Constant
    d) Variable

    Ans: (c)

36. The Schrodinger for the particle inside a finite potential well becomes _____
    a) $x > 0$
    b) $x < 0$
    c) $0 < X < L$
    d) $x > L$

    Ans: (c)

37. The Energy of the particle is proportional to _____
    a) n
    b) n^{-1}
    c) n^{2}
    d) n^{-2}

    Ans: (c)

38. When the Schrodinger equation is solved for E > V_o, the solutions will be _____
    a) Non-oscillatory
    b) Oscillatory Inside
    c) Oscillatory Outside
    d) Oscillatory inside as well as outside

    Ans: (d)

39. Particle in a box of finite potential can never be at rest.
    a) True
    b) False
    Ans: (a)

40. What is the minimum Energy possessed by the particle in a box?
    a) Zero
    b) $\frac{2mE}{\hbar^2}$
    c) $\frac{\hbar^2}{2m}$
    d) $\frac{n\pi x}{a}$

    Ans: (c)

41. 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)

Short Questions

1. What is quantum mechanics?
2. Give the physical interpretation of the wave function.
3. Explain normalization of the wave functions.
4. Describe De-Broglie's hypothesis and provide an experimental validity for the De Broglie's hypothesis.
5. Explain the Physical significance of Wave functions.

6. What you mean by $|\Psi|^2$?
7. What is the Schrodinger's postulate?
8. Define Stefan-Boltzmann's law.
9. Define Wien's displacement law.
10. Define Raleigh- Jean's law.
11. What is Compton Effect?
12. Define Eigen values and Eigen functions.
13. State the Heisenberg's uncertainty principle.

Long Questions

1. Describe Heisenberg's uncertainty principle?
2. Derive an expression for Schrodinger time independent wave equation.
3. Derive an expression for Schrodinger time dependent wave equation.
4. Derive an expression for the energy states of a Particle trapped in 1-Dimensional potential box. State the de Broglie hypothesis
5. What is Compton wavelength? Give its value.
6. What is the physical significance of wave function?
7. Find the energy of an electron in fundamental state confined to a one dimensional rigid box of length 1Å.
8. What are the applications of Schrödinger wave equations?
9. What is black body and what are its characteristics?
10. With which classical parameter, the Planck's constant can be correlated?
11. What is the value of average energy in Planck's black-body radiation distribution?
12. Write the time independent Schrodinger equation
13. Derive the one dimensional Schrodinger equation for a free particle
14. Derive the three dimensional Schrodinger equation for the motion of a particle under the action of a force using operator
15. Discuss the interpretation of a wave function
16. Derive the energy Eigen function for a particle in a square well potential
17. Derive the dimension less Schrodinger equation for simple harmonic oscillator
18. Define wave function. Give its significance and write conditions for a wave function to be well behaved.