Engineering physics – I

2Mark questions with Answers

UNIT – IV

QUANTUM PHYSICS

1. **State Plank's hypothesis.**

The atomic oscillators can absorb or emit energy in multiples of a small unit called quantum. The quantum of radiation is called photon. The energy of the photon (ε) is proportional to the frequency of radiation (v)

$$\varepsilon \propto v$$

i.e., $\varepsilon = hv$

where h is a constant known as Plank's constant.

2. **State Compton effect.**

When a beam of X-rays is scattered by a substance of low atomic number, the scattered radiation consists of two components. One has the same wavelength λ as the incident ray and the other has a slightly longer wavelength of scattered X-rays is known as Compton effect.

3. **What are matter waves?**

The waves associated with moving particles of matter (e.g., electrons, photons, etc) are known as matter waves or de-Broglie waves.

4. **How De-Broglie justified his concept?**

- Our universe is fully composed of light and matter.
- Nature loves symmetry. If radiation like light can act like wave and particle, then material particles (e.g., electron, neutron etc.) should also act as particle and wave.
- Every moving particle has always associated with a wave.

5. **Write an Expression for the de-Broglie wavelength associated with electrons.**

De-Broglie wave length associated with electrons accelerated by the potential V.

$$\lambda = h\sqrt{2m_0eV}$$

Where h=plank's constant
e= charge of the electron
m= mass of the electron
V=accelerating voltage

6. State the properties of the matter waves.

i. Lighter is the particle, greater is the wavelength associated with it.
ii. Smaller is the velocity of the particle, greater is wavelength associated with it.
iii. These waves are not electromagnetic waves.
iv. The velocity of de-Broglie wave is equal to the velocity of the material particle.

7. Mention some of the physical significances of the wave function.

The wave function (Ψ) relates the particle and wave nature of matter statistically. It is a complex quantity and hence we cannot measure it. If the particle is certainly to be found somewhere in a space of dimensions $dx,dy,dz,$ then the probability value is equal to one.i.e., $P=\iiint|\Psi|_2 dx\ dy\ dz=1$

8. What is an electron microscope?

- It is a microscope in which the object is illuminated by highly accelerated fast-moving electron beam.
- It has very high magnification of about 100,000 X and very high resolving power.
- It works on the principle of electron diffraction.

9. What is the basic principle in electron microscope?

The given object is illuminated by highly accelerated fast-moving electrons. The focussing of electron beam is done by magnetic fields The wave length associated with electron permits the detailed examination of tiny objects due to reduction of diffraction effects.

10. What are the types of electron microscope?

- Transmission Electron Microscope (TEM)
- Scanning Electron Microscope (SEM)

- Scanning Transmission Electron Microscope (STEM)
- Scanning Tunneling Microscope (STM)

11. Write an expression for the wavelength of matter waves?

Wavelength for matter waves is

$\lambda = \frac{h}{mv} = \frac{h}{p}$

Where h – Planck's constant

m – mass of the particle

v – velocity of the particle with which the wave is associated.

p- momentum of the particle

12. State Wien's displacement law.

It states that in the energy spectrum of a black body, the product of the wavelength corresponding to maximum energy (λ_m) and absolute temperature (T) is a constant. $\lambda_m T = constant$.

13. What is a wave function?

A variable quantity which characteristics de-Broglie wave is known as wave function and it is denoted by the symbol Ψ.

14. What are the disadvantages of STM?

- A small vibration, even a sound, could smash the tip and the sample together.
- A single dust particle, for example, could damage the needle.

15. Give the importance of Planck's radiation formula.

- It explains all regions of black body spectrum.
- It is based on quantum theory.
- t is used to derive other laws related to black body radiation.

16. Define tunneling effect.

Quantum mechanics leads to an entirely new result. It shows that there is a finite chance for the electron to leak to the other side of the barrier. We can say that the electron tunnelled through the potential barrier and hence in quantum mechanics, the phenomenon is called tunneling.

17. What is the principle of scanning tunnelling microscope?

STM has a metal needle that scans a sample by moving back and forth over it, gathering information about the curvature of the surface and follow the smallest changes in the contours of a sample. The needle doesn't touch the sample, however, but stays about the width of two atoms above it.

18. State Rayliegh – Jean's law

It states that the energy distribution in the block body spectrum is given by. $E\lambda = 8\pi kT\lambda_4$

Where, k – Boltzmann constant.

T – temperature

λ – wavelength

19. What is Compton wavelength?

The change in wavelength corresponding to scattering angle of 90_0 obtained in Compton wavelength.

Mathematically, $\Delta\lambda = hm_0c(1-cos\theta)$

When $\theta = 90_0, \Delta\lambda = hm_0c(1-cos90_0)$

$= hm0c(1-0)$

$hm_0c = 0.0243$

This is known as Compton wavelength of electron

20. Brief about the tunneling phenomenon?

In quantum mechanics a particle having lesser energy than the potential barrier can easily cross over the potential barrier by tunnelling through the barrier. This process is called tunnelling.

21. What are differences between Optical and Electron Microscopes?

Sl. No	Optical Microscope	Electron Microscope
1	Lenses used are made of glass.	Lenses are formed by electrostatic or magnetic fields.
2	Magnifying power attainable is of about 2,000 X.	Magnifying power attainable is of about 1,00,000 X.

3	It has a large aperture	It has a small aperture.
4	It resolves to the extent of 0.00002 m.	Inspite of its smaller aperture it has still higher resolving power.