# PHYSICS CLASS XII
# CHAPTER – 11 DUAL NATURE OF RADIATION AND MATTER

**Q.1. Write the relationship of de-Brogile wavelength $\lambda$ associated with a particle of mass m in tems of its kinetic energy K.**

**Ans.** Kinetic energy, K = $\frac{P^2}{2m}$

where, p = momentum, m = mass and

K = kinetic energy

$\Rightarrow$ p = $\sqrt{2mK}$

de-Broglie wavelength, $\lambda = \frac{h}{p} \Rightarrow \lambda = \frac{h}{\sqrt{2mK}}$.

**Q.2. A proton and an electron have same kinetic energy. Which one has greater de-Broglie wavelength and why?**

**Ans.** De-Brogile wavelength

$$\lambda = \frac{h}{P} = \frac{h}{\sqrt{2mK}} where\ K = KE$$

For given KE, $\lambda \propto \frac{1}{\sqrt{m}}$

$\because$ Electrons have smaller mass, $\lambda_e > \lambda_P$

For given kinetic energy, electrons have greater de-Broglie wavelength as these have smaller mass.





Address: Plot No 420, Behind Shopprix Mall, Vaishali Sector 5, Ghaziabad – 201010
M: 9999907099, 9818932244 O: 0120-4130999
Website: www.vaishalieducationpoint.com , www.educationsolution.co

**Q.3. Name an experiment which shows wave nature of electron. Which phenomenon was observed in this experiment using an electron beam?**

**Ans.** Davisson-German experiment shows wave nature of electron. Phenomena of constructive interference was observed in Davisson-Germer experiment.

**Q.4. What consideration led de-Brogile to suggest that material particles can also show wave property?**

**Ans.** Nature loves symmetry and matter can be converted into energy and vice-versa, i.e., matter and energy are two forms of the same entity.

**Q.5. If an electron behaves like a wave, what should determine the wavelength and frequency of this wave.**

**Ans.** Momentum and Energy

**Q.6. Is there any difference between light waves and matter waves?**

**Ans.** Yes, the velocity of light waves in vacuum is constant, whereas the velocity of matter waves in vacuum depends upon the wavelength of matter wave.

**Q.7. Why is the wave nature of matter not more apparent to our daily observations?**

**Ans.** de-Broglie wavelength associated with a body of mass (m), moving with velocity v is given by $\lambda = \frac{h}{mv}$. Since, the mass of the objects used in our daily life is very large, hence the de-Broglie wavelength associated with them is quite small and is not visible. Hence, the wave nature of matter is not more apparent to our daily observations.





Address: Plot No 420, Behind Shopprix Mall, Vaishali Sector 5, Ghaziabad – 201010
M: 9999907099, 9818932244 O: 0120-4130999
Website: www.vaishalieducationpoint.com , www.educationsolution.co

**Q.8. Radiation has dual nature i.e., it possesses the properties of both, wave and particle. This prompted de Broglie to predict dual nature of moving material particles. Thus, waves are associated with moving material particles which are called matter waves. The wavelength of matter waves is given by $\lambda = \frac{h}{mv}$, where m is the mass, v is the speed of the particle and h is Plank's constant.**

**Read the above para and answer the following questions**

**(i) How was the wave nature of electron established?**

**(ii) What are the de-Broglie wavelength associated with a particle (i) at rest (ii) moving with infinite speed?**

**(iii) What are the basic values displayed by this study?**

**Ans.** (i) Davisson and Germer observed diffraction patterns of slow moving electrons. And G.P. Thomson observed diffraction pattern of fast moving electrons. As diffraction is essentially a wave phenomenon, therefore, it was concluded that wave must be associated with moving electrons.

(ii) (a) At rest, $v = 0$, $\lambda = \frac{h}{mv} = \frac{h}{m\times 0} = \infty$

(b) Particle moving with infinite speed, $v = \infty$

$$\lambda = \frac{h}{mv} = \frac{h}{m\times\infty} = 0$$

(iii) The dual nature of moving material particles reveals in a way the nature of almighty God. He is in a visible form (i.e., Sakar) like a visible particle and also without any form (i.e., Nirakar) like a wave. It depends on us how we realize him.





Address: Plot No 420, Behind Shopprix Mall, Vaishali Sector 5, Ghaziabad – 201010
M: 9999907099, 9818932244 O: 0120-4130999
Website: www.vaishalieducationpoint.com , www.educationsolution.co

**Q.9. In a multi-storied building, once a fire broke out at midnight due to electrical short circuit. Vishwajeet along with others rushed to the spot, informed the fire station and put off the fire. By that time a huge amount of damage had been already done. Vishwajeet being secratery of the building decided to fix fire alarms (using photo cells) in all floors.**

**Read the above passage and answer the following questions.**

**(i) What values were shown by Vishwajeet in this situation?**

**(ii) A human eye can perceive a minimum light intensity is about $10^{-10}$ W/$m^2$. Calculate the number of photons of wavelength 5.6 × $10^{-7}$ m that must enter the pupil of area $10^{-4}$ $m^2$ for vision?**

**Ans.** (i) The values shown by Vishwajeet are

(a) Concern for society

(b) Social responsibility

(c) Application of knowledge

(ii) Energy falling on area per sec

$$= 10^{-10} \times 10^{-4}$$

But Energy/s = $\frac{nhc}{\lambda}$

$$\Rightarrow \quad n = \frac{Energy/s \times \lambda}{hc}$$

$$= \frac{10^{10} \times 10^{-4} \times 5.6 \times 10^{-7}}{6.63 \times 10^{-34} \times 3 \times 10^{8}}$$





Address: Plot No 420, Behind Shopprix Mall, Vaishali Sector 5, Ghaziabad – 201010
M: 9999907099, 9818932244 O: 0120-4130999
Website: www.vaishalieducationpoint.com , www.educationsolution.co

= $2.82 \times 10^4$ photons/s





Address: Plot No 420, Behind Shopprix Mall, Vaishali Sector 5, Ghaziabad – 201010
M: 9999907099, 9818932244 O: 0120-4130999
Website: www.vaishalieducationpoint.com , www.educationsolution.co