22. An electron of mass m and a photon have the same energy E. The ratio of de-Broglie wavelength associated with them is,

A. $\left(\frac{E}{2m}\right)^{1/2}$

B. $c\,(2mE)^{1/2}$

C. $\frac{1}{c}\left(\frac{2m}{E}\right)^{1/2}$

D. $\frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$

Ans-(D)

Given that electron has a mass m.

De-Broglie wavelength for an electron will be given as,

$$\lambda_e = \frac{h}{p} \quad \text{... (i)}$$

where,

h is the Planck's constant, and
p is the linear momentum of electron

Kinetic energy of electron is given by, $E = \frac{p^2}{2m}$

$$\Rightarrow \quad p = \sqrt{2mE} \quad \text{... (ii)}$$

From equation (i) and (ii), we have

$$\lambda_e = \frac{h}{\sqrt{2mE}} \quad \text{... (iii)}$$

Energy of a photon can be given as,

$$E = h\nu$$

$$\Rightarrow E = \frac{hc}{\lambda_P}$$

$$\Rightarrow \lambda_P = \frac{hc}{E} \quad \text{... (iv)}$$

Hence, λ_P is the de-Broglie wavelength of photon.

Now, dividing equation (iii) by (iv), we get

$$\frac{\lambda_e}{\lambda_P} = \frac{h}{\sqrt{2mE}} \cdot \frac{E}{hc}$$

$$\Rightarrow \frac{\lambda_e}{\lambda_P} = \frac{1}{c} \cdot \sqrt{\frac{E}{2m}}$$