Vidhi Shah 21BCE1297 E2 + TE2

BPHY101L DA2 - B

Q3 Compute the KE of proton for which de-Broglie wavelength is 1 picometer.

De-Broglie wavelength, $\lambda = \frac{h}{mv}$

$$\lambda^2 = \frac{h^2}{m^2v^2} \quad -(1)$$

$$KE = \frac{1}{2}mv^2 \Rightarrow mv^2 = 2KE \quad -(2)$$

Substituting (2) in (1)

$$\Rightarrow \lambda^2 = \frac{h^2}{2m(KE)}$$

$$\Rightarrow KE = \frac{h^2}{2m\lambda^2}$$

Now, $h = 6.6 \times 10^{-34}$ Js
$m = 9.1 \times 10^{-31}$ kg
$\lambda = 10^{-12}$ m

$$\Rightarrow KE = \frac{(6.6 \times 10^{-34})^2}{2 \times 9.1 \times 10^{-31} \times (10^{-12})^2}$$

$$= \frac{(6.6)^2}{2 \times 9.1} \times 10^{-13}$$

$$\Rightarrow \boxed{KE = 2.4 \times 10^{-13} \text{ J}}$$
$$\Rightarrow \boxed{KE = 1.5 \times 10^{6} \text{ eV}}$$

Q4 Compute the energy and momentum of a photon of wavelength 700 nm.

(i) According to Planck's constant formula,

$$E = \frac{hc}{\lambda}$$

$$\Rightarrow E = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{700 \times 10^{-9}}$$

$$= \frac{19.8}{700} \times 10^{-17}$$

$$\Rightarrow \boxed{E = 2.83 \times 10^{-19} \text{ J}}$$

$$\Rightarrow \boxed{E = 1.77 \text{ eV}}$$

(ii) $$\lambda = \frac{h}{mv}$$

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

$$\Rightarrow p = \frac{6.6 \times 10^{-34}}{700 \times 10^{-9}}$$

$$\Rightarrow p = 0.943 \times 10^{-27} \text{ kg m/s}$$

$$\Rightarrow \boxed{p = 9.43 \times 10^{-28} \text{ Kg.m/s}}$$