Related Problems

Question 3

The work function for cesium atom is 1.9 eV. Calculate (a) the threshold wavelength and (b) the threshold frequency of the radiation. If the cesium element is irradiated with a wavelength 500 nm, calculate the kinetic energy and the velocity of the ejected photoelectron

Answer:

$$E_0 = 1{\cdot}9\ \text{eV} = 1{\cdot}9 \times 1{\cdot}602 \times 10^{-19}\ \text{J}$$

$$\text{Threshold frequency } (\nu_0) = \frac{E_0}{h} = \frac{1{\cdot}9 \times 1{\cdot}602 \times 10^{-19}\ \text{J}}{6{\cdot}626 \times 10^{-34}\ \text{Js}} = 0{\cdot}459 \times 10^{15}\ \text{s}^{-1} = \mathbf{4{\cdot}59 \times 10^{14}\ s^{-1}}$$

$$\text{Threshold wavelength } (\lambda_0) = \frac{c}{\nu_0} = \frac{3 \times 10^8\ \text{m s}^{-1}}{4{\cdot}59 \times 10^{14}\ \text{s}^{-1}} = 0{\cdot}6536 \times 10^{-6}\ \text{m} = \mathbf{653{\cdot}6\ nm \approx 654\ nm}$$

$$E = E_0 + \frac{1}{2}mv^2$$

$$\text{Kinetic energy } \left(\frac{1}{2}mv^2\right) = E - E_0 = hc\left[\frac{1}{\lambda} - \frac{1}{\lambda_0}\right]$$

$$= \frac{(6{\cdot}626 \times 10^{-34}\ \text{Js}) \times (3 \times 10^8\ \text{m s}^{-1})}{10^{-9}\ \text{m}} \times \left[\frac{1}{500} - \frac{1}{654}\right]$$

$$= \frac{6{\cdot}626 \times 3 \times 154}{500 \times 654} \times 10^{-34+8+9} = \mathbf{9{\cdot}36 \times 10^{-20}\ J}$$

$$\text{Velocity } (v) = \sqrt{\frac{2 \times 9{\cdot}36 \times 10^{-20}}{m}\ \text{J}} = \sqrt{\frac{2 \times 9{\cdot}36 \times 10^{-20}\ \text{kg m}^2\text{s}^{-2}}{9{\cdot}1 \times 10^{-31}\ \text{kg}}}$$

$$= \sqrt{2{\cdot}057 \times 10^{11}\ \text{m}^2\ \text{s}^{-2}} = \sqrt{20{\cdot}57 \times 10^{10}\ \text{m}^2\ \text{s}^{-2}} = \mathbf{4{\cdot}5356 \times 10^5\ m\ s^{-1}}$$