2.11 It is desired to produce x-ray radiation with a wavelength of 1 Å. (*a*) Through what potential voltage difference must the electron be accelerated in vacuum so that it can, upon colliding with a target, generate such a photon? (Assume that all of the electron's energy is transferred to the photon.) (*b*) What is the de Broglie wavelength of the electron in part (*a*) just before it hits the target?

a) From section 2.1, Given,

$$E = h\nu = \frac{hc}{\lambda} = \frac{6.62607015\times10^{-34}(2.99792458\times10^{8})}{1\times10^{-10}}$$
$$= 1.0986446\times10^{-15}\ \text{J}(1\text{eV}/1.602176634\times10^{-19}\text{J}) = 12398.42\,\text{eV}$$

$V = E$ (eV)/e = 12398.42 eV/e ⇒ **V = 12,398.42 V**

b) From classical physics, the momentum of the electron is

$$p = \sqrt{2m_0E} = \sqrt{2(9.1093837\times10^{-31})1.0986446\times10^{-15}} = 4.473919\times10^{-23}\,\text{kg-m/s}$$

Per (2.3), the deBroglie wavelength is

$$\lambda = \frac{h}{p} = \frac{6.62607015\times10^{-34}}{4.473919\times10^{-23}}$$ ⇒ **$\lambda = 1.481044\times10^{-11}$ m = 0.1481 Å**