Solution

What size wavelengths are we talking about? Consider a photon with energy 3 eV, and therefore momentum p = 3 eV/c. Its wavelength is:

$$\lambda = \frac{h}{p} = \frac{4.14\times10^{-15}\ eV\cdot s}{3\ eV}\times c = \left(1.4\times10^{-15}\ s\ \right)\times\left(3\times10^{8}\ m/s\right) = 414\ nm$$

What is the wavelength of an electron with the same momentum?

a) $\lambda_e < \lambda_p$ **b) $\lambda_e = \lambda_p$** c) $\lambda_e > \lambda_p$

λ = h/p for all objects, so equal p means equal λ.

Note that the kinetic energy of the electron does not equal the energy of a photon with the same momentum (and wavelength):

$$KE = \frac{p^2}{2m} = \frac{h^2}{2m\lambda^2} = \frac{\left(6.625\times10^{-34}\ \mathrm{J\cdot s}\right)^2}{2(9.11\times10^{-31}\mathrm{kg})(414\times10^{-9}\ \mathrm{m})^2}$$

$$= 1.41\times10^{-24}\ \mathrm{J} = \boxed{8.8\times10^{-6}\ \mathrm{eV}}$$