

45. The initial wavelength of the photon is (using the result of problem 3)

$$\lambda = \frac{hc}{E} = \frac{1240 \text{ eV} \cdot \text{nm}}{17500 \text{ eV}} = 0.07086 \text{ nm}$$

or 70.86 pm. The maximum Compton shift occurs for $\phi = 180^\circ$, in which case Eq. 39-11 (applied to an electron) yields

$$\Delta\lambda = \left(\frac{hc}{m_e c^2} \right) (1 - \cos 180^\circ) = \left(\frac{1240 \text{ eV} \cdot \text{nm}}{511 \times 10^3 \text{ eV}} \right) (1 - (-1)) = 0.00485 \text{ nm}$$

where Table 38-3 is used. Therefore, the new photon wavelength is $\lambda' = 0.07086 \text{ nm} + 0.00485 \text{ nm} = 0.0757 \text{ nm}$. Consequently, the new photon energy is

$$E' = \frac{hc}{\lambda'} = \frac{1240 \text{ eV} \cdot \text{nm}}{0.0757 \text{ nm}} = 1.64 \times 10^4 \text{ eV} = 16.4 \text{ keV} .$$

By energy conservation, then, the kinetic energy of the electron must equal $E' - E = 17.5 \text{ keV} - 16.4 \text{ keV} = 1.1 \text{ keV}$.