2.15 (*a*) The electron's energy is measured with an uncertainty no greater than 0.8 eV. Determine the minimum uncertainty in the time over which the measurement is made. (*b*) The uncertainty in the position of an electron is no greater than 1.5 Å. Determine the minimum uncertainty in its momentum.

a) We are given $\Delta E = 0.8$ eV. Per (2.5), $\Delta E \, \Delta t \geq \hbar$. Therefore, the minimum uncertainty in time is

$$\Delta t = \frac{\hbar}{\Delta E} = \frac{6.58211957 \times 10^{-16} \text{ eV•s}}{0.8 \text{ eV}} \quad \Rightarrow \quad \underline{\boldsymbol{\Delta t = 8.22765 \times 10^{-16} \text{ s}}}$$

b) We are given $\Delta x = 1.5$ Å. Per (2.4), $\Delta p \, \Delta x \geq \hbar$. Therefore, the minimum uncertainty in momentum is

$$\Delta p = \frac{\hbar}{\Delta x} = \frac{1.054571817 \times 10^{-34} \text{ J•s}}{1.5 \times 10^{-10} \text{ m}} \quad \Rightarrow \quad \underline{\boldsymbol{\Delta p = 7.03048 \times 10^{-25} \text{ kg-m/s}}}$$