

$$\begin{aligned}
 5-22. \quad (a) \quad \lambda &= h/p = h/\sqrt{2mE_k} = hc/\sqrt{2mc^2E_k} \\
 &= \frac{1240 \text{ eV}\cdot\text{nm}}{[2(0.511 \times 10^6 \text{ eV})(5 \text{ eV})]^{1/2}} = 0.549 \text{ nm}
 \end{aligned}$$

$$d \sin \theta = \lambda/2 \text{ For first minimum (see Figure 5-16).}$$

$$d = \frac{\lambda}{2 \sin \theta} = \frac{0.549 \text{ nm}}{2 \sin 5^\circ} = 3.15 \text{ nm slit separation}$$

$$(b) \quad \sin 5^\circ = 0.5 \text{ cm}/L \text{ where } L = \text{distance to detector plane} \quad L = \frac{0.5 \text{ cm}}{2 \sin 5^\circ} = 5.74 \text{ cm}$$

$$5-25. \quad (a) \quad \text{At } x = 0: \quad P dx = |\psi(0,0)|^2 dx = |A e^0|^2 dx = A^2 dx$$

$$(b) \quad \text{At } x = \sigma: \quad P dx = |A e^{-\sigma^2/4\sigma^2}|^2 dx = |A e^{-1/4}|^2 dx = 0.61 A^2 dx$$

$$(c) \quad \text{At } x = 2\sigma: \quad P dx = |A e^{-4\sigma^2/4\sigma^2}|^2 dx = |A e^{-1}|^2 dx = 0.14 A^2 dx$$

(d) The electron will most likely be found at $x = 0$, where $P dx$ is largest.

$$5-30. \quad \Delta x \Delta p \approx \hbar \rightarrow \lambda \Delta p \approx h \rightarrow \Delta p \approx h/\lambda. \text{ Because } \lambda = h/p, p = h/\lambda; \text{ thus } \Delta p = p.$$

$$5-37. \quad E = hf \rightarrow \Delta E = h \Delta f$$

$$\Delta E \Delta t \approx h \rightarrow \Delta f \Delta t \approx 1 \text{ where } \Delta t = 0.85 \text{ ms}$$

$$\Delta f = 1/0.85 \text{ ms} = 1.$$

$$\text{For } \lambda = 0.01 \text{ nm} \quad f = c/\lambda = \frac{3.00 \times 10^8 \text{ m/s} \times 10^9 \text{ nm/s}}{0.01 \text{ nm}} 18 \times 10^9 \text{ Hz}$$

$$f = 3.00 \times 10^{19} \text{ Hz}$$

$$\frac{\Delta f}{f} = \frac{1.18 \times 10^9 \text{ Hz}}{3.00 \times 10^{19} \text{ Hz}} = 3.9 \times 10^{-11}$$

