P41.2 \( \frac{1}{2} \)

P41.4 (a) 4 (b) 6.03 eV

P41.6 \( 9.56 \times 10^{12} \)

P41.8 \( \left( \frac{3\hbar}{8m_e c} \right)^{1/2} \)

P41.10 (a) 5.13 meV (b) 9.41 eV (c) The much smaller mass of the electron requires it to have much more energy to have the same momentum.

P41.12 (a) \( \left( \frac{15\hbar}{8m_e c} \right)^{1/2} \) (b) \( 1.25\lambda \)

P41.14 (a) \( \frac{L}{2} \) (b) \( 5.26 \times 10^{-5} \) (c) \( 3.99 \times 10^{-2} \) (d) See the solution.

P41.16 (a) 0.196 (b) The classical probability is 0.333, significantly larger. (c) 0.333 for both classical and quantum models.

P41.18 (a) \( \frac{L}{2} - \frac{1}{2\pi} \sin \left( \frac{2\pi \ell}{L} \right) \) (b) See the solution. (c) The wave function is zero for \( x < 0 \) and for \( x > L \). The probability at \( \ell = 0 \) must be zero because the particle is never found at \( x < 0 \) or exactly at \( x = 0 \). The probability at \( \ell = L \) must be 1 for normalization. This statement means that the particle is always found somewhere at \( x < L \). (d) \( \ell = 0.585L \)

P41.20 See the solution; \( \frac{\hbar^2 k^2}{2m} \)

P41.22 (a) \( \frac{\hbar^2}{2mL^2} \left( \frac{4x^2}{L^2} - 6 \right) \) (b) See the solution.

P41.24 (a) \( \psi_1 (x) = \sqrt{\frac{2}{L}} \cos \left( \frac{\pi x}{L} \right) \) \( R_1 (x) = \frac{2}{L} \cos^2 \left( \frac{\pi x}{L} \right) \) \( \psi_2 (x) = \sqrt{\frac{2}{L}} \sin \left( \frac{2\pi x}{L} \right) \) \( P_2 (x) = \frac{2}{L} \sin^2 \left( \frac{2\pi x}{L} \right) \)

\( \psi_3 (x) = \sqrt{\frac{2}{L}} \cos \left( \frac{3\pi x}{L} \right) \) \( P_3 (x) = \frac{2}{L} \cos^2 \left( \frac{3\pi x}{L} \right) \) (b) See the solution.

P41.26 See the solution.

P41.28 \( 1.03 \times 10^{-3} \)

P41.30 (a) 0.903 (b) 0.359 (c) 0.417 (d) \( 10^{-6.59\times10^{12}} \)
P41.32 85.9

P41.34 3.92%

P41.36 (a) See the solution. \( b = \frac{m\omega}{2\hbar} \) (b) \( E = \frac{3}{2} h \omega \)  (c) first excited state

P41.38 (a) \( B = \left( \frac{m\omega}{\pi \hbar} \right)^{\frac{1}{4}} \)  (b) \( \delta \left( \frac{m\omega}{\pi \hbar} \right)^{\frac{1}{2}} \)

P41.40 See the solution.

P41.42 (a) \( 2.00 \times 10^{-10} \text{ m} \)  (b) \( 3.31 \times 10^{-24} \text{ kg} \cdot \text{m/s} \)  (c) 0.172 eV

P41.44 See the solution.

P41.46 (a) See the solution.  (b) 0.092 0 , 0.908

P41.48 (a) See the solution.  (b) 0.200  (c) 0.351  (d) 0.377 eV , 1.51 eV

P41.50 (a) \( \frac{h^2}{4mL^2} , \frac{5h^2}{8mL^2} , \frac{h^2}{mL^2} , \frac{5h^2}{4mL^2} \)  (b) See the solution, \( \frac{3h^2}{4mL^2} \)

P41.52 (a) \( \frac{2}{\sqrt{L}} \)  (b) 0.409

P41.54 (a) \( \sqrt{\left( \frac{nhc}{2L} \right)^2 + m^2 c^4 - mc^2} \)  (b) 46.9 fJ; 28.6%

P41.56 (a) \( \frac{3h \omega}{2} \)  (b) \( x = 0 \)  (c) \( \pm \sqrt{\frac{\hbar}{m\omega}} \)  (d) \( \left( \frac{4m^3 \omega^3}{\pi \hbar^3} \right)^{\frac{1}{4}} \)  (e) 0  (f) \( 8\delta \left( \frac{m\omega}{\hbar \pi} \right)^{\frac{1}{2}} e^{-4} \)

P41.58 (a) 0  (b) 0  (c) \( (2a)^{-\frac{1}{2}} \)