C 10. If the photons behaved like ordinary Newtonian particles, the particles would hit the screen at equal distances from the midpoint. This would give \( y-x=0 \) for all the particles. So the graph in Figure 14.12 would look like a single dot out from \( y-x=0 \):

\[
\begin{array}{c}
\text{# of 2-particle impacts}\uparrow \\
\downarrow \quad \text{\# of 2-particle impacts}\downarrow \\
\end{array}
\]

24. Length 2 m A standing wave can be set up in increments of \( \frac{1}{2} \lambda \).

\[
\begin{array}{c}
\lambda = 4 m \quad \lambda = 2 m \\
\lambda = 1 m \quad \lambda = 0.5 m
\end{array}
\]

So the string can vibrate with a standing wave of 0.5 m wavelength, but not wavelengths of 2.1 m or 1.9 m.

29. Yes, the atom would have more mass in the excited state. In the excited state, the atom has more energy. We know by \( E=mc^2 \) that energy is related directly to mass. So with higher energy, the atom also has more mass.

33. The energy change between \( E_2 \) and \( E_1 \) is the greatest. Photon energy is directly related to its frequency \( (E=h\nu) \), so the transition \( E_2 \) to \( E_1 \) gives photons with highest frequency. The transition \( E_4 \) to \( E_2 \) has the lowest energy change, so gives photons with the lowest frequency and longest wavelength \( (c=\lambda f) \).

5. \( E_{\text{photon}} = E_3 - E_2 = 3 \times 10^{-19} J = hf \)

\[
f = \frac{6.626 \times 10^{-34} J s}{3 \times 10^{-19} J} = 2.2 \times 10^{15} Hz
\]

This is in the visible region of the electromagnetic spectrum.