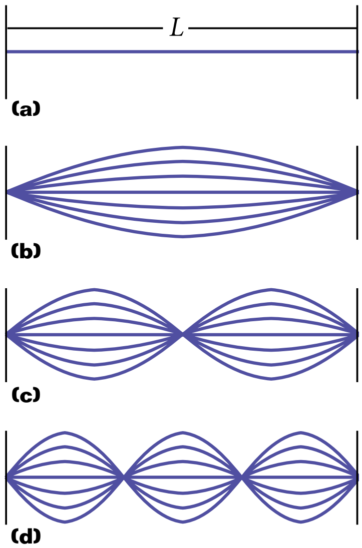

Figure 21
Only certain frequencies produce standing waves on this fixed string. The wavelength of these standing waves depends on the string length. Possible wavelengths include $2L$ **(b)**, L **(c)**, and $\frac{2}{3}L$ **(d)**.

Only certain frequencies, and therefore wavelengths, produce standing wave patterns. **Figure 21** shows standing waves for a given string length. In each case, the curves represent the position of the string at different instants of time. If the string were vibrating rapidly, the several positions would blur together and give the appearance of loops, like those shown in the diagram. A single loop corresponds to either a crest or trough alone, while two loops correspond to a crest and a trough together, or one wavelength.

The ends of the string must be nodes because these points cannot vibrate. As you can see in **Figure 21,** a standing wave can be produced for any wavelength that allows both ends of the string to be nodes. For example, in **Figure 21(b),** each end is a node, and there are no nodes in between. Because a single loop corresponds to either a crest or trough alone, this standing wave corresponds to one-half of a wavelength. Thus, the wavelength in this case is equal to twice the string length ($2L$).

The next possible standing wave, shown in **Figure 21(c),** has three nodes: one at either end and one in the middle. In this case, there are two loops, which correspond to a crest and a trough. Thus, this standing wave has a wavelength equal to the string length (L). The next case, shown in **Figure 21(d),** has a wavelength equal to two-thirds of the string length $\left(\frac{2}{3}L\right)$, and the pattern continues. Wavelengths between the values shown here do not produce standing waves because they allow only one end of the string to be a node.

SECTION REVIEW

1. A wave of amplitude 0.30 m interferes with a second wave of amplitude 0.20 m. What is the largest resultant displacement that may occur?
2. A string is rigidly attached to a post at one end. Several pulses of amplitude 0.15 m sent down the string are reflected at the post and travel back down the string without a loss of amplitude. What is the amplitude at a point on the string where the maximum displacement points of two pulses cross? What type of interference is this?
3. How would your answer to item 2 change if the same pulses were sent down a string whose end is free? What type of interference is this?
4. A stretched string fixed at both ends is 2.0 m long. What are three wavelengths that will produce standing waves on this string? Name at least one wavelength that would not produce a standing wave pattern, and explain your answer.
5. **Interpreting Graphics** Look at the standing wave shown in **Figure 22.** How many nodes does this wave have? How many antinodes?

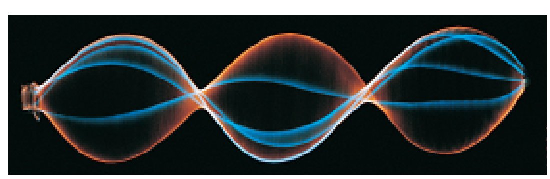

Figure 22