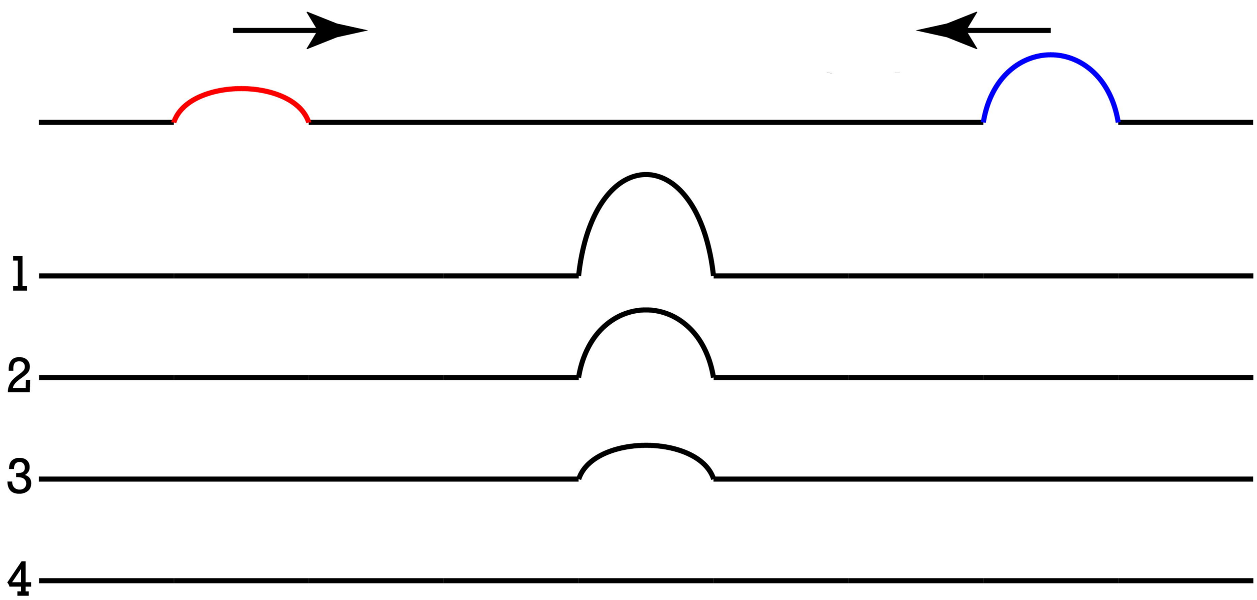
Flipping Physics Lecture Notes:

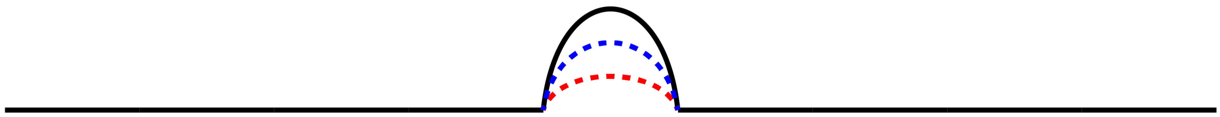
Wave Superposition Multiple Choice Problems

While I do prefer to show real demonstrations of physics concepts, wave interference via superposition is an Problem where we should go over some idealized multiple-choice problems. So here goes.

First Problem: Two wave pulses on the same string are headed towards one another as shown. When both occupy the same space, which diagram best describes the resulting wave form?
(Wave pulses are shown with different colors to make them easier to visualize and talk about.)

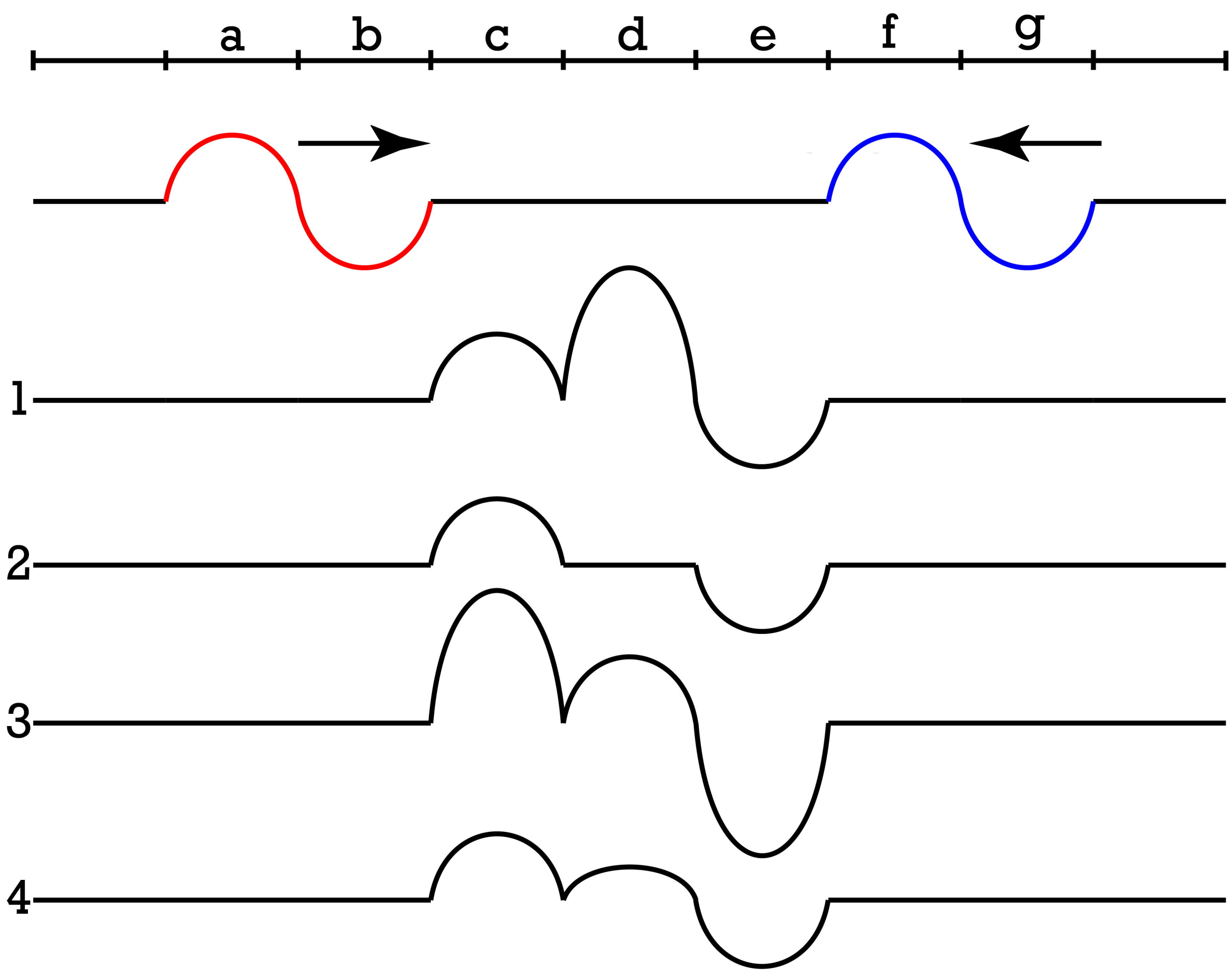


The correct answer is 1. This is wave interference via superposition. The two waves constructively interfere, and the resultant waveform is the addition of the two original waves:

1


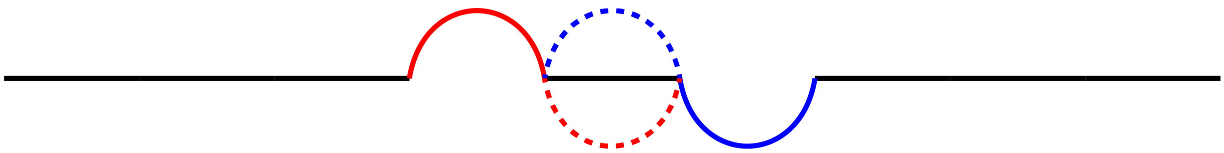
It is important to realize what happens after the two wave pulses interfere with one another. They will simply move on as if they never interfered in the first place. Which looks like this:

Second Problem: Two waves on the same string are headed towards one another as shown. When the red wave occupies locations c and d and the blue wave occupies locations d and e, which diagram best describes the resulting wave form?
(Wave pulses are shown with different colors to make them easier to visualize and talk about.)

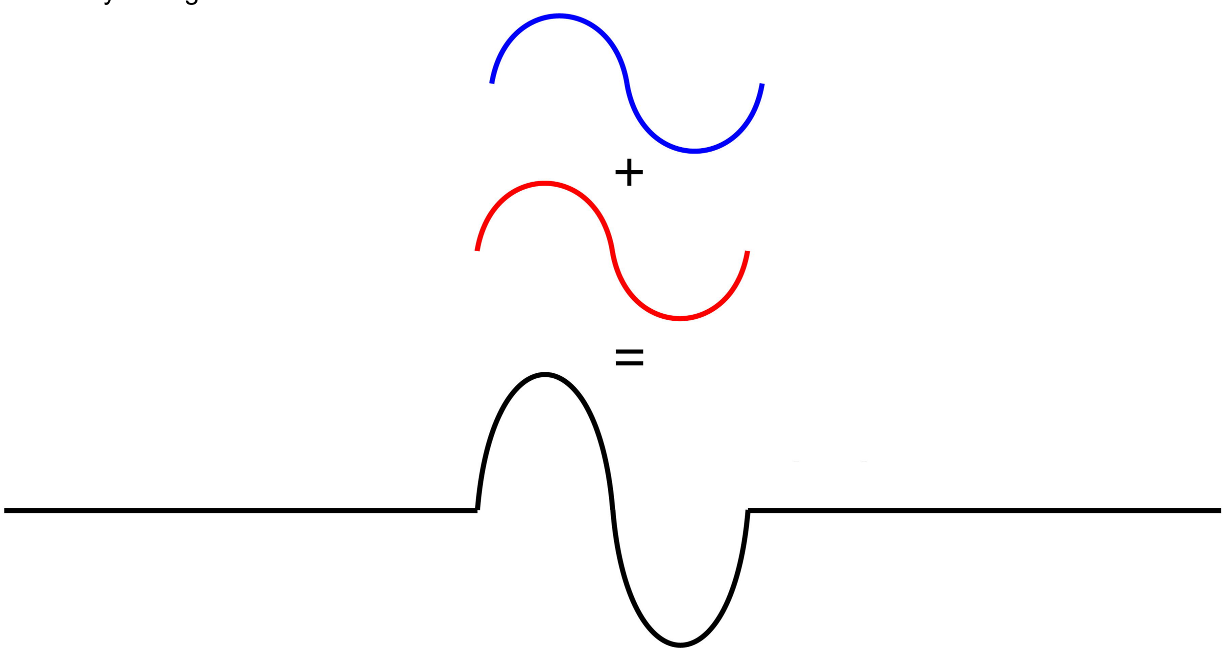


The correct answer is 2: Again, this is wave interference via superposition. However, the two waves only interfere with one another when they occupy the same space. They do **not** occupy the same space in regions c and e. They only occupy the same space in region d. Therefore, the original waves are still there in regions c and e. In region d, the two waves destructively interfere, and the resultant waveform is the addition of the two original waves. In fact, in this case, because the two waves have the same shape and amplitude, however, are on opposite sides of the string, the result is total destructive interference in region d. In other words, the string is completely flat in region d.

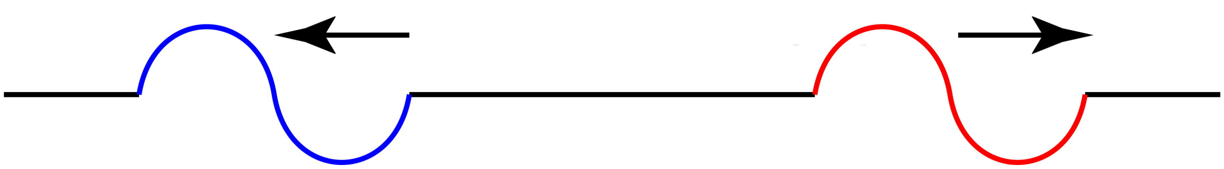
2



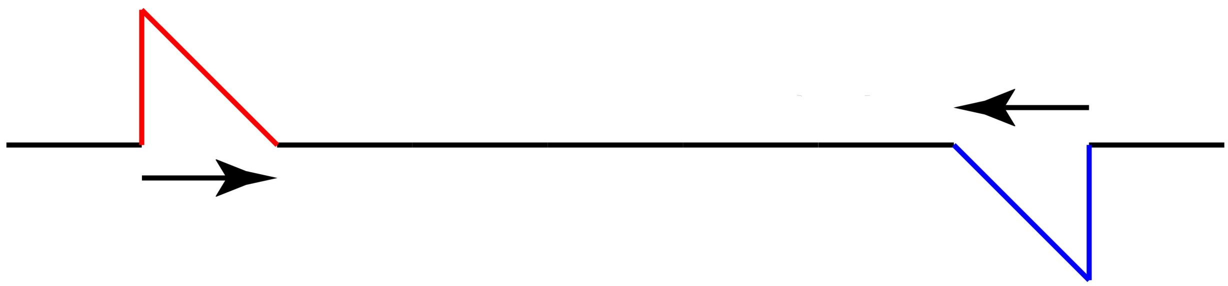
And here is what the two waves will look like while they occupy the same space which is halfway through c to halfway through e:



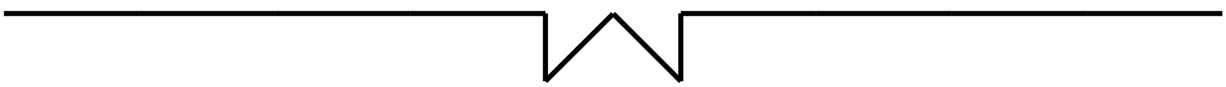
Again, it is important to realize what happens after the two wave pulses interfere with one another. They will simply move on as if they never interfered in the first place. Which looks like this:



Third Problem: Two wave pulses on the same string are headed towards one another as shown. When both occupy the same space, which diagram best describes the resulting wave form?
(Wave pulses are shown with different colors to make them easier to visualize and talk about.)



1



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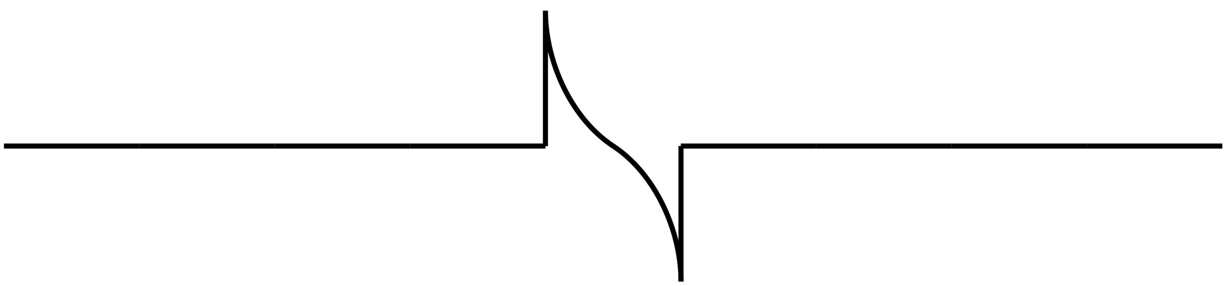

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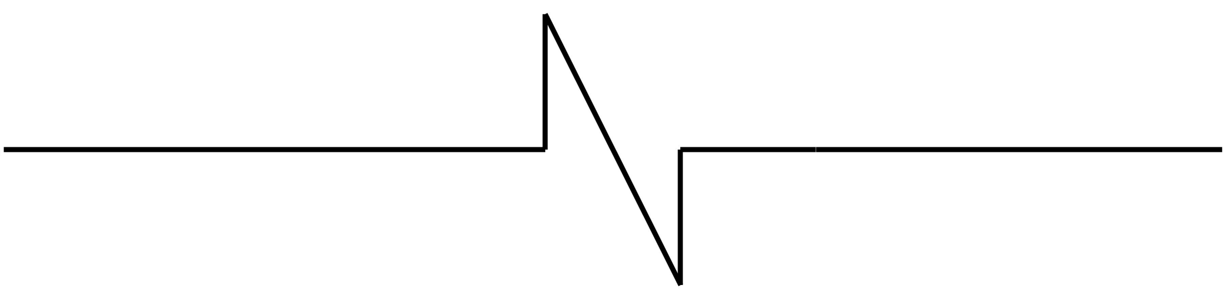
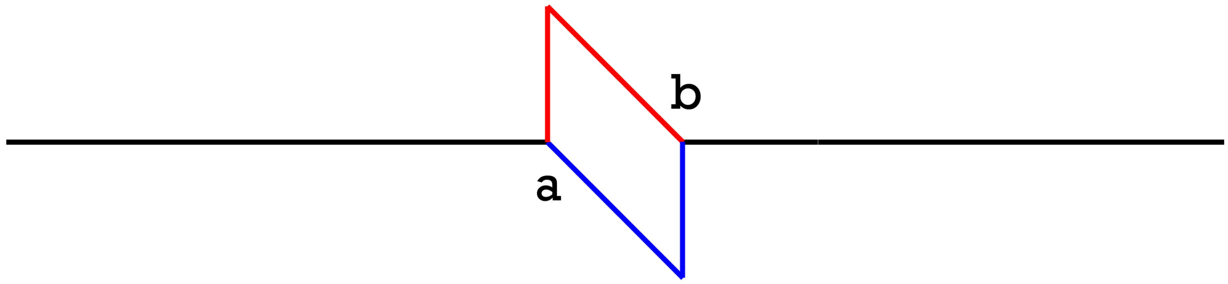


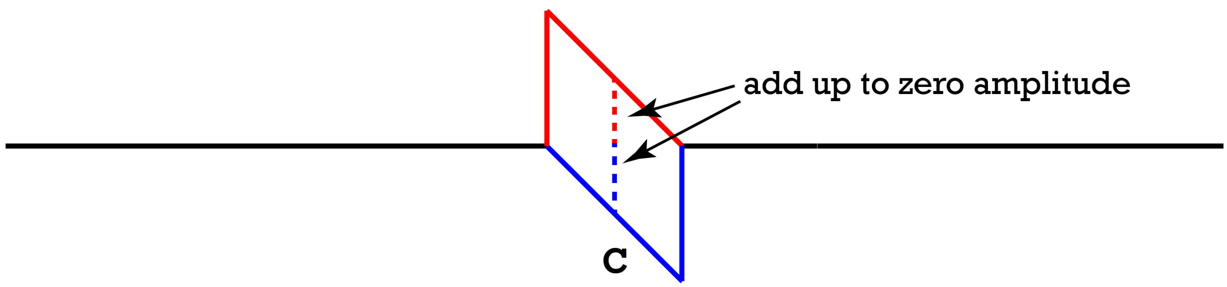
Again, again, this is wave interference via superposition. This is what the two waves look like individually when they occupy the same space. (Before we figure out the superposition.)



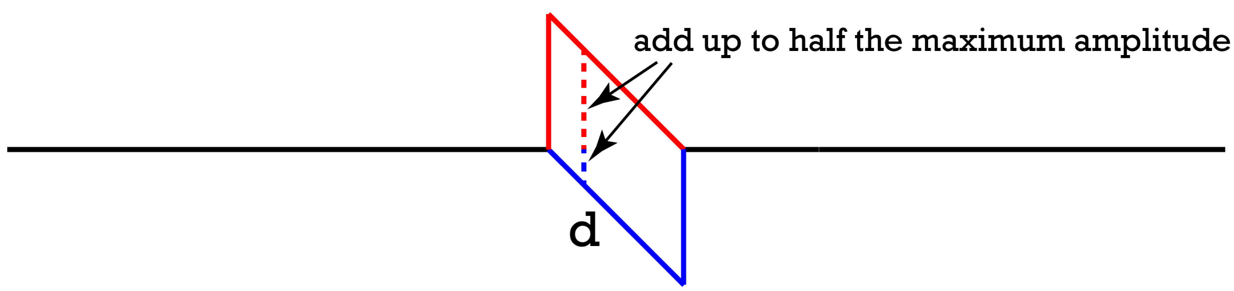
Let's look at a few points to see how they interfere via superposition.

- Location a: The left edge of the two waves. The amplitude of the red wave is at a maximum and the amplitude of the blue wave is zero. Add those together and you get the maximum amplitude of the red wave.
- Location b: The right edge of the two waves. The amplitude of the red wave is zero and the amplitude of the blue wave is at a maximum. Add those together and you get the maximum amplitude of the blue wave.
- At this point we know the answer is either 3 or 4.

Location c: Right in the middle of the two waves. The amplitude of the red wave is half its maximum height. The amplitude of the blue wave is half its maximum height. However, the red wave is above the string and the blue wave is below the string. These two amplitudes cancel one another out and the net amplitude right in the middle of the two waves is zero. At this point we *still* know the answer is either 3 or 4. ☺



Location d: One quarter of the way from left edge. Red wave is 3/4^{ths} of the maximum amplitude above equilibrium. Blue wave is 1/4th of the maximum amplitude below equilibrium. Those add up to ½ the maximum amplitude above equilibrium.



Therefore, the correct answer must be 4

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