

## Reflection and Superposition of Waves

HW: Worksheet—Waves practice problems

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## Principle of Superposition

- When energy from more than one wave source meet in the same point in a medium, the amplitudes of the two waves will combine as the waves pass through each other according to the **Principle of Superposition**:
  - The displacement of a particle in a medium will be the algebraic sum of the displacements of each wave at that point.

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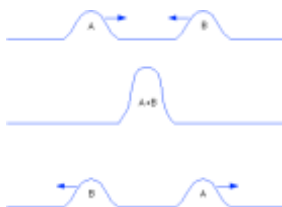
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## Principle of superposition

- For example, when two pulses with positive displacements (amplitudes) meet, the resulting waveform will have a displacement (amplitude) equal to the sum of the two individual positive displacements.
- The wave pulses each pass through that part of the medium and continue in their original directions...




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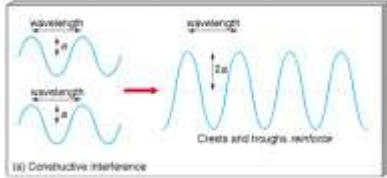
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### Constructive Interference:

- Occurs when two waves meet at the same point in a medium and have displacements in the same direction. The resulting waveform's amplitude is larger than each of the individual wave amplitudes.




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### Destructive Interference:

- Occurs when a wave with a positive displacement meets a wave with a negative displacement at the same point in a medium.
  - **TOTAL Destructive Interference** occurs when the two waves have amplitudes which are equal in magnitude and opposite in direction. The resulting wave has a zero amplitude.

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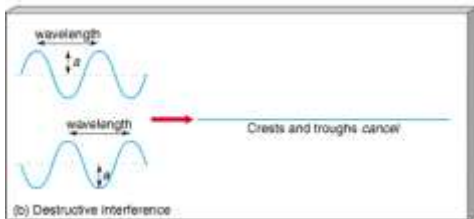
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### Destructive Interference:




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### Fixed-End Reflection of Pulses

- When a wave reaches a fixed boundary, the reflected pulse will always be inverted
- ([Click here for Animation](#))

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### Free-End Reflection of Pulses

- When a wave reaches a boundary of a medium which is free to vibrate, then the reflected wave will remain upright (in the same direction at which it hit the boundary)

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### Transmission and Reflection...

- Many times, waves reach a boundary and will reflect back into the original medium, but will also transmit some of its energy into the second medium...
  - The boundary between the media can act either like a fixed-end or a free-end, depending on the relative densities of the media:

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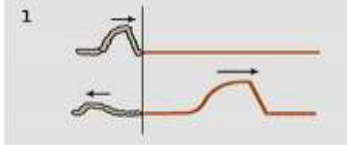
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## Transmission and Reflection

- When the wave is passing from a medium of higher density to a medium of lower density (from lower speed to higher speed), then the boundary will act like a free-end.
  - The wave reflects into the first medium upright...




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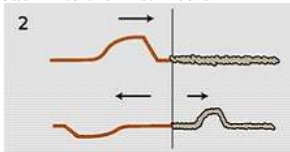
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## Transmission and Reflection

- When the wave is passing from a medium of lower density to a medium of higher density (from higher speed to lower speed), then the boundary will act like a fixed-end.
  - The wave reflects back into the first medium inverted...




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## Image References

- Constructive interference image (slide 3): [physics.bu.edu/~duffy/py105/WaveInterference.html](http://physics.bu.edu/~duffy/py105/WaveInterference.html)
- Constructive interference (slide 4) and Destructive interference (slide 6): [physics.fortlewis.edu/~AT303/HTML/AT30301.HTM](http://physics.fortlewis.edu/~AT303/HTML/AT30301.HTM)
- Fixed- and Free-end reflection (slides 7 and 8): [electron9.phys.utk.edu/~modules/n9/film.htm](http://electron9.phys.utk.edu/~modules/n9/film.htm)
- Transmission of waves (slides 10 and 11): [www.lightandmatter.com](http://www.lightandmatter.com)

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