

Essential Question

What happens when two waves meet?

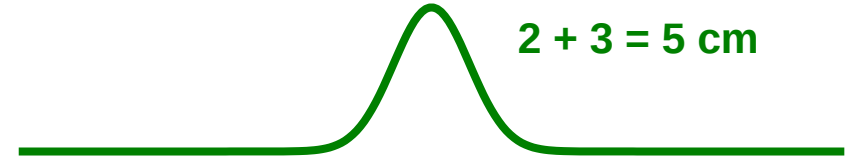
Superposition

- Waves can overlap
- Displacements add together
- Up is +, down is -

before

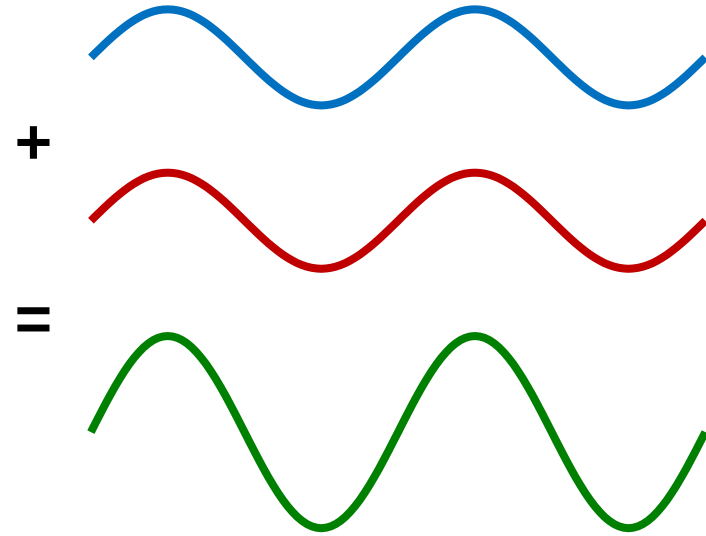


overlapping



Constructive Interference

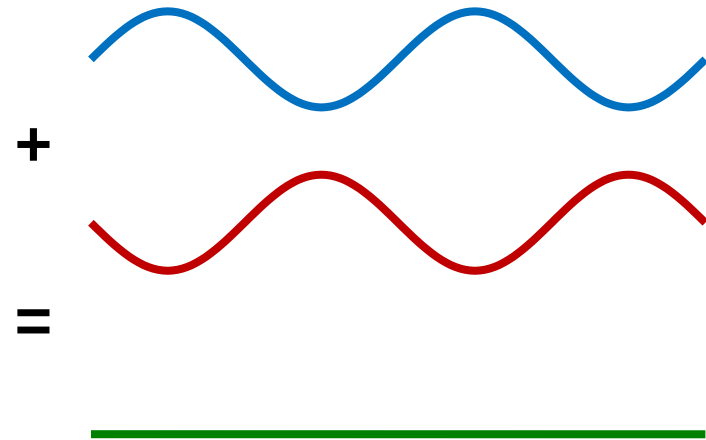
- Crest meets crest
- Trough meets trough
- Result: a bigger wave



crest + crest = bigger crest

Destructive Interference

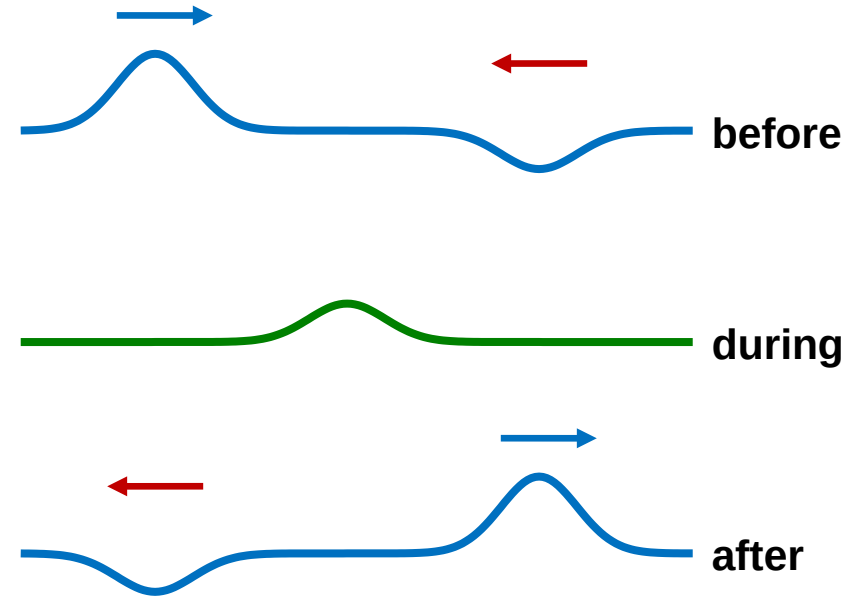
- Crest meets trough
- Displacements cancel
- Equal amplitudes: flat line



crest + trough = cancel

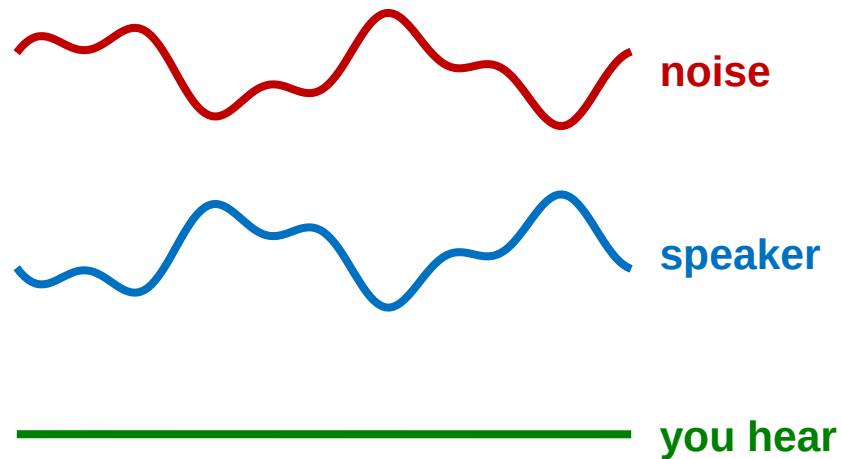
Waves Pass Through Each Other

- Pulses overlap, then separate
- Each keeps its shape
- Each keeps its direction



Noise-Cancelling Headphones

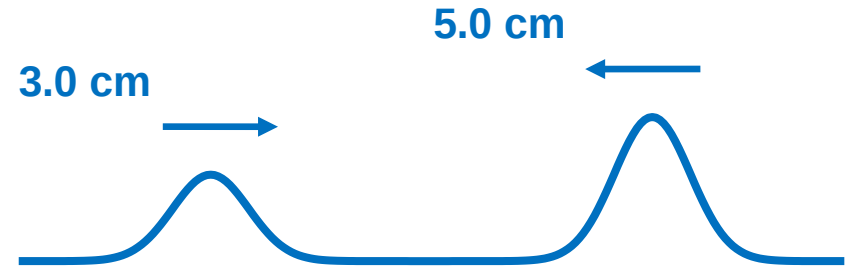
- Mic hears outside noise
- Speaker plays the flipped wave
- Destructive interference: quiet



the flipped wave cancels the noise

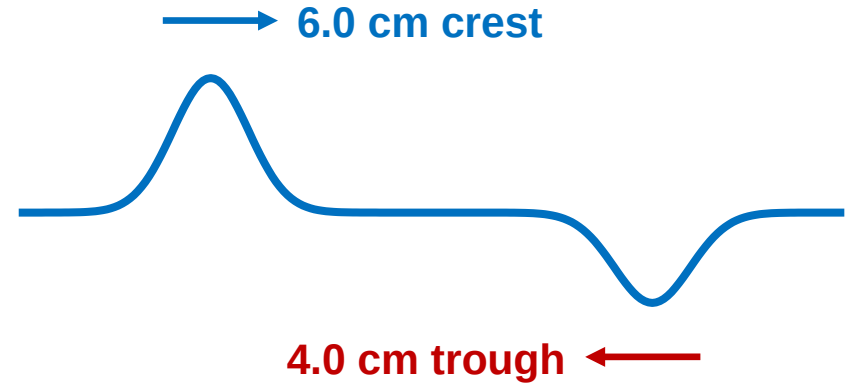
Example: Adding Two Crests

Two pulses travel toward each other on a rope. Both are crests. One is 3.0 cm tall, and the other is 5.0 cm tall. How tall is the rope when the pulses completely overlap?



Example: Crest Meets Trough

A 6.0 cm crest and a 4.0 cm trough travel toward each other on a rope. What is the displacement of the rope when they completely overlap?



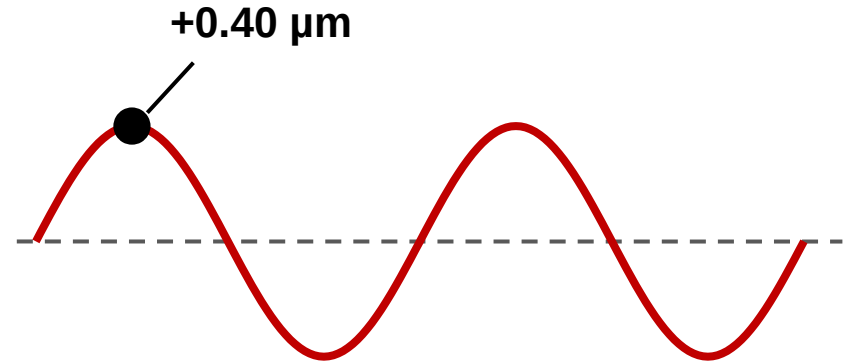
Example: After They Pass

The 6.0 cm crest and the 4.0 cm trough from the last example pass through each other. Describe each pulse after they separate.

Example: Canceling Noise

At one instant, the noise wave at your ear has a displacement of $+0.40\ \mu\text{m}$.

What displacement should the headphone speaker's wave have at that instant to cancel the noise?



Big Ideas

- Overlapping displacements add
- Crest + crest: constructive, bigger
- Crest + trough: destructive, cancel
- Waves pass through each other unchanged