Phys 100 2024

Lecture 29

Fri Read 9.2 - 9.4.

Mon: HW 5pm

Waves are a disturbance in a medium, resulting from co-ordinated motion of parts of the medium. The result is a pattern whose shape and motion can be described easily. We can clearly see waves on strings, slinkys and in water.

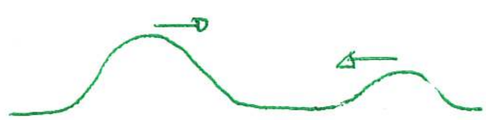
However, sound and light are apparently described by waves but we cannot easily observe a wave-like pattern. We can reveal the wave nature of these by a phenomenon called interference that is only readily described using the language of waves.

Interference of waves

Consider two pulses on a string

DEMO: PhET WoaS

* create
* observe reflection + overlap.



We see:

1) the two waves eventually pass through each other
2) during the period when the waves overlap they combine.

The combination is called a superposition and this phenomenon is called wave interference.

The rules by which the waves interfere are:

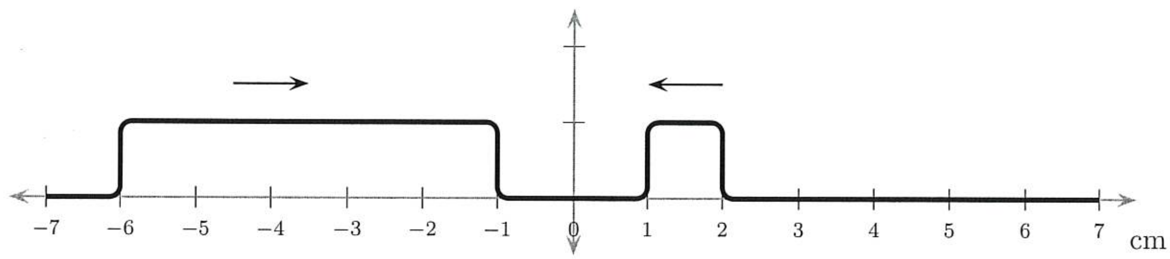
1) determine the profile of each wave as though the other were not present

2) at each horizontal location add the displacements of the waves) (if one is beneath the axis then it has a negative displacement). This gives the displacement of the combination at that location.

Slide 1. } → Interference of pulses
Slide 2 →

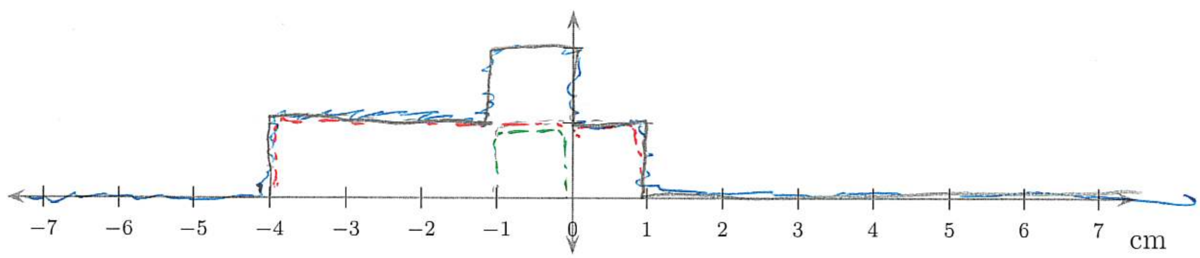
1 Interference of waves on a string

Two rectangular wave pulses move along a string with speeds 1 cm/s. Initially the string appears as illustrated.

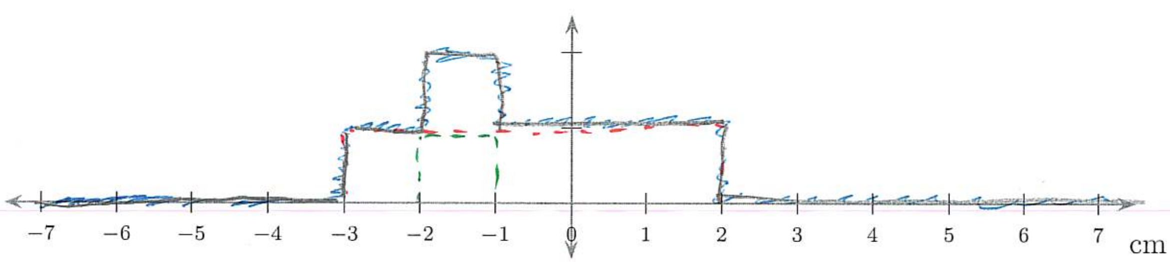


In the following questions the times refer to the time after this instant.

a) Illustrate the appearance of the string after 2 s has passed. Use the axes below to do this.

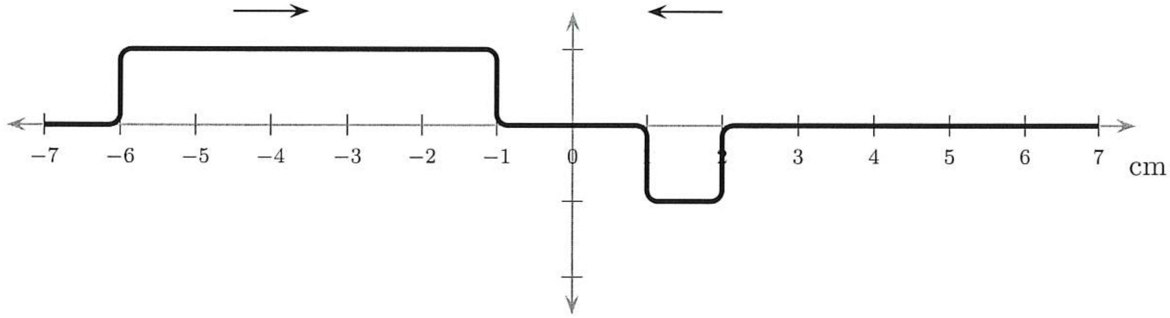


b) Illustrate the appearance of the string after 3 s has passed. Use the axes on the attached sheet to do this.



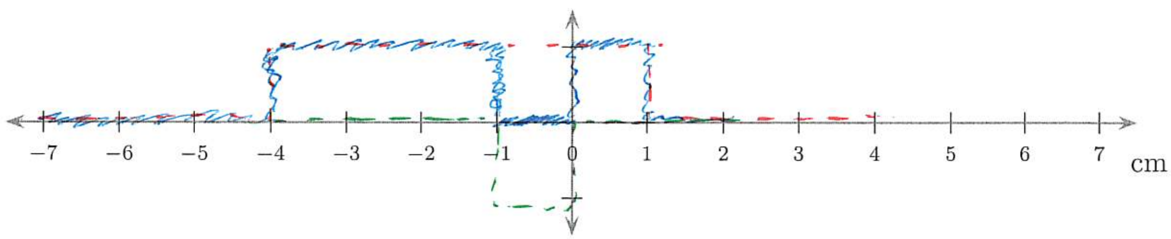
2 Interference of waves on a string; one inverted

Two rectangular wave pulses move along a string with speeds 1 cm/s. Initially the string appears as illustrated.

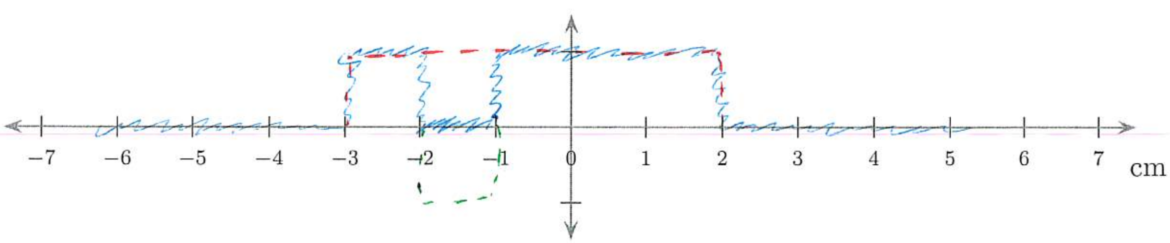


In the following questions the times refer to the time after this instant.

a) Illustrate the appearance of the string after 2 s has passed. Use the axes below to do this.



b) Illustrate the appearance of the string after 3 s has passed. Use the axes on the attached sheet to do this.



Interference of continuous waves

The same principles apply to continuous waves.

Slides : General Interference I -> V

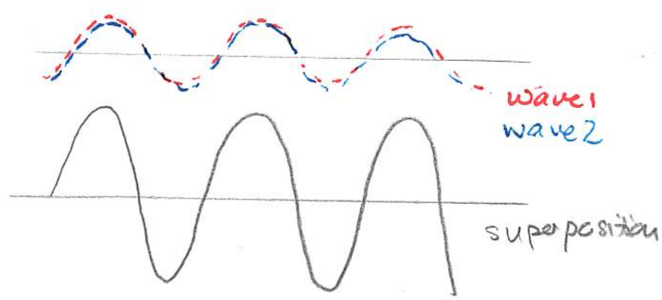
There are two extreme cases

1) Constructive interference – here the overlap is perfect

* crests of one wave align with crests of another
* troughs " " " " " troughs " "

Slide: Constructive interference

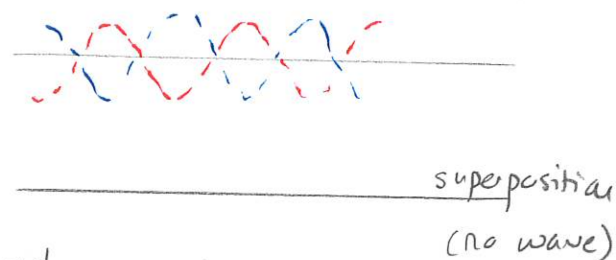
This results in a superposition with larger amplitude than either individual wave. If these were sound waves the combination would give a loud intensity



2 Destructive interference – here a crest aligns with a trough

Slide: Destructive interference

This results in a superposition with no amplitude. If these were sound waves then the combination would have zero intensity and could not be heard.



We can envisage how to produce such waves that will interfere for

* water
* sound
* light

The key will be to effectively have two sources.

Interference of water waves

Suppose that we produce two water waves in one tank. These will eventually overlap and interfere.

DEMO: PhET Wave Interference

* Interference Tab → Water waves
* Frequency at 75%
* Observe overlap – place sensors on constructive / destructive

We observe:

1) lines along which there is no disturbance ⇒ destructive
2) lines along which there is a large disturbance ⇒ constructive

Slide: Overlapping Water Waves

DEMO: Loyola Univ Video ~ 20s