Lecture 30

Mon: HW by 5pm

Read 9.3 → 9.4

Waves: Basic Concepts

Recall that a wave is a co-ordinated disturbance that propagates along a medium. The useful concepts to describe this are:

* amplitude = maximum (vertical) displacement away from equilibrium
* wavelength = distance (horizontal) between successive crests
* period = time between arrival of successive crests at one location
* frequency = 1/period
* wavespeed = rate at which pattern propagates.

A general rule for all waves is

$$\text{wavespeed} = \text{wavelength} \times \text{frequency} \qquad s = \lambda \times f$$

In any given medium it is possible to produce waves with various wavelengths and frequencies. However, the speed of the waves depends on the medium. For example:

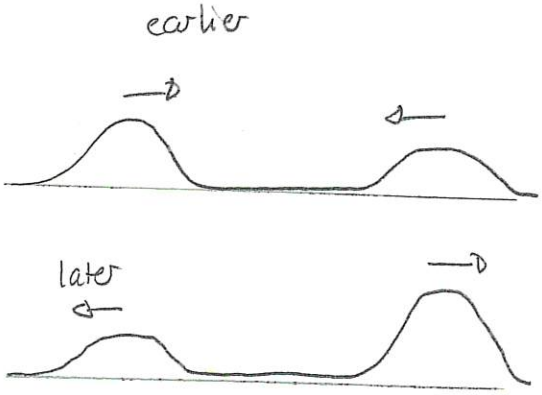
* waves on a string → tension and mass per meter
* sound → air temperature.
* light / radio waves → for waves that travel in a vacuum the speed is always

$$\text{Speed of light} = c = 3.0 \times 10^8 \text{ m/s}$$

Interference of waves

How can we tell whether a phenomenon is described by waves? In some situations, we can actually record the motion of portions of the medium and observe the wave aspects directly. In other situations an indirect way is to observe a phenomenon called interference, associated with combinations of two or more waves.

Consider two pulses on a string



Demo: PhET W.O.a.S

* Loose end, tension ~~medium~~ low, damping none
* Manual -> two pulses
* observe reflection
* show overlap

We observe:

* the two pulses eventually pass through each other
* during the period when they overlap, they produce a combination

While the waves overlap they "add" to form a superposition according to:

1) determine the profile of the individual waves
2) at each location add the heights of the two pulses (negative if beneath axis). This gives the displacement of the combination.

Slides 1->2

Quiz1 ~~80%~~ 90%

Note that pulses inverted relative to each other will partly cancel.

Quiz2 ~~80%~~ 90%

Quiz 3 ~~70% – 85%~~ 70% – 90%

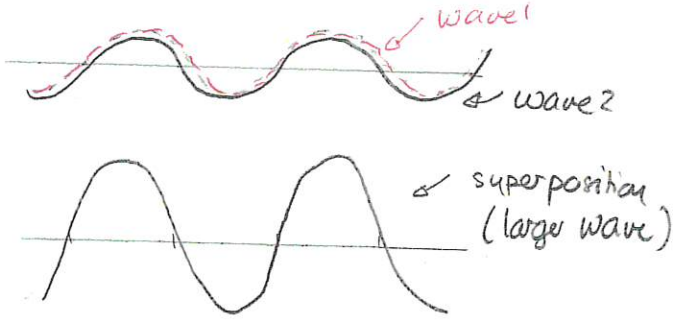
These principles also apply to continuous waves. Mathematically this is handled by adding trigonometric functions.

Slides: General Interference I → V

Two extreme combinations are important.

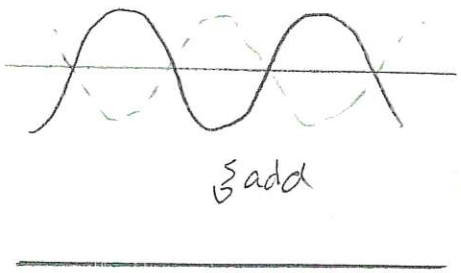
1) Perfect overlap (constructive interference) * crests of each wave align
   * troughs of " " "

Slide: Constructive Int



2) Perfect mismatch (destructive interference) * crest of one wave meets trough of another.

Slide: Destructive Int

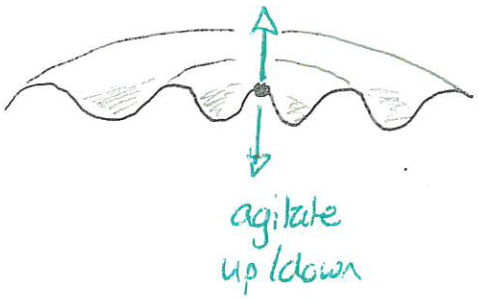


Quiz 4 ~~30% – 70%~~

Now consider situations where we create such waves.

Interference of Water Waves

We can create a water wave by agitating one location in a pool of water. By doing this in two locations we can produce two waves that overlap



Demo: PhET Wave Interference

* Interference Tab
* Water Waves – increase freq.
* Observe overlapping waves.
* Place sensors on constructive
  destructive

The two dimensional nature of this results in:

1) lines along which there is no disturbance ⇝ ~~can~~ destructive
2) lines along which there is a large " ⇝ constructive

Demo: Loyola U Video

Slide: Overlapping water waves

The animation illustrates that the lines along which destructive interference occurs depend on:

1) separation of sources
2) wavelength (or frequency) of waves.

Not in

Quiz 5

Slide: Result of