Lesson 46: Properties of Waves

Illustration 1: Is that Mr.C???

When you hear the word "waves" you probably have visions of hanging ten off of Waikiki.

- Although these are "waves", we will be looking at a more detailed definition of waves in the following lessons.
- Specifically we will be looking at **mechanical waves**, waves that travel through a **medium** (***substance***) like air, water, a rope, etc.

The plural of **medium** is **media**.

Always remember that any wave we discuss is just is a way of transferring energy from one place to another.

- The difference between transferring energy using waves compared to regular matter moving around (like a baseball) is that
  - a wave **pulse** starts in one spot and, except for a small amount of movement, the particles of the medium stay in one spot.
  - matter must actually move (kinetic energy) all the way over to something and strike it.

A wave **pulse** is a single crest or single trough (as defined in the next section) traveling through a medium.

Wavelength

Wavelength is a property of a wave that most people (once they know what to look for) can spot quickly and easily, and use it as a way of telling waves apart. Look at the following diagram...

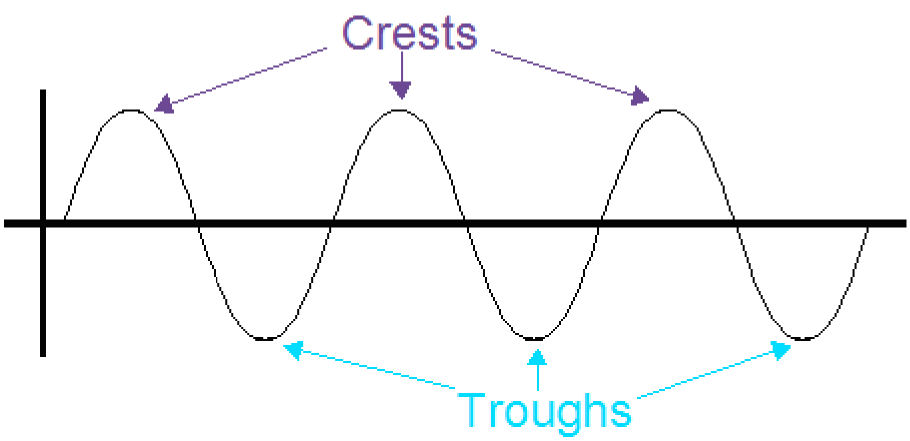

Illustration 2: Crests and troughs.

- Any of the parts of the wave that are pointing up like mountains above the equilibrium position are called **crests**. Any part that is sloping down like a valley is a **trough**.
- **Wavelength** is defined as the distance from a particular height on the wave to the next spot on the wave where it is at the same height and going in the same direction.
  - Usually it is measured in metres, just like any length.

- Since we do not want to overuse the letter "W" as a variable in physics, we switch to Greek and use the symbol **λ** (*lambda*) to represent **wavelength** in formulas.

- There isn't a special spot you have to start on a wave to measure wavelength, just make sure you are back to the same height going in the same direction. Most people do like to measure from one **crest** to the next **crest (**or **trough** to **trough),** just because they are easy to spot.

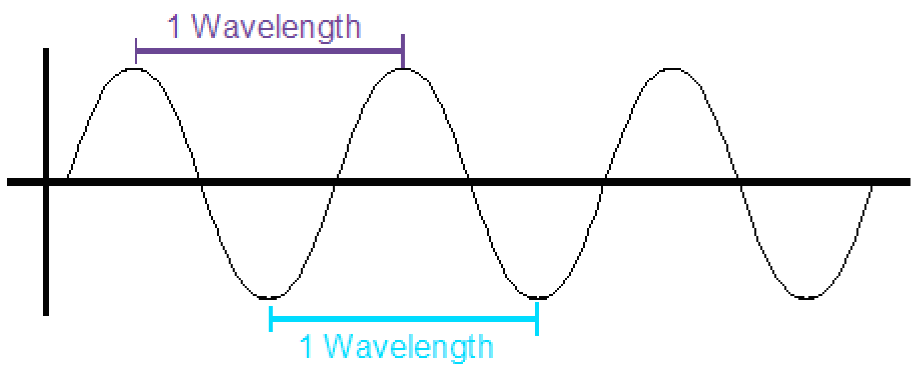

Illustration 3: Wavelength.

Amplitude

Amplitude is a measure of how big the wave is.

- Imagine a wave in the ocean. It could be a little ripple or a giant tsunami.
  - What you are actually seeing are waves with different amplitudes.
  - They might have the exact same **wavelength,** but the **amplitudes** of the waves can be very different.

The **amplitude** of a wave is measured as:

1. the height from the equilibrium point to the highest point of a crest or
2. the depth from the equilibrium point to the lowest point of a trough

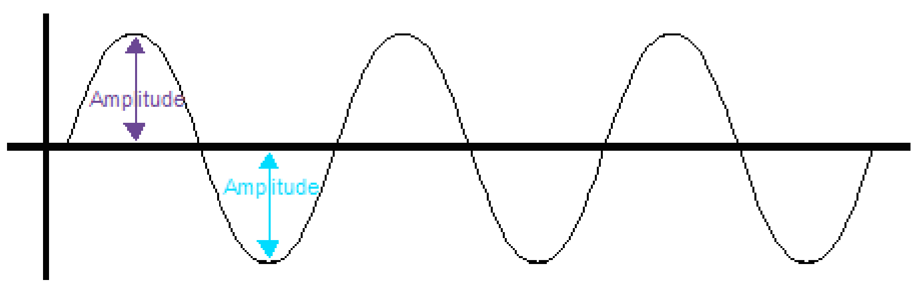

Illustration 4: Amplitude of a wave.

When you measure the **amplitude** of a wave, you are really looking at the energy of the wave.

- It takes more energy to make a bigger **amplitude** wave.
- Anytime you need to remember this, just think of a home stereo's amplifier… it makes the **amplitude** of the waves bigger by using more electrical energy.

Wave Diagrams

When you throw a rock into a lake, you will see waves moving as a series of round ripples moving outwards.

- You might see a bunch of waves rippling outwards (like circles within circles, called *concentric circles*), which forms a **wave train**. The waves shown in previous illustrations could be considered a wave train, since you can see a series of multiple crests and troughs, one after another.
- The leading part of the wave (in front of the rest of the wave is called the **wave front**.

It can become difficult to see exactly what the waves are doing in a medium, since the disturbance might be really small or hard to track.

- To try to simplify things, we often draw diagrams as a top down view of the waves, showing the **crests** of the waves as lines. **Troughs** are the gaps exactly in between crests.
- This wave train is being created by a **point source** exactly in the the centre. The **point source** could be a simple as a rock that had been thrown into water.

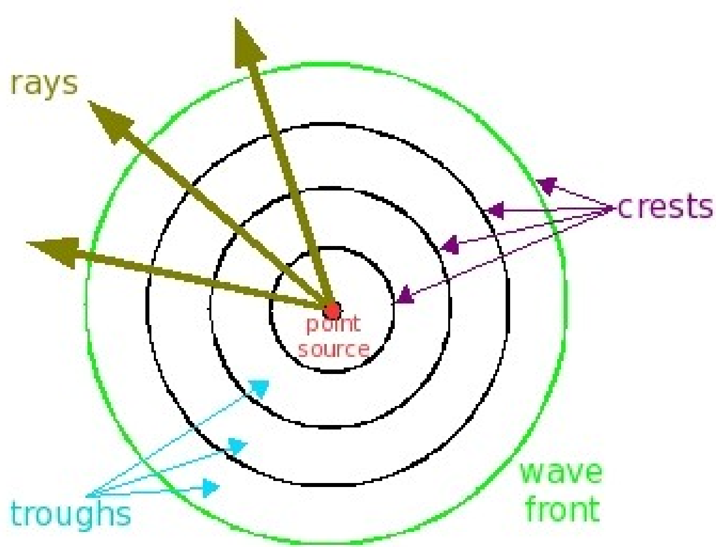

Illustration 5: A wave train shown from above. Notice that the wave front is the furthest out.

- We know that the wave train will spread outwards, the circles of the ripples getting bigger and bigger as the **wave front** spreads out.
    - We show this as the **rays** drawn in the diagram. The rays show the direction the wave is traveling outwards from the source. These **rays** are always drawn perpendicular to the **wave front**.
- Notice how the **rays** in this diagram are spreading away from each other as they move away from the point source. These are **diverging** (*spreading apart*) **rays**.
    - Since the rays are spreading out, this means that the energy of the wave is also being spread out over a larger and larger area. The wave will become weaker, until it finally vanishes.

Two Main Types of Waves

There are essentially two main types of waves (although there is a third called "surface waves" we don't need to study them); **transverse** and **longitudinal** waves.

Transverse Waves

Transverse waves are the waves that have the classical wave shape everyone thinks of when they imagine a wave.

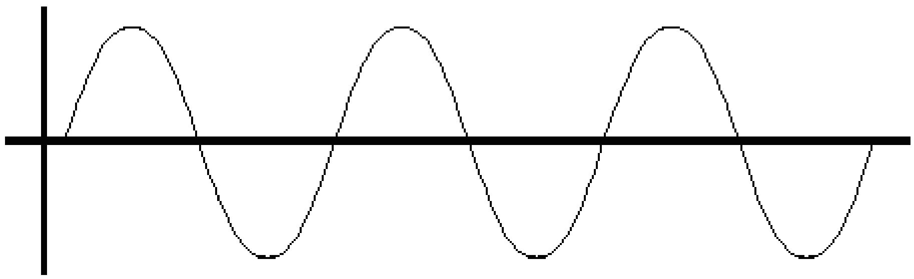

Illustration 6: Transverse wave.

- Particles of the medium move **perpendicular** to the direction the **transverse wave** itself is moving. For example, if the wave is moving to the right, the particles of the medium are moving up and down.
    - Try shaking a skipping rope or other long rope to get a wave like the one pictured above. Tie a ribbon to one spot on the rope and watch just the ribbon… you will see it bounces only up or down, while the wave travels away from you. They are moving **perpendicular** to each other.
- The best examples of **transverse waves** are plucking the strings on any stringed instrument.

Longitudinal Waves

Most people don't usually picture **longitudinal waves** when they think of a wave.

- Imagine securing one end of a Slinky to a wall.
- Now stretch out the Slinky by holding onto one end and walking backwards.
- Stop walking. While holding onto the end still, bunch up some of the coils in your hand. Let go.
- The Slinky will "sproing" back and forth away and towards you. There are areas where the Slinky is compressed, and parts where it is expanded. The "sproing" or **longitudinal wave** is moving **parallel** to the direction the particles are moving.

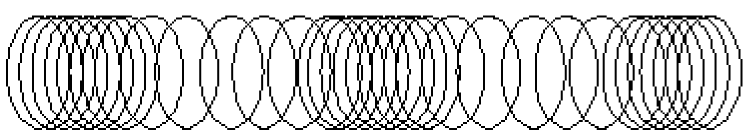

Illustration 7: Longitudinal wave.

- In this wave, the particles are moving left and right **parallel** to the motion of the wave.

The best example of longitudinal waves is sound.

- When you talk you are pushing, and sometimes not pushing, air out of your lungs past your vocal cords.

- There will be parts where the air particles are squished together (compressions), and others where they are allowed to separate (expansions).

Video Killed the Radio Star!

You can see me make some transverse and longitudinal waves on Youtube by clicking here .