13.3: Waves and Oscillations

We've all seen ripples in water produced when raindrops fall on a lake or pond. We've seen surfers ride on ocean waves. We have heard about sound waves. We've waved goodbyes to friends and family, though that last one probably isn't the kind of wave we're talking about in this chapter. What 'is' a wave?

A wave is an outcome. It is the result of an interaction between two parts of a system. A wave is something that happens when a source (someone or something) adds energy to a medium (material) that is governed by restoring forces. When both these things are present, a wave can result.

We know that restoring forces cause oscillations, so a wave is the oscillations of the atoms of the substance. Why do the atoms oscillate? Something pulled them away from their equilibrium position and started the motion. We know that atoms are connected to each other by chemical bonds so when one atom starts to oscillate, it causes its neighbors to begin oscillating as well. The transfer of energy from one atom to another causes the oscillation to 'move' through the material. The movement of the energy through the oscillating material is what we call a 'wave'. Waves can move from one medium to the next, like when an earthquake causes ripples in a swimming pool. Waves can reflect off an interface between two different mediums, like when light moves from the air to water and reflects off the water surface.

There are only two types of waves, mechanical and electromagnetic. Electromagnetic waves are the topic of a later chapter, so we will focus our attention on mechanical waves. Mechanical waves travel through a material (medium) of some kind. Mechanical waves can travel through solids, liquids or gases. When you wiggle the end of a garden hose, or pluck a guitar string you've created a mechanical wave. When you hear the sound of a guitar, or when an earthquake shakes the walls of your house you are experiencing the transfer of mechanical wave energy from one medium to another.

Types of Mechanical Waves

There are only two types of mechanical waves, transverse and longitudinal. These terms refer to the way that the atoms of the material move as the energy passes through the material. Mechanical waves share a common set of variables used to describe their behavior and there are only a few small differences between the types.

Because there are many points of similarity between oscillations and waves, there is a significant overlap between the terms used to describe them. This can sometimes become a point of confusion because there are two aspects to describing mechanical waves. One is the description of the energy moving through the material (the 'wave' itself) and one is a description of how the atoms of the material behave as the wave passes through it. Although these ideas are related, they are not the same.