**Section 1: The Nature of Waves Notes**

* A [**wave**](javascript:top.hrwSpawnGlossaryTerm('wave');)is any disturbance that transmits energy through matter or empty space.

***Wave Energy***

* Energy can be carried away from its source by a wave. You can observe an example of a wave if you drop a rock in a pond.

(**READ ONLY:** Waves from the rock’s splash carry energy away from the splash. However, the material through which the wave travels does not move with the energy. Look at **Figure 1.** Can you move a leaf on a pond if you are standing on the shore? You can make the leaf bob up and down by making waves that carry enough energy through the water. But you would not make the leaf move in the same direction as the wave.)

***Waves and Work***

* As a wave travels, it does work on everything in its path.

(**READ ONLY:** The waves in a pond do work on the water to make it move up and down. The waves also do work on anything floating on the water’s surface. For example, boats and ducks bob up and down with waves. The fact that these objects move tells you that the waves are transferring energy.)

***Energy Transfer Through a Medium***

* Most waves transfer energy by the vibration of particles in a medium.
* A [**medium**](javascript:top.hrwSpawnGlossaryTerm('medium');)is a substance through which a wave can travel.
* A medium can be a solid, a liquid, or a gas. The plural of *medium* is *media*.

(**READ ONLY:** When a particle vibrates (moves back and forth, as in **Figure 2**), it can pass its energy to a particle next to it. The second particle will vibrate like the first particle does. In this way, energy is transmitted through a medium.)

* A vibration is one complete back-and-forth motion of an object.
* Sound waves need a medium.
* Sound energy travels by the vibration of particles in liquids, solids, and gases. If there are no particles to vibrate, no sound is possible.

(**READ ONLY:** If you put an alarm clock inside a jar and remove all the air from the jar to create a vacuum, you will not be able to hear the alarm.

* Other waves that need a medium include ocean waves, which move through water, and waves that are carried on guitar and cello strings when they vibrate.
* Waves that need a medium are called *mechanical waves*.

(**Figure 3** shows the effect of a mechanical wave in Earth’s crust: an earthquake.)

* Earthquakes cause seismic waves to travel through Earth’s crust. The energy they carry can be very destructive to anything on the ground.

***Energy Transfer Without a Medium***

* Some waves can transfer energy without going through a medium.
* Visible light is one example. Other examples include microwaves made by microwave ovens, TV and radio signals, and X rays used by dentists and doctors. These waves are *electromagnetic waves.*
* Although electromagnetic waves do not need a medium, they can go through matter, such as air, water, and glass.
* The energy that reaches Earth from the sun comes through electromagnetic waves, which go through space.

(**READ ONLY:** As shown in **Figure 4,**you can see light from stars because electromagnetic waves travel through space to Earth. Light is an electromagnetic wave that your eyes can see.)

* Light waves are electromagnetic waves, which do not need a medium.

***Types of Waves***

* All waves transfer energy by repeated vibrations.
* Waves can be classified based on the direction in which the particles of the medium vibrate compared with the direction in which the waves move.
* The two main types of waves are *transverse waves* and *longitudinal* *waves.*
* Sometimes, a transverse wave and a longitudinal wave can combine to form another kind of wave called a *surface wave.*

***Transverse Waves***

* Waves in which the particles vibrate in an up-and-down motion are called [**transverse waves**](javascript:top.hrwSpawnGlossaryTerm('transverse%20wave');)**.**
* *Transverse* means “moving across.” The particles in this kind of wave move across, or perpendicularly to, the direction that the wave is going. To be *perpendicular* means to be “at right angles.”

[**READ ONLY:** wave moving on a rope is an example of a transverse wave. In **Figure 5,** you can see that the points along the rope vibrate perpendicularly to the direction the wave is going. The highest point of a transverse wave is called a *crest,* and the lowest point between each crest is called a *trough* (TRAWF).]

* Although electromagnetic waves do not travel by vibrating particles in a medium, all electromagnetic waves are considered transverse waves.
* Waves are made of vibrations that are perpendicular to the direction of motion.

***Longitudinal Waves***

* In a [**longitudinal wave**](javascript:top.hrwSpawnGlossaryTerm('longitudinal%20wave');)**,** the particles of the medium vibrate back and forth along the path that the wave moves.

(**READ ONLY:** You can make a longitudinal wave on a spring. When you push on the end of the spring, the coils of the spring crowd together.)

* A part of a longitudinal wave where the particles are crowded together is called a *compression*.

[**READ ONLY:** When you pull back on the end of the spring, the coils are pulled apart. A part where the particles are spread apart is a *rarefaction* (RER uh FAK shuhn).]

* Compressions and rarefactions are like the crests and troughs of a transverse wave.

***Sound Waves***

* A sound wave is an example of a longitudinal wave.
* Sound waves travel by compressions and rarefactions of air particles.

(**READ ONLY:** Figure **7** shows how a vibrating drum forms compressions and rarefactions in the air around it.)

* Sound energy is carried away from a drum by a longitudinal wave through the air.

***Combinations of Waves***

* When waves form at or near the boundary between two media, a transverse wave and a longitudinal wave can combine to form a *surface wave*.

(**READ ONLY:** An example is shown in **Figure 8.** Surface waves look like transverse waves, but the particles of the medium in a surface wave move in circles rather than up and down. The particles move forward at the crest of each wave and move backward at the trough.)

* Ocean waves are surface waves.

(**READ ONLY:** A floating bottle shows the circular motion of particles in a surface wave.