**Section 3: Wave Interactions**

(**READ ONLY:** The planets and the moon shine because light from the sun reflects off them. Without reflection, you would not be able to see the planets.)

***Reflection***

* **Reflection** happens when a wave bounces back after hitting a barrier.
* All waves–including water, sound, and light waves–can be reflected.

(**READ ONLY:** The reflection of water waves is shown in **Figure 1.** Light waves reflecting off an object allow you to see that object. For example, light waves from the sun are reflected when they strike the surface of the moon. These reflected waves allow us to enjoy moonlit nights.)

* A reflected sound wave is called an *echo*.
* Waves are not always reflected when they hit a barrier.
* A wave is transmitted through a substance when it passes through the substance.

***Refraction***

* **Refraction** is the bending of a wave as the wave passes from one medium to another at an angle.
* A light wave passing at an angle into a new medium– such as water–is refracted because the speed of the wave changes.
* When a wave moves from one medium to another, the wave’s speed changes. When a wave enters a new medium, the wave changes wavelength as well as speed. As a result, the wave bends and travels in a new direction.

***Refraction of Different Colors***

(**READ ONLY:** When light waves from the sun pass through a droplet of water in a cloud or through a prism, the light is refracted. But the different colors in sunlight are refracted by different amounts, so the light is *dispersed,* or spread out, into its separate colors.

* Although all light waves travel at the same speed through empty space, when light passes through a medium such as water or glass, the speed of the light wave depends on the wavelength of the light wave.
* Different colors of light have different wavelengths, their speeds are different, and they are refracted by different amounts. As a result, the colors are spread out, so you can see them individually.

***Diffraction***

(**READ ONLY:** Suppose you are walking down a city street and you hear music. The sound seems to be coming from around the corner, but you cannot see where the music is coming from because a building on the corner blocks your view. Why do sound waves travel around a corner better than light waves do?)

* Most of the time, waves travel in straight lines.

(**READ ONLY:** For example, a beam of light from a flashlight is fairly straight. But in some circumstances, waves curve or bend when they reach the edge of an object.)

* The bending of waves around a barrier or through an opening is known as**diffraction****.**

**I*f You Can Hear It, Why Can’t You See It?***

* The amount of diffraction of a wave depends on its wavelength and the size of the barrier or opening the wave encounters.

(**READ ONLY:** You can hear music around the corner of a building because sound waves have long wavelengths and are able to diffract around corners. However, you cannot see who is playing the music because the wavelengths of light waves are much shorter than sound waves, so light is not diffracted very much.)

***Interference***

* You know that all matter has volume. Therefore, objects cannot be in the same space at the same time.
* Waves are energy, not matter. So, more than one wave can be in the same place at the same time. Two waves can meet, share the same space, and pass through each other!
* When two or more waves share the same space, they overlap. The result of two or more waves overlapping is called **interference****.**

***Constructive Interference***

* *Constructive interference* happens when the crests of one wave overlap the crests of another wave or waves.

**(READ ONLY:** The troughs of the waves also overlap. When waves combine in this way, the energy carried by the waves is also able to combine. The result is a new wave that has higher crests and deeper troughs than the original waves had. In other words, the resulting wave has a larger amplitude than the original waves had.)

***Destructive Interference***

* *Destructive interference* happens when the crests of one wave and the troughs of another wave overlap.

(**READ ONLY:** The new wave has a smaller amplitude than the original waves had. When the waves involved in destructive interference have the same amplitude and meet each other at just the right time, the result is no wave at all.)

***Standing Waves***

(**READ ONLY:** If you tie one end of a rope to the back of a chair and move the other end up and down, the waves you make go down the rope and are reflected back. If you move the rope at certain frequencies, the rope appears to vibrate in loops, as shown in **Figure 5.)**

* The loops come from the interference between the wave you made and the reflected wave. The resulting wave is called a **standing wave****.**
* In a standing wave, certain parts of the wave are always at the rest position because of total destructive interference between all the waves. (Other parts have a large amplitude because of constructive interference.)

(READ ONLY: When you move a rope at certain frequencies, you can create different standing waves.)

* A standing wave only *looks* as if it is standing still. Waves are actually going in both directions.
* Standing waves can be formed with transverse waves, such as when a musician plucks a guitar string, as well as with longitudinal waves.

***Resonance***

The frequencies at which standing waves are made are called *resonant frequencies.*

When an object vibrating at or near the resonant frequency of a second object causes the second object to vibrate, **resonance** occurs.

A resonating object absorbs energy from the vibrating object and vibrates, too.

(**READ ONLY:** An example of resonance is shown in **Figure 6**on the previous page.

(**READ ONLY:** You may be familiar with another example of resonance at home–in your shower. When you sing in the shower, certain frequencies create standing waves in the air that fills the shower stall. The air resonates in much the same way that the air column in a marimba does. The amplitude of the sound waves becomes greater. So your voice sounds much louder.)