Unit 4: Light and Sound Show

In this unit, you will acquire a conceptual understanding of the nature of sound and electromagnetic radiation. You will also learn to apply the Law of Conservation of Energy to explain how energy is transferred as waves propagate. You will study how sound behaves in the presence of different obstacles and how light is manipulated by positioning mirrors and lenses in its path.

KEY TERMS

Waves are constant fluctuations that can travel through matter or space. When you throw a rock in a puddle, the water forms waves that move outward from the place where the rock hit the water. Waves can move through solids, liquids, gases, and empty space. (S8P4a)

Frequency is the number of vibrations per a unit of time that a wave possesses. If you counted the number of wave peaks from throwing the rock in a puddle that occurred in a minute, you could determine the wavelength of that vibration. (S8P4a)

Wavelengths are the distance from one peak of a wave to the next peak of the wave. (S8P4a)

Amplitude is the property of a wave that describes half the distance between the height of the peak of a wave and the trough (the bottom) of a wave. In a surf wave, the amplitude represents the amount of water displaced, which can be very large. (S8P4a)

The characteristics of a wave are determined by the wavelength, frequency, and amplitude of the wave. (S8P4a)

Electromagnetic radiation is a term that is used to describe radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays. Radio waves have the smallest frequency and the longest wavelength. Gamma rays are at the other end of the electromagnetic radiation spectrum. Gamma rays have the largest frequency and the shortest wavelength. (S8P4a)

Electromagnetic waves do not require a medium to move through. Electromagnetic waves transport energy that is stored in the electric and magnetic field. (S8P4a)

Mechanical waves are caused by a disturbance or vibration that causes the molecules in matter to bump into each other and transfer the energy from one molecule to the next in a set direction. Matter is required as a medium for the waves to move through, so mechanical waves cannot occur in the vacuum of space. (S8P4a)
**Sound** is a mechanical wave that can be heard as it moves through a medium, such as air, and displaces the air, creating zones of high and low pressure. When fireworks go off on the Fourth of July, you can hear the sound. With some of the larger fireworks, you can also feel the air as the pressure from the firework exploding pushes the air away from the firework. (S8P4e)

When people refer to the **pitch** of a sound, they are referring to the sensation of the frequency of the wave. The **intensity** of a sound is related to the amplitude of the wave. (S8P4f)

When people refer to **light**, they are usually referring to the visible light they can see. Light is not considered matter and has no mass. The behavior of light can be explained by the introduction of a massless particle called a photon or by studying the way that electromagnetic waves interact with matter. (S8P4b)

There are several processes that light can go through as it encounters matter. **Reflection** occurs when light bounces off a medium. When light is reflected, not all the light is reflected. **Refraction** occurs when light moves through a medium and bends as the medium slows down the light as it moves through the medium. When you look through a glass of water and an object behind the glass appears to change shape, the light reflected by that object has been refracted by the glass. **Diffraction** occurs when light encounters an obstacle and slightly bends as it passes around the object. If you hold a CD and see the colors of the rainbow, this is the light being diffracted by the surface of the CD. **Absorption** occurs when light strikes a surface and the energy of the photon is taken up by the matter. An object lying in the sun will warm up as the sunlight transforms into heat energy. (S8P4b)

When the human eye sees **colors**, it is seeing the parts of the spectrum of light that are reflected from an object. A blue object reflects the wavelengths of light that we see as blue. (S8P4c)

**Important Tip**

- The ways waves travel is known as wave propagation. As waves propagate, some of the energy is transferred. When light travels through a glass of water, it slows down and is refracted. Some of the energy that is lost—and that causes the light to slow down—is transferred into the water and glass as thermal energy. (S8P4a)
Sample Items 13–16

Item 13

As a race car drives away from an observer, the observer notes that the sound from the car gets quieter and the pitch lowers.

Which statement BEST describes how the sound wave changes as the race car drives away?

A. The frequency increases and the amplitude increases.
B. The frequency increases and the amplitude decreases.
C. The frequency decreases and the amplitude increases.
D. The frequency decreases and the amplitude decreases.

Item 14

An advertisement claims that a new type of cotton cloth looks red because of the way the cloth is woven and not because of the dye used on the cloth.

Which statement BEST explains why the chemical dye is responsible for the red appearance of the cloth?

A. The chemical absorbs the light from the visible spectrum except for red that is reflected to the eye.
B. The chemical absorbs all the red light from the visible spectrum that is reflected to the eye.
C. The light is refracted and the longest wavelength shows through the one that is red.
D. The chemical reaction produces a red light that is emitted, so the cloth looks red.
**Item 15**

Which of these will remain unchanged when a sound wave travels from the air to water?

A. amplitude  
B. frequency  
C. speed  
D. wavelength

**Item 16**

A lab group designs an experiment to test which of four identical bottles will produce the sound with the highest pitch when air is blown across the opening at the top. Their initial hypothesis is that the highest pitches are produced when equal amounts of water and air are in the bottle. When blowing air across the tops of the bottles, Bottle 4 produces the sound with the highest pitch.

Which would be the BEST hypothesis based on their results?

A. The pitch of the sound produced when air is blown across a bottle does not depend on the contents of the bottle, but only on the size of the bottle.  
B. The highest pitches are produced when the total mass of air in the bottle is greater than the total mass of the water in the bottle.  
C. Sounds with the highest pitch are produced when all air is removed from the bottle.  
D. The pitch of the sound increases as the amount of air in the bottle decreases.