Science Benchmark: 06:06

Heat, light, and sound are all forms of energy. Heat can be transferred by radiation, conduction and convection. Visible light can be produced, reflected, refracted, and separated into light of various colors. Sound is created by vibration and cannot travel through a vacuum. Pitch is determined by the vibration rate of the sound source.

Standard 06:

Students will understand properties and behavior of heat, light, and sound.

Shared Reading

Energy – Heat, Light, and Sound

A two-year-old boy has plenty of it, and the sun has a bunch of it. Do you know what it is? If not, let me give you a definition. "A source of usable power." By now most of you have probably guessed the answer. It's energy. The sun definitely qualifies. What about a two-year-olds energy? Is it "a source of usable power" as the definition states? As you may know, two-year-olds are usually bundles of energy, but their energy cannot be used by others.

This unit is going to discuss three types of energy: heat, light, and sound. As we discuss them, be sure to watch for similarities as you learn some background on each. So, if you/re ready, here we go.

Heat

If you go camping, you usually build a fire to sit around at night. You may make S'mores, have hot chocolate and stay warm. Have you ever wondered why a marshmallow cooks without touching the flame, why the smoke rises, or why water in a pan boils? Heat can move from one object to another in three different ways: conduction, convection and radiation.

Conduction is the heat transfer through a substance or from a substance to another by direct contact. Everything is made up of small particles. When the particles touch slow-moving particles, the energy is transferred. This causes slower particles to speed up and the faster particles to slow down. You can demonstrate this by rubbing your hands together very fast for 30 seconds. Now touch them to your ears. Can you feel the heat transfer from your hands to your ears? As your ears warms, your hands will cool until the particles in each are moving at the same speed. Another example of conduction is a pan on the stove. If the stove is heated, the pan gets hot.

Conduction

Conduction - heat transfer through a substance, or from a substance, to another substance, by direct contact of particles

Grade	Benchmark	Standard	Page
06	06 : 06	06	13.1.1

Substances that transfer heat better than others are *conductors*. Can you think of other examples of conductors? Insulators are substances that do not conduct heat easily. Glass, wood, plastic and rubber are all insulators. Pans have plastic or wood handles to keep the pan from conducting heat to your hand and burning it. Can you think of other examples of insulators?

Convection is the heat transfer in liquids and gases as particles circulate in currents. This transfer of energy causes warm substances to rise and cool ones to sink. In heat transfer by convection, the particles in a liquid or gas speed up as they are heated. This causes the particles to move apart and the substance becomes lighter. As the heated substance rises, the cooler, heavier substance moves down. These currents exchange heat through this movement.

Convection of liquids

Warm, red water on the bottom. Card is in between the jars.

After the card has been removed.

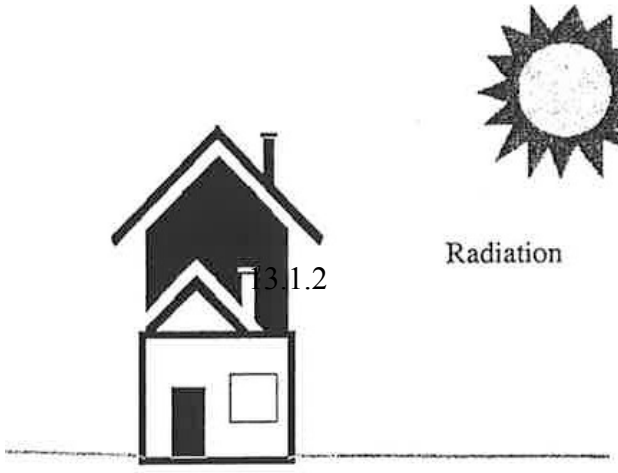
You can observe convection in a simple experiment. Get two baby food jars. Fill one with hot water and a drop of red food color. Fill the other with cold water and a drop of blue food coloring. Place a card over the mouth of the cold water jar and turn it upside down on top of the warm water. Carefully pull out the card. You should see warm red water rising and cold water sinking.

Radiation is the transfer of heat through space in the form of waves. The heat we receive from the sun is radiant heat. Radiant heat travels as waves through space. Heat waves hit Earth and cause warming. Our atmosphere traps the warmth. Your house gets warm when the sun's waves or rays travel through a window and are trapped in your house, warming it. Heat waves are invisible. All warm objects radiate or give off heat waves. Some other examples of radiation are the heat surrounding a fire, the heat given off by an electric heater, and the heat near a hot oven.

conductor

convection – the heat transfer in liquids and gases as particles circulate in currents

radiation – transfer of heat through space in the form of waves



Radiation

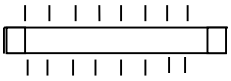
13.1.2

Light

If you were asked to make a list of all the things that give us light, what would you write? Light bulbs, candles or campfires may be on your list. The sun is an important source also. Light is energy that travels in waves and is produced by hot, energetic objects.

Light bulbs are hot, energetic objects. If you have ever touched a light bulb while it is on, you know it is hot. You know the light bulb needs energy because you have to turn the light switch on to provide electricity for it. The electricity flows through either a thin metal wire or a gas. The wire or gas glows and gives off light when heated.

Glowing Wire



Glowing Glass

Sound

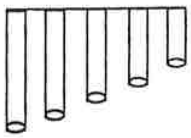
If a tree falls in the forest and no one is there, does it make any sound? *Sound* is a form of energy that causes particles to vibrate back and forth. How would you answer the question about the tree falling in the forest?

When the tree hits the ground it causes the particles in the air to vibrate. *Vibration* is a rapid movement back and forth. The tree creates vibrations in the air as it falls. The vibrations spread out in all directions. If the vibrations in the air reach you, your eardrum will vibrate and you will hear the sound of the tree falling.

Have you ever placed your hands over your ears because someone was yelling? The loudness or intensity of a sound depends on the energy used. The more energy used, the louder the sound. you use a lot more energy to yell than you do to whisper. The same is true with all sounds: the more energy expended, the louder the sound.

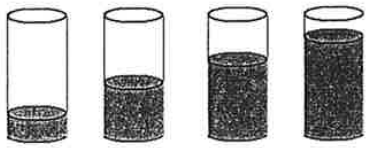
Do you sing or play a musical instrument? If you do, you understand *pitch*, how high or low a sound is. The pitch of an instrument changes by adjusting its length or width. A trombone's sound changes from low to high as the slide is moved in. The pitch of musical instruments can also be changed by tightening the strings which increases the speed of vibration.

Below are some different sizes of chimes. Which do you think will have the highest pitch? The lowest pitch? If you guessed the shortest chime would have the highest pitch, you are right. It has the shortest length of metal to vibrate. The longest chime will have the lowest pitch because it has the longest length of metal to vibrate. Now look at the next example.



Pitch – how high or low a musical note sounds
Sound – a form of energy that causes particles to vibrate back and forth
Vibration – a rapid movement back and forth

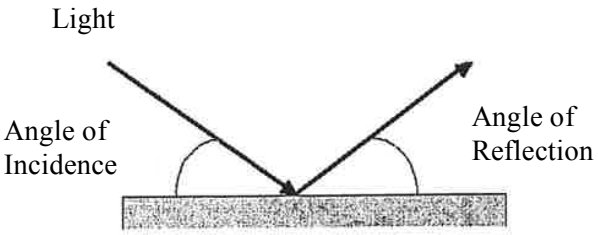
Below are glasses filled with different levels of water. Which do you think will have the highest pitch when it is struck with a metal object? Which will have the lowest pitch? This one is a little bit trickier for there are two substances in the glass – air and water. Which one is going to vibrate to make the sound? If you guessed the water will vibrate, you are correct. Thus, the glass with the last amount of water would have the highest pitch because it has the shortest length of water to vibrate. The opposite is also true. The glass with the most amount of water would have the lowest pitch because it has the longest length of water to vibrate.



If you blew air across the tops of these bottles, which one would have the highest pitch and which one would be the lowest pitch? Why? Which substance is vibrating now?

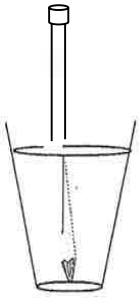
To keep areas quiet, such as libraries, there are materials placed in the rooms such as carpet and upholstered chairs to absorb noise. The *absorption* soaks up any noise so people can study in quiet surrounds.

One way the three forms of energy are alike is that they can be reflected. Think back to the last time you looked in a mirror. You saw a *reflection*. If light wasn't reflected, you wouldn't have seen anything. Light strikes the mirror at an *angle of incidence*. It bounces off at the same angle, the *angle of reflection.*



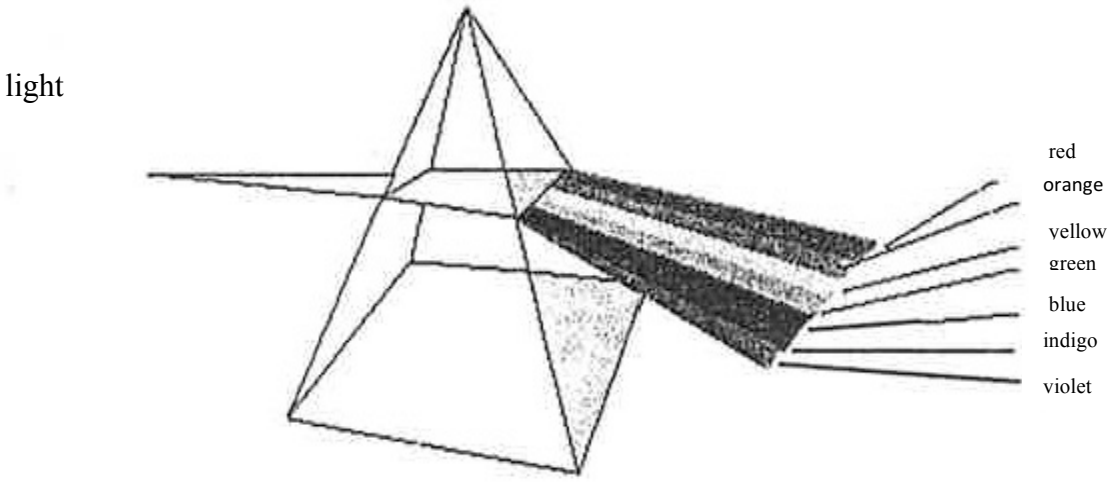
We are very familiar with reflection when it comes to mirrors and other items that reflect images. Did you know that everything reflects light? When we look at things, the color that we see is light that is reflected from the object. For example, if we look at a red apple it reflects red and absorbs (takes in) all the colors but red. What color is reflected when you look at a banana? What colors are absorbed when you look at a banana? All colors are reflected if an object appears white. All colors are absorbed if an object appears black. Most objects reflect more than one color, creating a vast number of color combinations. Sound waves are reflected from canyon walls if you shout loudly. You may have enjoyed hearing the echo of your voice. Heat waves are reflected from windows by aluminum foil placed over them. This keeps houses cooler in the summer.

Absorption – taking in or swallowing up energy
Angle of reflection – the angle at which light bounces off a surface
Angel of incidence – the angle at which light strikes a surface
Reflection – when rays of light or heat are reflected or bounced off other objects



Energy waves can also be *refracted,* or best. Light is easiest to observe as it is refracted. Light always travels in a straight line when going through a single *medium*. In some mediums, such as air, light travels quickly. In other mediums, such as water and glass, light travels more slowly. When light travels from one type of medium to another, the light changes speed and is refracted. Look at the picture of the pencil in the glass of water. The light rays bend as the light rays pass from the water to the air, making the pencil look bent. This is also seen in a rainbow. To get the same effect, shine a light through a *prism.* You will create the same rainbow spectrum as seen in a rainbow made by nature. As you can see in the picture below, white light is actually made up of seven different colors.

Heat, light and sound are similar to each other. They are forms of energy and they travel in waves.



A Prism Refracting Light

Medium – any substance through which a wave is transmitted
Prism – a clear glass or plastic shape that breaks light into the color spectrum
Refraction – when light goes from one medium to another medium (air to water) and is bent

Science Language Students Need to Understand and Use

1. **Angle of incidence:** the angle at which light strikes a surface
2. **Angle of reflection:** the angle at which light bounces off a surface
3. **Absorption:** taking in or swallowing up energy
4. **Conduction:** heat transfer through a substance or from a substance, to another substance by direct contact of particles.
5. **Conductor:** a substance that allows heat, electricity or sound to travel through it.
6. **Convection:** heat transfer in liquids and gases as molecules circulate in currents
7. **Medium:** any substance through which a wave is transmitted
8. **Pitch:** how high or low a musical note sounds
9. **Prism:** a clear glass or plastic shape that breaks light into the color spectrum
10. **Radiation:** heat transfer through space in the form of waves
11. **Reflection:** when rays of light or heat are reflected or bounced off other objects
12. **Refraction**: when light goes from one medium to another medium, (from air to water) and is bent
13. **Sound:** a form of energy that causes particles to vibrate back and forth
14. **Spectrum:** the colors red, orange, yellow, green, blue, indigo, and violet, arranged in the order of their wavelengths and seen when white light passes through a prism.
15. **Vibration:** a rapid back and forth movement