

# Electricity

## KEY CONCEPTS

**Voltage:** The measure of the difference in electrical potential between two points in a circuit. Think of it as the amount of electrical “pressure” available to make a current flow between points.

**Current:** The measure of how much electricity is flowing past a circuit point in a given amount of time (Similar to the flow rate of water in a hose).

**Resistance:** A measure of the opposition to electrical flow or current in the circuit.

**Capacitance:** The measure of a device’s ability to store electrical charge.

## DESCRIPTION

The subject of electricity deals with electrical charges, how they interact with one another, and how they move through circuits to power lamps, run motors, and perform other tasks.

Some electrical components included in electrical circuits are resistors, capacitors, lamps, switches, and motors. **Resistors** are made from materials that resist the flow of electricity, such as thin films of carbon. High value resistors decrease the flow of electricity to a great extent; low value resistors only to a small extent. Resistance is measured in **ohms**, such as five ohms or 10,000 ohms. A **Capacitor** is a device that stores electrical charge. It is usually made of two pieces of metal foil or electrical conductors that are separated by a non-conducting film. One important characteristic of capacitors is that it takes time to fully charge or discharge them to a given voltage. This time is controlled by the value of the capacitor and by the value of the resistance in the circuit. Lamps are usually made from a high resistance wire such as tungsten that heats up and glows brightly when electricity flows through it. Less electricity flowing in the circuit means less light. Small DC motors work by utilizing the magnetic field produced around wires when electricity flows through them. By using a clever arrangement of coils and permanent magnets, the motor uses the interaction of the magnetic fields to produce rotation. One characteristic of these motors is that they actually have less overall resistance to electricity when they are stopped, placed under a heavy load, or just starting than they do when they are normally operating.

## Light and Optics

### KEY CONCEPTS

***Light Spectrum:*** The most commonly referred to regions of the light spectrum are the infrared, visible, and ultraviolet. The word “spectrum” refers to the Range of wavelengths and energies these regions span.

***Lens:*** Device used to bend light from an object in ways that focus, magnify, shrink, or project images of the object.

***Focal Length:*** Length from a lens to the point where all the parallel light rays passing through the lens from a light source meet.

### DESCRIPTION

White light is the sum of the visible light colors we see coming from the sun or emanating from the traditional tungsten filament lamp. It is the addition of red, orange, yellow, blue, indigo, and violet wavelengths of the light spectrum that, as a collection, our eyes perceive as white in color. These colors become visible to us individually when white light is separated through dispersion by a prism or the water droplets in a rainbow.

The visible light we see coming from the sun or a light bulb is only a portion of the total spectrum coming from these sources. The rest of the light is invisible to our eyes, and these invisible wavelengths are either longer than the visible ones, as in infrared regions, or shorter, as in the ultraviolet region. Red is the longest visible wavelength at approximately 650 nanometers (.000000650 meters), and violet is the shortest visible wavelength at about 410 nanometers. Although we cannot see the infrared region with our eyes, we can detect it with instruments, and we feel it as heat. We cannot see the ultraviolet region either, but again instruments can detect it; one of its effects is well known to us as sunburn.

Another property of light is that it can be refracted or bent. This means that its direction can be changed as it moves from one medium to another, such as from air to glass or from air to water. Different materials have different abilities to bend light. We have learned how to use this property by producing lenses that bend light to focus it, magnify objects, project images, and correct our vision.

# Weather

## KEY CONCEPTS

- Solar Energy:*** Radiation from the sun that warms the earth and drives the circulation of the atmosphere and the oceans.
- Winds:*** Air currents that result from the atmosphere attempting to move warm air or cold air from one place to another in order to evenly distribute the heat from the sun.
- Coriolis Effect:*** The curving path a moving object (or the wind) appears to follow when viewed from a rotating surface, like the surface of the Earth.
- Axis Tilt:*** The angle at which Earth's axis is tipped relative to the plane of Earth's revolution around the sun. Earth's axis tilt is what causes our seasons.
- Orbit Shape:*** The shape of the orbit of a revolving object; in this case, the shape of Earth's orbit around the sun. Earth's orbit shape is almost, but not exactly, circular
- Precipitation:*** The products of condensation in the atmosphere that fall to Earth in the form of snow, rain, hail, etc. Water vapor in the air changes from a gas to liquid droplets or ice crystals when the air temperature reaches the dew point.
- Dew point:*** The temperature at which condensation begins on a surface; the relative humidity is always 100% at the dew point.

## DESCRIPTION

The weather we experience is fueled by the absorption of solar energy by Earth. Although the total amount of solar energy received by Earth varies very little throughout the year, the energy received at any particular place on Earth varies considerably. The seasons are caused by regular variations in the amount of solar energy reaching a given place on Earth. The amount of solar energy that hits any one place depends on Earth's 23.5 tilt and the time of the year. For example, during the summer months, North America is tilted toward the sun so the sun's rays strike North America more directly. As a result, we receive the most solar energy at this time, which leads to warm temperatures. As winter approaches, North America is tilted away from the sun, and we receive less solar energy, resulting in cooler temperatures. The **Seasons Lab** and the **Orrery** illustrate the key concepts related to the seasons.

Earth receives more solar energy at the equator than near the poles. Because physical systems seek equilibrium, in this case thermal equilibrium, air motions and ocean currents are generated that move the warmer air and water toward the poles and the colder air and water towards the equator. These atmospheric winds and ocean currents appear to curve in their path as they move over Earth's surface. This curving motion is called the Coriolis Effect and is caused by Earth's rotation on its axis. In the Northern Hemisphere, winds and currents appear to curve to the right of their path, while in the Southern Hemisphere winds and currents curve to the left. The Coriolis Effect leads to the characteristic circulation of air around the low and high-pressure systems that create the winds and weather that we experience. The **Coriolis Fountain** and Coriolis Globe exhibits illustrate the curving effects resulting from rotation.

On a smaller scale, if the air becomes saturated with water vapor, condensation will occur, leading to precipitation in the form of rain or snow. The **Snow Chamber** creates snowflakes from the water vapor in your breath while the **Dew Point** exhibit demonstrates dew formation as you may see it in your back yard. The dew point is the temperature at which condensation begins on a surface.

## Oscillators, Resonance, and Wave

### KEY CONCEPTS

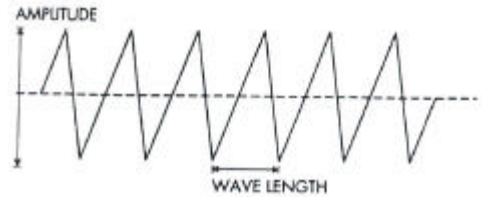
**Frequency:** A repetitive event's rate of occurrence. It's usually measured in cycles per second and called "hertz."

**Wave Shape:** The graph of an occurrence, if it's periodic in nature, will often produce a picture resembling a wave. Three common shapes are a square wave, a sawtooth wave, and a sine wave.

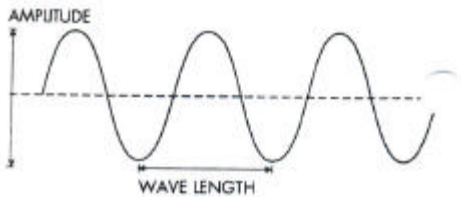
**Audi Spectrum:** The span of sound frequencies (vibrations) audible to the human ear. It spans from about 15 hertz to 20,000 hertz for the average young person.

**Resonance:** A large increase in a system's response due to a small input of energy that's matched to the system's cycle. Pushing someone on a swing at just the right time again and again produces a large amplitude swing.

SAWTOOTH WAVE



SINE WAVE



### DESCRIPTION

Waves and oscillatory phenomena are found throughout nature and in many human inventions. An understanding of the fundamentals facilitates further study in many areas of physical science.

Oscillating systems are systems that exhibit some aspect that is repetitious and regular. For example, a pendulum swings back and forth again and again; sound in a series of traveling air "pulses" described by a series of compressions and rarefactions; and electronic pulses from a circuit can produce synthesized sound, a time clock, or run an AC motor. We use wave descriptions partially to understand the behavior of light and particles.

Many of the exhibits in the Experiment Gallery deal with oscillatory phenomena. Two in particular illustrate these important concepts: the Sound Lab and Waves on a String.

## Pendulums

### KEY CONCEPTS

**Frequency:** The rate of occurrence of a repetitive event. Usually measured in cycles per second, which is given the name “hertz.”

**Period:** The time it takes for an event to complete one full cycle.

**Length:** The length of a pendulum is measured from the point from which it is hung to the center of the hanging mass.

### DESCRIPTION

Pendulums are interesting objects to experiment with because their action involves so many of the concepts involved in mechanics. Some of the phenomena that can be investigated by studying pendulums include gravity, periodic or oscillatory motion, and energy relationships.

Perhaps the most interesting and useful characteristic of a pendulum is that its swing period depends on its length and not its mass. A pendulum may be made many times heavier (or lighter), but if it's the same length it will swing at the same rate. The accepted equation used to determine the period of a pendulum's swing at angles smaller than 10 is:

$$\text{Period} = 2\pi \sqrt{\frac{L}{g}}$$

Where the period is the time in seconds it takes to complete one full swing; "L" is the length of the pendulum in meters; and "g" is the acceleration due to gravity (9.8 m/s<sup>2</sup> on Earth).

## Other Exhibits (Not Pictured)

### *MacFourier*

Choose a wave shape at the Fourier Analyzer and listen to the sound it makes. Then, be creative and draw your own new wave. What sound will it make?

### *Mobiles Lab\**

Shapes balance and twist suspended from a system of rods and clips.

### *Pendulum Clock*

An antique pendulum clock demonstrates a practical use of a pendulum.

### *Sawtooth Grapher*

A marker graphs the cycles of a tank and siphon system on a turning drum.

### *Stress Analyzer Bench*

At the Stress Analyzer Bench, you'll discover how engineers design the strongest bridge with the least amount of material. View beams and bridges through polarized light windows, and watch colored patterns move and change shape in response to stress as you push, pull, and add weight.

### *Variable Length Pendulum*

Now that you know so much about pendulums, can you decide what you can do to make it swing faster? This exhibit will allow you to change the length of a pendulum and observe the difference in swing speeds.

### *Vibrations and Frequencies*

Investigate the concepts of wavelength, frequency, and period by manipulating a pendulum, a tuning fork, and a frequency meter.

**\*These exhibits are listed as NOT AVAILABLE, but will be shipped to us as part of the package deal. There may be some defect or malfunction that will have to be addressed before the exhibit can be used.**

## The Resource Center

The Resource Center is not an exhibit as such. It is a comfortable place within the IDEA Place where students/visitors may conduct independent research on science related topics.

## The Activity Station



The Activity Station provides visitors with the opportunity to experience fun hands-on science activities. These activities will be supervised by IDEA Place staff.

Teachers may select the activities that they would like their class to participate in prior to their visit. This will maximize the effectiveness of the visit by connecting

the visit directly to content discussed in the classroom. New activities will be developed and added to this list as the need arises.

### *Acids and Bases*

Two activities using common household items to introduce pH and the concept of acids and bases.

### *Weather Activities*

Cloud in a Bottle  
Collapsing Cans  
A Fire Tornado  
Convection Currents

### *Paper Chromatography*

Black is Beautiful  
Other Solvents  
Colors in Foods

### *Carbon Dioxide Activities*

Floating Bubbles  
Flame's Out  
Balloons  
Blue to Yellow  
The Squealing Tongs  
Boiling

### *Resonance Activities*

Waves On a String  
Resonant Pendulums  
Singing Glass  
Tuning Forks  
Conch Shells  
Hoot Tubes  
Organ Pipes

### *Electricity Activities*

Permanent Magnets  
Electricity and Magnets  
Single Loop Motor  
Practical Motors  
DC Generators  
Van Degraff Generator

