At-Home Learning Packet
The Crossroads School
8th Grade Science

Please Note:

This packet is designed for students who are unable to access the 8th grade science Google Classroom due to Internet or technology limitations. *It is strongly recommended that students access and complete the material provided on Google Classroom if able.*

Directions:

This packet provides the opportunity to access information related to standards MS-PS2-3, MS-PS2-5, MS-PS3-1, MS-PS3-2, and MS-PS3-5. Any completed work will be collected upon students' return to school.

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Accessing Google Classroom:

Watch this YouTube Video and follow the steps shown.

Youtu.be/Q8RN8F6Scww

Many additional school materials, resources, or information can be found on the Crossroads Science website and the Crossroads Lab Website:

Crossroadssci.weebly.com
Crossroads323.weebly.com

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Everyday Mysteries: What is static electricity?

By Library of Congress, adapted by Newsela staff on 01.13.17
Word Count **459**
Level **830L**

Ryan Solymar of San Jose Street Elementary School in Los Angeles, California, got to experience the wonders of static electricity as he and his hair became part of an experiment. Photo by David Bohrer/Los Angeles Times via Getty Images

Question: How does static electricity work?

Answer: Static electricity is an imbalance between positive and negative electric charges in an object.

Protons, Electrons And Neutrons

Have you ever walked across the room to pet your dog, but got a shock instead? Perhaps you took your hat off on a dry winter's day and had a "hair raising" experience? Or maybe you made a balloon stick on the wall after rubbing it against your clothes?

Why do these things happen? Is it magic? No; it's static electricity! But how does it work?

All physical things are made up of tiny parts called atoms. A single atom is made of even smaller parts. They are protons, electrons and neutrons. Each of these parts has a certain type of charge. The protons are positively charged, the electrons are negatively charged and the neutrons are neutral.

Opposite charges attract each other. For example, negative charges (electrons) attract positive charges (protons). If charges are the same, however, they push each other away. Since every object is made of atoms, the charges add up to give the object an overall charge. Most of the time, positive and negative charges are balanced. A balanced charge makes that object neutral.

Static Charge Wants To Jump Toward Its Opposite

Static electricity is the result of an imbalance between negative and positive charges in an object. These charges can build up on the surface of an object. They keep building up until they find a way to be released or discharged. The static charge always wants to jump toward its opposite charge.

When certain materials rub against one another, they transfer negative charges, or electrons. For example, if you rub your shoe on the carpet, your body collects extra electrons. The electrons cling to your body until they can be released. Say you're walking along the carpet to pet your dog. As you reach and touch your furry friend, you get a shock. This shock is caused by the extra electrons being released, or jumping, from you to your pet.

What about that "hair raising" experience? As you remove your hat, electrons are transferred from hat to hair — creating an interesting hairdo! Remember, objects with the same charge try to push each other away. Because your hairs all have the same charge, they will stand on end. Your hairs are simply trying to get as far from each other as possible!

When you rub a balloon against your clothes and it sticks to the wall, you are adding more electrons (negative charges) to the surface of the balloon. The wall now has a more positive charge than the balloon. As the two touch each other, the balloon will stick because of the rule that opposites attract.

Quiz

1 Which sentence from the article explains why we don't get a static electric shock every time we touch a surface?

(A) Static electricity is an imbalance between positive and negative electric charges in an object.

(B) For example, negative charges (electrons) attract positive charges (protons).

(C) Most of the time, positive and negative charges are balanced.

(D) The static charge always wants to jump toward its opposite charge.

2 Based on the information and examples in the article, which of the following conclusions can be drawn?

(A) Static electricity is common and harmless.

(B) Movement always increases electrons.

(C) Static electricity can build up on any surface.

(D) Objects contain more electrons than protons.

3 What is the relationship between protons and electrons?

(A) They keep adding up to give an object an overall charge.

(B) They try to get as far away from each other as possible.

(C) They build up until they find a way to be released or discharged.

(D) They attract each other because they have different charges.

4 According to the article, what effect do neutrons have on the overall charge of an atom?

(A) They make an atom's charge neutral.

(B) They do not influence an atom's charge.

(C) They make an atom's charge more positive.

(D) They make an atom's charge more negative.

Explainer: What is electricity?

By Mary Bellis, ThoughtCo. on 10.31.19
Word Count **1,661**
Level **MAX**

An electrical spark is created when a sheet pf photographic film is placed between two high voltage electrodes. Initially, the film builds up a charge on the surface and acts like as a capacitor. At a certain potential voltage the film breaks down and allows electrons to flow. The flowing electrons superheat the air resulting in an electrical spark which is recorded in the film emulsion. Photo by: Ted Kinsman/Science Source

_This article from ThoughtCo has intentionally not been leveled by Newsela staff, and has not been edited for accuracy or quality. _

Electricity is a form of energy. Electricity is the flow of electrons. All matter is made up of atoms, and an atom has a center, called a nucleus. The nucleus contains positively charged particles called protons and uncharged particles called neutrons. The nucleus of an atom is surrounded by negatively charged particles called electrons. The negative charge of an electron is equal to the positive charge of a proton, and the number of electrons in an atom is usually equal to the number of protons. When the balancing force between protons and electrons is upset by an outside force, an atom may gain or lose an electron. When electrons are "lost" from an atom, the free movement of these electrons constitutes an electric current.

Electricity is a basic part of nature and it is one of our most widely used forms of energy. We get electricity, which is a secondary energy source, from the conversion of other sources of energy, like coal, natural gas, oil, nuclear power and other natural sources, which are called primary sources. Many cities and towns were built alongside waterfalls (a primary source of mechanical energy) that turned water wheels to perform work. Before electricity generation began slightly over 100 years ago, houses were lit with kerosene lamps, food was cooled in iceboxes, and rooms were warmed by wood-burning or coal-burning stoves. Beginning with Benjamin Franklin's experiment with a kite one stormy night in Philadelphia, the principles of electricity gradually became understood. In the mid-1800s, everyone's life changed with the invention of the electric light bulb. Prior to 1879, electricity had been used in arc lights for outdoor lighting. The lightbulb's invention used electricity to bring indoor lighting to our homes.

How Is A Transformer Used?

To solve the problem of sending electricity over long distances, George Westinghouse developed a device called a transformer. The transformer allowed electricity to be efficiently transmitted over long distances. This made it possible to supply electricity to homes and businesses located far from the electric generating plant.

Despite its great importance in our daily lives, most of us rarely stop to think what life would be like without electricity. Yet like air and water, we tend to take electricity for granted. Everyday, we use electricity to do many functions for us — from lighting, heating and cooling our homes, to being the power source for televisions and computers. Electricity is a controllable and convenient form of energy used in the applications of heat, light and power.

Today, the United States (U.S.) electric power industry is set up to ensure that an adequate supply of electricity is available to meet all demand requirements at any given instant.

How Is Electricity Generated?

An electric generator is a device for converting mechanical energy into electrical energy. The process is based on the relationship between magnetism and electricity. When a wire or any other electrically conductive material moves across a magnetic field, an electric current occurs in the wire. The large generators used by the electric utility industry have a stationary conductor. A magnet attached to the end of a rotating shaft is positioned inside a stationary conducting ring that is wrapped with a long, continuous piece of wire. When the magnet rotates, it induces a small electric current in each section of wire as it passes. Each section of wire constitutes a small, separate electric conductor. All the small currents of individual sections add up to one current of considerable size. This current is what is used for electric power.

How Are Turbines Used To Generate Electricity?

An electric utility power station uses either a turbine, engine, water wheel, or other similar machine to drive an electric generator or a device that converts mechanical or chemical energy to electricity. Steam turbines, internal-combustion engines, gas combustion turbines, water turbines and wind turbines are the most common methods to generate electricity.

Most of the electricity in the United States is produced in steam turbines. A turbine converts the kinetic energy of a moving fluid (liquid or gas) to mechanical energy. Steam turbines have a series of blades mounted on a shaft against which steam is forced, thus rotating the shaft connected to the generator. In a fossil-fueled steam turbine, the fuel is burned in a furnace to heat water in a boiler to produce steam.

Coal, petroleum (oil) and natural gas are burned in large furnaces to heat water to make steam that in turn pushes on the blades of a turbine. Did you know that coal is the largest single primary source of energy used to generate electricity in the United States? In 1998, more than half (52 percent) of the county's 3.62 trillion kilowatt-hours of electricity used coal as its source of energy.

Natural gas, in addition to being burned to heat water for steam, can also be burned to produce hot combustion gases that pass directly through a turbine, spinning the blades of the turbine to generate electricity. Gas turbines are commonly used when electricity utility usage is in high demand. In 1998, 15 percent of the nation's electricity was fueled by natural gas.

Petroleum can also be used to make steam to turn a turbine. Residual fuel oil, a product refined from crude oil, is often the petroleum product used in electric plants that use petroleum to make steam. Petroleum was used to generate less than three percent (3 percent) of all electricity generated in U.S. electricity plants in 1998.

Nuclear power is a method in which steam is produced by heating water through a process called nuclear fission. In a nuclear power plant, a reactor contains a core of nuclear fuel, primarily enriched uranium. When atoms of uranium fuel are hit by neutrons they fission (split), releasing heat and more neutrons. Under controlled conditions, these other neutrons can strike more uranium atoms, splitting more atoms, and so on. Thereby, continuous fission can take place, forming a chain reaction releasing heat. The heat is used to turn water into steam, that, in turn, spins a turbine that generates electricity. In 2015, nuclear power is used to generate 19.47 percent of all the country's electricity.

As of 2013, hydropower accounts for 6.8 percent of U.S. electricity generation. Its a process in which flowing water is used to spin a turbine connected to a generator. There are mainly two basic types of hydroelectric systems that produce electricity. In the first system, flowing water accumulates in reservoirs created by the use of dams. The water falls through a pipe called a penstock and applies pressure against the turbine blades to drive the generator to produce electricity. In the second system, called run-of-river, the force of the river current (rather than falling water) applies pressure to the turbine blades to produce electricity.

Other Generating Sources

Geothermal power comes from heat energy buried beneath the surface of the earth. In some areas of the country, magma (molten matter under the earth's crust) flows close enough to the surface of the earth to heat underground water into steam, which can be tapped for use at steam-turbine plants. As of 2013, this energy source generates less than 1 percent of the electricity in the country, though an assessment by the U.S. Energy Information Administration reported that nine western states can potentially produce enough electricity to supply 20 percent of the nation's energy needs.

Solar power is derived from the energy of the sun. However, the sun's energy is not available full-time and it is widely scattered. The processes used to produce electricity using the sun's energy have historically been more expensive than using conventional fossil fuels. Photovoltaic conversion generates electric power directly from the light of the sun in a photovoltaic (solar) cell. Solar-thermal electric generators use the radiant energy from the sun to produce steam to drive turbines. In 2015, less than 1 percent of the nation's electricity was supplied by solar power.

Wind power is derived from the conversion of the energy contained in wind into electricity. Wind power, like the sun, is usually an expensive source for producing electricity. In 2014, it was used for roughly 4.44 percent of the nation's electricity. A wind turbine is similar to a typical wind mill.

Biomass (wood, municipal solid waste (garbage) and agricultural waste, such as corn cobs and wheat straw) includes some other energy sources for producing electricity. These sources replace fossil fuels in the boiler. The combustion of wood and waste creates steam that is typically used in conventional steam-electric plants. In 2015, biomass accounts for 1.57 percent of the electricity generated in the United States.

The electricity produced by a generator travels along cables to a transformer, which changes electricity from low voltage to high voltage. Electricity can be moved long distances more efficiently using high voltage. Transmission lines are used to carry the electricity to a substation. Substations have transformers that change the high voltage electricity into lower voltage electricity. From the substation, distribution lines carry the electricity to homes, offices and factories, which require low voltage electricity.

How Is Electricity Measured?

Electricity is measured in units of power called watts. It was named to honor James Watt, the inventor of the steam engine. One watt is a very small amount of power. It would require nearly 750 watts to equal one horsepower. A kilowatt represents 1,000 watts. A kilowatt-hour (kWh) is equal to the energy of 1,000 watts working for one hour. The amount of electricity a power plant generates or a customer uses over a period of time is measured in kilowatt-hours (kWh). Kilowatt-hours are determined by multiplying the number of kWs required by the number of hours of use. For example, if you use a 40-watt light bulb five hours a day, you have used 200 watts of power, or .2 kilowatt-hours of electrical energy.

Quiz

1 Read the following statement.

Fossil fuels are the MOST efficient primary source of energy for generating electricity.

Which sentence from the article BEST supports the statement above?

(A) Geothermal power comes from heat energy buried beneath the surface of the earth.

(B) In 2015, nuclear power is used to generate 19.47 percent of all the country's electricity.

(C) In 1998, more than half (52 percent) of the county's 3.62 trillion kilowatt-hours of electricity used coal as its source of energy.

(D) The processes used to produce electricity using the sun's energy have historically been more expensive than using conventional fossil fuels.

2 Read the list of sentences from the article.

1. *We get electricity, which is a secondary energy source, from the conversion of other sources of energy, like coal, natural gas, oil, nuclear power and other natural sources, which are called primary sources.*
2. *An electric generator is a device for converting mechanical energy into electrical energy.*
3. *Most of the electricity in the United States is produced in steam turbines.*
4. *Steam turbines, internal-combustion engines, gas combustion turbines, water turbines and wind turbines are the most common methods to generate electricity.*

Which two sentences taken together provide the BEST evidence to support the idea that ALL of the ways in which electricity is generated require kinetic energy?

(A) 1 and 4

(B) 1 and 2

(C) 2 and 3

(D) 2 and 4

3 What is the meaning of the phrase "induces a small electric current" as used in the following sentence?

When the magnet rotates, it induces a small electric current in each section of wire as it passes.

(A) a current is procured as the magnet rotates

(B) a current is generated as the magnet rotates

(C) a current is activated as the magnet rotates

(D) a current is instigated as the magnet rotates

4 Read the selection/paragraph from the section "Other Generating Sources."

> *The electricity produced by a generator travels along cables to a transformer, which changes electricity from low voltage to high voltage. Electricity can be moved long distances more efficiently using high voltage. Transmission lines are used to carry the electricity to a substation. Substations have transformers that change the high voltage electricity into lower voltage electricity. From the substation, distribution lines carry the electricity to homes, offices and factories, which require low voltage electricity.*

Which of the following can be inferred from the selection above?

(A) Electricity generated in a power plant is more effective at higher voltages.

(B) Different types of electrical lines and equipment are used in order to transfer high and low voltage electricity.

(C) Electricity used in our homes must be generated in a power plant before being ready for use.

(D) Different types of activities in our homes, offices, and factories require electricity at either a high or low voltage.

The interconnected relationship between electricity and magnetism

By ThoughtCo.com, adapted by Newsela staff on 10.31.19

Word Count **532**

Level **1110L**

Image 1. A simple electromagnet shows how electricity and magnetism are connected. An electromagnet is a type of magnet in which the magnetic field is generated by an electric current. Photo: Jasmin Awad, EyeEm/Getty Images

Electricity and magnetism are separate yet interconnected phenomena. Together they form the basis for electromagnetism, which is the study of charge and the forces associated with charge.

Aside from the force of gravity, almost every occurrence in daily life stems from electromagnetism. These forces are responsible for the interactions between atoms and the flow of energy. They are also responsible for nuclear force, which controls the formation of an atom's nucleus and its breakdown, or decay.

Yet how do we define electricity and magnetism, and how do they work? Read on to find out.

Electricity And The Atom

Atoms are basic units of matter that are defined by their chemical elements in the periodic table. An atom contains protons, neutrons and electrons. Protons and neutrons exist within the nucleus of an atom, whereas the electrons move around an atom. In a neutral state, an atom or molecule has the same number of protons and electrons.

Electricity is the phenomenon of electric charges, whether they are stopped or moving. Electric charge comes from protons, which have a positive charge, or electrons, which have a negative charge.

Electric charge can also come from an ion, which is an atom or molecule that has an uneven number of protons and electrons. This results in the ion or molecule having a positive or negative charge.

Positive and negative charges attract each other. This means that protons are attracted to electrons. On the other hand, like charges repel each other, which means that protons repel other protons and electrons repel other electrons.

The Phenomena Of Magnetism

Familiar examples of electricity include lightning - which occurs naturally -and the flow of electricity that comes from an outlet or battery. Some common units of measuring electricity include the ampere (A) or amp, voltage (V) and watt (W). These units, along with others, describe the flow of electricity, also known as electrical current.

When a particle is stationary, or stopped, it has an electric field, yet if the charge is moving, it also generates a magnetic field.

Magnetism is the phenomenon of a moving electric charge. This motion creates a magnetic force which influences the particles around it. The force, described as a magnetic field, can also trigger charged particles to move, producing an electric current.

In magnetism, like electricity, particles with opposite charges are attracted to each other and particles with similar charges are repelled from each other. Any magnetic particle or object has a "north" and "south" pole, with the directions based on the orientation of the Earth's magnetic field. Earth's magnetic field is created from moving iron in the Earth's core.

A Few Magnetism Examples

Familiar examples of magnetism include a compass needle's reaction to Earth's magnetic field and bar magnets attracting and repelling each other. Electrons moving around atoms produce a magnetic field. Power lines, hard discs and speakers rely on magnetic fields to function. Magnetism, like electricity, also has associated units of measurement, such as the tesla (T).

Special waves such as light have both electric and magnetic characteristics and the two features of the wave travel in the same direction but oriented at a right angle (90 degrees) to one another.

Quiz

1 Read the sentence from the introduction [paragraphs 1-3].

> *Electricity and magnetism are separate yet interconnected phenomena.*

Which of the following options BEST supports the idea that the electricity and magnetism are interconnected?

(A) Electricity is the phenomenon of electric charges, whether they are stopped or moving.

(B) When a particle is stationary, or stopped, it has an electric field, yet if the charge is moving, it also generates a magnetic field.

(C) Any magnetic particle or object has a "north" and "south" pole, with the directions based on the orientation of the Earth's magnetic field.

(D) Magnetism, like electricity, also has associated units of measurement, such as the tesla (T).

2 According to the article, electromagnetism affects forces all around us.

Which paragraph BEST supports the idea outlined above?

(A) Electricity and magnetism are separate yet interconnected phenomena. Together they form the basis for electromagnetism, which is the study of charge and the forces associated with charge.

(B) Aside from the force of gravity, almost every occurrence in daily life stems from electromagnetism. These forces are responsible for the interactions between atoms and the flow of energy. They are also responsible for nuclear force, which controls the formation of an atom's nucleus and its breakdown, or decay.

(C) Positive and negative charges attract each other. This means that protons are attracted to electrons. On the other hand, like charges repel each other, which means that protons repel other protons and electrons repel other electrons.

(D) Familiar examples of electricity include lightning - which occurs naturally -and the flow of electricity that comes from an outlet or battery. Some common units of measuring electricity include the ampere (A) or amp, voltage (V) and watt (W). These units, along with others, describe the flow of electricity, also known as electrical current.

3 How are molecules in a neutral state different from ions?

(A) Molecules in a neutral state have even numbers of protons and electrons, while ions have more of one or the other.

(B) Ions have even numbers of protons and electrons, while molecules in a neutral state have more of one or the other.

(C) Molecules in a neutral state always have more protons than electrons, while ions have more electrons than protons.

(D) Ions always have more protons than electrons, while molecules in a neutral state have more electrons than protons.

4 Which characterization accurately describes BOTH electricity and magnetism?

(A) In both electricity and magnetism, the currents of each are measured using the units of ampere, voltage or watt.

(B) In both electricity and magnetism, the tesla is the main way to figure out a particle's "north" and "south" pole.

(C) In both electricity and magnetism, electrons have positive charges and protons have negative charges.

(D) In both electricity and magnetism, particles with opposite charges attract each other and similar charges repel each other.

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An explanation of the two types of energy: potential and kinetic

By Gale, Cengage Learning on 12.15.19
Word Count **543**
Level **MAX**

Billiards, often called pool, is a good example of how energy can be transferred between objects. When a ball is still, it has potential energy. When a ball moves, it has kinetic energy. When one ball hits another, kinetic energy is transferred to the second ball. Photo by PIRO4D/Pixabay

Energy is involved in nearly everything we do. It is defined as the ability to do work, to set an object in motion. There are several different kinds of energy. Kinetic energy is the energy an object has when it is in motion. Vibration, forward motion, turning and spinning are all examples of kinetic energy. Kinetic energy is directly proportional to the mass of an object. If two objects move at the same speed, and one has twice the mass of the other, the object with twice the mass will have twice the kinetic energy.

Potential energy is the energy an object has because of its position; it is energy waiting to be released. For example, a weight suspended above the ground has potential energy because it can be set in motion by gravity. Compressed or extended springs also have potential energy.

Thermal energy is the kinetic energy of atoms vibrating within matter. The faster the atoms move, the hotter the object becomes. Electrical energy is the kinetic energy resulting from the motion of electrons within any object that conducts electricity. Chemical energy is the potential energy stored in molecules. Thermal, electrical and chemical energy are all forms of kinetic or potential energy.

What Laws Control Energy?

One of the most fundamental laws of physics is that energy cannot be created or destroyed, only transformed from one form into another. For example, if a suspended weight falls, its potential energy becomes kinetic energy. When a car burns fuel, the fuel's chemical energy is transformed into thermal energy, which in turn, is transformed into kinetic energy by the engine to make the car move.

Energy can also be transferred from one object to another. Think about a game of pool. When a moving ball hits a still one, the moving ball stops or slows down, and the still one begins to move. The majority of the first ball's kinetic energy has been transferred to the second ball, while a small amount has been converted to thermal energy by the collision. If you could measure the temperature on the surface of each ball, you would find there was a slight rise in temperature at the point of contact. The total amount of energy involved — kinetic and thermal — remains the same. No energy was created or destroyed by the collision.

Who Wrote These Laws?

The person who laid the groundwork for the study of energy was English mathematician and physicist Isaac Newton (1642–1727). Newton developed the laws of motion, which describe how objects are acted upon by forces. Newton's ideas formed the basis for much of physics, in fact. He studied at Cambridge University, where he excelled in mathematics and developed the field of calculus while he was still a student. Newton later became a professor at Cambridge, where he built the first reflecting telescope and studied optics.

He published his most important work in 1687, the Principia Mathematica. This book describes Newton's three laws of motion and the law of gravitation, which are a major part of the foundation of modern science. Newton also had an interesting life. He became Master of Mint in England, where he supervised the making of money, and later became the first scientist to be knighted.

Quiz

1 How does reducing the mass of a moving object by half (1/2) change its kinetic energy?

(A) kinetic energy will be half of what it was before

(B) kinetic energy will be double of what it was before

(C) there is no relationship between mass and kinetic energy

(D) decreasing the mass will make the object go faster, increasing its kinetic energy

2 Which piece of evidence explains the cause of Newton's effect on physics?

(A) The person who laid the groundwork for the study of energy was English mathematician and physicist Isaac Newton (1642–1727).

(B) Newton developed the laws of motion, which describe how objects are acted upon by forces.

(C) Newton later became a professor at Cambridge, where he built the first reflecting telescope and studied optics.

(D) He published his most important work in 1687, the "Principia Mathematica."

3 Why is heat or thermal energy considered a form of kinetic energy?

(A) Heat or thermal energy is a measure of particle vibration, vibration is a type of motion.

(B) Heat or thermal energy increases the speed at which an object moves from place to place.

(C) Heat or thermal energy must always be stored in great quantities for an object to move.

(D) Heat or thermal energy is a form of stored energy.

4 Read the following selection from the introduction [paragraphs 1-3].

> *Potential energy is the energy an object has because of its position; it is energy waiting to be released.*

What conclusion is BEST supported by the selection above?

(A) All still objects have potential energy.

(B) Some objects have more energy than others.

(C) Most still objects do not have potential energy.

(D) Potential energy makes objects move.

5 Which choices are examples of an energy transformation?

1. *baking a cake*
2. *a tennis racket hitting a ball*
3. *a car speeding off from a stop sign*

(A) 1 and 2

(B) 1 and 3

(C) 2 and 3

(D) 1, 2 and 3

6 How are the sections organized to help to develop understanding?

(A) by description; to help to introduce and give examples of several types of energies

(B) by scientific questions; to help readers to understand what they should be asking themselves

(C) by cause and effect; to demonstrate how different types of energies affect each other

(D) by guiding questions; to help readers to understand major concepts in energy

7 Why is Sir Isaac Newton an important person in the field of physics?

(A) Sir Isaac Newton was the first person to calculate the shape and size of the solar system.

(B) Sir Isaac Newton developed many of the laws of physics we still use today.

(C) Sir Isaac Newton developed a mathematical formula to calculate the mass of any object.

(D) Sir Isaac Newton's laws of chemistry and biology changed the way we study science.

8 What is one reason why the author includes the information about what energies a car uses?

(A) to explain how energy makes a car move

(B) to provide an example of chemical energy

(C) to provide an example of how energy can change

(D) to explain what thermal energy is

What is heat energy?

By Encyclopaedia Britannica on 09.09.19
Word Count **781**
Level **MAX**

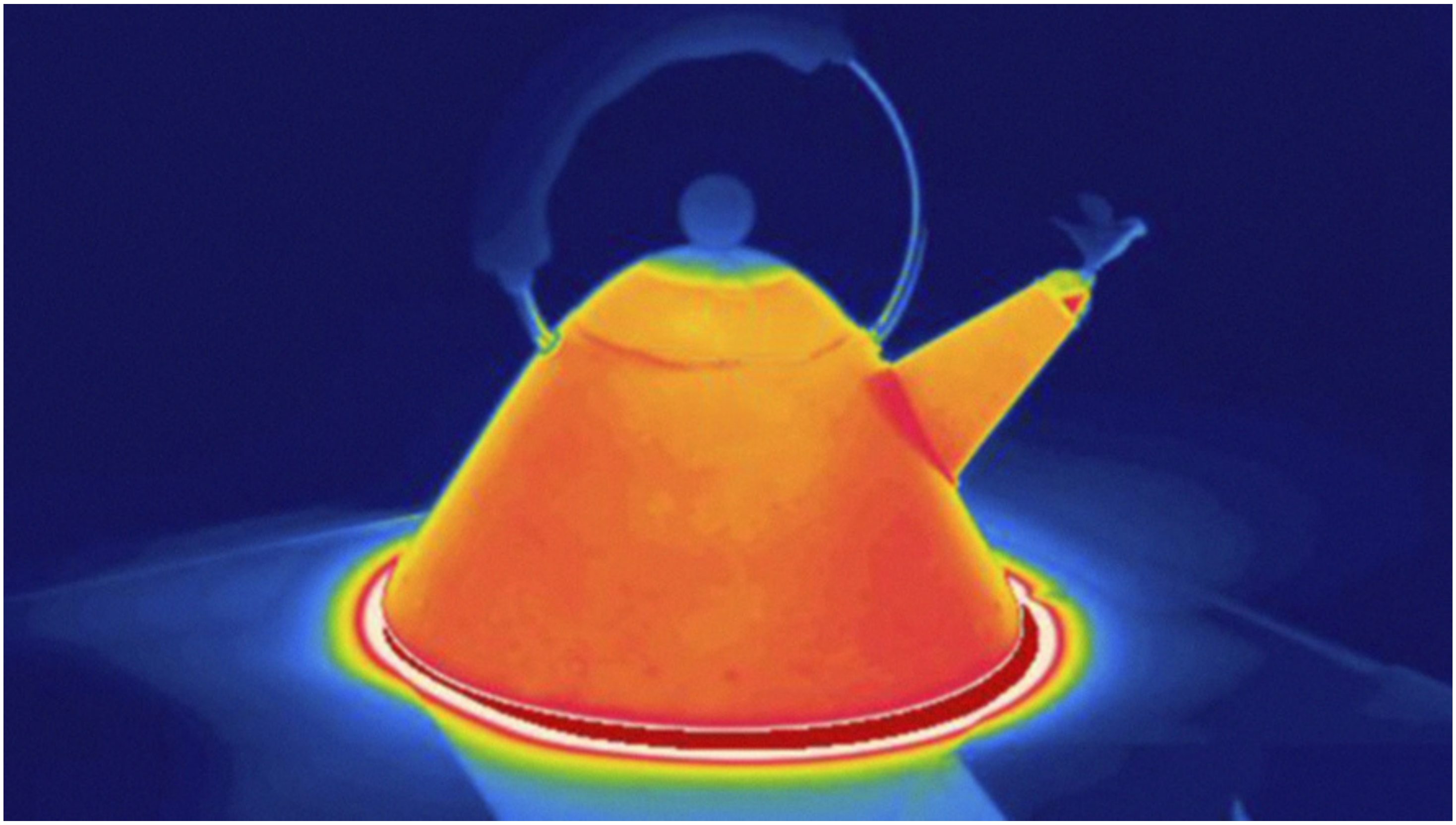


Image 1. A thermogram of a hot tea kettle. Photo by: Science Stock Photography/Science Source

In physics, heat is energy that is transferred from one body to another because of a difference in temperature. Heat is so well-known from our earliest childhood that we hardly think about it. A steaming bowl of soup, an active radiator and a sauna feel hot, a book and a chocolate bar at room temperature seem less hot, and an ice cube feels cold. In everyday speech it is common to say that the soup has more heat than the book and that the ice cube has less heat than the chocolate bar. However, people often use the word heat when what they really mean is temperature or a type of energy called thermal energy.

What Is Heat?

Temperature is a measure of hotness or coldness. If two objects at different temperatures are brought together, energy is transferred — that is, heat flows — from the hotter object to the colder one. A radiator gives off heat, warming the cooler air around it. If a person holds an unwrapped chocolate bar, his or her hands transmit heat to the chocolate, eventually melting it. It is incorrect to speak of the heat in an object itself, because heat is restricted to energy being transferred. Energy that is stored in an object because of its temperature is called thermal energy.

It can be difficult at first to understand the difference between heat, temperature and thermal energy. To better understand these three related concepts, it is helpful to know what actually makes things hot or cold. Heat, temperature and thermal energy are all concerned with microscopic movements within matter. These movements are explained by what is called the kinetic theory of matter.

Molecules In Motion

All matter, whether a solid, liquid or gas, is composed of tiny particles such as molecules and atoms. These particles are constantly in motion — traveling, vibrating or rotating randomly in all directions. One of the many different forms of energy is the energy something has because of its motion. This type of energy is called kinetic energy. The kinetic energy of the particles in matter is the basis of temperature, thermal energy and heat.

Temperature is the measurement of how fast, on average, the particles in something are moving. Microwaving a bowl of soup, for example, raises the temperature of the soup by speeding up the average motion of its molecules. The molecules in the hot soup are traveling faster overall than they did before the soup was heated. Conversely, the molecules in an ice cube are moving more slowly.

Temperature is thus a measure of intensity. It does not depend on the quantity of matter being considered. An ice chip and a brick of ice will have the same temperature if the average speed of their particles is the same.

Thermal energy, on the other hand, represents the total amount of kinetic energy of an object's molecules and other particles. A hot bowl of soup has more thermal energy than a cold bowl of soup because the total amount of its particles' motion is greater. However, a hot bowl of soup possesses more thermal energy than a cup of soup at the same temperature. Likewise, an iceberg has far more thermal energy than a piping-hot bowl of soup. The iceberg is so much larger than the bowl of soup that the sum of the motion of all its particles is greater than that of the soup. This is true even though the soup has a higher temperature. Temperature is a measure of the overall speed of the particles' motion; thermal energy is a measure of the total energy the particles have because of their motion.

Thermal energy represents the amount of heat that something could potentially give off. Heat is the transfer of thermal energy from a hotter substance to a colder one. Transferring heat to a substance usually raises its temperature.

In nearly all cases, matter increases in volume when there is an increase in temperature. In gases the increase is a large one. As the molecules that make up the gas begin speeding up, they also begin spreading out. If the pressure and weight of the gas remain the same, the increase in volume will be in direct proportion to the increase in temperature.

The transfer of heat to a solid causes it to expand as well — but to a much smaller degree than a gas. In a metal rod every unit length of the rod becomes longer when it expands. Liquids in general behave like solids and expand slightly when the temperature is raised.

The reverse is also true. When an object gives off heat and its temperature drops, it contracts.

Quiz

1 Read the paragraph from the section "Molecules In Motion."

> *Temperature is thus a measure of intensity. It does not depend on the quantity of matter being considered. An ice chip and a brick of ice will have the same temperature if the average speed of their particles is the same.*

Which two words would BEST replace "intensity" and "quantity" in the paragraph above?

(A) power; amount

(B) volume; portion

(C) activity; condition

(D) brightness; length

2 Read the selection from the section "Molecules In Motion."

> *The molecules in the hot soup are traveling faster overall than they did before the soup was heated. Conversely, the molecules in an ice cube are moving more slowly.*

Why did the author use the word "conversely"?

(A) to emphasize an important result

(B) to highlight an unusual result

(C) to introduce an opposite effect

(D) to suggest a cause and effect

3 Select the paragraph from the article that suggests it is common to confuse the concepts of heat and thermal energy.

(A) In physics, heat is energy that is transferred from one body to another because of a difference in temperature. Heat is so well-known from our earliest childhood that we hardly think about it. A steaming bowl of soup, an active radiator and a sauna feel hot, a book and a chocolate bar at room temperature seem less hot, and an ice cube feels cold. In everyday speech it is common to say that the soup has more heat than the book and that the ice cube has less heat than the chocolate bar. However, people often use the word heat when what they really mean is temperature or a type of energy called thermal energy.

(B) All matter, whether a solid, liquid or gas, is composed of tiny particles such as molecules and atoms. These particles are constantly in motion — traveling, vibrating or rotating randomly in all directions. One of the many different forms of energy is the energy something has because of its motion. This type of energy is called kinetic energy. The kinetic energy of the particles in matter is the basis of temperature, thermal energy and heat.

(C) Thermal energy, on the other hand, represents the total amount of kinetic energy of an object's molecules and other particles. A hot bowl of soup has more thermal energy than a cold bowl of soup because the total amount of its particles' motion is greater. However, a hot bowl of soup possesses more thermal energy than a cup of soup at the same temperature. Likewise, an iceberg has far more thermal energy than a piping-hot bowl of soup. The iceberg is so much larger than the bowl of soup that the sum of the motion of all its particles is greater than that of the soup. This is true even though the soup has a higher temperature. Temperature is a measure of the overall speed of the particles' motion; thermal energy is a measure of the total energy the particles have because of their motion.

(D) Thermal energy represents the amount of heat that something could potentially give off. Heat is the transfer of thermal energy from a hotter substance to a colder one. Transferring heat to a substance usually raises its temperature.

4 Read the following statement.

Changes in temperature affect each state of matter in a different way.

Which sentence from the article provides the BEST support for the above statement?

(A) The kinetic energy of the particles in matter is the basis of temperature, thermal energy and heat.

(B) Microwaving a bowl of soup, for example, raises the temperature of the soup by speeding up the average motion of its molecules.

(C) In nearly all cases, matter increases in volume when there is an increase in temperature.

(D) The transfer of heat to a solid causes it to expand as well — but to a much smaller degree than a gas.

The transfer of thermal energy can occur in three ways

By National Geographic Society on 02.13.20
Word Count **1,088**
Level **MAX**

Image 1. Radiation is one way that heat transfer occurs. All objects radiate some amount of heat as electromagnetic waves, even humans. Hotter objects, like light bulbs and campfires, radiate higher-energy light that we can see. Photo by National Geographic

Thermal energy comes from the movement of atoms. Since atoms make up the entire known universe – and it is impossible to reach absolute zero (minus 273.15 degrees Celsius or minus 459.67 degrees Fahrenheit), the theoretical temperature at which even atoms are frozen in place – everything has thermal energy. Whether they are zipping around in a gas or barely shivering in a solid, atoms are constantly moving.

Although all objects have thermal energy, they do not all have the same amount. Extremely hot objects such as the sun have vastly more thermal energy than cold objects like ice. However, the sun can transfer some of its thermal energy to ice, which is what causes an ice cube to melt on a warm, sunny day. The movement of thermal energy from a hotter object to a colder object is called heat transfer.

Heat transfer can happen in three different ways: through conduction, convection, and radiation. All three forms of heat transfer happen constantly in daily life, and in fact, heat transfer is essential to life itself.

Conduction

Conduction requires contact between the objects involved. Solids, liquids and gases can all conduct heat. As with any form of heat transfer, there must be a temperature difference for conduction to happen, and thermal energy is always transferred from the hotter object to the colder one. Once the objects reach the same temperature, the heat transfer stops. This is called thermal equilibrium.

On a microscopic level, conduction happens when particles bump into each other. Consider a cold metal spoon in a hot cup of coffee: The molecules in the coffee are moving freely and the metal molecules in the spoon are vibrating. Since the coffee is hotter than the spoon, its molecules are (overall) moving more. As they bump up against the spoon, the coffee molecules transfer some of their energy to the spoon molecules. As these collisions keep happening, the spoon gets warmer and the coffee gets slightly cooler until both are the same temperature.

Once the spoon and the coffee reach this thermal equilibrium, the particles do not quit bumping against each other. They continue transferring energy back and forth, but there is no longer a net flow of thermal energy in one direction. The two objects remain at the same temperature unless acted on by something else that adds or subtracts heat from them. In most cases, that something is the air in the room, which draws heat from the coffee. Eventually, if allowed to sit, the coffee cup, the coffee, and the spoon will all be the same temperature as the ambient air. They are once again at thermal equilibrium, but this time with their surroundings.

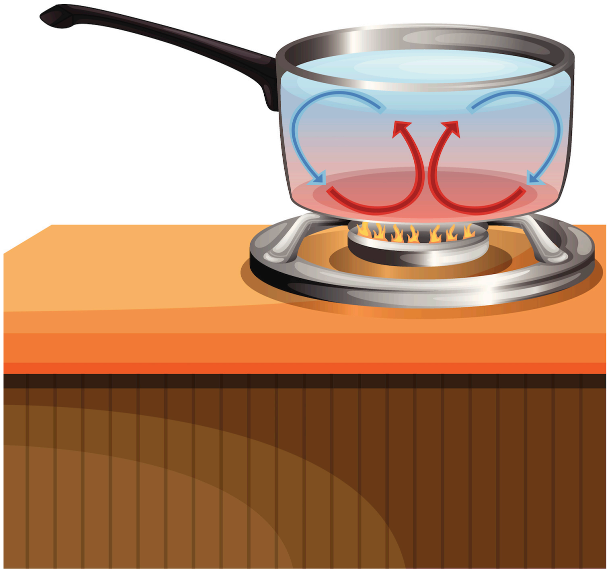
Some materials conduct heat better than others. Materials that conduct heat well, like metals, are called conductors, while materials that do not conduct heat well, like wood and plastic, are called insulators. This is why people often choose wooden or plastic-handled spoons when cooking – they do not get nearly as hot as metal spoons.

Convection

Heat transfer via convection happens only within fluids, like liquids and gases. Fluids are not very good conductors, so they transfer heat mostly by convection. Consider a pot of water heating on a stove: The heat source –the stove burner – is beneath the pot, so water near the bottom of the pot heats up first. Fluids expand when they heat up, so the water near the bottom becomes less dense. The difference in density between water at the bottom and at surface produces circulation currents. Hotter, less-dense water begins to rise and displace colder, denser water, which then sinks to the bottom where it is heated and begins to repeat the cycle. As time goes on, more of these circulation currents develop, transferring heat throughout the liquid. These convection currents can be easily observed when boiling rice in water.

Convection currents also allow heated air to circulate through a room. The phrase "heat rises" should really be "heated air rises," since it is the heated air molecules that are rising and circulating.

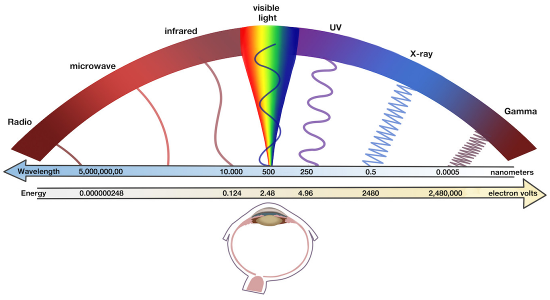
Convection plays a large role in moving plate tectonics. Earth's solid outer layer, the lithosphere, sits on top of a semi-molten layer called the asthenosphere. The asthenosphere is heated from even-hotter regions below, so – just like a pot on a stove – this heat source creates slow, but massive, convection currents within the asthenosphere, which causes some of the movement of Earth's tectonic plates.



Radiation

To understand radiant energy, we need to understand electromagnetic waves. Light can act as both a particle and a wave, and when it acts as a wave, the waves are referred to as electromagnetic. These waves can have different amounts of energy based on how fast they vibrate up and down. Fast-vibrating (high-frequency) waves have more energy than slow-vibrating (low-frequency) waves. All of these waves exist on the electromagnetic spectrum, with low-energy waves on one end and high-energy waves on the other. Humans can only see light waves in a specific part of this range, called the visible spectrum.

Radiation is the transfer of heat via electromagnetic waves. All objects radiate some amount of heat as electromagnetic waves, even humans. Humans radiate energy as infrared light, which is too low-energy for us to see. However, we still feel it as heat – in fact, infrared radiation is commonly referred to as "heat rays." Hotter objects, like light bulbs and campfires, radiate higher-energy light that we can see.



Radiation can even transfer heat through the vacuum of space. The sun radiates heat through millions of miles of empty space down to Earth. Because the sun has so much thermal energy, it radiates many kinds of electromagnetic waves, including infrared light, visible light, ultraviolet light, and X-rays. Ultraviolet light and X-rays are high-energy forms of light that we cannot see.

Quiz

1 Which characterization accurately describes BOTH conduction and convection?

(A) Both only occur when currents are created by different densities.

(B) Both only occur when there is contact between two solid objects.

(C) Both can involve solids or gases, and need the presence of insulators in order to occur.

(D) Both can involve liquids or gases, and need a temperature difference in order to occur.

2 Which option BEST explains how thermal equilibrium interacts with heat transfer between particles?

(A) Thermal equilibrium stops the transfer of energy in just one direction when both objects reach the same temperature, but allows their particles to continue transferring that energy back and forth.

(B) Thermal equilibrium always transfers energy from the hotter object to the colder one, and increases the energy and speed of moving particles in both objects as the temperature decreases.

(C) Thermal equilibrium helps the transfer of energy between the particles of some materials better than others, but always stops the transfer of energy in materials like plastic and wood.

(D) Thermal equilibrium quickly transfers energy back to the particles of the object that was originally hotter, and requires that the particles in both objects have reached equal energy and density.

3 Which statement BEST explains the advantage of including Image 2 in the article?

(A) The image illustrates the temperature differences between hot and cold water using red and blue arrows familiar to most readers of the article.

(B) The image illustrates the circulation of hot water rising and cold water sinking during convection using the example that is described in the article.

(C) The image illustrates the effects of the heat transfer occurring with the air above an object in addition to the convection that is happening inside it.

(D) The image illustrates the way that the asthenosphere is heated from even hotter regions below it to create slow but massive convection currents.

4 How does Image 3 in the section “Radiation” support the reader's understanding of electromagnetic waves?

(A) It uses colored stripes to demonstrate that UV light and X-rays are low-energy forms of light.

(B) It indicates the reactions that take place within the human eye for visible light to be seen.

(C) It places different kinds of light on a spectrum to indicate the variations in their energy levels.

(D) It shows the differences in energy between light acting as a particle and light acting as a wave.