Electricity for Kids

Intro

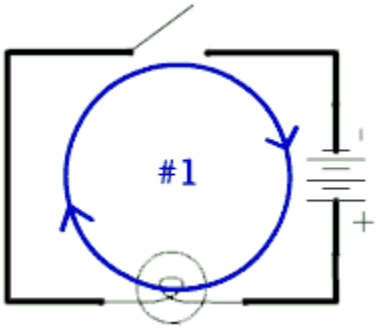
What is Electricity?

In order to understand the basics of electricity, it helps to first understand about atoms.

Atoms are small particles that make up all matter. They are so small that it takes billions and billions of them just to make something useful like a pencil. Inside the atom are even smaller objects called electrons, protons, and neutrons. Electrons have a negative charge (-) and the protons have a positive charge (+). The protons and neutrons stick to together in the center of the atom, called the nucleus. The electrons spin fast around the outside. The positive charge of the protons keeps the electrons from flying off and leaving the atom.

The electrons in the atom are where electricity gets its name. In some elements, there are electrons on the outside of the atom that, when a force is applied, can come loose and move to another atom. When a bunch of atoms are together and electrons are moving from one atom to the other in the same direction, this is called electricity. Electricity is the "flow" of electrons.

How do we make electrons move to make electricity?



We make electricity by creating an electric circuit. Let's take the case where you are turning on a light in your house: when you flip the switch "on" you are completing the electric circuit and causing electricity and electrons to flow through the light bulb, turning the light "ON."

Here are some key elements to a circuit:

- Power source: Could be a battery or your wall outlet
- Conductor: The wires that carry the electricity from place to place
- Load: what the electricity is powering, like the light bulb in the example above
- Switch: The switch that connects the circuit together to start the electricity flowing

Is electricity safe?

Electricity can be dangerous. Some important things to keep in mind:

1. Never play with electricity.
2. Always follow the instructions on electrical equipment and ask your mom or dad for help if you don't understand.
3. Never stick anything but a proper plug into a wall outlet.
4. When you unplug something from the wall, don't pull on the cord, use the plug.
5. Never put electronic items into the water, especially if they are plugged in.
6. Don't place items on top of electrical cords. The cords could get damaged and cause a fire.

These are just some safety precautions to take when using electricity.

Physics: Intro to Electricity

Test Quiz

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1) What small particles make up all matter?

Dust
Rocks
Minerals
Atoms
Crystals

---

2) What atomic particles have a positive charge?

Neutrons
Electrons
Protons
Photons
All of the above

---

3) What atomic particles spin around the outside of the nucleus?

Neutrons
Electrons
Protons
Photons
All of the above

---

4) Electricity is the flow of _____.

Neutrons

Electrons
Protons
Photons
All of the above

---

5) What is the portion of an electric circuit that is being powered? (for example, a light bulb)

Power Source
Switch
Load
Conductor
None of the Above

---

6) What part of an electric circuit completes the circuit and starts the flow of electricity when it is closed?

Power Source
Switch
Load
Conductor
None of the Above

---

7) What part of an electric circuit are the wires that carry the electricity?

Power Source
Switch
Load
Conductor
None of the Above

---

8) What part of an electric circuit is a battery?

Power Source
Switch
Load
Conductor
None of the Above

---

9) True or False: You should never put electronic items into the water.

TRUE
FALSE

10) What precaution should you take when dealing with electricity?

Don't place items on electrical cords

Don't unplug items by pulling on the cord

Always follow the instructions on electrical items

Don't play with electricity

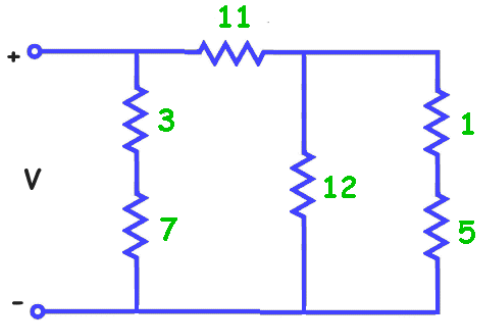
All of the above

Electronic Circuits

All the electronics that we use today are based on complex electronic circuits. Electronic circuits combine components, wires, and electricity to accomplish some function.

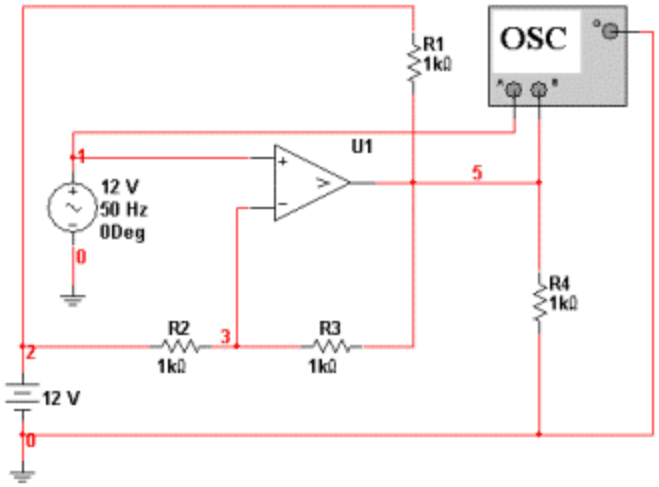
Basic Circuit

The basic electronic circuit has a power source, wires connecting components, and components. Here is a simple example showing some resistors connected in parallel and series.



Schematic

The drawings of complex electronic circuits are called schematics. Schematics show how the different components are all connected together. There are standard symbols for different components that allow different engineers to work on the same project.



Example of a schematic

Printed Circuit Board

A printed circuit board is used to connect many different electronic components into a working circuit. The "wires" connecting the components are built right into the board. There are even different layers of the board with each layer having its own set of wires. Small holes called "vias" are drilled through the board to make connections from layer to layer. Components are then soldered to the surface of the board to make the electrical connections.

Power and Ground

In a complex printed circuit board there will generally be at least one layer dedicated to ground and one to the power supply. The layer for ground is called the ground plane. The ground plane serves as a return path for current for many of the components. Most active components have at least one pin that must connect to ground.

A complex circuit will also typically have at least one DC power supply. On some very complex circuit boards there may be multiple power supplies. A typical power supply will be +3.3V, +2.5V, or +1.8V depending on the technology used. Generally a full layer of the circuit board is dedicated to the main power supply voltage. This power supply is used to power the active components.

Passive Components

Passive components in a circuit are components that don't require any external power. They reside in the current path of the circuit and don't need to connect to the power supply. Some examples of passive components include resistors, capacitors, inductors, and connectors.

Active Components

Active components in a circuit need external power. They connect to the power supply and can inject power into the circuit such as amplifying a signal. Examples of active components include diodes, transistors, and integrated circuits such as the CPU in your computer.

Interesting Facts about Electronic Circuits

- The ground plane is often abbreviated as GND or with a symbol that looks like an upside down arrow or triangle.
- The term "printed circuit board" is often abbreviated as PCB.
- An analog circuit is one where the current or voltage varies continuously with time.
- A digital circuit is one where the electrical signals take on defined values that represent zeros and ones.
- There can be extremely complex circuits inside computer chips. High-end CPUs for computers have circuits made up of billions of transistors.

Physics: Electric Circuits

Test Quiz

---

1) What makes up an electronic circuit?

Electrical components

A power source

Wires

All of the above

None of the Above

---

2) What is an electrical schematic?

A type of electrical power source

An electrical component that switches current

A drawing of an electrical circuit

A type of electrical conductor

An electrical formula

---

3) True or False: A printed circuit board can have many layers.

TRUE

FALSE

---

4) What are the small holes in printed circuit boards called?

Dots
Taps
Drills
Layers
Vias

5) What is the layer in a printed circuit board that is dedicated to ground called?

Ground region
Ground plane
Ground area
Groundery
Low land

6) What type of electrical components do not require a power supply to work?

Active components
Passive components

7) What type of electrical components require a power supply to work?

Active components
Passive components

8) Which of the following is an example of a passive component?

Diode
Transistor
Integrated Circuit
Resistor
All of the above

9) What does PCB stand for in electronics?

Passive Circuit Board
Printed Current Board
Protective Current Base
Passive Capacitor Board
Printed Circuit Board

10) What type of circuit works with electric signals that represent zeros and ones?

Analog circuit

Digital circuit

Physics for Kids
Electric Current

Current is the flow of an electric charge. It is an important quantity in electronic circuits. Current flows through a circuit when a voltage is placed across two points of a conductor.

Flow of Electrons

In an electronic circuit, the current is the flow of electrons. However, generally current is shown in the direction of the positive charges. This is actually in the opposite direction of the movement of the electrons in the circuit.

How is current measured?

The standard unit of measurement for current is the ampere. It is sometimes abbreviated as A or amps. The symbol used for current is the letter "i".

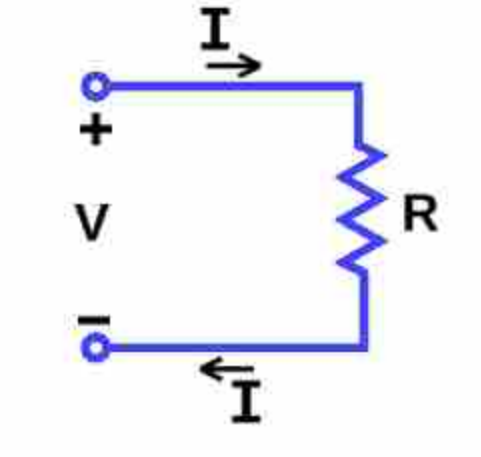
Current is measured as the flow of electric charge over time through a given point in an electric circuit. One ampere is equal to 1 coulomb over 1 second. A coulomb is a standard unit of electric charge.

Calculating Current

Current can be calculated using Ohm's Law. It can also be used to figure out the resistance of a circuit if the voltage is also known or the voltage of a circuit if the resistance is known.

$$I = V/R$$

where I = current, V = voltage, and R = resistance



Current is also used to calculate power using the following equation:

P = I * V

where P = power, I = current, and V = voltage.

AC versus DC

There are two main types of current used in most electronic circuits today. They are alternating current (AC) and direct current (DC).

- Direct Current (DC) - Direct current is the constant flow of electric charge in one direction. Batteries generate direct current to power handheld items. Most electronics use direct current for internal power often converting alternating current (AC) to direct current (DC) using a transformer.
- Alternating Current (AC) - Alternating current is current where the flow of electric charge is constantly changing directions. Alternating current is mostly used today to transmit power on power lines. In the United States the frequency at which the current alternates is 60 Hertz. Some other countries use 50 Hertz as the standard frequency.

Electromagnetism

Current also plays an important role in electromagnetism. Ampere's law describes how a magnetic field is generated by an electric current. This technology is used in electric motors.

Interesting Facts about Current

- The direction of the current flow is often shown with an arrow. In most electronic circuits the current is shown as flowing towards ground.
- The current in a circuit is measured using a tool called an ammeter.
- The flowing of electric current through a wire can sometimes be thought of like the flowing of water through a pipe.
- The electrical conductivity of a material is the measurement of the ability of the material to allow for the flow of electrical current.

Physics: Electric Current
Test Quiz

1) What is electrical current?

- The potential difference between two points in an electric circuit
- The rate at which electrical energy is transferred
- The flow of electric charge
- All of the above
- None of the Above

2) What is the unit of measurement for electrical current?

- Volt
- Ampere
- Watt
- Coulomb
- Ohm

3) What letter is used to represent current in an electrical diagram or formula?

- c
- e
- v
- p
- i

4) What is the standard unit of measurement for electrical charge?

- Volt
- Ampere
- Watt
- Coulomb
- Ohm

5) According to Ohm's Law, current equals the voltage divided by the _____.

- Resistance
- Inductance
- Capacitance
- Power

Conductance

6) If you have a 12 Volt battery placed across a 6 Ohm resistor, what will the current be?

0.5 Amps
1 Amp
2 Amps
4 Amps
5 Amps

7) If you place a 50 Volt power source across a 10 Ohm resistor, what will the current be?

0.5 Amps
1 Amp
2 Amps
4 Amps
5 Amps

8) If the current is 2 Amps and the voltage is 8 Volts, what is the power?

4 Watts
6 Watts
10 Watts
16 Watts
28 Watts

9) What do we call current that only flows in one direction?

AC current
DC current

10) What do we call current that constantly changes direction?

AC current
DC current

Physics for Kids

Ohm's Law

One of the most important and basic laws of electrical circuits is Ohm's law which states that the current passing through a conductor is proportional to the voltage over the resistance.

Equation

Ohm's law may sound a bit confusing when written in words, but it can be described by the simple formula:

$$I = \frac{V}{R}$$

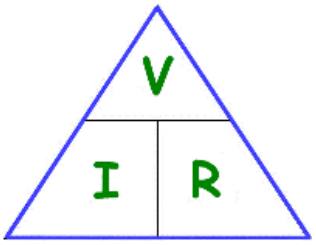
where I = current in amps, V = voltage in volts, and R = resistance in ohms

This same formula can be also be written in order to calculate for the voltage or the resistance:

$$I = \frac{V}{R} \quad \text{or} \quad V = IR \quad \text{or} \quad R = \frac{V}{I}$$

Triangle

If you ever need help in remembering the different equations for Ohm's law and solving for each variable (V, I, R) you can use the triangle below.

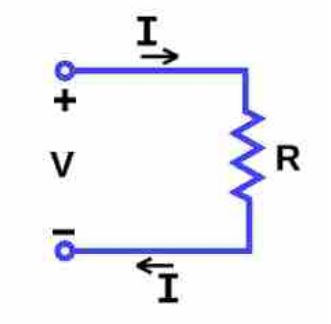


As you can see from the triangle and the equations above, voltage equals I times R, current (I) equals V over R, and resistance equals V over I.

Circuit Diagram

Here is a diagram showing I, V, and R in a circuit. Any one of these can be calculated using Ohm's

law if you know the values of the other two.



How Ohm's Law Works

Ohm's law describes the way current flows through a resistance when a different electric potential (voltage) is applied at each end of the resistance. One way to think of this is as water flowing through a pipe. The voltage is the water pressure, the current is the amount of water flowing through the pipe, and the resistance is the size of the pipe. More water will flow through the pipe (current) the more pressure is applied (voltage) and the bigger the pipe is (lower the resistance).

Example Problems

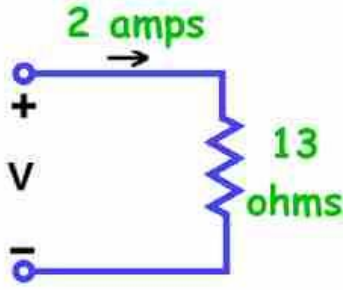
1. If the resistance of an electrical circuit is increased, what will happen to the current assuming the voltage remains the same?

Answer: The current will decrease.

2. If the voltage across a resistance is doubled, what will happen to the current?

Answer: The current will double as well.

Explanation: If you look at the equation V= IR, if R stays the same then if you multiple V*2 (double the voltage), you must also double the current for the equation to remain true.



3. What is the voltage V in the circuit shown

Answer: V = I * R = 2 x 13 = 26 volts

Interesting Facts about Ohm's Law

- It is generally applied only to direct current (DC) circuits, not alternating current (AC) circuits. In AC circuits, because the current is constantly changing, other factors such as capacitance and inductance must be taken into account.
- The concept behind Ohm's law was first explained by German Physicist Georg Ohm who the law is also named after.
- The tool for measuring volts in an electric circuit is called a voltmeter. An ohmmeter is used for measuring resistance. A multimeter can measure several functions including voltage, current, resistance, and temperature.

Physics: Ohm's Law

Test Quiz

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1) According to Ohm's Law, current equals the voltage divided by the _____.

Resistance
Inductance
Capacitance
Power
Conductance

---

2) What equation would you use to solve for voltage?

V = I/R
V = PR
V = CI
V = IR
V = R/I

---

3) What does the letter 'I' stand for in Ohm's Law?

Resistance
Inductance
Capacitance
Voltage
Current

---

4) What does the letter 'R' stand for in Ohm's Law?

Resistance
Inductance
Capacitance
Reactance

Rate of change

5) If the current in an electrical circuit is constant, what will happen to the voltage if the resistance is increased?

The voltage will decrease

The voltage will increase

The voltage will stay the same

6) If there are 10 Volts across a 5 Ohm resistor, what is the current?

0.5 Amps

1 Amp

2 Amps

15 Amps

50 Amps

7) If there are 40 Volts and 5 Amps running through an electrical circuit, what is the resistance of the circuit?

1 Ohm

2 Ohms

4 Ohms

6 Ohms

8 Ohms

8) If there are 7 Amps running through a 3 Ohm resistor, what will the voltage be across the resistor?

2.5 Volts

10 Volts

17 Volts

21 Volts

42 Volts

9) If you increase the voltage across a resistor, what will happen to the current?

The current will decrease

The current will increase

The current will stay the same

10) If you increase the size of the resistor and keep the voltage the same, what will happen to the current?

The current will decrease
The current will increase
The current will stay the same

Physics for Kids
Resistors, Capacitors, and Inductors

The three basic elements used in electronic circuits are the resistor, capacitor, and inductor. They each play an important role in how an electronic circuit behaves. They also have their own standard symbols and units of measurement.

Resistors

A resistor represents a given amount of resistance in a circuit. Resistance is a measure of how the flow of electric current is opposed or "resisted." It is defined by Ohm's law which says the resistance equals the voltage divided by the current.

Resistance = voltage/current
or
R = V/I

Resistance is measured in Ohms. The Ohm is often represented by the omega symbol: Ω.

The symbol for resistance is a zigzag line as shown below. The letter "R" is used in equations.

Resistor Symbol

Capacitors

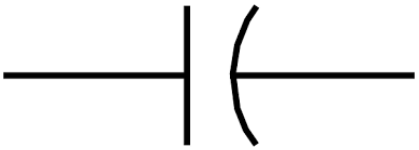
A capacitor represents the amount of capacitance in a circuit. The capacitance is the ability of a component to store an electrical charge. You can think of it as the "capacity" to store a charge. The capacitance is defined by the equation

C = q/V
where q is the charge in coulombs and V is the voltage.

In a DC circuit, a capacitor becomes an open circuit blocking any DC current from passing the capacitor. Only AC current will pass through a capacitor.

Capacitance is measured in Farads.

The symbol for capacitance is two parallel lines. Sometimes one of the lines is curved as shown below. The letter "C" is used in equations.



Capacitor Symbol

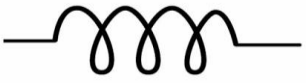
Inductors

An inductor represents the amount of inductance in a circuit. The inductance is the ability of a component to generate electromotive force due to a change in the flow of current. A simple inductor is made by looping a wire into a coil. Inductors are used in electronic circuits to reduce or oppose the change in electric current.

In a DC circuit, an inductor looks like a wire. It has no affect when the current is constant. Inductance only has an effect when the current is changing as in an AC circuit.

Inductance is measured in Henrys.

The symbol for inductance is a series of coils as shown below. The letter "L" is used in equations.



Inductor Symbol

Interesting Facts about Resistors, Capacitors, and Inductors

- The resistance of a material is the opposite or the inverse of the conductivity.
- The Ohm is named after German physicist Georg Ohm.
- The Farad is named after English physicist Michael Faraday.
- The Henry is named after American scientist Joseph Henry.
- Combinations of capacitors, inductors, and resistors are used to build passive filters that will only allow electronic signals of certain frequencies to pass through.

Physics: Resistors, Capacitors, and Inductors

Test Quiz

---

1) Which of the following represents the ability of a component to store an electrical charge?

- Resistance
- Capacitance
- Inductance
- All of the above
- None of the Above

---

2) Which of the following represents the ability of a component to generate electromotive force due to a change in the flow of current?

- Resistance
- Capacitance
- Inductance
- All of the above
- None of the Above

---

3) Which of the following represents the ability of a component to oppose the flow of current?

- Resistance
- Capacitance
- Inductance
- All of the above
- None of the Above

---

4) What is the standard unit of measurement for resistance?

- Volt
- Henry
- Farad
- Ampere
- Ohm

---

5) What is the standard unit of measurement for capacitance?

- Volt
- Henry

Farad
Ampere
Ohm

6) What is the standard unit of measurement for inductance?

Volt
Henry
Farad
Ampere
Ohm

7) What does the schematic symbol for a capacitor look like?

A zigzag line
A series of coils
Two parallel lines

8) What does the schematic symbol for an inductor look like?

A zigzag line
A series of coils
Two parallel lines

9) What does the schematic symbol for a resistor look like?

A zigzag line
A series of coils
Two parallel lines

10) According to Ohm's Law, current equals the voltage divided by the _____.

Power
Inductance
Capacitance
Resistance
Conductance

Physics for Kids

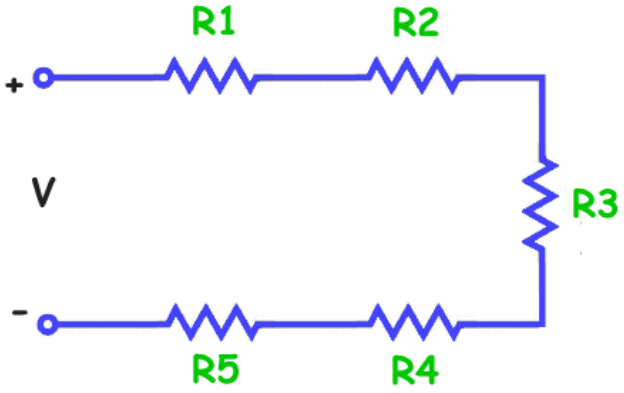
Resistors in Series and Parallel

When resistors are used in electronic circuits they can be used in different configurations. You can calculate the resistance for the circuit, or a portion of the circuit, by determining which resistors are in series and which are in parallel. We'll describe how to do this below. Note that the total resistance of a circuit is often called the equivalent resistance.

Series Resistors

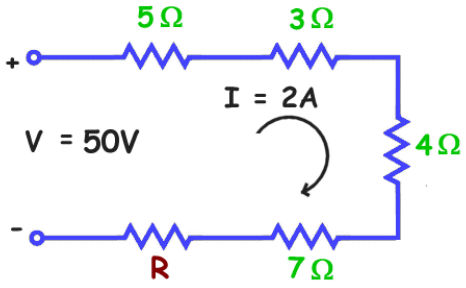
When resistors are connected end-to-end in a circuit (like shown in the picture below) they are said to be in "series." In order to find the total resistance of resistors in series you just add up the value of each resistor. In the example below the total resistance would be R1 + R2.

Here is another example of a number of resistors in series. The total value of the resistance across the voltage V is R1 + R2 + R3 + R4 + R5.



Sample problem:

Using the circuit diagram below, solve for the value of the missing resistance R.



Answer:

First we'll figure out the equivalent resistance of the entire circuit. From Ohm's law we know that Resistance = Voltage/current, therefore

Resistance = 50volts/2amps
Resistance = 25

We can also figure out the resistance by adding up the resistors in series:

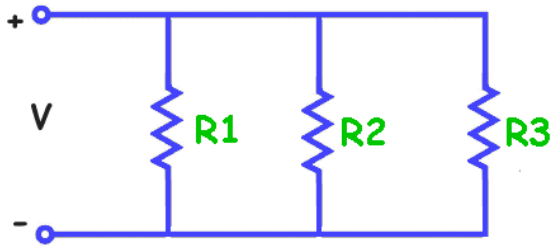
Resistance = 5 + 3 + 4 + 7 + R
Resistance = 19 + R

Now we plug in 25 for resistance and we get

25 = 19 + R
R = 6 ohms

Parallel Resistors

Parallel resistors are resistors that are connected across from each other in an electric circuit. See the picture below. In this picture R1, R2, and R3 are all connected in parallel to each other.



When we calculated the series resistance, we totaled the resistance of each resistor to get the value. This makes sense because the current of a voltage across the resistors will travel evenly across each resistor. When the resistors are in parallel this is not the case. Some of the current will travel through R1, some through R2, and some through R3. Each resistor provides an additional path for the current to travel.

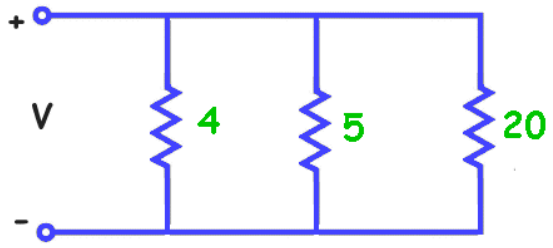
In order to calculate the total resistance "R" across the voltage V we use the following formula:

$$\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}$$

You can see that the reciprocal of the total resistance is the sum of the reciprocal of each resistance in parallel.

Example problem:

What is the total resistance "R" across the voltage V in the circuit below?



Answer:

Since these resistors are in parallel we know from the equation above that
1/R = ¼ + 1/5 + 1/20
1/R = 5/20 + 4/20 + 1/20

1/R = 10/20 = ½
R = 2 Ohms

Note that the total resistance is less than any of the resistors in parallel. This will always be the case. The equivalent resistance will always be less than the smallest resistor in parallel.

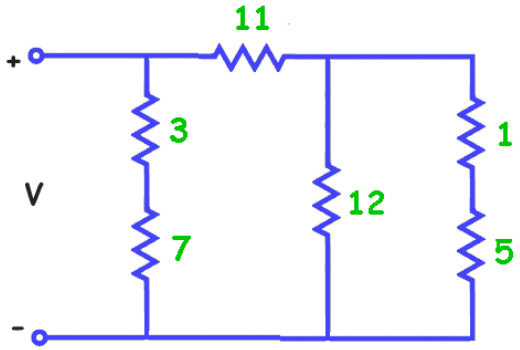
Series and Parallel

What do you do when you have a circuit with both parallel and series resistors?

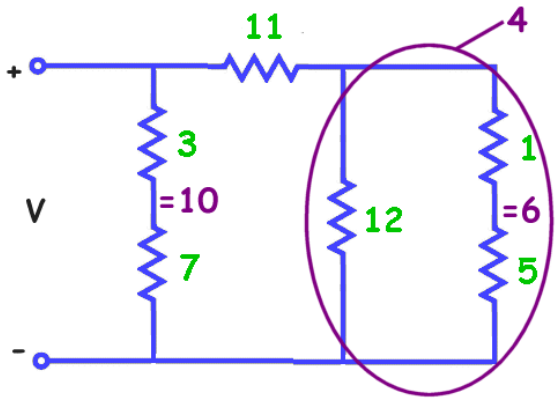
The idea for solving these types of circuits is to break down smaller parts of the circuit into series and parallel sections. First do any sections that have only series resistors. Then replace those with the equivalent resistance. Next solve the parallel sections. Now replace those with equivalent resistors. Continue through these steps until you reach the solution.

Example problem:

Solve for the equivalent resistance across the voltage V in the electrical circuit below:



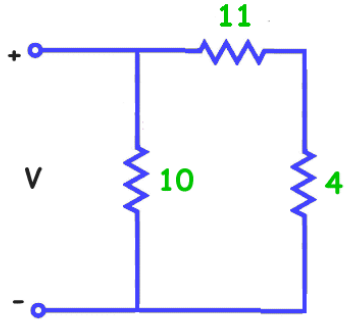
First we will total the two series resistors on the right (1 + 5 = 6) and on the left (3 + 7 = 10). Now we have reduced the circuit.



We see on the right that the total resistance 6 and the resistor 12 are now in parallel. We can solve for these parallel resistors to get the equivalent resistance of 4.

1/R = 1/6 + 1/12
1/R = 2/12 + 1/12
1/R = 3/12 = ¼
R = 4

The new circuit diagram is shown below.



From this circuit we solve for the series resistors 4 and 11 to get 4 + 11 = 15. Now we have two parallel resistors, 15 and 10.

1/R = 1/15 + 1/10

1/R = 2/30 + 3/30
1/R = 5/30 = 1/6
R = 6

The equivalent resistance across V is 6 ohms.

Physics: Resistors in Series and Parallel Test Quiz

1) What is the total resistance of a circuit called?

- Absolute resistance
- Equivalent resistance
- Comprehensive resistance
- Unlimited resistance
- Inclusive resistance

2) Which of the following best describes resistors connected in parallel?

- Resistors connected end-to-end
- Resistors that connect to capacitors
- Resistors that aren't in the same circuit
- Resistors connected across from one another
- None of the Above

3) Which of the following best describes resistors connected in series?

- Resistors connected end-to-end
- Resistors that connect to capacitors
- Resistors that aren't in the same circuit
- Resistors connected across from one another
- None of the Above

4) What formula would be used to calculate the equivalent resistance if R1 and R2 were connected in series?

- R = R1 * R2
- R = 1/R1 + 1/R2
- 1/R = 1/R1 + 1/R2
- R = R1/R2
- R = R1 + R2

5) What formula would be used to calculate the equivalent resistance if R1 and R2 were connected in parallel?

- R = R1 * R2
- R = 1/R1 + 1/R2
- 1/R = 1/R1 + 1/R2

R = R1/R2

R = R1 + R2

---

6) What is the equivalent resistance of two 10 ohm resistors in series?

5 Ohms

10 Ohms

20 Ohms

30 Ohms

50 Ohms

---

7) What is the equivalent resistance of two 10 ohm resistors in parallel?

5 Ohms

10 Ohms

20 Ohms

30 Ohms

50 Ohms

---

8) What is the equivalent resistance of three 30 ohm resistors in series?

3 Ohms

10 Ohms

40 Ohms

60 Ohms

90 Ohms

---

9) What is the equivalent resistance of three 30 ohm resistors in parallel?

3 Ohms

10 Ohms

40 Ohms

60 Ohms

90 Ohms

---

10) When you have a circuit with both series and parallel resistors, what do you do first when calculating the equivalent resistance?

The series resistors

The parallel resistors

It doesn't matter which you do first

Physics for Kids

Electrical Conductors and Insulators

Some materials allow electric current to flow more freely than others. These materials are called conductors. Other materials are resistant to the flow of electric current. These materials are called insulators. Conductors and insulators are both important in the field of electronics.

Electrical Conductors

Electrical conductors allow electric current to flow easily because of the make up of their atoms. In a conductor, the outer electrons of the atom are loosely bound and can freely move through the material when an electric charge is applied.

Conductive Materials

In general, the best electrical conductors are metals. Metals tend to have electrons in the outer layer of their atoms that are freely shared. The most conductive of all the elements is silver. Unfortunately, silver is too rare and expensive to use in most electrical equipment. Today, the most commonly used electrical conductor is copper. Copper is used in electrical wiring and electrical circuits throughout the world.

Conductance and Resistance

Another way to think of conductance is as the opposite of resistance. The resistance of a material is a measurement of how well a material opposes the flow of electric current. Sometimes conductance is represented by the letter "G" where G is the inverse of resistance, R.

$$G = 1/R$$

Using Ohm's law we know that resistance is equal to voltage divided by current or R = V/I, therefore

$$G = I/V$$

Superconductors

A superconductor is a material that is a perfect conductor. It has an electrical resistance of zero. All of the superconductors that have been discovered by scientists to date require a very cold temperature on the order of minus 234 degrees C in order to become superconductors.

Electrical Insulators

The opposite of a conductor is an insulator. An insulator opposes the flow of electricity. Insulators are important to keep us safe from electricity. The wire that carries electricity to your computer or television is covered with a rubber-like insulator that protects you from getting electrocuted. Good insulators include glass, the air, and paper.

Semiconductors

Some materials behave in between a conductor and an insulator. These materials are called semiconductors. Semiconductors are important in electronics such as computers and mobile phones because their conductivity can be controlled allowing for current to flow in just one direction or only under certain circumstances. The most commonly used semiconductor in electronics today is silicon.

Interesting Facts about Electrical Conductors and Insulators

- Most good electrical conductors are also good conductors of heat.
- Temperature can play an important role in the conductance of a material. In general, the higher the temperature the lower the conductivity as resistance increases with temperature.
- Aluminum has a lower conductivity than copper, but is sometimes used in wiring for lower cost.
- Many electronics companies are headquartered in "Silicon Valley", California, which is nicknamed after the semiconductor silicon.

Physics: Electrical Conductors and Insulators

Test Quiz

---

1) What type of materials allow electricity to flow freely?

- Conductors
- Currents
- Insulators
- Voltages
- Inductors

---

2) What type of materials are resistant to the flow of electricity?

- Conductors
- Currents
- Insulators
- Voltages
- Inductors

---

3) Which of the following is the most conductive element?

- Silicon
- Iron
- Carbon
- Hydrogen
- Silver

4) Conductance is the inverse of what measurement?

- Inductance
- Resistance
- Voltage
- Capacitance
- Current

5) What do we call a material that has a resistance of zero?

- Superconductor
- Major conductor
- Minor insulator
- Semiconductor
- Super insulator

6) Why are electrical insulators important?

- They help the flow of electricity
- They provide power for electric circuits
- They are used to protect us from electricity
- They help conduct heat
- They are not important

7) Which of the following is a good insulator?

- Paper
- Glass
- Air
- All of the above
- None of the Above

8) What element is a good electrical semiconductor?

- Copper
- Silicon
- Gold
- Sulfur
- Silver

9) What metal is the most commonly used conductor in electronic wiring and electronic circuits?

- Silver
- Zinc
- Lead

Platinum

Copper

---

10) The _____ of a material is a measurement of how well a material opposes the flow of electric current.

Inductance

Voltage

Resistance

Capacitance

Current

Electricity for Kids

Digital Electronics

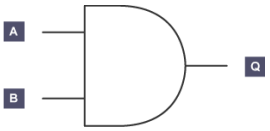
Digital electronics are electric circuits that work on only two fixed values: "1" and "0". They use a series of 1's and 0's to store and communicate information. They can also perform math using just 1's and 0's. This is called Boolean math or Boolean logic.

How do they get just 1's and 0's?

In most digital electronic circuits when the voltage of the circuit is positive and near the supply voltage it represents a 1. This is also called HIGH. When the voltage is close to the ground level (or zero), it represents a 0, which is also sometimes called LOW. With these two signals most anything can be stored and communicated including the picture on the screen you're looking at right now. But it takes a LOT of these signals running VERY fast!

What are electronic gates?

In digital electronics, gates are electrical functions that are performed on 1's and 0's. Sort of like simple math. One example of this is the AND gate. There are two inputs and one output to an AND gate. The output is only a 1 if both inputs are a 1. If either input is a 0, the output is a 0. An even simpler gate is the Inverter. In this case there is one input and one output. If a 1 is input, then a 0 is output. If a 0 is input then a 1 is output. It just Inverts the signal.



A logic AND gate with two inputs and one output

What are electronic chips?

Electronic chips are a whole bunch of electronic gates put into one small area. These chips can have millions and millions of gates in order to do all sorts of complex stuff. There are chips that do graphics for your computer screen, chips that have lots of memory for saving data, and chips that run programs like your computer's CPU. To make electronic chips, special materials called semiconductors are used together with expensive precision equipment. Hundreds of engineers may spend years just to design and invent one complex electronic chip.

Integrated Circuit computer chip called a CPU

Where are they used?

Digital electronics are used throughout the world including in computers, iPods, video games, televisions, cameras, cell phones, and cars. Although digital electronics are a relatively new invention in the world, most of us could hardly imagine a world without them.

Fun facts about Digital Electronics

- The main semiconductor used in electronic chips is silicon. Silicon is the most abundant element in the Earth's crust after oxygen.
- A lot of the internet information is sent over fiber optics. With fiber optics light is used instead of electricity to send the information.
- The first computer chip was invented by Jack Kilby while working for the company Texas Instruments.
- In 2011 Apple became the largest buyer of computer chips in the world because of the iPhone.

Physics: Digital Electronics
Test Quiz

1) What fixed values are used for communications, storage, and math in digital electronics?

- 1 through 10
- 0 through 7
- 0 and 1
- 1 and 2
- All 10 based numbers

2) What value is called HIGH in digital electronics?

- 0
- 1
- 2
- 10
- 100

3) What value is called LOW in digital electronics?

- 0
- 1
- 2
- 10
- Negative 1

4) What do we call math that just uses 1s and 0s?

- Algebra
- Hexagonal math
- Doubles math
- Boolean math
- Octagonal math

5) If a HIGH or a 1 is input into an inverter, what is the output?

- 0
- 1
- 11
- 1
- 10

6) What are the possible inputs to an AND gate that can produce an output of 1?

0
1
10
11
All of the above

---

7) Where are digital electronics used?

Cell phones
Cameras
Cars
Computers
All of the above

---

8) True or False: It can take hundreds of engineers years to design some complex computer chips.

TRUE
FALSE

---

9) What element is a good electrical semiconductor and is used to make most digital chips?

Copper
Gold
Silicon
Sulfur
Silver

---

10) What company was the largest computer chip buyer in the world in 2011?

IBM
General Motors
Samsung
Apple
Dell

Electricity for Kids
Communications

One of the great changes to our world over the past 100 years has been the invention of electronic communications. It all started with the telegraph and since then new inventions and innovations have created an information age that includes smart phones and high definition video over the internet.

Telegraph

The invention that got electronic communications started was the telegraph. It was invented by Samuel Morse in 1836. He also developed the Morse Code which allowed the signals that the telegraph sent over the wires to represent words and phrases.

Telephone

Around 40 years after the telegraph, Alexander Graham Bell received the patent for the telephone. Now instead of just beeps of sound, a person's voice could be transmitted over long distances of electric wires. Later inventions like faxes and modems would allow other information to pass over the same wires. Large switching networks were built throughout the world allowing telephones in nearly every home to connect with each other.

Fiber optic tubes of glass use light pulses to communicate

Fiber Optics

As the amount of information has grown, more and more data needs to be transmitted over long distances. One of the ways to send data faster is with fiber optics. Fiber optics are long skinny tubes (like wires) made of glass. Instead of electricity they transmit light. Light can travel at much faster speeds and over longer distances than electrical pulses. There are fiber optic connections today that can send 100 billion signals per second!

Radio Frequency

Radios have been used for a long time, but in the 1990s cell phones started to become popular. Cell phones send information using radio frequencies through the air. New technologies have allowed for faster signals and even video to be sent to and from cell phones.

Cell phones use radio frequencies to communicate through the air

Internet

Perhaps the most important invention in the area of electronic communications during recent times is the internet. The internet is made up of millions of electrical and fiber optic links. These links form a network that allows information to get passed and "switched" all over the world. More information is now available at your fingertips and on your computer at home than you could hope to read in a lifetime.

Fun facts about Electronic Communications

- There are around 250 billion emails sent every day. Around 80% of these are spam.
- Around 20 hours of video are uploaded to YouTube every minute.
- Fiber optics are good because they use less energy and are better for the environment than electrical wires. They are also very resistant to weather.
- The first telephone pole was built in 1876.
- There are over 4 billion cell phones in the world. Over 100 million cell phones are thrown away every year.
- The first cell phone was invented by the company Motorola.

Physics: Electronic Communications

Test Quiz.

1) What invention started the electronic communications age?

- Telephone
- Telegraph
- Cell phone
- Fiber optics
- Transistor

2) Who invented the telephone?

- Thomas Edison
- Eli Whitney
- Samuel Morse
- Alexander Graham Bell
- Isaac Newton

3) What are fiber optic cables made of?

- Copper
- Silicon
- Silver
- Gold
- Glass

4) Who invented the telegraph?

- Thomas Edison
- Eli Whitney
- Samuel Morse
- Alexander Graham Bell
- Isaac Newton

5) How is data transmitted over fiber optic cables?

- Pulses of light
- Electrical digital signals
- Dots and dashes
- Electrical analog signals
- Radio Frequency Signals

6) How is data transmitted using cell phones?

Pulses of light
Electrical digital signals
Dots and dashes
Electrical analog signals
Radio Frequency Signals

---

7) True or False: The internet uses only radio frequency signals to send data.

TRUE
FALSE

---

8) What company invented the first cell phone?

Apple
Samsung
Texas Instruments
Motorola
Google

---

9) What is an advantage of fiber optics over electrical wires?

Fiber optics uses less energy
Fiber optics is faster
Fiber optics can travel over longer distances
Fiber optics are resistant to weather
All of the above

---

10) True or False: Modern electronic communications has made little impact to our day-to-day lives.

TRUE
FALSE

Electricity for Kids
Uses and Applications

We use electricity constantly in our daily lives. It is one of the most important types of power and energy that we use.

Electricity in our House

Electricity travels to our house over power lines from a big power plant somewhere far away. Your parents actually have to pay for how much electricity is used. There is an electric meter outside of your house that keeps track of this. The more the lights are on or the TV is running, the higher the bill will be from the electric company.

Once the power comes to our house, it gets sent out on wires to sockets in the walls. We can plug all sorts of things into these sockets and use the power from electricity. In our homes we power lights, air conditioning, televisions, ovens, and more from electricity. Without it, we'd be bored, hot, and sitting in the dark.

Batteries

Some electricity comes from batteries. Batteries use chemicals to store up electricity that can power devices like cell phones, radio controlled cars, handheld video games, and flashlights. Batteries run out of power after a while and either need to be recharged or recycled. Remember to always recycle your batteries as there are dangerous chemicals in them!

Other uses

Electricity is used in cars too. There is a big battery to help the engine get started. Then the engine generates electricity for the radio, lights, and other cool features. Some cars run 100% on electricity by using big batteries that get charged up from a wall socket.

Electricity also can make magnetism. This can be used to create giant powerful magnets as well as fast and quiet magnetic trains. Electric motors generate magnetism to turn the motor and cause movement for all sorts of uses.

History

One of the first great uses of electricity was for communication using Morse Code and the Telegraph in 1840. This allowed messages to be sent long distances in an instant. After that came the telephone and the radio and, in 1880, electric light. These inventions and the use of electricity changed the world. Electricity continued to change the world with new inventions such as the TV and, even more recently, the personal computer and the cell phone.

Fun facts about the Uses of Electricity

- 25% of the city of San Francisco's energy is generated by wind power.
- Electric eels use electricity to ward off enemies. They can produce a shock of around 500 volts.
- Our bodies use electricity to communicate including telling our heart to keep beating.
- Two famous scientists, Thomas Edison and Nikola Tesla, once had an argument over what kind of electricity we should use in our homes, AC or DC. Tesla won and AC is delivered to most homes still today.
- Electricity was first used in homes for lighting.

Physics: Uses of Electricity

Test Quiz

---

1) True or False: The electricity you use in your house or apartment is free.

TRUE

FALSE

---

2) How does electricity typically get to a home or apartment?

Through the air

Through cable

Over power lines

From satellite

Using radio frequency waves

3) Where do batteries get the energy to produce electricity?

- Sunlight
- Gasoline
- Hydropower
- Natural gas
- Chemical reactions

4) True or False: Batteries eventually run out of power and need to be recycled or recharged.

- TRUE
- FALSE

5) Which of the following is an example of how electricity is used in a home?

- Air conditioning
- Television
- Lights
- Oven
- All of the above

6) Which of the following electrical items is typically powered by a battery?

- Air conditioning
- Cell phone
- Refrigerator
- All of the above
- None of the Above

7) What early electrical invention allowed messages to be sent using Morse Code?

- Telephone
- Automobile
- Telegraph
- Internet
- Computer

8) What scientist argued with Thomas Edison over AC versus DC electrical power?

- Albert Einstein
- Marie Curie
- Eli Whitney
- Nikola Tesla

Isaac Newton

---

9) What was the first use of electricity in homes?

Lighting

Television

Air conditioning

Wi-Fi

Cooking

---

10) True or False: Some animals use electricity to fight off enemies.

TRUE

FALSE

Physics for Kids
Electricity in Nature

Electricity is not only found in power lines and electronics made by man, but is also found in nature. In fact electricity is all around us. We see it in lightning storms, animals use it as a defense, even our bodies use it to send messages to our muscles.

Lightning

One of the most fantastic displays of electricity in nature is lightning. Lightning occurs when large amounts of electrostatic energy builds up in clouds from the energy of storms. When electrically charged regions of clouds discharge their energy, a large flash of electricity can be seen in the sky. Lightning may occur from cloud to cloud or it can occur from cloud to the ground.

Lightning strikes carry huge amounts of energy. A typical lightning strike carries an electric current of over 30,000 amps and delivers 500 megajoules of energy.

Lightning also creates a loud noise called thunder. This is because the air within lightning gets so hot, that it transforms into plasma for a short period of time. When the molecules of air turn from gas to plasma, their expansion causes a shockwave that we hear as thunder.

Animals

Some animals use electricity to survive in nature. Many of these animals are found in the ocean

where some use electricity to detect objects around them (sort of like seeing) and others use electricity to fend off predators or even hunt for food.

One of the most famous of the electric animals is the electric eel. The electric eel can produce large amounts of electricity, enough to even kill a human or stun a large horse. The eels typically swim into a school of fish, discharge a large amount of electricity, and then dinner is served!

Another example of animals using electricity is electroreception. Many fish such as sharks, lampreys, and catfishes have the ability to generate electric fields and then use these fields to detect objects around them. This helps them to "see" in dark areas and to sense hidden prey.

Human Body

Not only can we see electricity at work in nature, we are constantly using electricity in our bodies. Every time we move a muscle, it's the result of an electrical signal being sent from our brain to our muscles telling them to move. We actually have a complex system of nerves throughout our bodies that use electric signals to control everything we do.

Static Electricity

Lightning isn't the only form of electrostatic energy we see in nature. Static electricity charges build up all around us. You probably have noticed static electricity when you went down a slide at the park and your hair stood up strait. The friction from the slide on your body caused a build up of charge that made your hair stand up. Sometimes you can even build up a charge on your body that will shock someone else when you touch them. This is static electricity.

The Earth

Deep inside the Earth huge electric currents are generated from the spin of the Earth's iron core. These electric currents in turn cause a magnetic field that extends well beyond the surface of the Earth and into outer space.

The Earth's magnetic field is important because it protects the Earth from the solar wind of the Sun. Without the protection of magnetic field, there would likely be no life on Earth. The magnetic field also enables the use of compasses to tell the direction.

Physics: Electricity in Nature

Test Quiz

---

1) Which of the following is an example of electricity in nature?

- Cell phones
- Air conditioning
- Lightning
- Television

Power grid

2) Thunder is a result of the molecules of air turning from gas to _____.

Liquid
Plasma
Solid
Ice
Carbon

3) True or False: Lightning always strikes the ground.

TRUE
FALSE

4) Which animal uses electricity to kill their prey?

Electric shark
Lightning bug
Blue whale
Electric eel
Firefly

5) Which animal uses electricity to help 'see' in the dark?

Panthers
Owls
Cats
Snakes
Sharks

6) True or False: Nerves in our bodies use electrical signals to tell the brain what is happening.

TRUE
FALSE

7) What electrical field does the Earth's core generate that protects the Earth from the Sun?

Static field

Lightning field
Magnetic field
Voltage field
Ampere field

8) True or False: Lightning can produce huge amounts of energy that can kill a person.

TRUE
FALSE

9) What type of electricity makes your hair stand up straight after sliding down a slide?

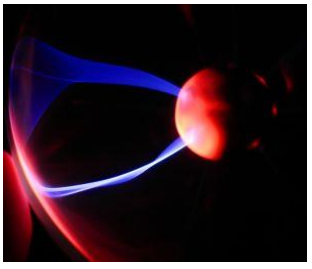
Magnetic
Direct current
Alternating
Static
Digital

10) What is it called when animals use electricity to 'see' in the dark?

Night vision
Electroreception
Electrosight
Dark sight
Electrovision

Electricity

Static Electricity



Static electricity is the build up of an electrical charge on the surface of an object. It's called "static" because the charges remain in one area rather than moving or "flowing" to another area.

We see static electricity every day. It can even build up on us. For example, when we rub our feet on the carpet and then zap something when we touch it. That is static electricity that we have built up on the surface of our skin discharging onto another object. We also see it when our hair gets charged and sticks straight up or when our pant legs keep sticking to our legs. This is all static electricity that has built up on the surface of an object.

Lightning is a powerful form of static electricity

What is static electricity?

In our study of atoms we learned that atoms are made up of tiny particles called neutrons, protons, and electrons. The neutrons and protons make up the nucleus. The electrons spin around the outside of the nucleus. A static charge is formed when two surfaces touch each other and the electrons move from one object to another. One object will have a positive charge and the other a negative charge. Rubbing the items quickly, like when you rub a balloon fast over something or your feet on the carpet, will build up a large charge. Items with different charges (positive and negative) will attract, while items with similar charges (positive and positive) will push away from each other. Sort of like a magnet.

One example of this is when you slide down a slide and all of your hair stands up straight. This is because the friction of sliding has caused a positive charge to be built up on each hair. Since each hair has the same charge, they all try to push away from each other and end up standing up straight.

Likewise, when your skin is charged with static electricity and you touch something metal, like a door handle, the metal is very conductive and will quickly discharge the static electricity, creating a zap or small spark.

Does it have any real uses?

Static electricity has several uses, also called applications, in the real world. One main use is in printers and photocopiers where static electric charges attract the ink, or toner, to the paper. Other uses include paint sprayers, air filters, and dust removal.

It can damage electronics

Static electricity can also cause damage. Some electronic chips, like the kind that are in computers, are very sensitive to static electricity. There are special bags to store electrical components in so they don't get destroyed by static electricity. Also, people that work with these kinds of electronics wear special straps that keep them "grounded" so they won't build up a static charge and ruin the electronic components.

Fun facts about static electricity

- A spark of static electricity can measure thousands of volts, but has very little current and only lasts for a short period of time. This means it has little power or energy.
- Lightning is a powerful and dangerous example of static electricity.
- As dangerous as lightning is, around 70% of people struck by lightning survive.
- Temperatures in a lightning bolt can hit 50,000 degrees F.
- Static electricity will build up faster on a dry non-humid day.

Physics: Static Electricity

Test Quiz

---

1) What is static electricity?

Electricity that flows in one direction

Electricity that is sent over the air

Electricity that constantly changes direction

An electrical charge on the surface of an object

It is another name for digital electronics

---

2) True or False: Static electricity constantly flows in the same direction.

TRUE

FALSE

---

3) What two atomic particles make up the nucleus of the atom?

Electrons and protons

Neutrons and electrons

Neutrons and protons

Quarks and electrons

Neutrons and quarks

---

4) What atomic particles move from one surface to another in order to form a static charge?

Electrons

Protons

Neutrons

All of the above

None of the Above

5) What happens when two items with positive charges come close to each other?

They attract each other

They will join together

They will cause an explosion

They repel each other

None of the Above

6) Which of the following is a practical application for static electricity?

Printers

Air filters

Copiers

Paint sprayers

All of the above

7) True or False: Static electricity will build up faster on a dry day.

TRUE

FALSE

8) What type of electronics can be easily damaged by a static electricity discharge?

Light bulbs

Fans

Electronic chips

Copper wires

Connectors

9) True or False: If you have built up a static electric charge on your skin, it is likely to discharge when you touch something metal.

TRUE

FALSE

10) Which of the following is an example of static electricity?

An electric socket in your home

Electricity for a light bulb

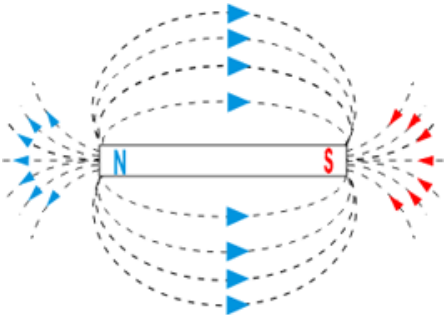
Your pants sticking to your legs
All of the above
None of the Above

Physics for Kids
Magnetism

Magnetism is an invisible force or field caused by the unique properties of certain materials. In most objects, electrons spin in different, random directions. This causes them to cancel each other out over time. However, magnets are different. In magnets the molecules are uniquely arranged so that their electrons spin in the same direction. This arrangement of atoms creates two poles in a magnet, a North-seeking pole and a South-seeking pole.

Magnets Have Magnetic Fields

The magnetic force in a magnet flows from the North pole to the South pole. This creates a magnetic field around a magnet.



Have you ever held two magnets close to each other? They don't act like most objects. If you try to push the South poles together, they repel each other. Two North poles also repel each other.

Turn one magnet around, and the North (N) and the South (S) poles are attracted to each other. Just like protons and electrons - opposites attract.

Where do we get magnets?

Only a few materials have the right type of structures to allow the electrons to line up just right to create a magnet. The main material we use in magnets today is iron. Steel has a lot of iron in it, so steel can be used as well.

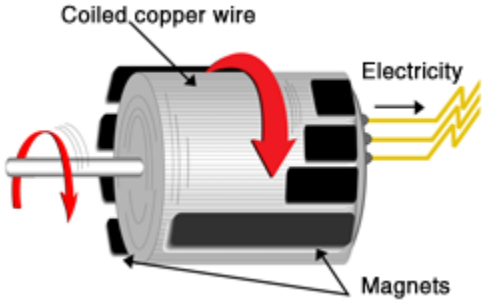
The Earth is a giant magnet

At the center of the Earth spins the Earth's core. The core is made up of mostly iron. The outer portion of the core is liquid iron that spins and makes the earth into a giant magnet. This is where we

get the names for the north and south poles. These poles are actually the positive and negative poles of the Earth's giant magnet. This is very useful to us here on Earth as it lets us use magnets in compasses to find our way and make sure we are heading in the right direction. It's also useful to animals such as birds and whales who use the Earth's magnetic field to find the right direction when migrating. Perhaps the most important feature of the Earth's magnetic field is that it protects us from the Sun's solar wind and radiation.

The Electric Magnet and Motor

Magnets can also be created by using electricity. By wrapping a wire around an iron bar and running current through the wire, very strong magnets can be created. This is called electromagnetism. The magnetic field created by electromagnets can be used in a variety of applications. One of the most important is the electric motor.



Physics: Magnetism
Test Quiz

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1) The magnetic force of a material comes from the spinning of what atomic particle?

- Proton
- Nucleus
- Neutron
- Electron
- Photon

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2) What happens if you hold the north poles of two different magnets close to each other?

- They will attract each other
- They will repel each other
- They will grow very hot

Nothing will happen

3) What happens if you hold the south pole of one magnet close to the north pole of another magnet?

They will attract each other

They will repel each other

They will grow very hot

Nothing will happen

4) What is the main element used to create a magnet?

Carbon

Gold

Magnesium

Oxygen

Iron

5) What creates the protective magnetic field around the Earth?

Volcanoes

The movement of the ocean

The Earth's core

The Moon

Photons from the Sun

6) What does the Earth's magnetic field protect us from?

The Moon crashing into the Earth

Solar winds and radiation from the Sun

The atmosphere from escaping into space

Meteorites

Nothing

7) True or False: Compasses point north because the Earth is basically a giant magnet.

TRUE

FALSE

8) Powerful magnets can be created by wrapping a wire around iron and running _____ through the wire.

Heat
Water
Cold
Electricity
None of the Above

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9) In magnetic materials, all the electrons are spinning in _____ .

Opposite directions
The same direction
Random directions

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10) True or False: Some animals use the Earth's magnetic field to find the right direction when migrating.

TRUE
FALSE

Physics for Kids
Electromagnetism and Electric Motors

Electromagnetism

The word "electromagnetism" in physics is used to describe one of the fundamental forces of nature. This force is between subatomic particles such as protons and electrons. It helps to hold matter together.

Electromagnetism is also used to describe how a magnetic field is created by the flowing of electric current. We will be discussing this type of electromagnetism on this page.

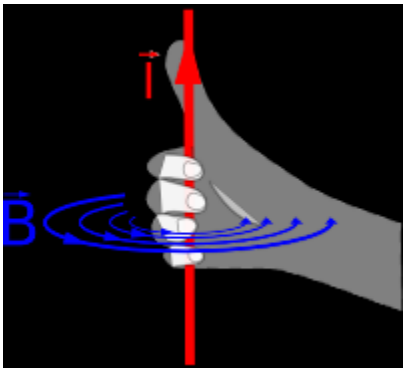
Electromagnet

When an electronic current flows through a wire, it generates a magnetic field. This is an important concept in electricity. The magnetic field can be increased by coiling the wire. This allows more current to flow through a smaller distance and increases the magnetic field.

Right-Hand Rule

When current is flowing through a wire, the magnetic field rotates around the wire. The direction of

the current determines the direction of the magnetic field. You can figure out the direction of the magnetic field using the "right-hand rule".



To determine the direction of the magnetic field, look at the picture above. Take your right hand and point your thumb in the direction of the current (I). Now wrap your fingers around the wire. Your fingers will point in the direction of the rotation of the magnetic field (B).

Motors

One of the important applications of electromagnetism is the electric motor. An electric motor converts electrical energy into physical movement. Electric motors generate magnetic fields with electric current through a coil. The magnetic field then causes a force with a magnet that causes movement or spinning that runs the motor.

Electric motors are used in all sorts of applications. There are even several electric motors inside your computer including one to turn the fan, one to open and shut the CDROM drive, and one to operate the hard drive.

Electromagnetic Induction

Another important application of electromagnetism is induction. Induction is when movement is used to create electricity (the opposite of using electricity to create movement). As a wire is moved through a magnetic field, current will begin to flow through it.

Generators

Electric generators convert mechanical energy into electrical energy using induction. As a coil of wire is spun between two opposite magnets, an electric current is generated that can be used to power electronic devices.

Generators can get their power from a wide variety of sources. Two popular electric generators of renewable energy include hydropower and wind power.

Fun Facts about Electromagnetism and Electric Motors

- Some electric generators can be driven by human power such as a hand crank or a bicycle to generate electricity.
- Danish physicist Hans Orsted was the first to discover that a magnetic field was produced by the flow of electric current.

- American physicist Joseph Henry discovered electromagnetic inductance and built the first electromagnetic motor.
- Loudspeakers use electromagnets to vibrate the cone and produce sound.
- Using electromagnetism, powerful magnets can be turned on and off using electricity, unlike permanent magnets.

Physics: Electric Motors
Test Quiz

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1) What term is used to describe how a magnetic field is created by the flow of electric current?

Magneto force
Electrolysis
Magnicity
Electromagnetism
Hydropower

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2) Will the magnetic field be stronger in a coiled wire or a straight wire?

Coiled wire
Straight wire
The same in both

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3) You can find the direction of the magnetic field by using the _____ rule.

High five
Right hand
Sleight of hand
Upper hand
Left hand

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4) True or False: Electric motors are not very useful except when used in cars.

TRUE
FALSE

5) What do we call a device that converts electricity into mechanical movement?

- Electrical generator
- Electrical coil
- Electrical charge
- Electrical field
- Electrical motor

6) What is it called when physical movement is used to create electrical energy?

- Electromagnetic deduction
- Electromagnetic division
- Electromagnetic intuition
- Electromagnetic induction
- Electromagnetic persuasion

7) What do we call a device that converts mechanical movement into electricity?

- Electrical generator
- Electrical coil
- Electrical charge
- Electrical field
- Electrical motor

8) True or False: Electromagnetism can be used to create powerful magnets using electricity.

- TRUE
- FALSE

9) What scientist is credited with discovering that a magnetic field was produced by the flow of electric current?

- Albert Einstein
- Hans Orsted
- Nikola Tesla
- Thomas Edison
- Isaac Newton

10) Which of the following is an example of an electrical generator?

- Electric fan
- Electric car

Hydropower dam
All of the above
None of the above