



Module 3 – Nautical Science

Unit 5 – Physical Science

Chapter 20 - Basic Electricity

Section 1 – What Is Electricity?



What You Will Learn to Do

Demonstrate an understanding of Physical Science



Objectives

1. Describe the fundamental theory of electricity
2. Describe the properties of conductors and insulators
3. Describe the six common methods of producing voltage



Key Terms



CPS Key Term
Questions 1 - 8



Key Terms

Electricity -

The presence and motion of electrons, protons and other charged particle; manifests itself as attraction, repulsion, luminous and heating effects

Battery -

One or more cells assembled in a common container to act as a source of electrical power



Key Terms

- Conductor -** A material or object that permits an electric current to flow easily
- Insulator -** Materials that are poor conductors (as in electricity or heat); Materials that have few free electrons
- Schematic -** Of, relating to or in the form of a scheme or diagram



Key Terms

Electromotive force -

> Symbol: E or emf

Voltage that causes current to flow through a circuit; the potential difference in charge between two points in a circuit (as in a cell or generator)

Photoelectric -

Involving, relating to, or utilizing any of various electrical effects due to the interaction of radiation (such as light) with matter



Key Terms

Thermocouple - A device for measuring temperature in which a pair of wires of dissimilar metals (such as copper and iron) are joined and the free ends of the wires are connected to an instrument (such as a voltmeter) that measures the difference in potential created at the junction of the two metals



Opening Question



Name the three best conductors of electricity, and explain why two of them are used most often.

1.

2.

3.

(Use CPS "Pick a Student" for this question.)





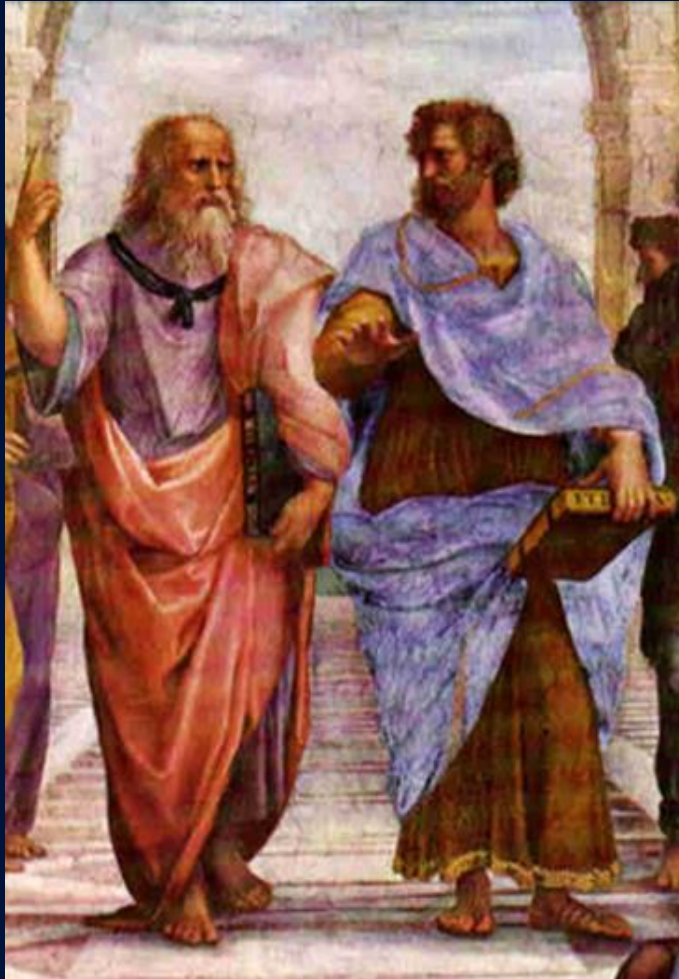
Warm Up Questions



CPS Lesson Questions 1 - 2



Introduction



The study of **electricity** began with the ancient Greeks.



Introduction

Rubbing
amber with
a cloth
created a
force that
attracted
the cloth to
the amber.





Introduction

Rubbing two pieces of amber with two cloths caused the cloths to repel one another as much as they were attracted to the amber.





Introduction

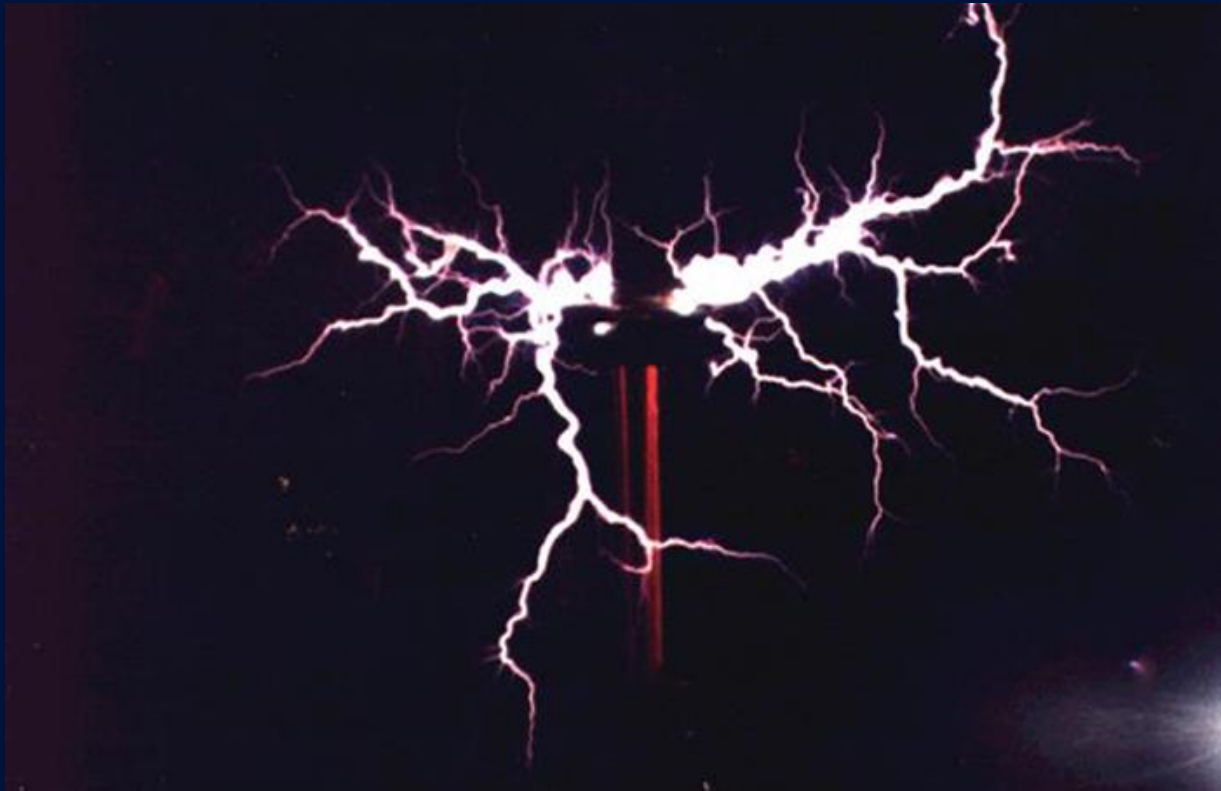
The forces the Greeks observed were called electric (from the Greek word for amber).





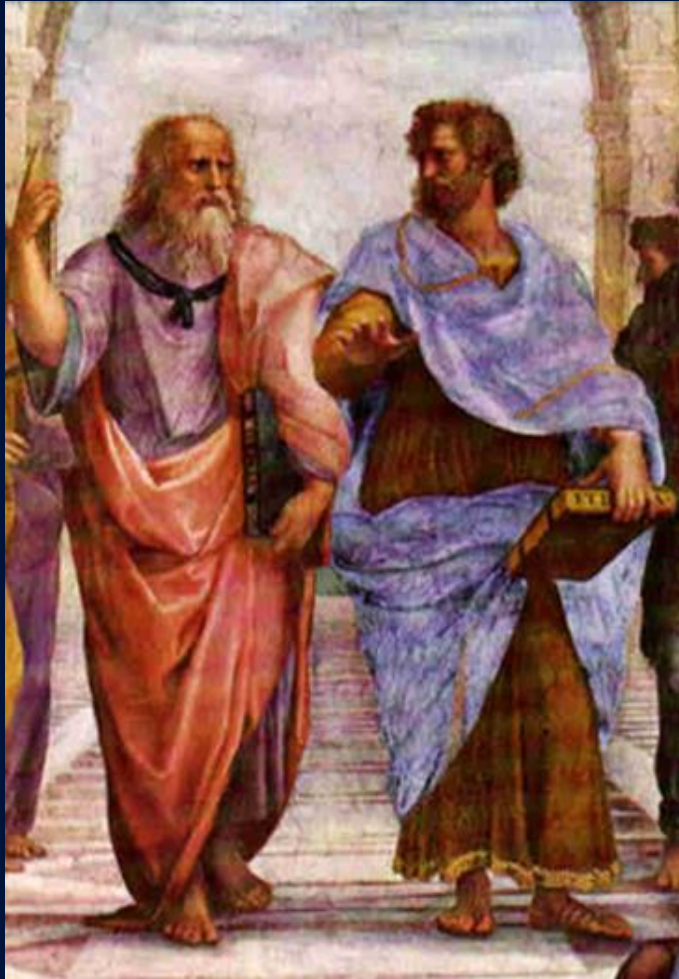
Introduction

The cloths and amber were said to be electrically charged.





Introduction

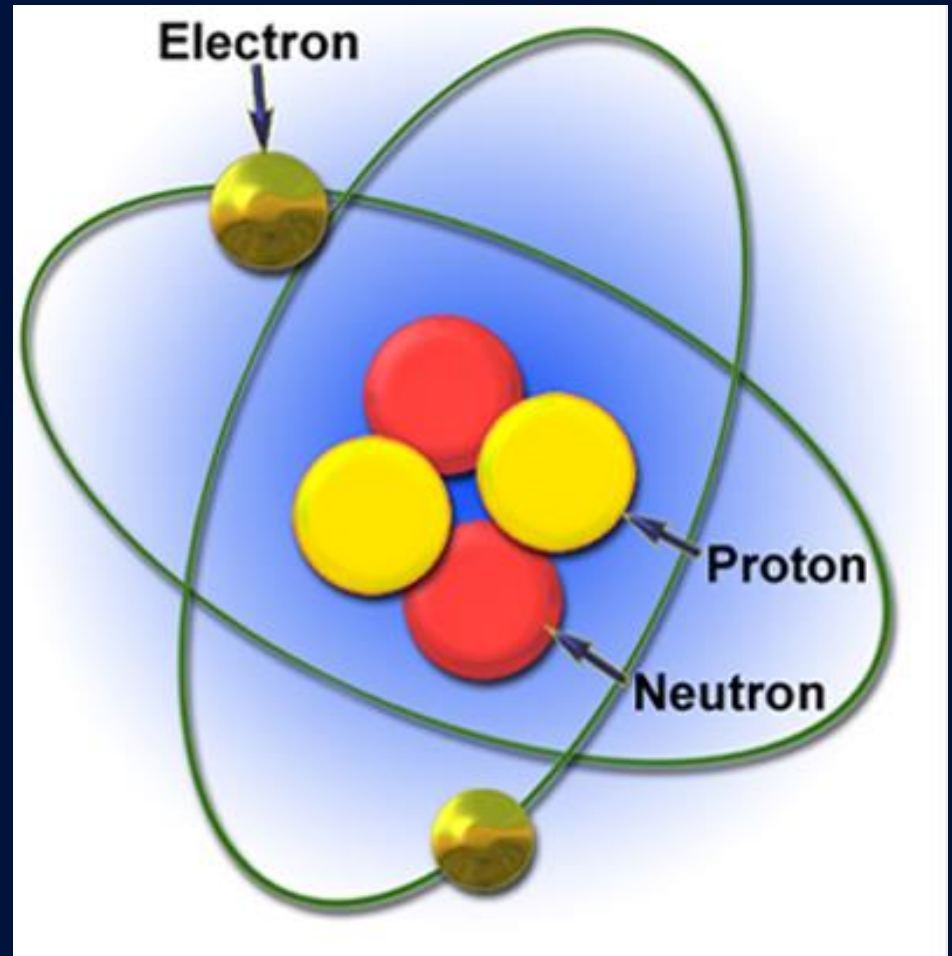


The Greeks could not explain electrical force.



Introduction

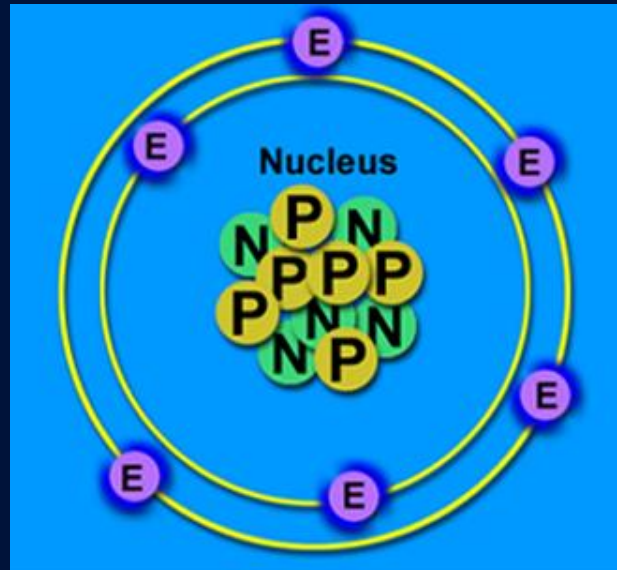
The true cause of electricity was determined with the development of the atomic theory of matter.





Introduction

Scientists could explain electrical charges when they found atoms were composed of negatively charged particles (electrons) orbiting positively charged particles (protons) and neutrons which have no charge.

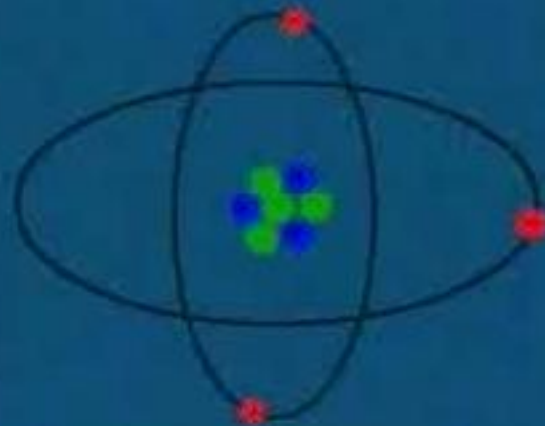




Introduction

ATOMS AND ELECTRICITY

Atoms, such as the Lithium atom below, are composed of a nucleus...





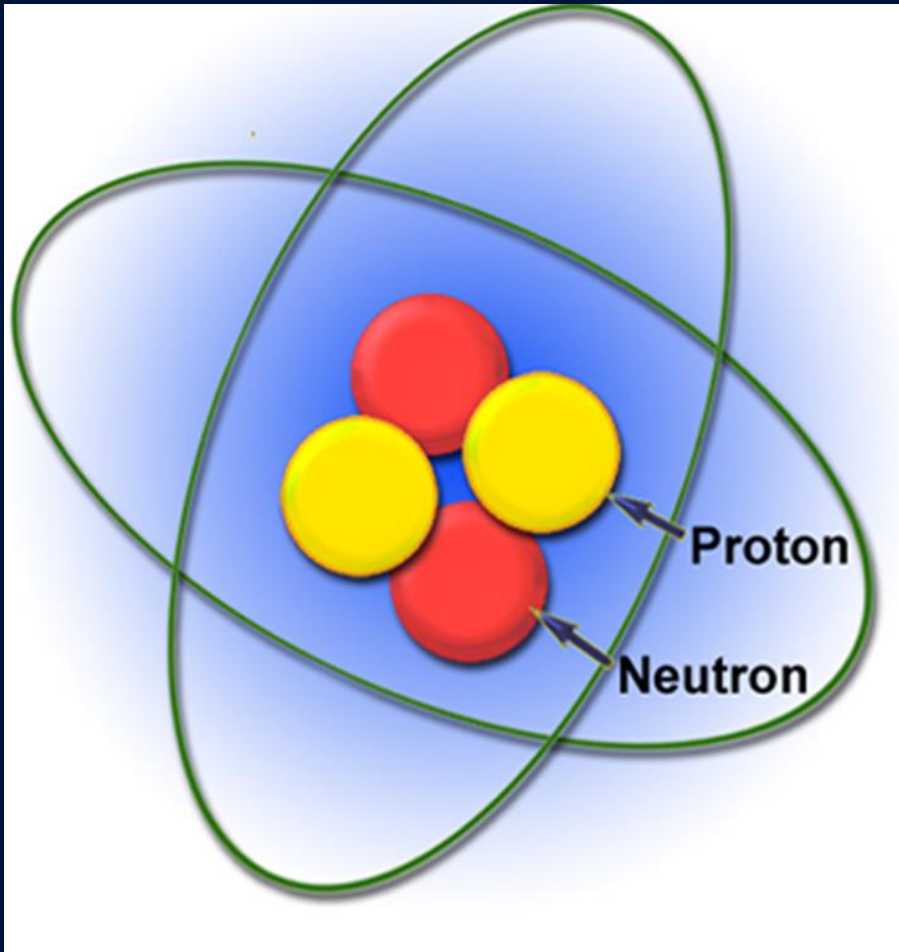
Introduction

Under most conditions, an atom will have no charge.





Introduction



If the number of electrons is increased, an atom becomes negatively charged.

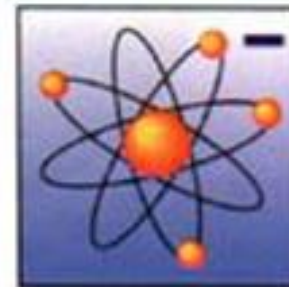
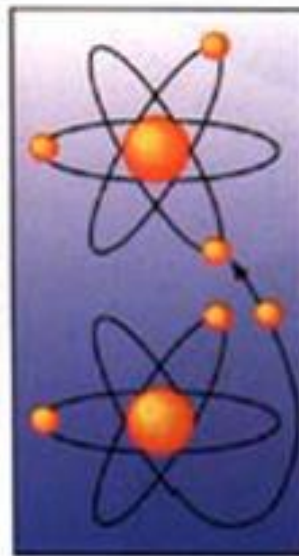
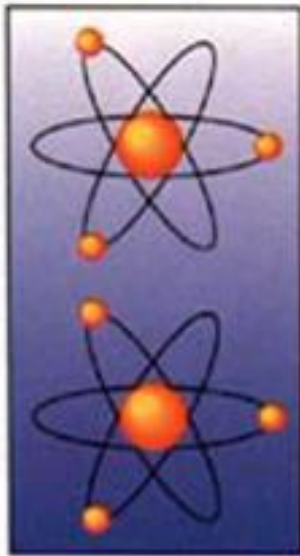
If electrons are removed, an atom will have a positive charge.



Introduction

Charged atoms are called ions.

Neutral atoms



Negative ion

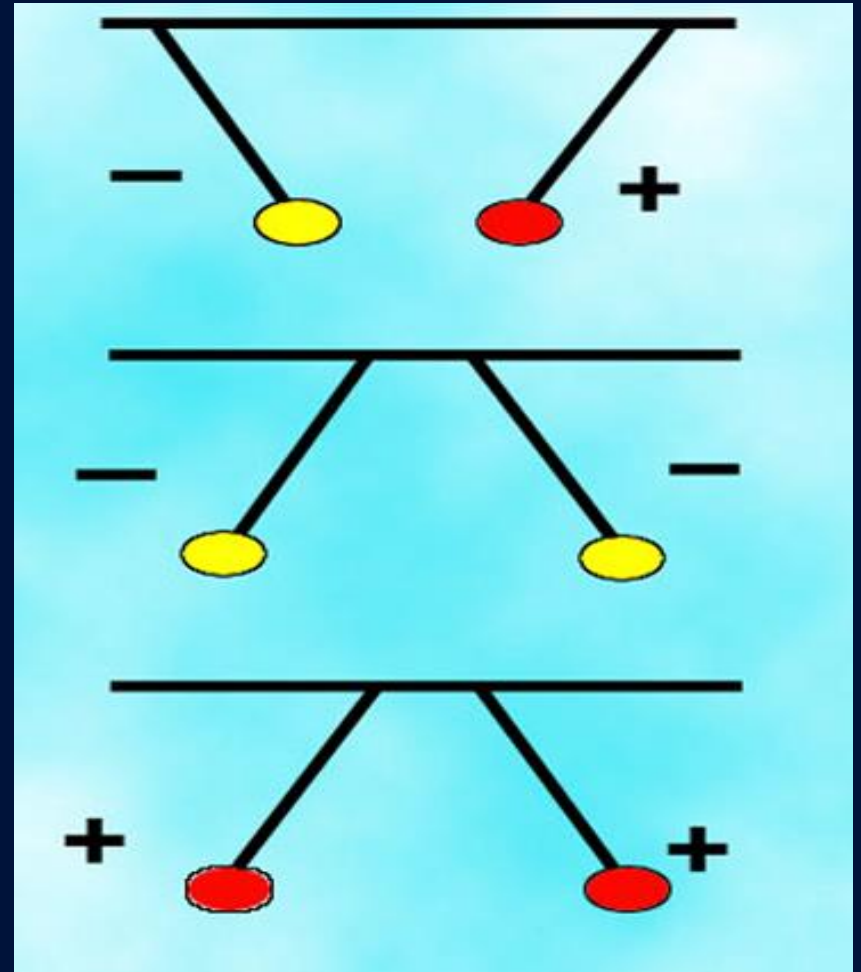


Positive ion



Introduction

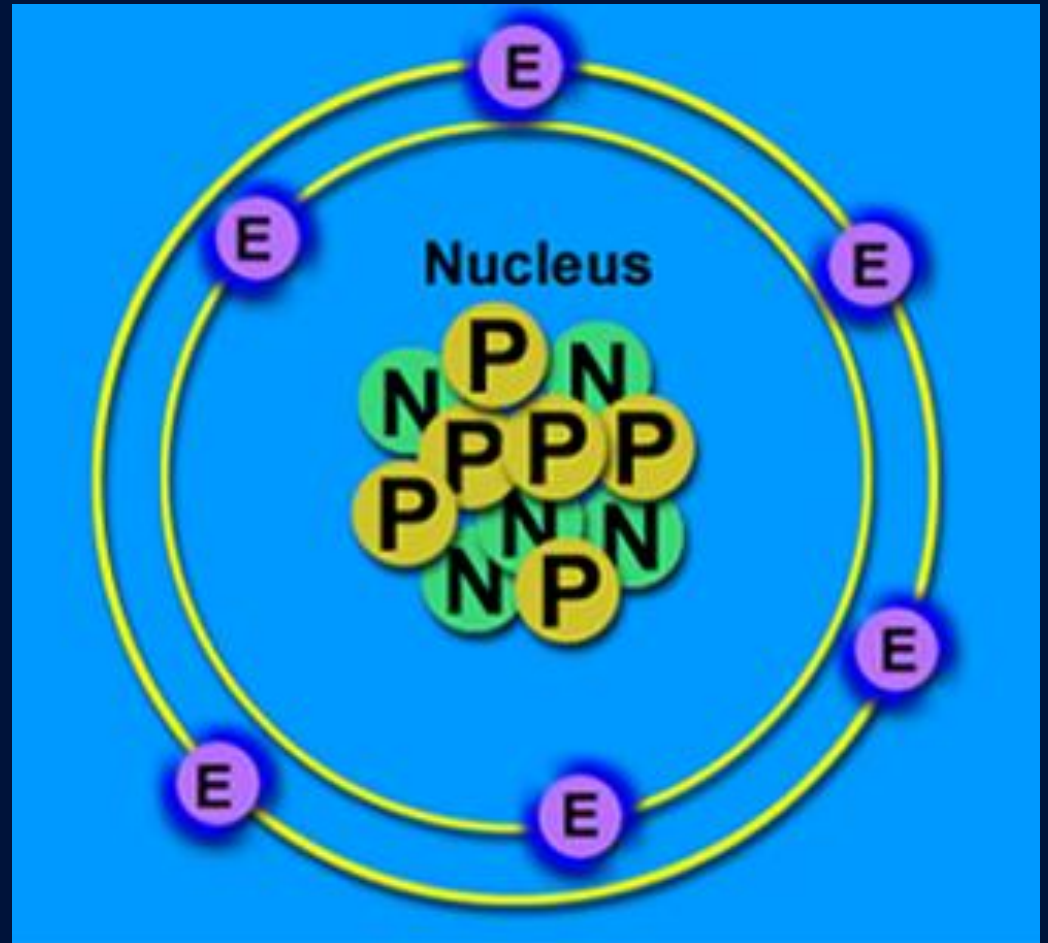
Unlike charges attract each other while like charges repel each other.





Introduction

In the atom, electrons are held in their orbit by the attractive force between them and protons in the nucleus.





Introduction

In the Greeks' experiments with amber, the cloth picked up electrons from the amber, becoming negatively charged.

This left the amber with a positive charge, and unlike charges attract one another.





Check On Learning Questions



CPS Lesson
Questions 3 - 4



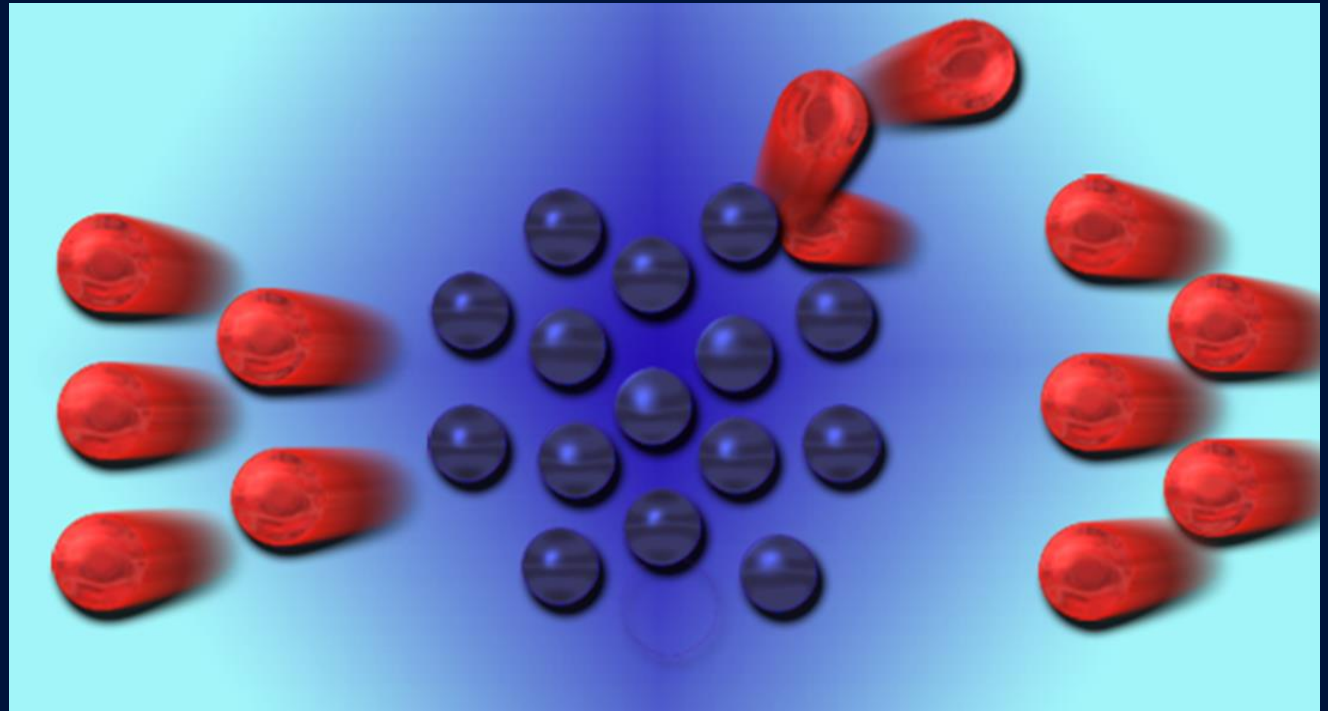
Conductors and Insulators





Conductors and Insulators

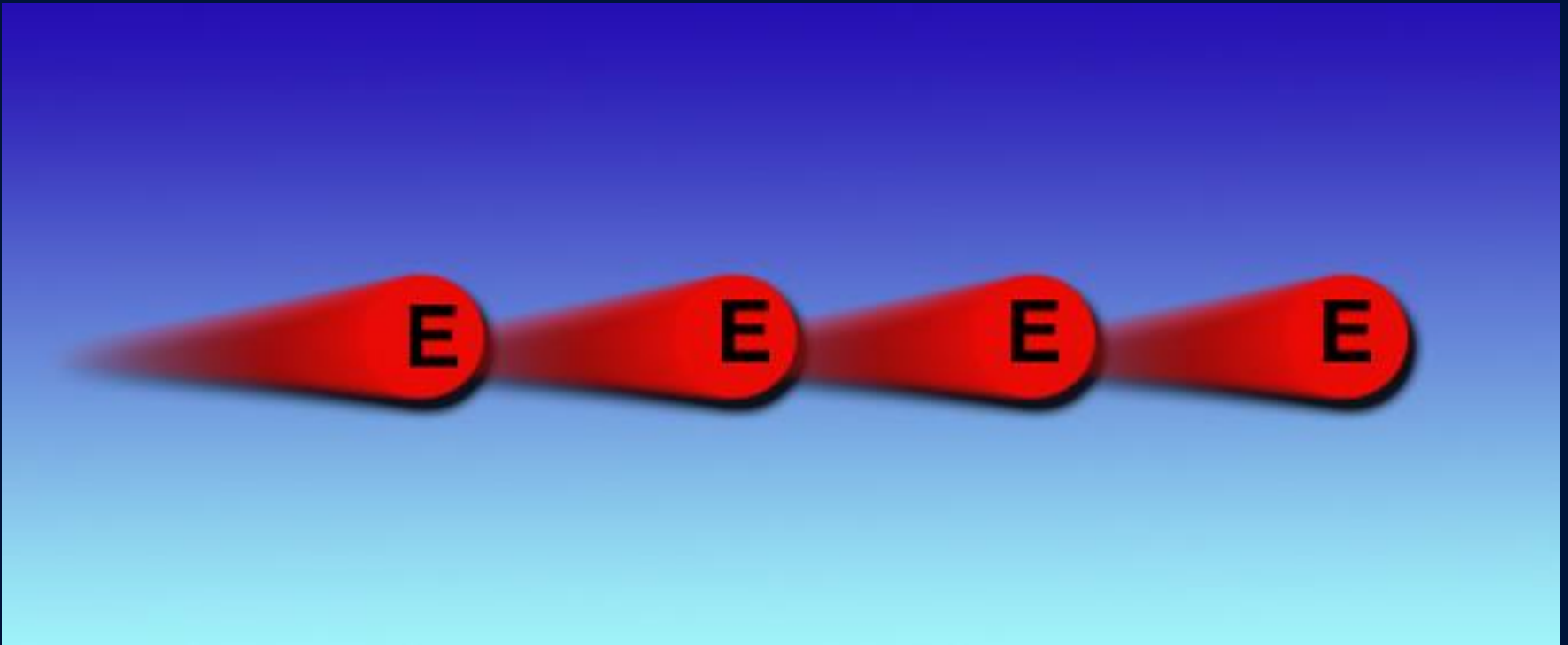
An electric charge can move through a material if it has a large number of free electrons. Electrons can easily move from atom to atom in material with a large number of free electrons.





Conductors and Insulators

Substances that allow free movement of electrons due to their atomic structure are called **conductors**.





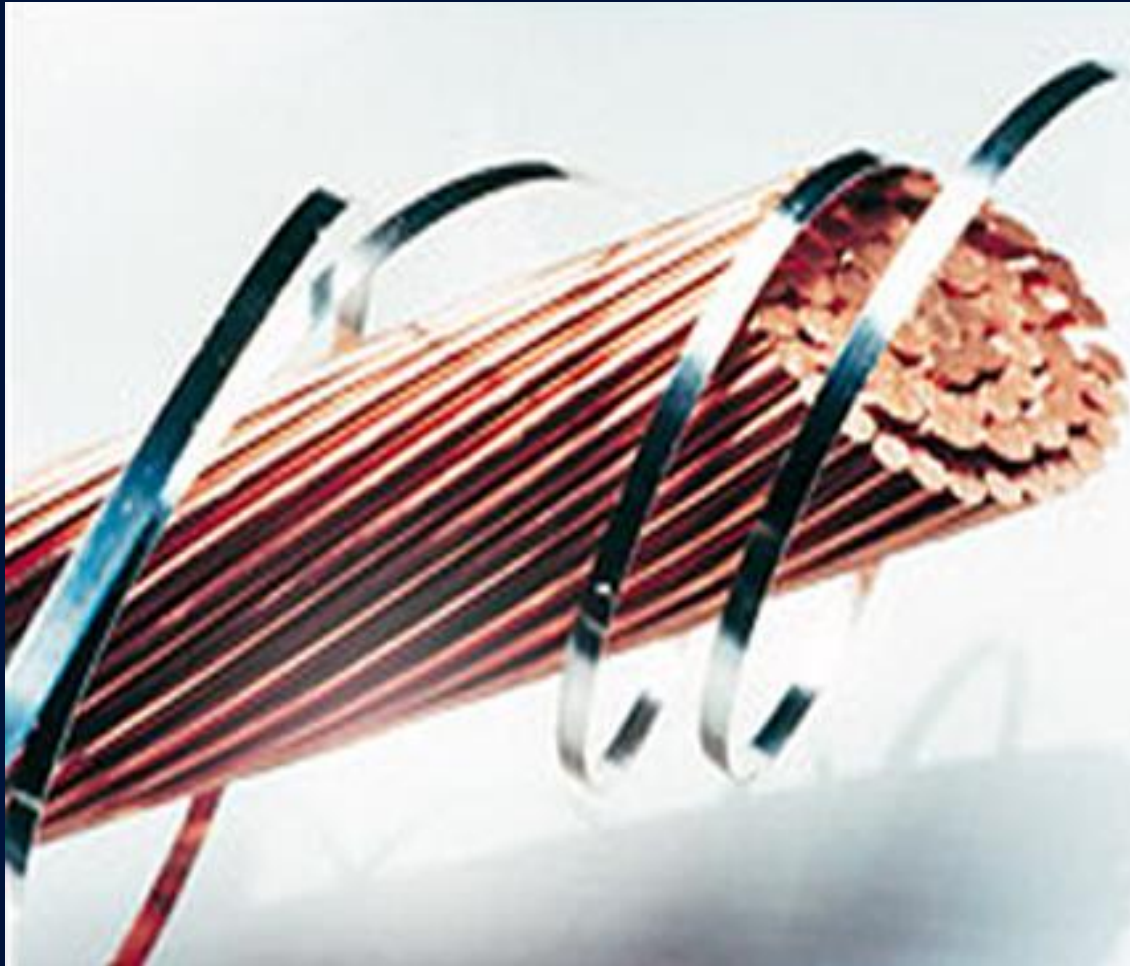
Conductors and Insulators



Silver, copper, and aluminum wire, in that order, are the best **conductors**.



Conductors and Insulators



Copper and aluminum wire are the most commonly used because they are the least expensive.



Conductors and Insulators

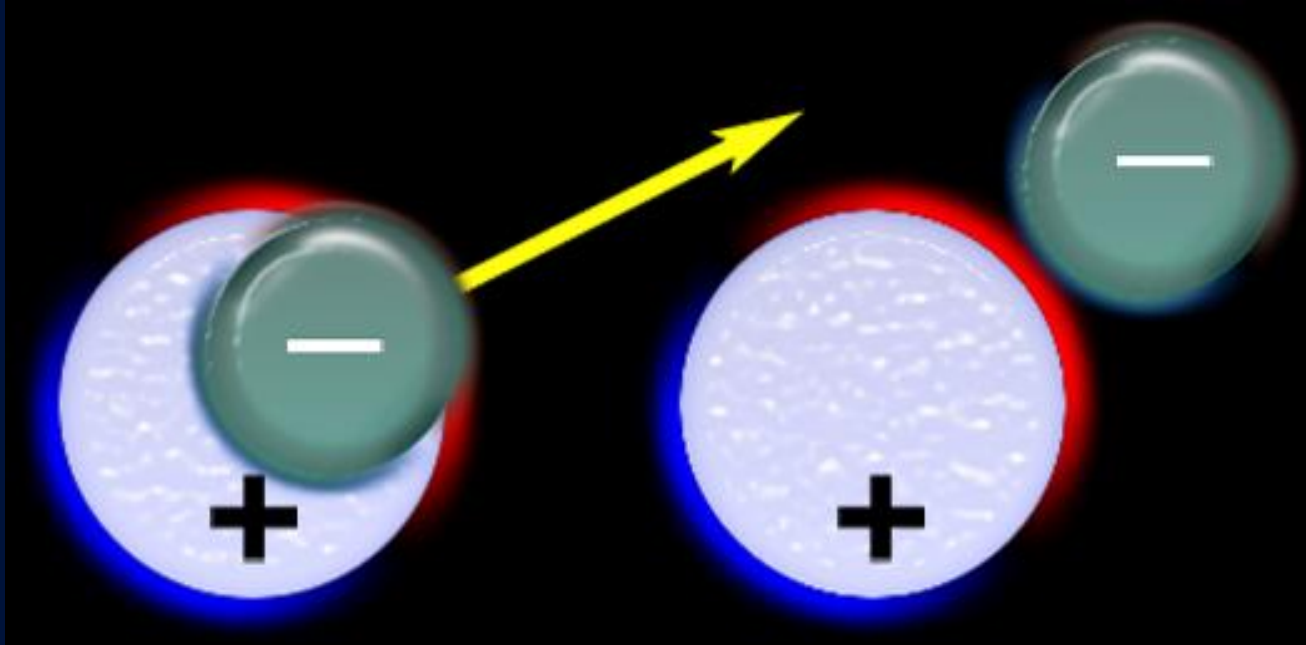
Electrical energy is conveyed as a wave traveling at the speed of light through conductors by free electrons.





Conductors and Insulators

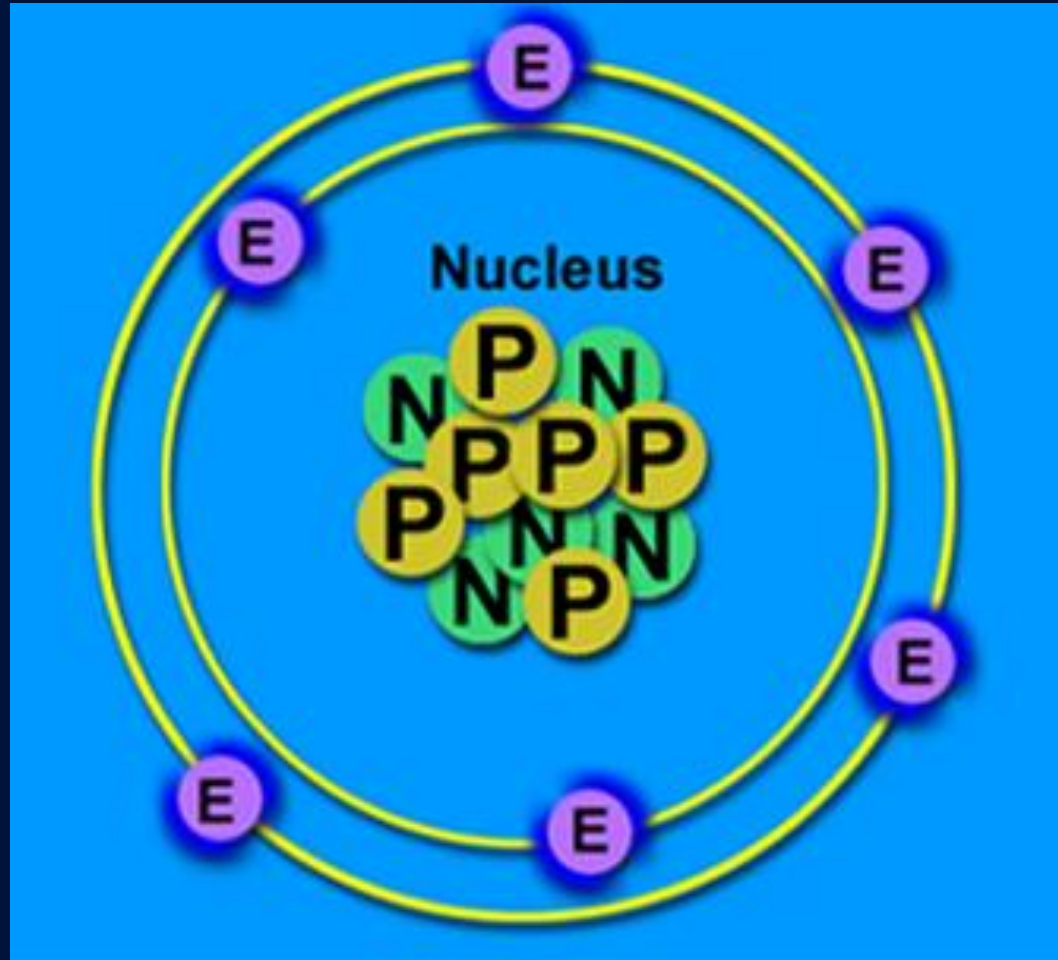
As the electrical energy passes, each electron moves a short distance to the next atom, displacing one or more electrons by forcing them out of their orbits.





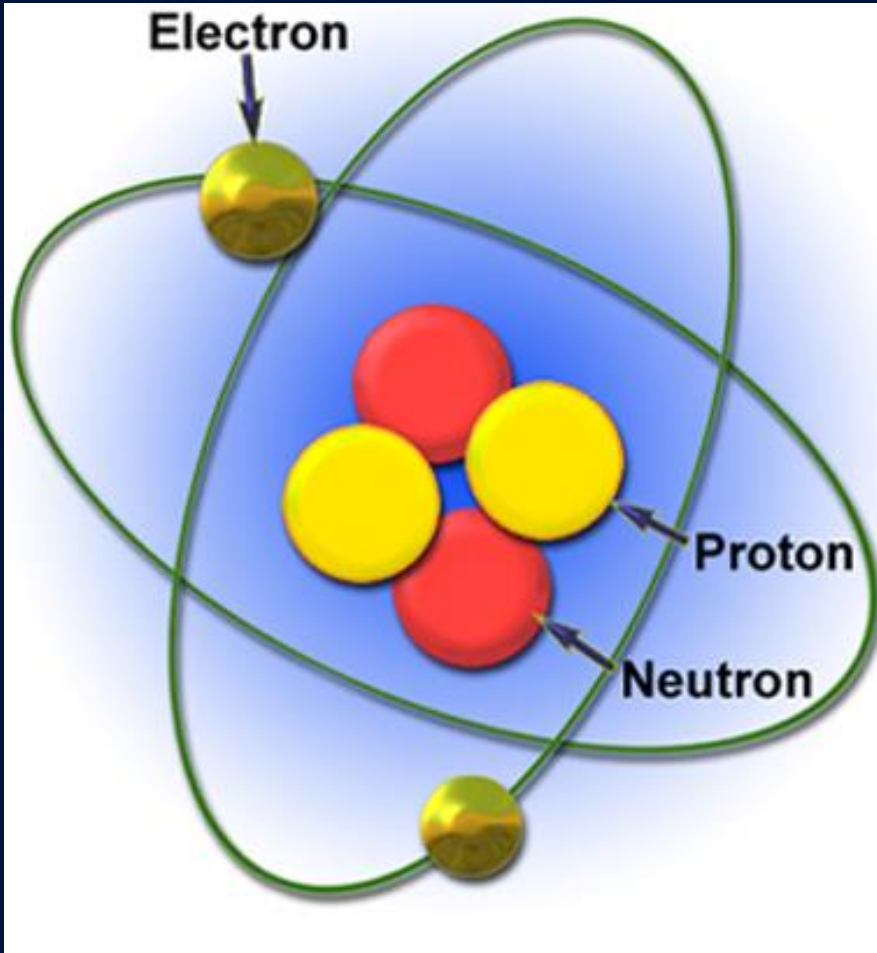
Conductors and Insulators

The replaced electrons repeat the process in other nearby atoms.





Conductors and Insulators



Some substances have very few free electrons and are therefore poor conductors.



Conductors and Insulators

These substances, such as rubber, glass, or dry wood, are called **insulators**.



Glass

Rubber



Wood



Conductors and Insulators

Good conductors such as wire carry electricity and are covered by insulating material to prevent electricity from being diverted from the conductors.





Check On Learning Questions



CPS Lesson
Questions 5 - 6



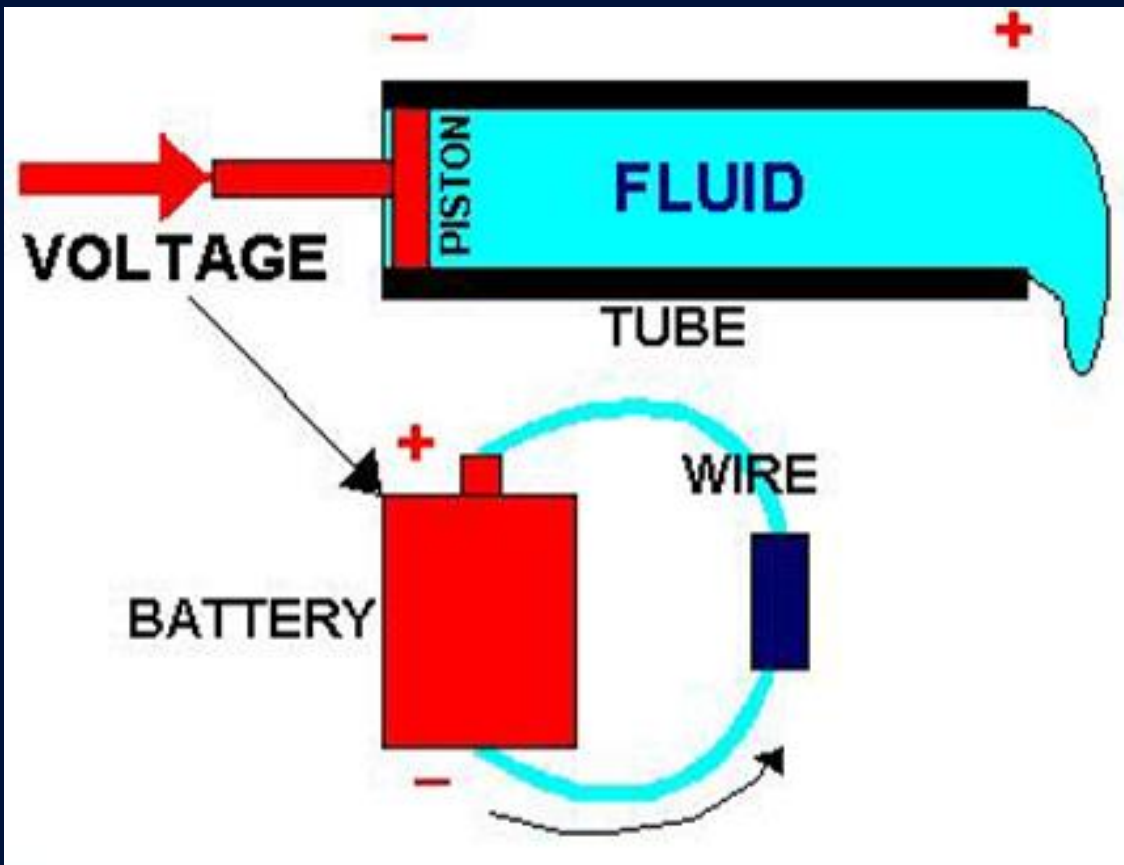
Voltage



Michael Smith 2001
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Voltage



The force that causes **electricity** to move in a conductor is called voltage or **electromotive force**, symbolized by the letter E .



Voltage

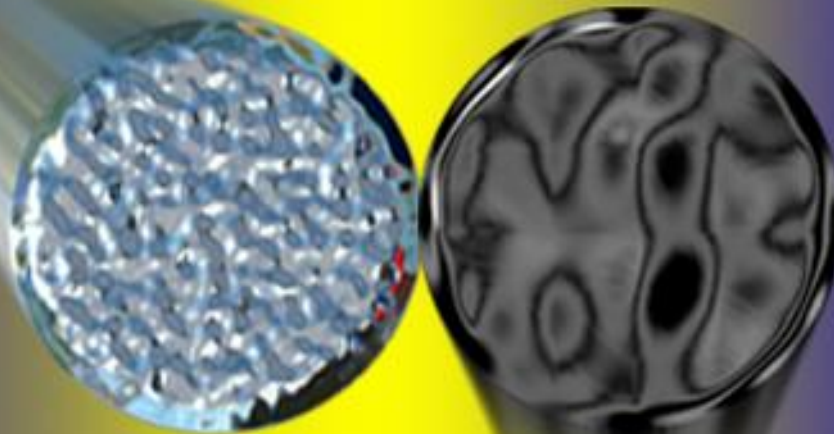
There are six basic ways to generate voltage.

1. Friction
2. Pressure
3. Heat
4. Light
5. Chemical action
6. Magnetism



Voltage

Voltage can be produced by rubbing two materials together.



1. Friction



Voltage



Static electricity is the most common name for electricity generated through friction.

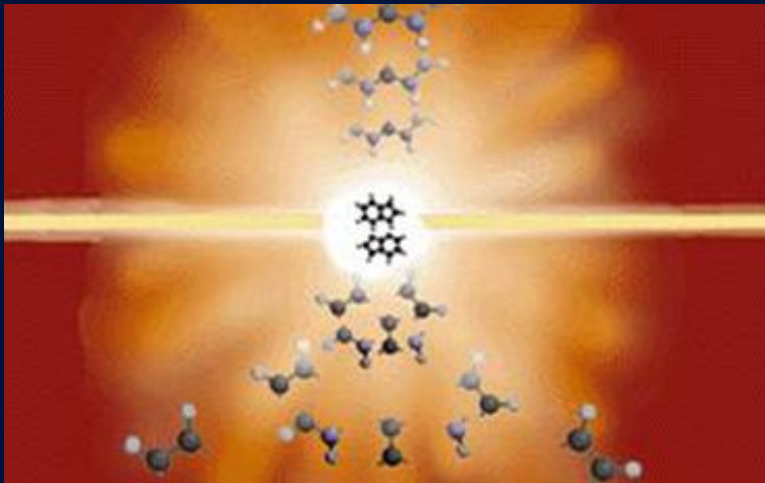
It occurs often in dry environments.



Voltage

2. Pressure:

Creating pressure by squeezing crystals, such as natural quartz or manufactured crystals, produces voltage.



Compressed electrons tend to move through a crystal at predictable frequencies.



Voltage

Crystals are frequently used in communications equipment.



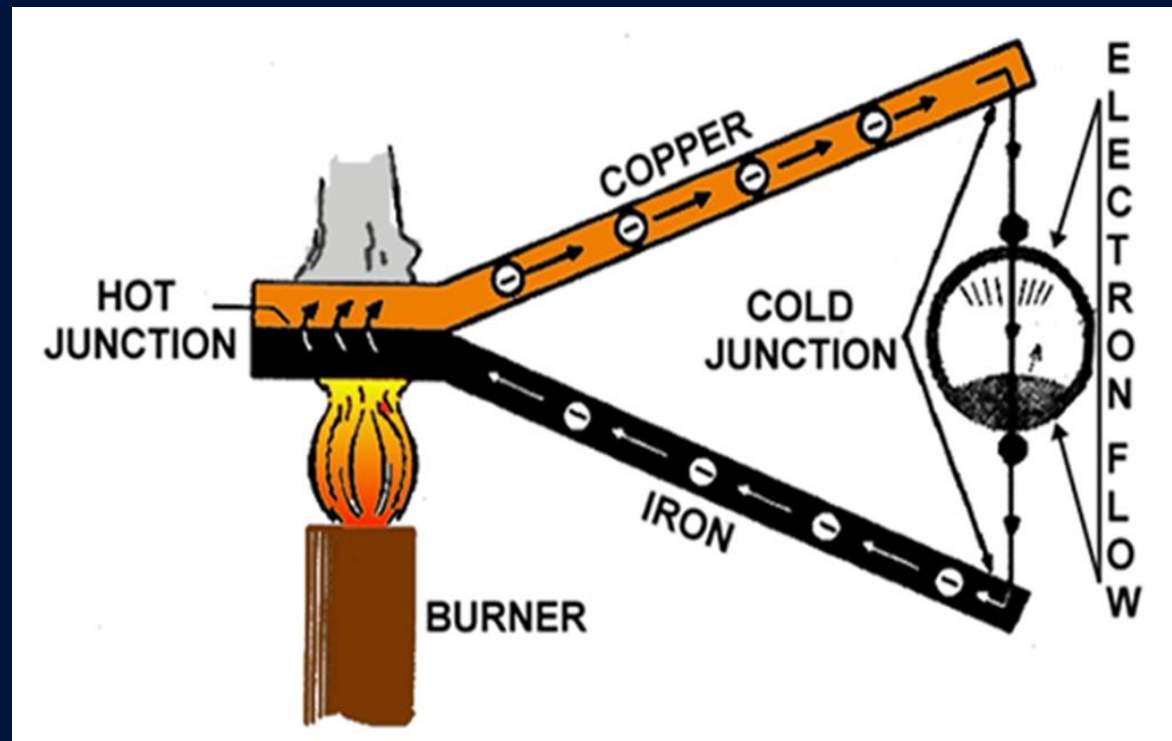


Voltage

3. Heat

Voltage can be produced by heating the place where two unlike metals are joined.

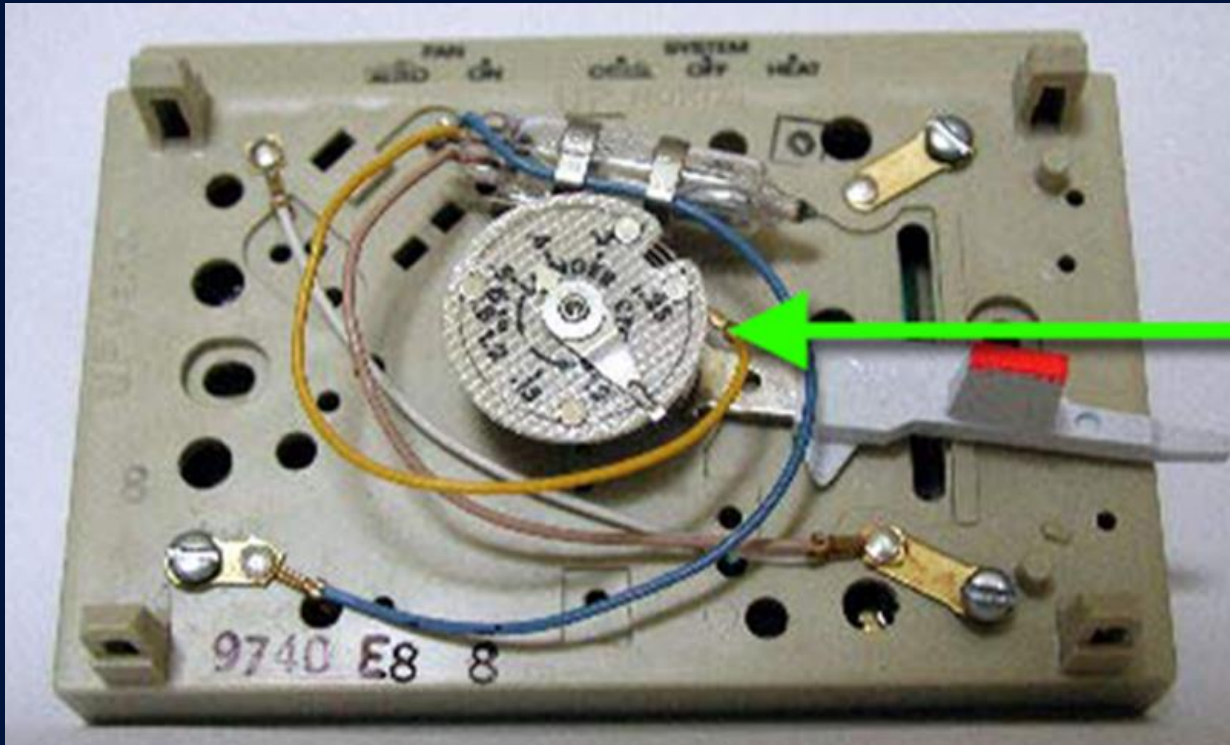
The difference in temperature of the two metals determines the amount of voltage.





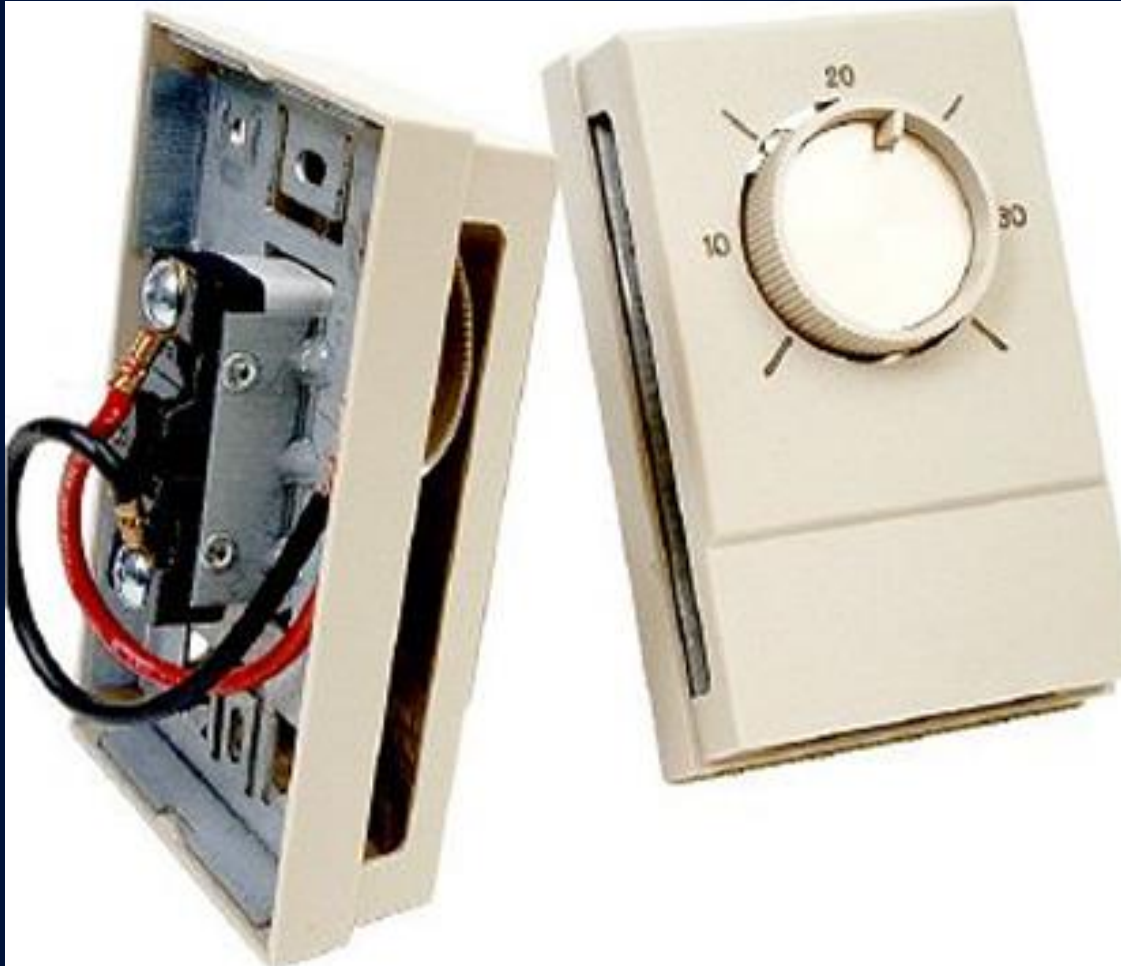
Voltage

The hot junction where the moving electrons from the metals meet is called a **thermocouple**.





Voltage



Thermocouples are often used to measure and regulate temperature, as in a thermostat.



Voltage

Photoelectric voltage is produced when light strikes a photosensitive (light-sensitive) substance.

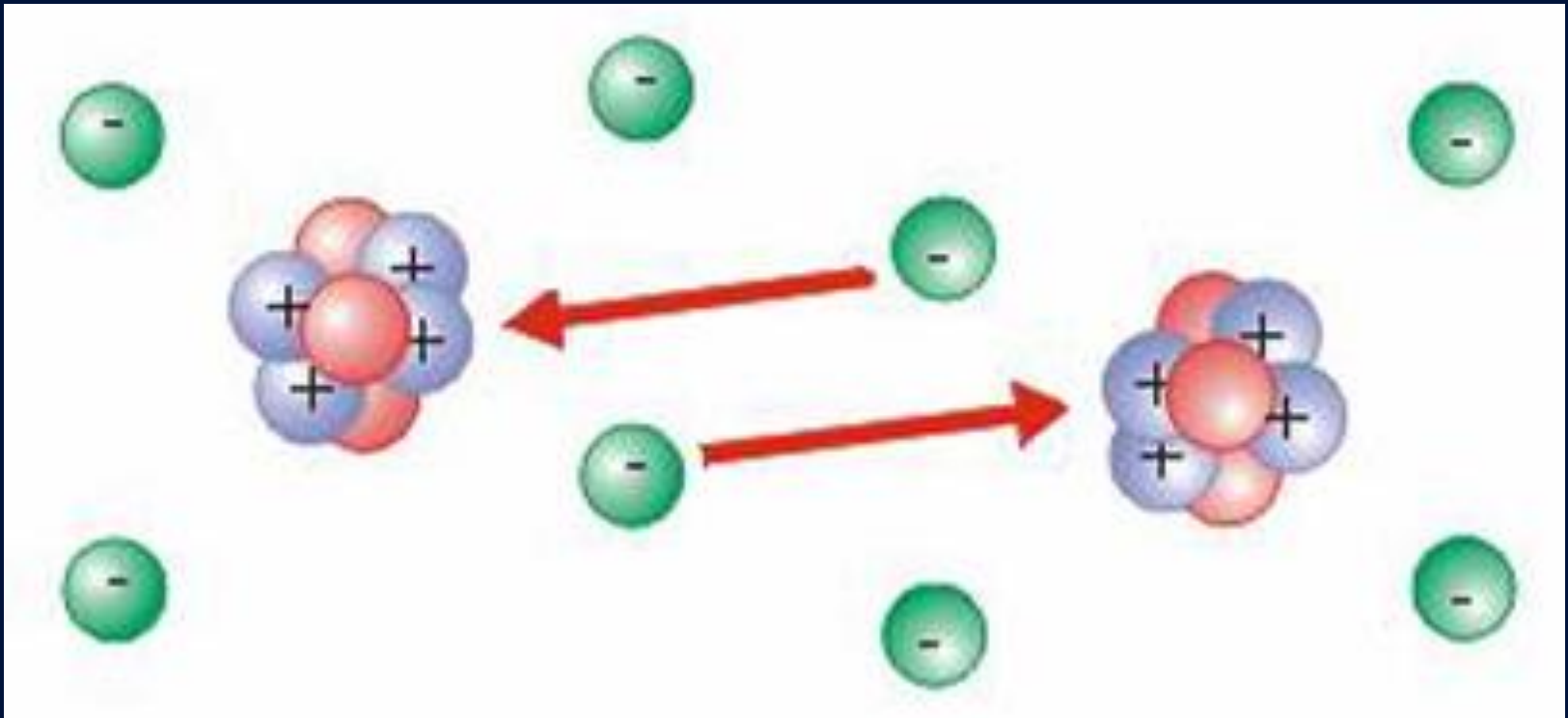


4. Light



Voltage

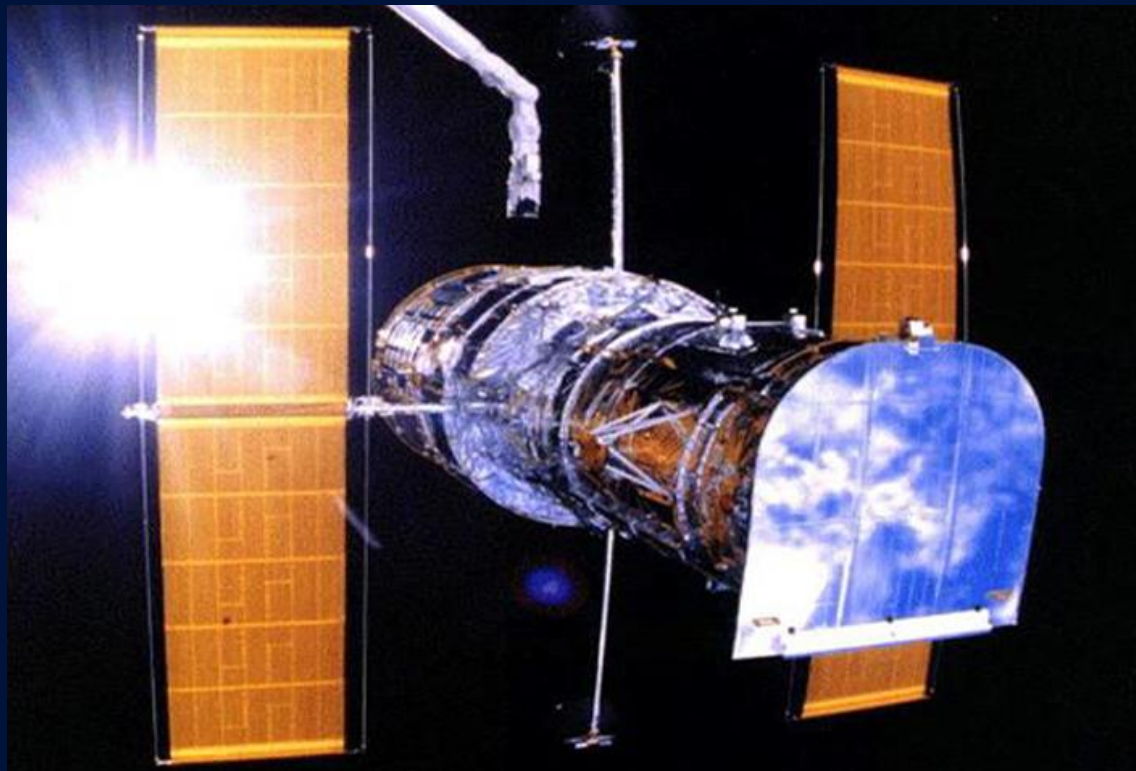
Light dislodges electrons from their orbits around surface atoms.





Voltage

The **photoelectric** cell operates on this principle.





Voltage

Use of light-produced voltage is growing. This type of electricity can be produced without generating carbon-based waste products or depleting natural resources.

Applications include:

- buildings
- batteries
- cameras
- burglar alarms





Voltage

Voltage can be produced by chemical reactions, as in a **battery** cell.



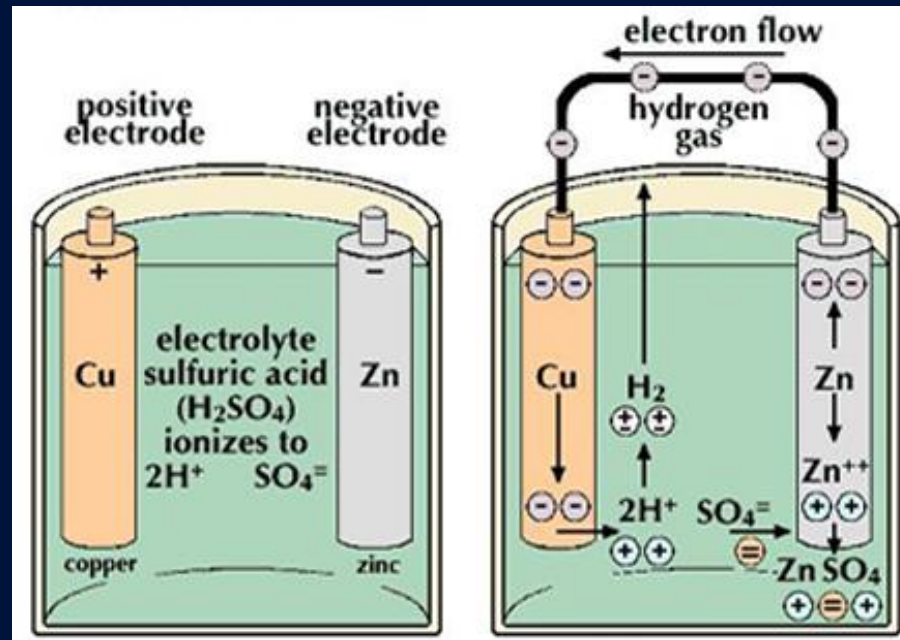
5. Chemical action



Voltage

A simple voltaic **battery** consists of a carbon strip (positive) and a zinc strip (negative) suspended in a solution of water and sulfuric acid.

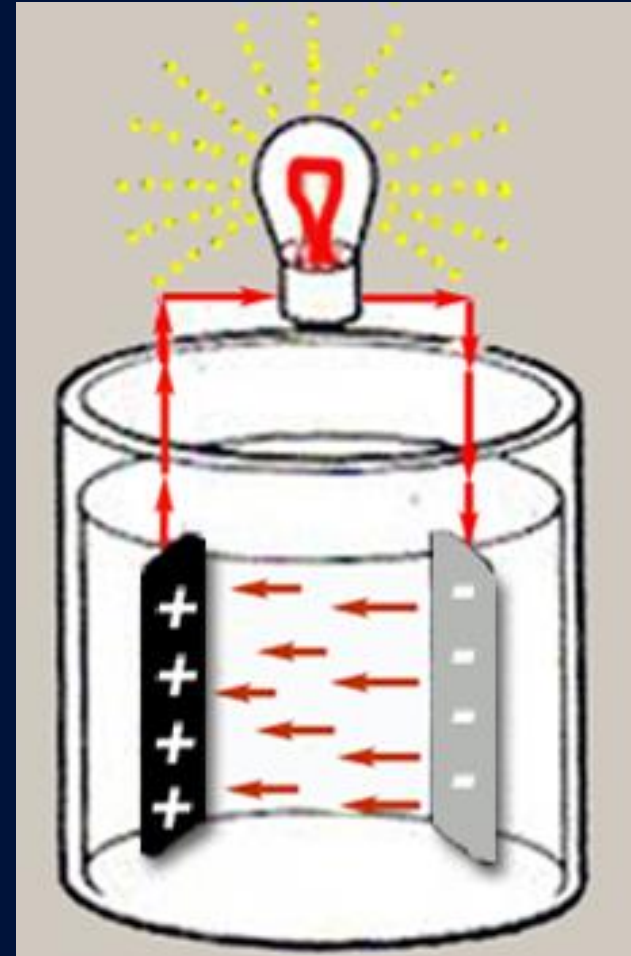
The solution is called the *electrolyte*.





Voltage

The chemical action that results from this combination causes electrons to flow between the zinc and carbon electrodes.





Voltage





Voltage

Batteries are used as sources of electrical energy in automobiles, boats, aircraft, ships, and portable equipment.



Automobile



Boats



Aircraft

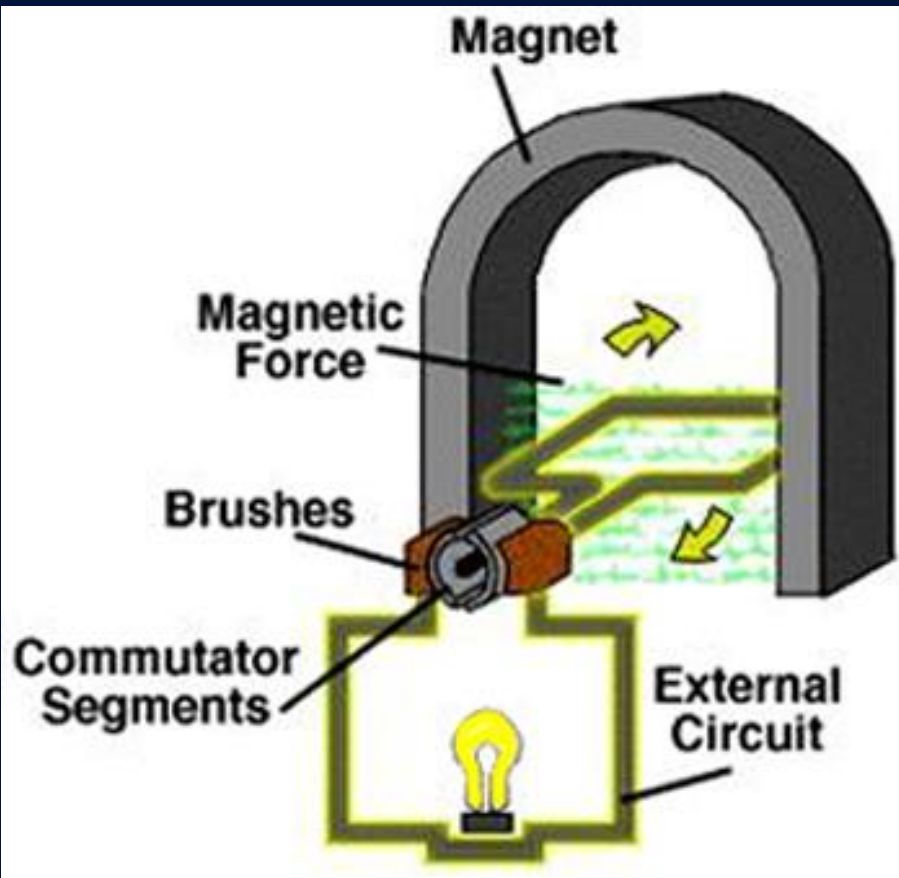


Equipment



Voltage

6. Magnetism



Voltage can be produced when a conductor moves through a magnetic field cutting the field's line of force.



Voltage

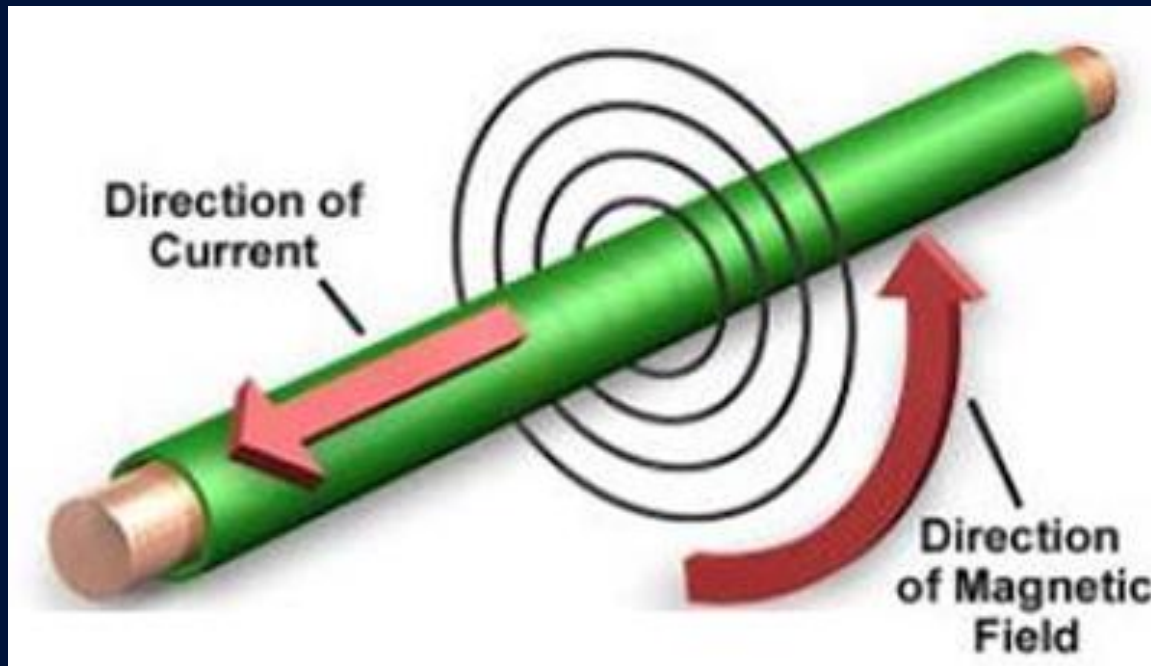
This method is used in electrical generators and is the most common source of power.





Voltage

Usually, a copper-wire conductor is moved back and forth through the magnetic field created by a U- or C-shaped electromagnet.





Voltage

An instrument designed to measure voltage in an electrical circuit is called a **voltmeter**.



Voltmeter



Review Question



Name one mechanism using each of the following voltage sources: pressure, light, chemical action, and magnetism.

1.

2.

3.

(Use CPS "Pick a Student" for this question.)





Closing Questions



CPS Lesson
Questions 7 - 8



Questions?

