Electricity

Chapter 20

GA Performance Standards

SPS10. Students will investigate the properties of electricity and magnetism.

SPS10. A. Investigate static electricity in terms of

- Friction
- Induction
- conduction

SPS10. B. Explain the flow of electrons in terms of

- Alternating and direct current
- The relationship among voltage, resistance, and current
- Simple series and parallel circuits

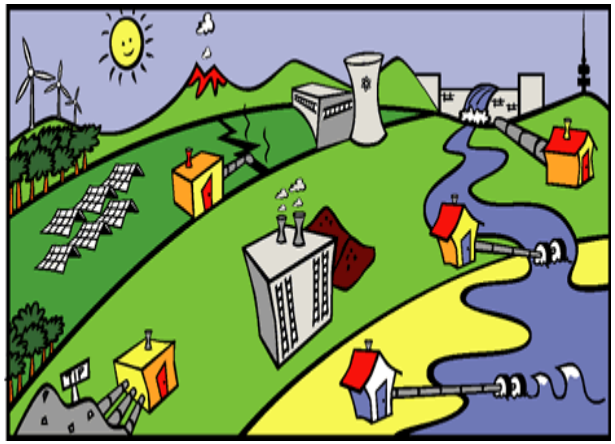
SPS10. C. Investigate applications of magnetism and/or its relationship to the movement of electrical change as it relates to

- Electromagnets
- Simple motors
- Permanent magnets

What is Electricity?

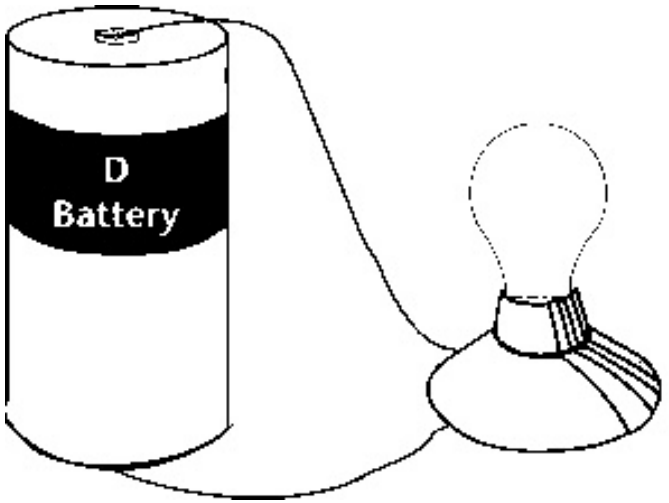
•Electricity is the flow of electrical power or charge.

•It is a secondary energy source which means that we get it from the conversion of other sources of energy, like coal, natural gas, oil, nuclear power and other natural sources, which are called primary sources.

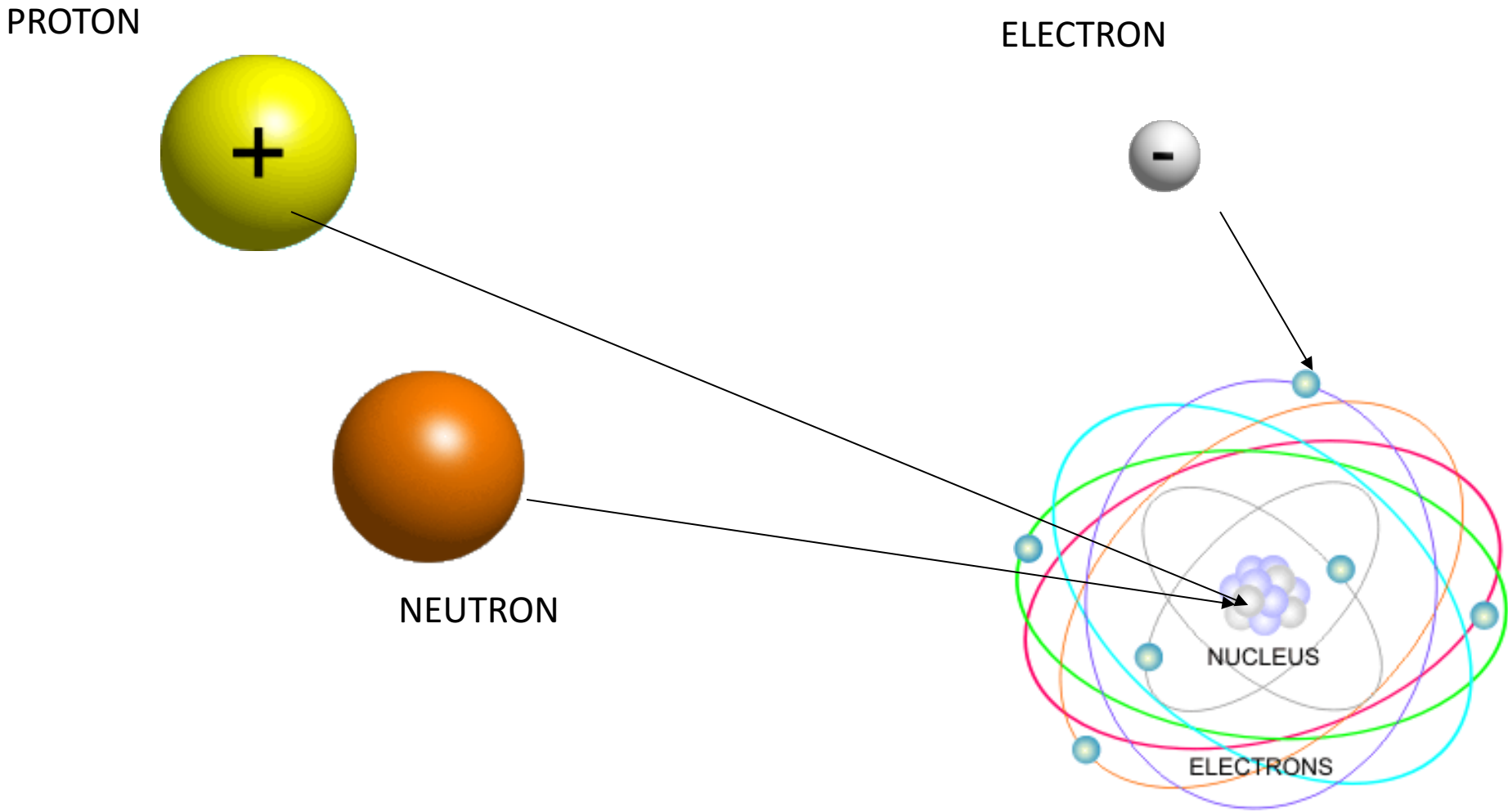


- Electrical energy is the energy associated with electric charges
- **Electric charge** is a property that causes subatomic particles such as protons and electrons to attract or repel each other

Electric Charge



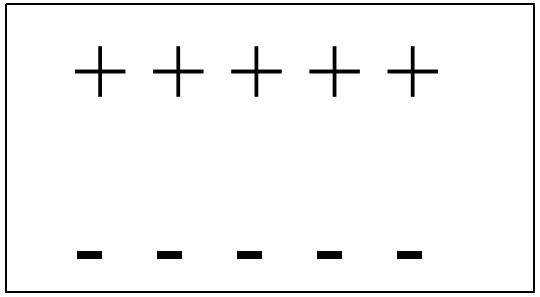
Atoms contain particles called protons, neutrons and electrons.



Atoms basics

- Protons have a positive charge and electrons have a negative charge
- An atom has a cloud of negatively charged electrons surrounding the positively charged nucleus.
- The atom is neutral since it has equal numbers of protons and neutrons
- **An excess or shortage of electrons produces a net electric charge**

In most atoms, the number of protons equals the number of electrons and the charges cancel each other out, and the atom has no net charge.



Atoms become charged by gaining or losing **electrons.**

BEFORE	AFTER
+-+-+-+- = (0) if it loses an electron	+-+-+-+ = (+) positive charge
+-+-+-+- = (0) if it gains an electron	+-+-+-+- - = (-) negative charge

Electric force

- **Electric force** is the force of attraction or repulsion between electrically charged objects
- electric force between two objects is proportional to the net charge on each object,
- Electric force between two objects is inversely proportional to the square of the distance between them

Electric force

- Example: doubling the charge on one object doubles the electric force
- Example: doubling the distance between the objects the electric force is one fourth as strong

- Inside an atom electric forces are stronger then gravitational force, but on large scale matter is mostly neutral and electric forces are close to zero.

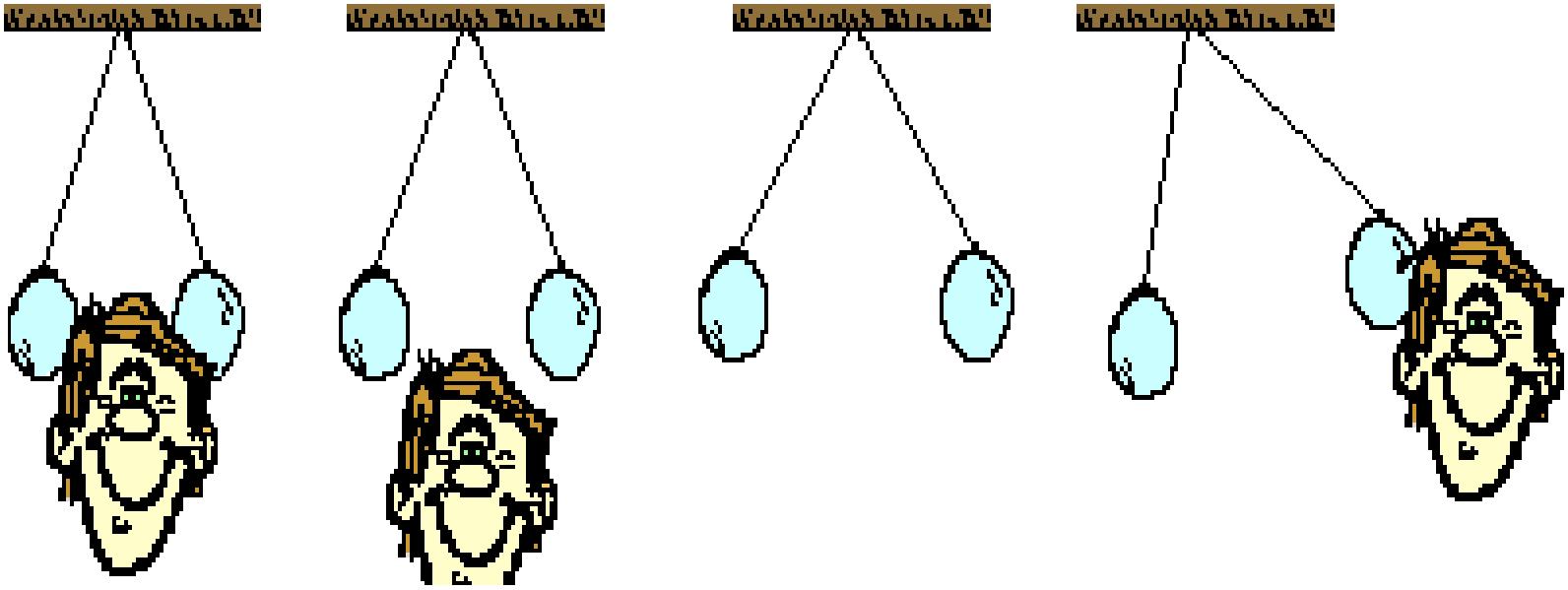
Electrically charged

objects obey

the following rules:

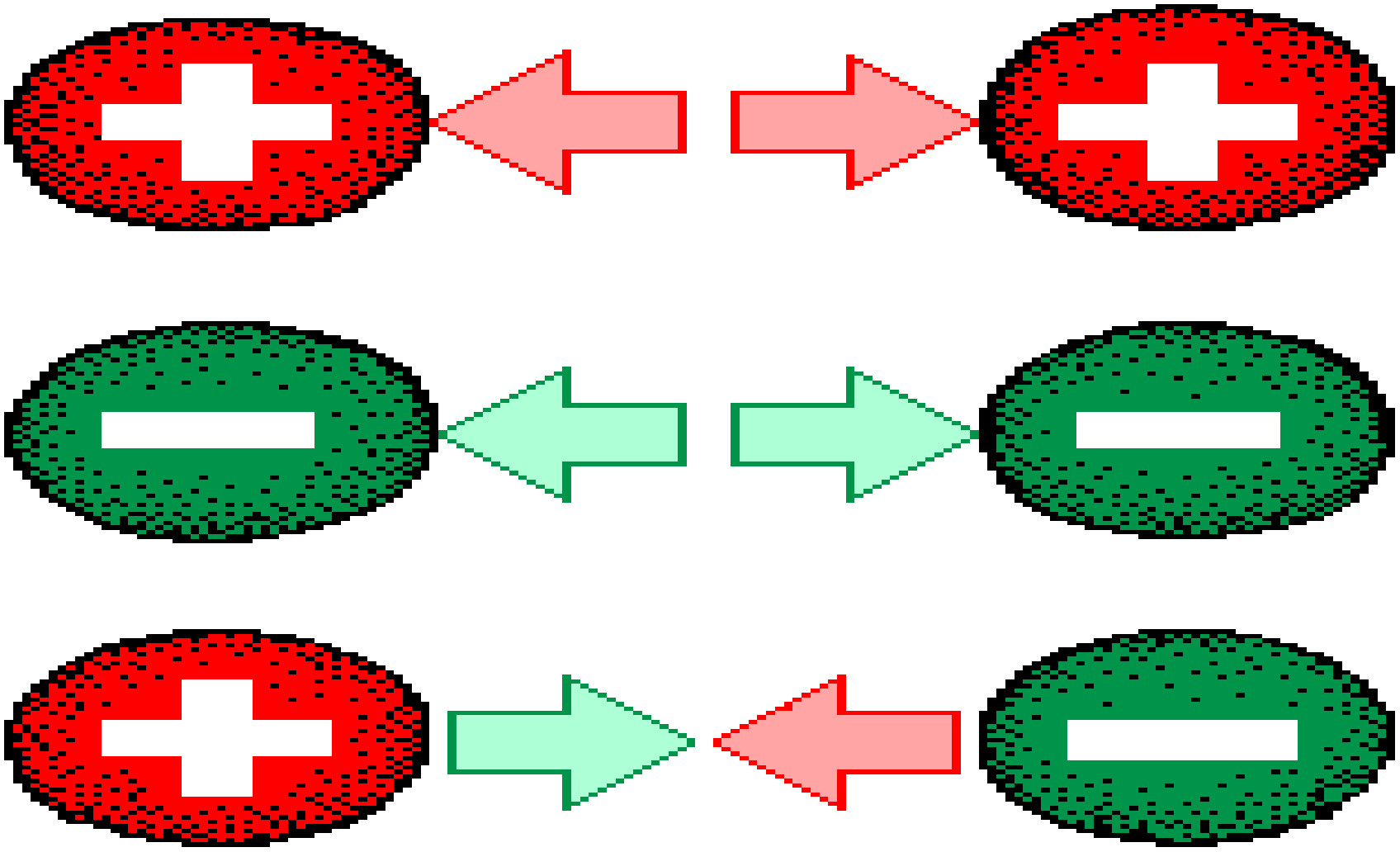
1. Law of conservation of charge:

Charge may be transferred from object to object, but it cannot be created nor destroyed

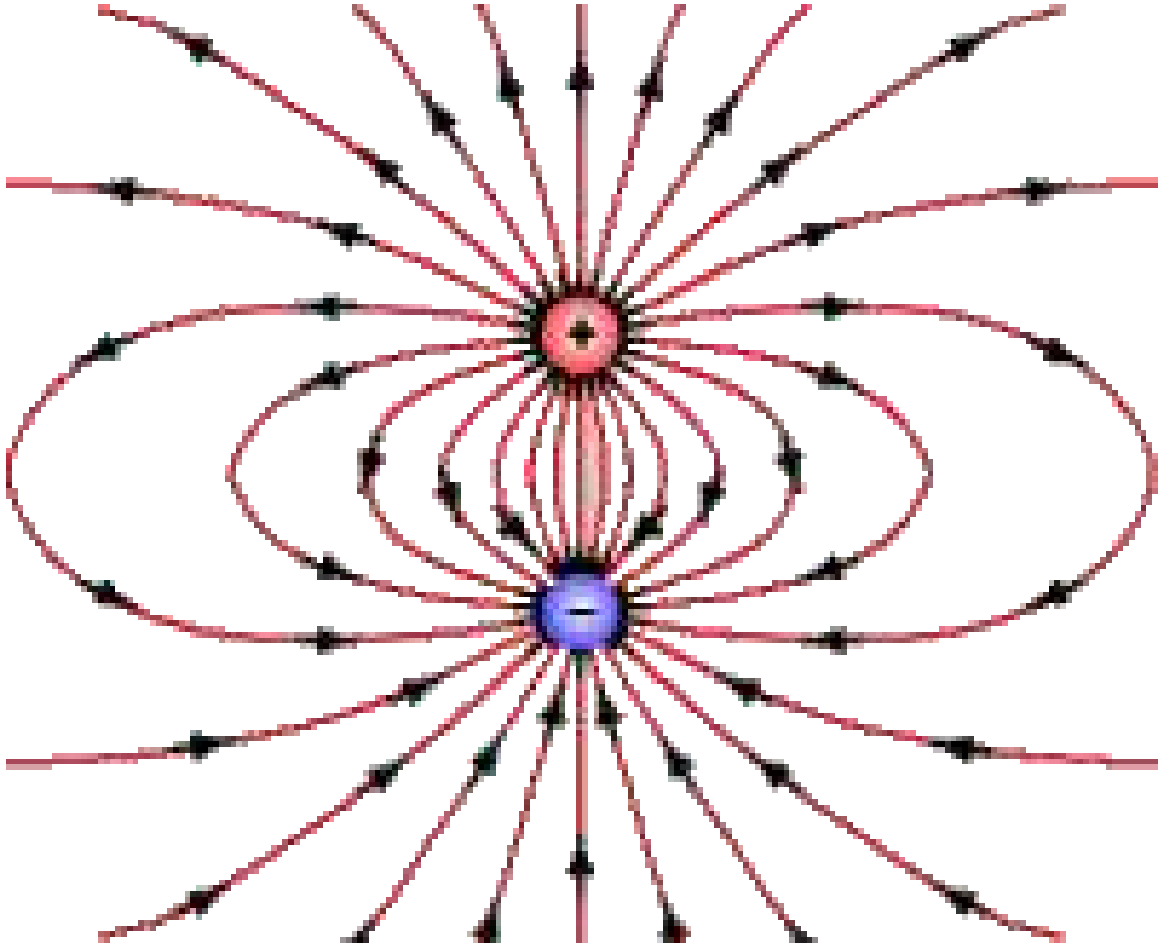


Two balloons rubbed on human hair will become negatively-charged and have an attractive interaction with the hair. If the hair is removed, the balloons repel.

2. **Like charges repel, and opposite charges attract.**



3. Surrounding every charge is an electric field.



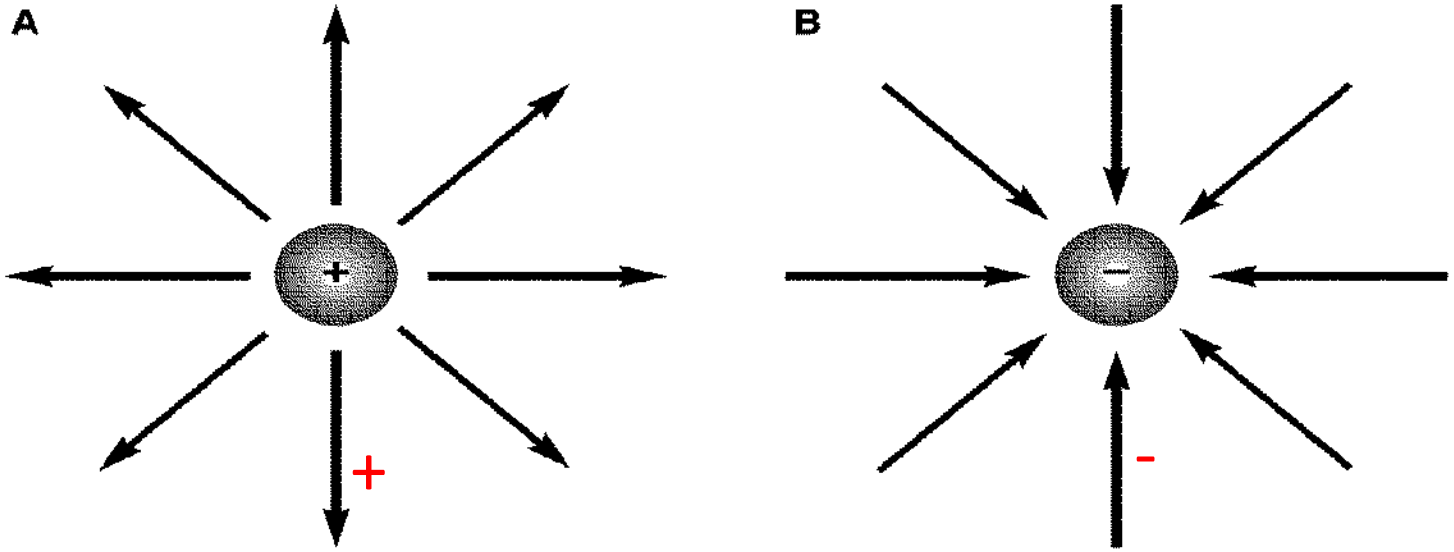
Electric Field

- **Electric field** is a field in a region of space that exerts electric forces on charged particles
- the electric field is produce by electric charges or by changing magnetic fields
- **the strength of an electric field depends on the amount of charge that produces the field and on the distance from the field.**
- The more net charge an object has the greater is the force on it

Electric field

Positive- Out

Negative- In

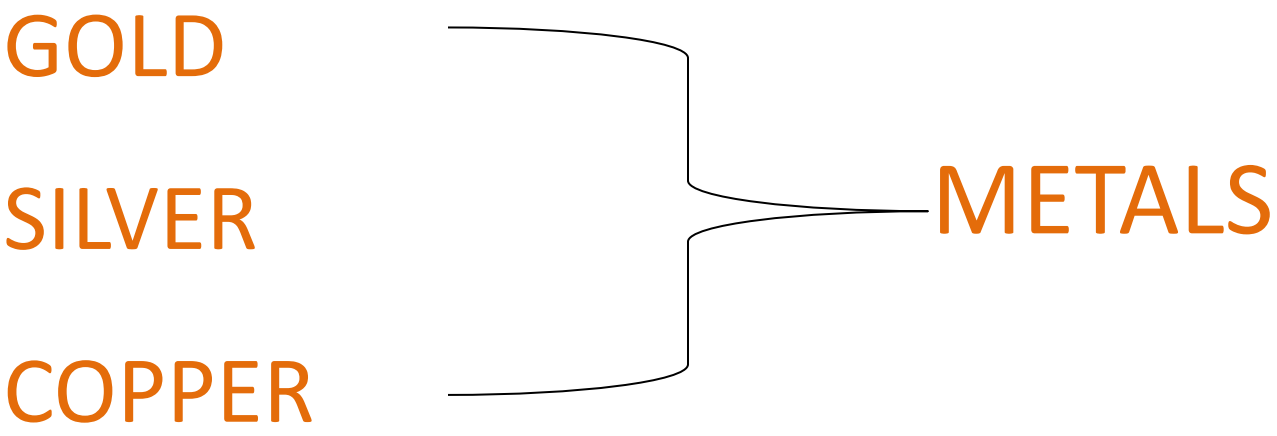


Electric field depends on: distance and charge

The electric field around a positive charge points outward

The electric field around a negative charge points inward

4. Electrons move easily through conductors:



5. Electrons do not move easily through insulators:

PLASTIC

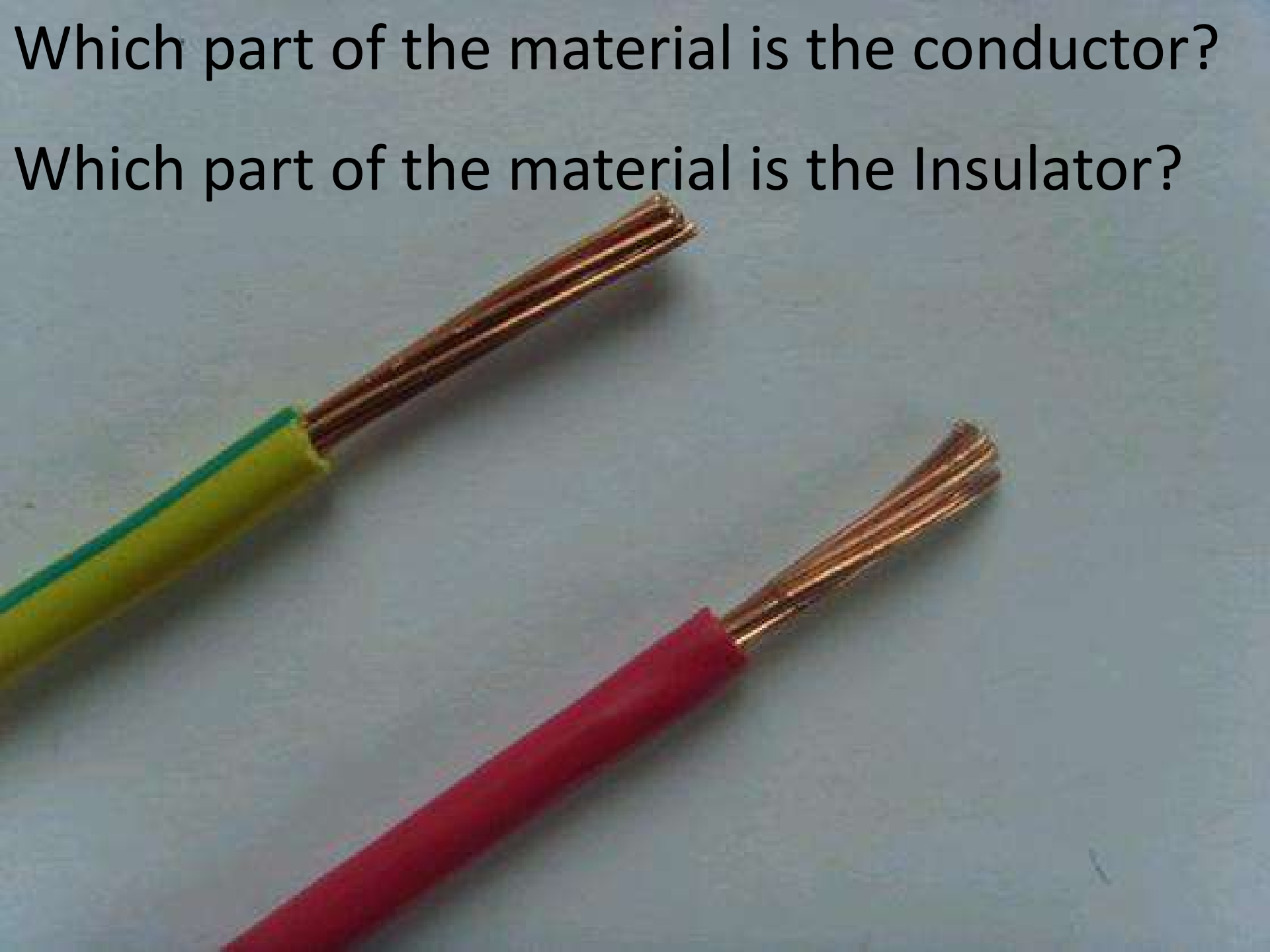
WOOD

RUBBER

GLASS

Which part of the material is the conductor?

Which part of the material is the Insulator?



Types of electricity

1. Static electricity is the study of the behavior of electric charges, including how charge is transferred between objects (in three ways).

Have you ever felt a shock when you touched an object after walking across a carpet? A stream of electrons jumped to you from that object. This is called **static electricity**.

Static Electricity Video

Transferring Electric Charge

1. charge transfer by friction (rubbing)
   - Static electricity transferred by rubbing a balloon on the boy's hair

Transferring Electric Charge

2. Charge transfer by contact (direct contact)

- Van de Graaff generator – machine that produces static electricity

Transferring Electric Charge

3. charge transfer by induction (without contact)
   - Shocking your hand on a doorknob before touching it
   - Being struck by lightning b/c you are standing near a tree.

Types of electricity

2. Electric Current is a continuous flow of electrons.

example: wall outlet

Electric Current and Ohm’s Law

How do we use electricity?

We use electricity to do many jobs for us -- from lighting and heating/cooling our homes, to powering our televisions and computers.

Electricity is a controllable and convenient form of energy used in the applications of heat, light and power.

Why it's important!!!!!

- Without electric current, many devices would not exist, including telephones, personal computers, and lightning!

A. The flow of charges through a wire or conductor is called **electric current**.

1. Current is usually the flow of electrons.
2. Electric current is measured in **amperes (A)**.
3. Charges flow from high voltage to low voltage.

   a. **Voltage difference-** the push that causes charges to move, measured in **volts (V)**.

4. For charges to flow, the wire must always be connected in a closed path, or **circuit**.

2 types of electric current (DC/AC)

Direct Current (DC)

- Flow of electric charge in only one direction.
- Flashlight and other battery operated devices use DC.

Alternating Current (AC)

- Flow of electric charge that regularly reverses its direction.
- Current in your homes, schools, and etc is AC

Electric Current (I)

- AC= alternating current- reverses direction
  ex: current in schools and homes
- DC= direct current- one direction
  ex: current in a battery
  - Current travels easily through conductors.
  - Current travels poorly through insulators.

Resistance

Resistance is the tendency for a material to oppose the flow of electrons, changing electrical energy into thermal energy and light.

- All materials have some electrical resistance.
- Resistance is measured in Ohms, Ω.
- Making wires thinner, longer, or hotter increases the resistance.

Resistance (R)

Resistance is affected by:

1. **Thickness (thin wires have more resistance than thick wires)**
2. **Temperature (increases as temperature increases)**
3. **Length (greater in longer wires than shorter wires)**

20.2 Electric Current and Ohm's Law

- Insulators create resistance (opposition to the flow of charges in a material)

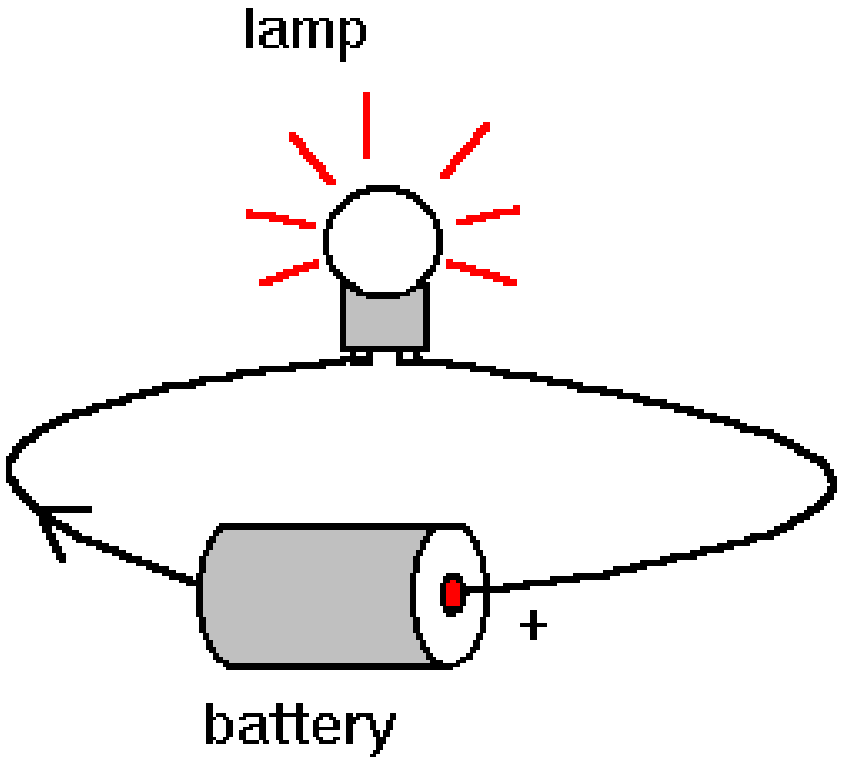
- A material's thickness, length, and temperature affects its resistance

Electric Current and Ohm's Law

- Remember, resistance is opposition to the flow of charges in a material
- Is resistance greater or lesser in a longer wire?
  - Greater- electrons travel farther
- Is resistance greater or lesser in thinner wire?
  - Greater- electrons collide less often
- Is resistance greater or lesser in a hotter wire?
  - Greater- electrons collide more often

Electric Current and Ohm's Law

- In order for charge to flow in a conducting wire, the wire must be connected in a complete loop that includes a source of electrical energy



Voltage (V)

- Potential difference-difference in electrical charges between 2 objects; also called voltage
- Batteries supply voltage
- Voltage sources include other devices like solar cells, and generators.

Ohm's Law

The current in a circuit equals the voltage difference divided by the resistance:

Current = (I) is measured in amperes.
Voltage difference = (V) is measured in volts.
Resistance = (R) is measured in ohms.

$$\text{Current} = \frac{\text{voltage difference}}{\text{resistance}} \quad \text{or} \quad I = \frac{V}{R}$$

Practice Example

- What is the resistance if the voltage is 3 volts and the current is 9 amps?

Practice Example

- What is the voltage is the resistance is 12 ohms and the current is 4 amps?

Practice Example

- What is the current if the voltage is 14 volts and the resistance is 7 ohms?

Electrical Charge

Why It's Important!

The convenience and safety of household electricity depend on how the electric circuits in your home are designed.

Electrical Energy

Circuits rely on generators at power plants to produce a voltage difference across the outlet, causing the charge to move when the circuit is complete.

<u>Two Types of Circuits:</u>

1. Series Circuits
2. Parallel Circuits

Series / Parallel Circuits

Series circuit- the current has only one loop

a) wired one after another, so the amount of current is the same throughout every part.

b) Open circuit- if any part of a series is disconnected, no current flows through the circuit.

c) Example: strings of holiday lights.

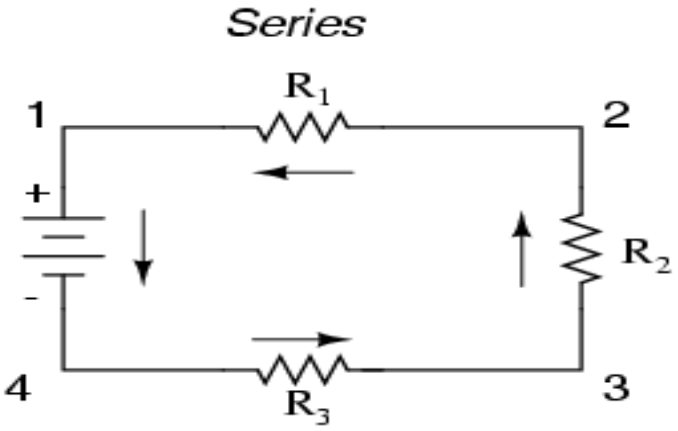
2. Parallel circuit- contains two or more branches for current to move through.

a. Individual parts can be turned off without affecting the entire circuit.

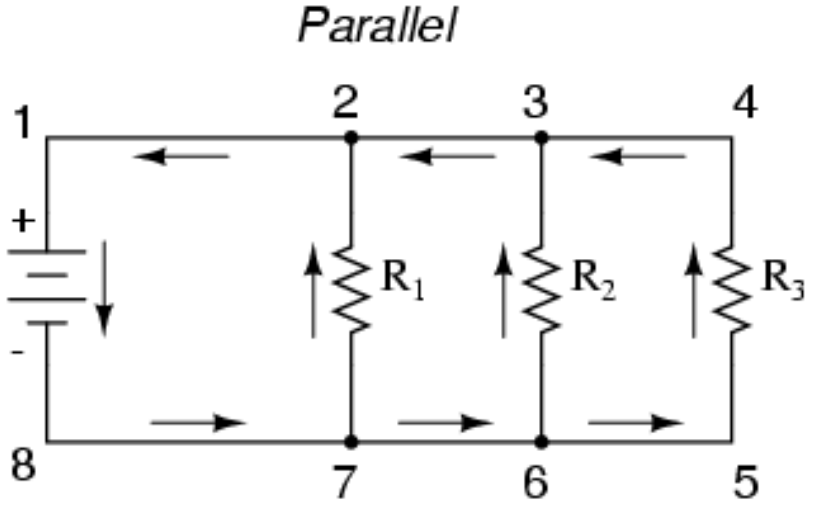
b. Example: the electrical system in a house.

Series and Parallel Circuits

- Series Circuit



- Parallel Circuit



Electrical Energy

Household circuits use parallel circuits connected in a logical network.

1. Each branch receives the standard voltage difference from the electric company.
2. Electrical energy enters your home at the circuit breaker or fuse box and branches out to wall sockets, major appliances, and lights.

Guards against overheating electric wires.

1. **Electric fuse** contains a small piece of metal that melts if the current becomes too high, opening the circuit and stopping the flow of current.
2. **Circuit breaker** contains a small piece of metal that bends when it gets hot, opening the circuit and stopping the flow of current.