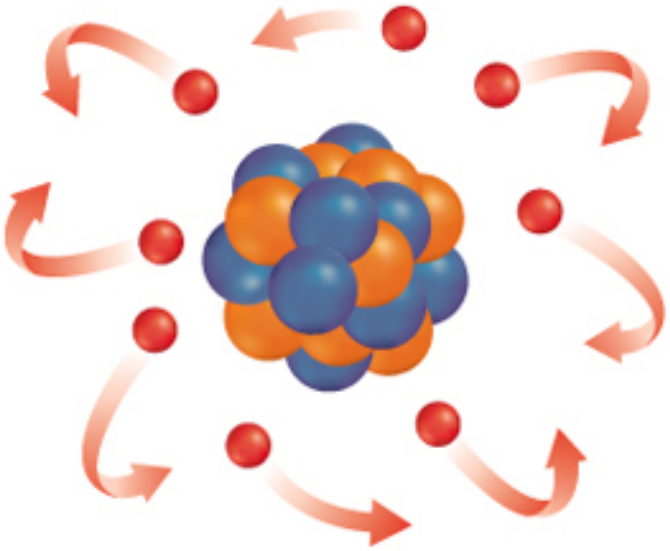
Electric Charge

Positive and Negative Charge

- Atoms contain particles called protons, neutrons, and electrons.
- Protons and electrons have electric charge, and neutrons have no electric charge.



Electric Charge

Positive and Negative Charge

- Protons have positive electric charge and electrons have negative electric charge.
- The amount of positive charge on a proton equals the amount of negative charge on an electron.

Electric Charge

Positive and Negative Charge

- Objects with no net charge are said to be electrically neutral.
- An atom contains equal numbers of protons and electrons, so the positive and negative charges cancel out and an atom has no net electric charge.

Electric Charge

Transferring Charge

- Compared to the electrons in carpet atoms, electrons are bound more tightly to the atoms in the soles of your shoes.
- When you walk on the carpet, electrons are transferred from the carpet to the soles of your shoes.

Electric Charge

Transferring Charge

- The soles of your shoes have an excess of electrons and become negatively charged.
- The carpet has lost electrons and has an excess of positive charge.
- The accumulation of excess electric charge on an object is called **static electricity**.

Electric Charge

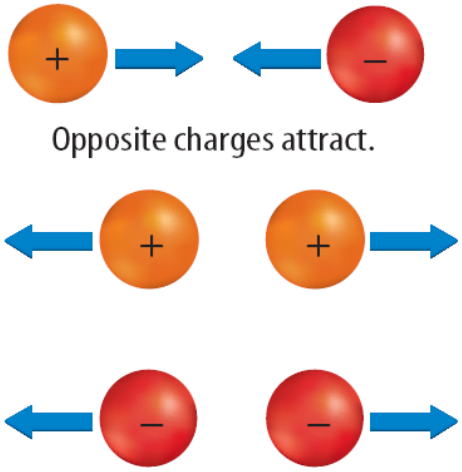
Conservation of Charge

- According to the **law of conservation of charge**, charge can be transferred from object to object, but it cannot be created or destroyed.
- Whenever an object becomes charged, electric charges have moved from one place to another.

Electric Charge

Charges Exert Forces

- Unlike charges attract each other, and like charges repel each other.
- The force between electric charges also depends on the distance between charges. The force decreases as the charges get farther apart.



Electric Charge

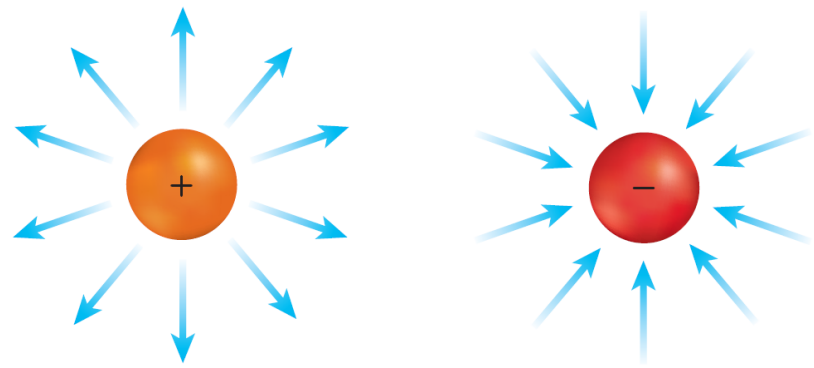
Charges Exert Forces

- The force between any two objects that are electrically charged decreases as the objects get farther apart.
- This force also depends on the amount of charge on each object.
- As the amount of charge on either object increases, the electrical force also increases.

Electric Charge

Electric Fields

- An **electric field** surrounds every electric charge and exerts the force that causes other electric charges to be attracted or repelled.
- Any charge that is placed in an electric field will be pushed or pulled by the field.



Electric Field Near Positive Charge

Electric Field Near Negative Charge

Electric Charge

Comparing Electric and Gravitational Forces

- The force of gravity between you and Earth seems to be strong. Yet, compared with electric forces, the force of gravity is much weaker.
- The chemical bonds that form between atoms in molecules also are due to the electric forces between the atoms.
- These electric forces are much larger than the gravitational forces between the atoms.

Electric Charge

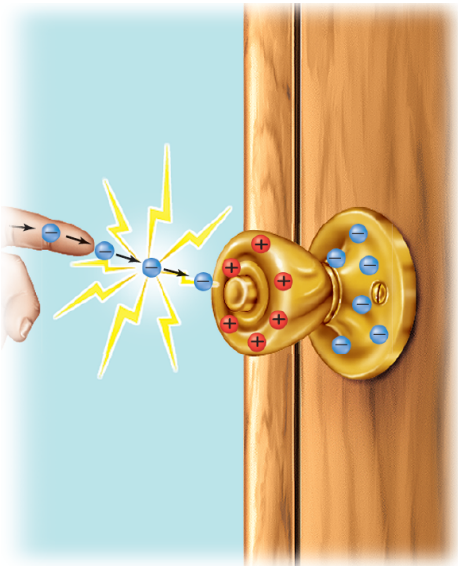
Comparing Electric and Gravitational Forces

- The electric forces between the objects around you are much less than the gravitational forces between them.
- Most objects that you see are nearly electrically neutral and have almost no net electric charge.
- As a result, there is usually no noticeable electric force between these objects.

Electric Charge

Conductors and Insulators

- If you reach for a metal doorknob after walking across a carpet, you might see a spark.
- The spark is caused by electrons moving from your hand to the doorknob.



Electric Charge

Conductors

- A material in which electrons are able to move easily is a **conductor**.
- The best electrical conductors are metals.
- The atoms in metals have electrons that are able to move easily through the material.

Electric Charge

Insulators

- A material in which electrons are not able to move easily is an **insulator**.
- Electrons are held tightly to atoms in insulators.
- Most plastics are insulators.
- The plastic coating around electric wires prevents a dangerous electric shock when you touch the wire.

Electric Charge

Charging Objects

- Rubbing two materials together can result in a transfer of electrons.
- Then one material is left with a positive charge and the other with an equal amount of negative charge.
- The process of transferring charge by touching or rubbing is called **charging by contact**.

Electric Charge

Charging at a Distance

- Because electrical forces act at a distance, charged objects brought near a neutral object will cause electrons to rearrange their positions on the neutral object.

Electric Charge

Charging at a Distance

- The balloon on the left is neutral. The balloon on the right is negatively charged. It produces a positively charged area on the sleeve by repelling electrons.
- The rearrangement of electrons on a neutral object caused by a nearby charged object is called **charging by induction**.

Electric Charge

Lightning

- Lightning is a large static discharge.
- A static discharge is a transfer of charge between two objects because of a buildup of static electricity.
- A thundercloud is a mighty generator of static electricity. As air masses move and swirl in the cloud, areas of positive and negative charge build up.

Electric Charge

Lightning

- Eventually, enough charge builds up to cause a static discharge between the cloud and the ground.
- As the electric charges move through the air, they collide with atoms and molecules. These collisions cause the atoms and molecules in air to emit light.

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Electric Charge

Thunder

- Lightning also generates powerful sound waves.
- The electrical energy in a lightning bolt rips electrons off atoms in the atmosphere and produces great amounts of heat.
- The heat causes air in the bolt's path to expand rapidly, producing sound waves that you hear as thunder.

Electric Charge

Grounding

- A discharge can occur any time that charge builds up in one area.
- Providing a path for charge to reach Earth prevents any charge from building up.
- Earth is a large, neutral object that is also a conductor of charge.

Electric Charge

Grounding

- Any object connected to Earth by a good conductor will transfer any excess electric charge to Earth.
- Connecting an object to Earth with a conductor is called grounding.

Electric Charge

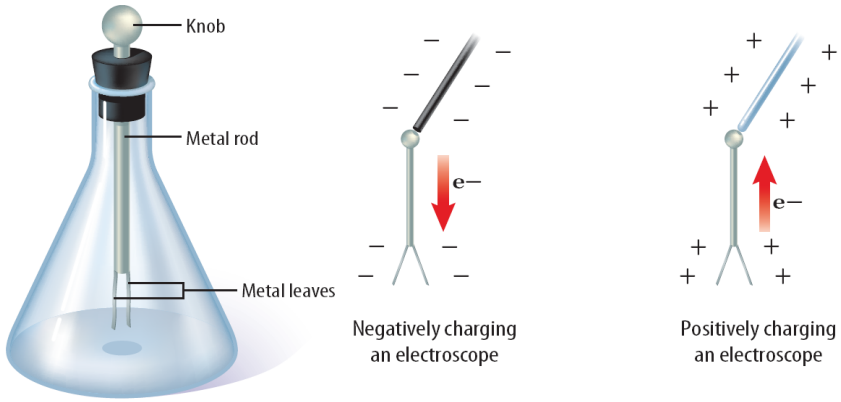
Detecting Electric Charge

- The presence of electric charges can be detected by an **electroscope**.
- One kind of electroscope is made of two thin, metal leaves attached to a metal rod with a knob at the top.
- The leaves are allowed to hang freely from the metal rod.

Electric Charge

Detecting Electric Charge

- When the device is not charged, the leaves hang straight down.



- Notice the position of the leaves on the electroscope when they are A uncharged, B negatively charged, and C positively charged.