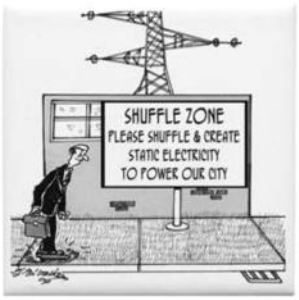
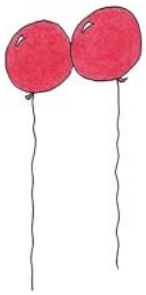
KEY How do electric charges behave?

April 30, 2019 9:06 PM

science 9

UNIT 3: PHYSICS





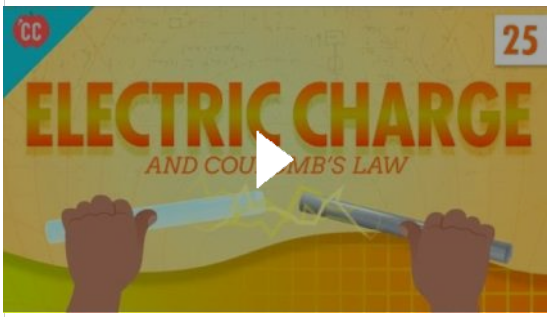
"You're calling it love, but it's really just static electricity."

BOOK 2: HOW DO ELECTRIC CHARGES BEHAVE?

name: Key block: _____

1

[Electric Charge: Crash Course Physics #25](#)
CrashCourse



PART A ELECTRONS CARRY A NEGATIVE CHARGE, AND PROTONS CARRY A POSITIVE CHARGE.

Rub two different materials together. Depending on the materials you use, something may come off one and transfer to the other, and the two materials will attract to each other. About 250 years ago, American scientist Benjamin Franklin used the term negative charges to describe the "somethings" rubbed off a material. He said that an excess of postive charge were left behind.

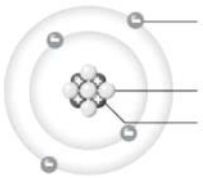
Today we know the negative charges are the charges of electrons, and the positive charges are the charges of protons.

Protons are part of the nucleus of atoms and are held firmly in place, so they cannot be rubbed off materials.

Electrons can be rubbed off, because they surround the nucleus and some are not tightly bound to it. (easily removed) (valence shells)

Recall that all matter is made of tiny particles called atoms.

At the centre of the atom is the nucleus, which contains particles called neutrons and protons.



Neutrons do not have a charge. Protons have a positive charge, so the nucleus is positive charged.

Around the positive nucleus are much lighter particles called electrons that have a negative charge.

If the number of positive charges equals the number of negative charges, the atom is neutral or uncharged.

When electrons are rubbed off a material, it becomes positively charged. The material that gains electrons becomes negatively charged.

Charging a material by rubbing is called charging by friction. Whether a material gains or loses electrons depends on the combination of materials.

For example: Clouds may be charged by friction in a thunderstorm.

Clouds in storms can become ***charged by friction***. Warm, moist air causes strong updrafts in the clouds. At the same time, hail and ice crystals fall from the top, causing downdrafts. As droplets and crystals collide, electrons are stripped from upward-moving particles and are carried downward. As a result, clouds are **negatively charged** at the bottom and **positively charged** at the top.

In order to study static charge in lightning and in other phenomena, scientists needed a device that could produce large amounts of static charge in the **laboratory.**

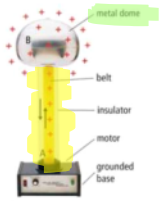


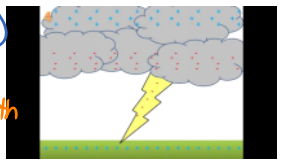
Figure 7.5 Charge is transferred onto a moving belt at the base of the generator, position A, and is transferred off the belt onto the metal dome, position B.

The first successful "lightning" machine was invented in 1929 by American physicist Robert Van de Graaff. The Van de Graaf generator uses Friction to produce a large static charge on a metal dome. A moving belt produces a static charge at the base of the generator. The belt carries this charge to the top where it collects on the dome.

PRACTICE

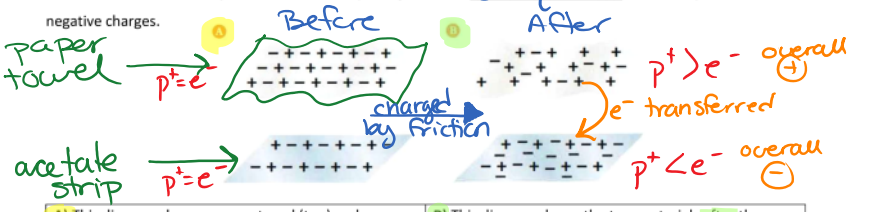
How do you think lightening forms?

static electricity build up in the clouds (difference in charges)
⊖ charge is disrupted ... e^- search for other ⊕ charge + get neutralized by contact with Earth



ELECTRICALLY NEUTRAL AND ELECTRICALLY CHARGED MATERIALS

- Uncharged **Materials:** Before two materials are rubbed together, they have equal numbers of positively charged protons (⊕) and negatively charged electrons (⊖). Because the equal numbers of positive and negative charges cancel each other out, the materials are electrically neutral.
- Charged **Materials:** If electron are rubbed off one material, the protons stay behind and the material becomes electrically charged. So does the material that gains the electrons. A material or object that is electrically charged has an unequal number of positive and negative charges.



A) This diagram shows a paper towel (top) and an acetate strip (bottom) before they are rubbed together.	B) This diagram shows the two materials after they are rubbed together.
Both strips have equal ⊕ and ⊖ charge, so they are electrically neutral.	e^- are rubbed off the paper towel, and collect on the acetate strip. The paper towel is now ⊕ charged and the acetate is now ⊖ charged.

Homework **Assignment #1: Worksheet Q #1-7**

Complete this assignment in the space provided below.

1. The atom consists of three smaller particles.

   (a) Give the name and charge of each of these particles. protons, electrons, neutrons

   (b) State where in the atom each of the three particles is found.

   p^+ and n^0 = nucleus

   e^- = shells (orbit the nucleus)

2. Explain the relationship among negative charges, positive charges, electrons, and protons.

   protons are positively charged
   electrons are negatively charged

3. When is an atom uncharged or neutral?

   when the atom has equal $p^+ = e^-$

4. How are solid materials charged?

   materials are charged by friction, when e^- are transferred from one to the other

5. What is the overall charge when an atom has more protons than electrons?

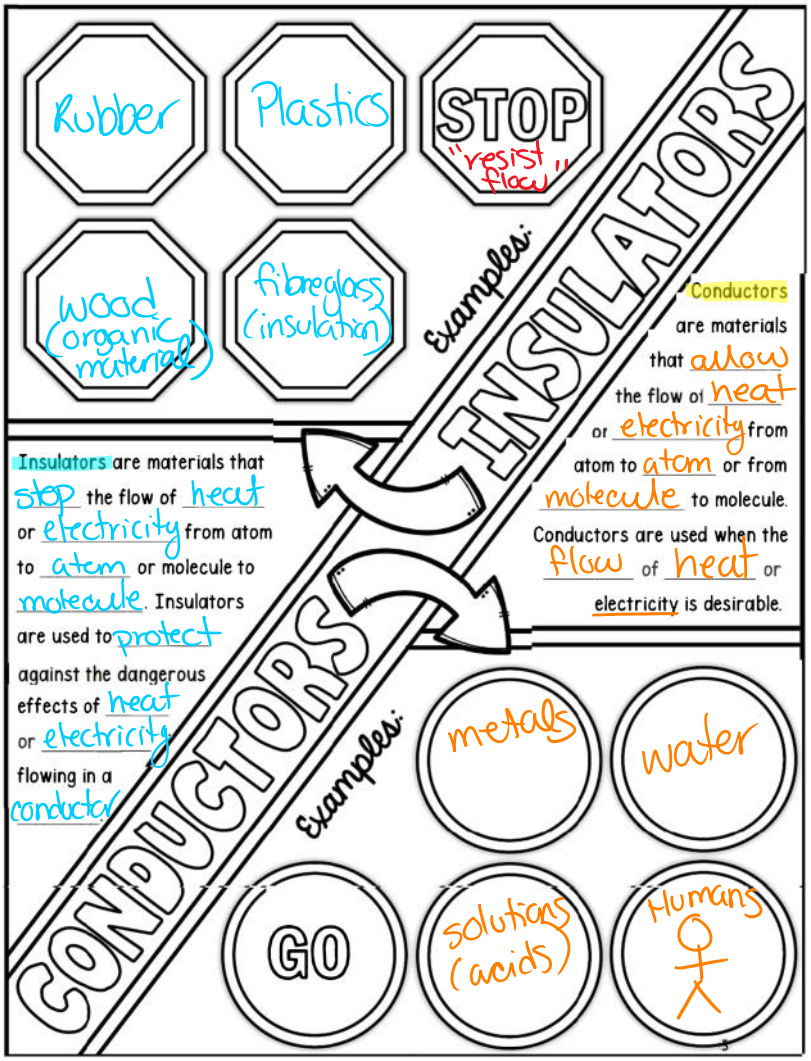
   ⊕ charge

6. What happens to the charge on an atom when it gains electrons?

   becomes ⊖ charged.

7. What can happen to electrons during friction? Describe what sometimes happens in terms of charges when you rub two different types of materials together.

   when two different materials are rubbed together, e^- will be "rubbed off" of one material, and transfered to the other. Leaving one material ⊕ (e^- have left) and the other ⊖ (e^- are gained)


INSULATORS
Rubber
Plastics
STOP
"resist flow"
Examples:
wood (organic material)
fiberglass (insulation)
Insulators are materials that stop the flow of heat or electricity from atom to atom or molecule to molecule. Insulators are used to protect against the dangerous effects of heat or electricity flowing in a conductor
Conductors are materials that allow the flow of heat or electricity from atom to atom or from molecule to molecule. Conductors are used when the flow of heat or electricity is desirable.
CONDUCTORS
Examples:
metals
water
GO
solutions (acids)
Humans

INSULATORS & CONDUCTORS

insulator (prevent e⁻ from flowing down the rod)

If you held a neutral plastic rod in the middle and rubbed just one end of the rod with a paper towel, the end you rubbed would become charged. The other end of the plastic rod would remain neutral.

"charging by friction"

The electrons you added to the neutral plastic by ***friction*** will stay in one place.

- Materials that **DO NOT allow** charges to move easily are called **electrical** insulators
  - Electrons removed from one location on an insulator are ***not replaced*** by electrons from another location.
  - *EXAMPLES:* glass, plastic, ceramics, wood, rubber.

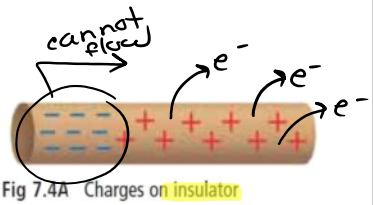


Fig 7.4A Charges on insulator

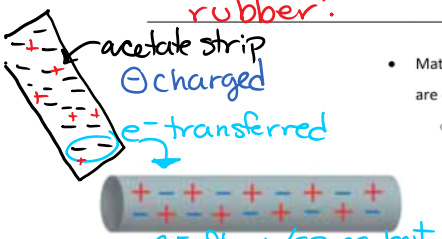


Fig 7.4B Charges on conductor

- Materials that allow **electrons to travel freely** are called electrical conductors
  - If a charged ⊖ acetate strip is touched to one end of a metal rod, the excess electrons on the acetate will ***spread evenly*** over the entire length of the rod.
  - Metals are **GOOD** conductors because the atoms in metals have *at least one* electron that is easily transferred
  - These electrons are sometimes called "sea of electrons" because they are free to move throughout the conductor. (free e⁻)

*that's why metals form ions!

Since static electricity is charge that is held nearly fixed (still) in one place, **only** insulators can retain a static charge.

conductors such as copper and aluminum **allow** charge to flow.

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Electrical Power, Conductors, and Your Dream Home: Crash Course Engineering #21
CrashCourse

READING ABOUT: STATIC CHARGE PG 7-8

Complete the following reading about static electricity and charge on materials.
Be sure to "Mark the Text" and highlight KEY DEFINITIONS as you read along.

ALSO, answer the "Reading Check" questions in the side margin as you go!

Before You Read

Why do you get a shock when you walk across a carpet in wool socks and then touch a metal door handle? Record your thoughts on the lines below.

(answers will vary)

Mark the Text

Identify Concepts

Highlight each question head in this section. Then use a different colour to highlight the answers to the questions.

What is static charge?

When materials are rubbed together, you might see them cling to each other or move away from each other. Materials that behave in this way are said to carry an electric charge. When a charge stays in place for some length of time, it is described as static electricity or **static charge**.

Why does rubbing make materials charged?

Recall that all matter is made up of atoms. Most of the mass of an atom is in its nucleus—its central core region. The nucleus is made up of two types of particles. Protons are particles that have a positive (+) charge. Neutrons are particles that do not have a charge so they are neutral. The space around the nucleus contains fast-moving particles called electrons. Electrons have a negative (–) charge.

The overall charge of a material depends on the balance between the positive and negative charges in all the atoms of the material. A material may be neutral, have a positive charge, or have a negative charge.

When two materials are rubbed, electrons from the atoms of one material may move to the atoms of the other material. The movement of electrons from one atom to another changes the charge on the atoms. When an atom loses electrons, it is left with more protons than electrons, so its charge is positive. When an atom gains electrons, it has more electrons than protons, so its charge is negative.

Reading Check

1. Name the two types of charged particles in an atom.

proton
electron

7

Charges in a material that is neutral (uncharged)	Charges in a material that is positively charged	Charges in a material that is negatively charged
+ + − + − − − − + − + +	+ + + + + − − − + + + +	− − − + − + − − − + − +
equal protons and electrons	more protons than electrons	more electrons than protons

How else can charges be produced?

You already know that charges can be produced by rubbing (friction). This can happen in nature when air rubs against ice crystals and dust particles in clouds, producing lightning. Scientists also use a friction-producing machine called a **Van de Graaff generator** to create charges that they can study.

How easily do charges move in different materials?

Electrons cannot move easily in materials such as **acetate** (a type of plastic), rubber, wool, and glass. Materials that do not let electrons move through them easily are called **insulators**. Charges tend to build up on insulators.

Electrons can move easily through materials such as metals. Materials that let electrons move through them easily are called **conductors**. Sometimes, a conductor is used to transfer static charges from an object to the ground. Allowing charge to flow into Earth's surface is called **grounding**.

Reading Check

2. What does a conductor allow to move easily through it?

electrons

How are charges measured?

Electric charges are measured in units called **coulombs** (C). A bright light bulb, for example, allows about 1 C (one coulomb) of electric charge to pass through it each second.

Charges on insulator

Charges on conductor

HW May 2nd + reading

Homework **Assignment #2: Complete Worksheets Pages #9-11**
Complete this assignment in the space provided below.

Charge it

Vocabulary	
acetate	negative
atoms	neutral
conductors	neutrons
coulomb	nucleus
electric	positive
electrons	protons
grounding	static charge
insulators	Van de Graaff generator

Use the terms in the vocabulary box to fill in the blanks. You may use terms more than once. You will not need to use every term.

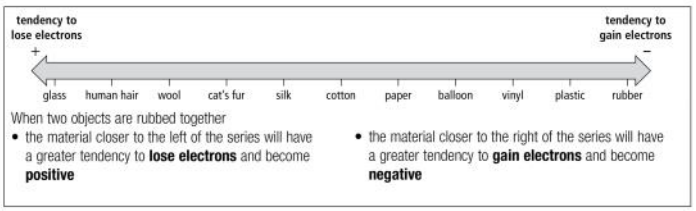
1. Static electricity is also known as static charge. This refers to the build-up of electric charge in one place.
2. All matter is made of tiny particles called atoms.
3. The positively charged nucleus is the centre of the atom. It consists of positively charged subatomic particles called protons and subatomic particles with no charge called neutrons.
4. The negatively charged subatomic particles called electrons occupy the area around the nucleus.
5. An object is uncharged or neutral when the number of positive charges equals the number of negative charges.
6. If an atom loses an electron, it has more protons than electrons. This atom will have an overall positive charge.
7. If an atom gains an electron, it has more electrons than protons. This atom will have

positive charges equals the number of negative charges.

6. If an atom loses an electron, it has more protons than electrons. This atom will have an overall _____positive_____ charge.
7. If an atom gains an electron, it has more electrons than protons. This atom will have an overall _____negative_____ charge.
8. Glass and acetate are examples of _____insulators_____ because they do not allow electrons to move easily through them. Metals like copper and aluminum are good _____conductors_____ because they allow electrons to move freely through them.
9. The _____coulomb_____ is a unit of electric charge.
10. Scientists use a(n) _____Van de Graaf generator_____ to create static charge.
11. Lightning rods on top of buildings allow static charges from lightning to flow into Earth's surface. This is known as _____grounding_____.

Static charge detective

Use the following diagram to answer the questions.



When two objects are rubbed together

- the material closer to the left of the series will have a greater tendency to **lose electrons** and become **positive**
- the material closer to the right of the series will have a greater tendency to **gain electrons** and become **negative**

1. As you take your clothes out of the dryer, your wool socks are clinging to your silk skirt. What is the charge on the wool socks and on the silk skirt?

Charge on socks _____positive (+)_____

Charge on skirt _____negative (−)_____

2. You use a plastic comb to comb your hair. What is the charge on your hair and on the comb?

Charge on comb _____(−)_____

Charge on hair _____(+)_____

3. You use a paper towel to rub off some dirt on a glass window. What is the charge on the glass and on the paper towel?

Charge on window _____(+)_____

Charge on paper towel _____(−)_____

4. You rub a balloon along your cat's back, causing the cat's fur to stand up. What is the charge on the balloon and on the cat's fur?

Charge on balloon _____(−)_____

Charge on cat's fur _____(+)_____

Conductors and insulators

Define and identify conductors and insulators as directed below.

1. Define the following terms.

(a) conductor a material that allows e⁻ to move freely

(b) insulator a material that does NOT allow e⁻ to move freely

2. On the first line, indicate whether the object is a conductor or an insulator. On the second line, state whether or not the material allows electrons to move freely. (e⁻ = electron)

(a) 

insulator

✗ e⁻ flow

(b) 

insulator

✗ e⁻ flow

(c) 

conductor

✓ e⁻ flow

(d) 

conductor

✓ e⁻ flow

(e) 

conductor

✓ e⁻ flow

(f) 

insulator

✗ e⁻ flow

11

PART B: OPPOSITE CHARGES ATTRACT EACH OTHER, AND LIKE CHARGES REPEL EACH OTHER.

Long before scientists knew what positive charges and negative charges were, they knew how charges interacted with each other.

Two important properties of charges are summarized in the **law of electric charge:**

The Law of Electric Charge

1. opposite charges attract each other
2. Like charges repel

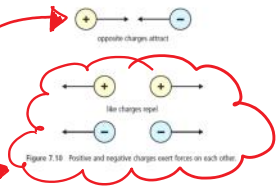


Figure 7.10 Positive and negative charges exert forces on each other.

The **law of electric charge** applies to all individual charges.

This means that a negative charge does not ***JUST attract*** another positive charge....BUT ALSO....

- ✓ *every negative charge attracts* every positive charge
- ✓ *every negative charge* repels *every other negative charge*
- ✓ *every positive charge repels* every other positive charge

When you bring together objects that have an excess of either positive charges or negative charges, you see the overall result of all these different attraction and repulsions.

ATTRACTION BETWEEN CHARGED OBJECTS AND NEUTRAL OBJECTS

The law of electric charge explains why **charged objects** attract **neutral objects** (Figure 3.11).

All neutral objects have an equal number of **protons and electrons.**

Therefore, they have an equal number of **positive and negative** charges.

When you bring a charged object near a neutral object, the electrons in the neutral object DO NOT come off.

Instead, the positive and negative charges in the molecules of the object stretch apart from each other.


Figure 3.11 In this photo, the comb is charged, and the water is neutral.

ex. run a plastic comb through your hair ....

LAB ACTIVITY

LAB SIMULATION: https://phet.colorado.edu/en/simulation/balloons-and-static-electricity

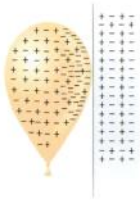


Figure 3.12 This diagram shows why a charged balloon sticks to an electrically neutral wall. The negative charges in the wall are pushed away from the surface by the negative charges on the balloon. Then the positive ends of the molecules in the wall are attracted to the negative charges on the balloon. These forces of attraction are strong enough to hold the balloon to the wall.

Figure 3.12 shows what happens to a neutral wall when a charged balloon comes close to it.

The negative charges in the wall are pushed away from the surface by the negative charges on the balloon.

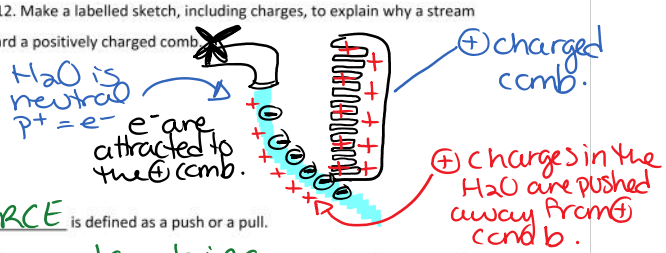
Then the positive ends of the molecules in the wall are attracted to the negative charges on the balloon.

These forces of attraction are strong enough to hold the balloon to the wall.

PRACTICE

1. State the law of electric charge.

2. Refer to Figures 3.11 and 3.12. Make a labelled sketch, including charges, to explain why a stream of neutral water bends toward a positively charged comb.



PART C: ELECTRIC FORCE

FORCE is defined as a push or a pull.

When something is touching that is being moved, it is an example of contact **forces**, which are forces that can have an effect only on objects that they touch

The **amount** of electric force depends on the **amount of charge** on each object and the distance separating the objects. **Increasing** the amount of charge **increases the electric force**.

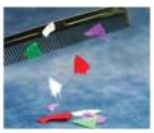


Figure 7.9 Even though the comb is not touching the paper on the table, the paper is attracted to the charged comb.

Suppose you bring a charged comb near small pieces of paper. ***Without*** making contact, the paper will be attracted to the comb.

An electric force is a push or pull between charged objects. The electric force is an example of action-at-a-distance forces, which can apply force to an object without touching it.

CHARGING BY CONDUCTION

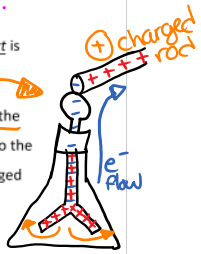
When a negative object is touched to a neutral electroscope, electrons are added to the electroscope. These extra electrons spread evenly over the entire metal surface of the electroscope leaves .

Figure 7.11 A negatively charged rod adds extra electrons to the electroscope.

Since BOTH metal leaves now have a negative charge, they they lift as they repel each other .

Charging a NEUTRAL **object** TOUCHING *it to a charged object* is called **charging by** CONDUCTION.

Touching the neutral electroscope with a positively charged object would have the same result. Electrons from the metal in the electroscope would be **attracted** to the positive object. Therefore, the metal leaves would both become positively charged after e⁻ leave the electroscope and are transferred to the positive object.



CHARGING BY INDUCTION

The leaves of a neutral electroscope can be made to separate even if the knob is not touched with a charged object.

If you bring a negatively charged object NEAR ***but not touching***, the knob of the electroscope, the negative charge will repel the electrons in the knob. The **electroscope is a conductor**, so the e⁻ will move down **to the leaves** (but not removed)

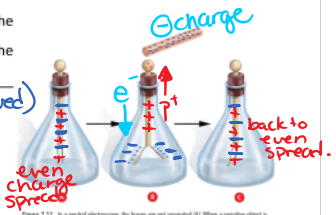


Figure 7.12 In a neutral electroscope, the leaves are not separated (A). When a negative object is brought close to the positive knob, electrons in the knob are pushed down to the leaves, causing the leaves to separate (B). When the negative object is removed, the leaves return to their original position because no charge was transferred between the object and the electroscope (C). The charges simply moved or separated.

The leaves of the electroscope will have a ***temporary negative charge*** and will repel each other. The knob will be positively charged.

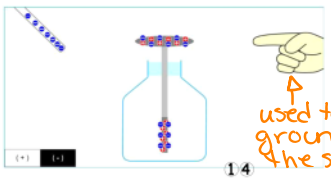
This is called Charging by Induction. When an object is charged by induction, no electrons are actually transferred from one object to the other. Instead, inducing a charge only repositions electrons inside the object.

If you move the charged object away, the leaves will *go back to their original position.*

ELECTROSCOPE LAB SIMULATION: https://javalab.org/en/electroscope_en/

Table #1: Electroscope Induction

+ Charged Rod	- Charged Rod



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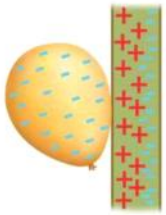

Figure 7.13 A charged balloon sticks to the wall because a positive charge is induced on the surface of the wall.

REVISIT: THE ATTRACTION OF NEUTRAL OBJECTS

Induction explains why neutral objects and charged objects **attract** each other.

For example, when you rub a balloon in your hair, the balloon becomes negatively charged. Since the balloon is an insulator, the negative charge remains in a *nearly* fixed location on the balloon.

If you place the charged balloon against the wall, the negative charges in the wall are repelled away from the balloon.

The part of the wall closest to the balloon now has a positive charge because the electrons in that region are **repelled due to induction**. The negative charge on the balloon will be attracted to the positive wall, and therefore the balloon will "stick" to the wall.

PRACTICE

1. What is the definition of an electric force?

an electric force is a push or pull between charged objects.

2. Explain what is meant by action-at-a-distance force.

an electric force that applies without touching.

3. According to the laws of static charge, explain how:

(a) like charges react

Like charges repel ⊖ ⊖ and ⊕ ⊕

(b) opposite charges react

opposite charges attract ⊕ → ← ⊖

(c) neutral objects react to charged objects

electrons in the neutral object will shift either towards or away from the charged object (depends if ⊕ or ⊖)

4. What is electric force proportional to?

The electric force is proportional to the size of charge.

5. In terms of charge transfer, what is the difference between charging by conduction and charging by induction?

charging by conduction involves charging a neutral object by touching a charged object to it. charging by induction is causing ⊕ & ⊖ charge in a neutral object by NOT touching.

6. When a charged balloon sticks to the wall, does the wall become charged by induction or conduction?

the wall has become charged by induction => no e^- have been transferred from the wall, only temporarily shifted.

READING ABOUT: ELECTRIC FORCE PG 16-17

Complete the following reading about electric forces and their properties.
Be sure to "Mark the Text" and highlight KEY DEFINITIONS as you read along.

ALSO, answer the "Reading Check" questions in the side margin as you go!

Before You Read

If you rub a balloon on a sweater it will stick to the wall. Why? Write your ideas on the lines below.

_____

_____

Make Flash Cards

For each paragraph, think of a question that might be on a test. Then write the question on one side of a flash card. Write the answer on the other side. Quiz yourself until you can answer all the questions.

What laws describe electric charges?

Electric force is a pull (attraction) or a push (repulsion) between objects that are charged. The **laws of static charge** describe what happens when charged and uncharged objects come close to each other.

The Laws of Static Charge

1. Objects with the same charge repel each other.
2. Objects with opposite charges attract each other.
3. Charged objects attract neutral objects.

Reading Check

1. What will happen if a pen with a positive charge comes near paper with a negative charge?

_____

_____

_____

_____

The electric force that acts on any pair of objects depends on:

- the type of charge on the objects (positive, negative, or neutral)
- the amount of charge on the objects
- the distance between the objects

If you increase the amount of charge on objects, you increase the electric force. If you increase the distance between objects, you decrease the electric force.

What is an electroscope?

An electroscope is a device that can be used to detect the presence of charge. A typical electroscope has one or two lightweight strips of metal that bend easily. These metal strips, called leaves, are attached to a central metal rod that has a metal sphere at the top. Sometimes, the leaves and metal rod are enclosed in glass or plastic so that air movement does not affect the device. When the leaves repel each other, you know they are charged.

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Section 7.2 Electric Force

Reading Checks

Pages 104–105

1. they will be attracted

2. neutral objects are temporarily charged by induction

What is charging by conduction?

When you charge a neutral object by touching it to a charged object, it is called **charging by conduction**. For example, if you touch a neutral electroscope with a negatively charged rod, electrons are added to the electroscope and spread over the surface of the metal leaves. The leaves then become negatively charged and repel each other.

What is charging by induction?

You do not have to touch the sphere of an electroscope to make the leaves separate. If you bring a negatively charged rod near—but not touching—the sphere, the rod will repel the electrons in the sphere. The negative charges will move down to the leaves and the leaves will repel each other. This is called **charging by induction**. The sphere will be left with a temporary positive charge. If the negatively charged rod is removed, the electrons will move back to the sphere, and the sphere will be neutral again.

Why are neutral objects attracted to charged objects?

Neutral objects are attracted to charged objects because the neutral objects are temporarily charged by induction. For example, a negatively charged balloon sticks to a neutral wall because the balloon's negative charges repel the wall's negative charges. In other words, a positive charge is induced on the surface of the wall. The negative balloon is attracted to the positive wall surface.

Reading Check

2. Why are neutral objects attracted to charged objects?

Charging an electroscope by conduction

Charging an electroscope by induction

Homework

Assignment #3: Complete Worksheets Pages #18-20
Complete this assignment in the space provided below.

Neutral, positive, or negative charges?

Answer the questions below in the spaces provided.

1. What are the three laws of static charge?
   - (a) _____
   - (b) _____
   - (c) _____

2. For each situation illustrated below, will the objects shown attract or repel each other?

(a) _____ (b) _____ (c) _____

(d) _____ (e) _____ (f) _____

1 8

Interpreting Illustrations

Neutral, positive, or negative charges?
Page 106

1. Answers A, B, and C can be in any order.
   - **(a)** Opposite charges attract.
   - **(b)** Like charges repel.
   - **(c)** Neutral objects are attracted to charged objects.
2. **(a)** attract
   - **(b)** attract
   - **(c)** attract
   - **(d)** repel
   - **(e)** repel
   - **(f)** attract

Charging by conduction or induction

Analyze the situations below. Do they describe charging by conduction or induction?

1. Identify whether the situation is describing charging by conduction or induction.

(a) You notice the build-up of dust on a computer screen when it is on. _____

(b) You walk across a carpet and experience a shock when you touch a metal doorknob. _____

(c) You rub a balloon against your hair and bring it close to a pile of salt on the table. This causes the salt crystals to "jump up and dance." _____

2. Identify whether the illustration shows charging by conduction or induction.

(a)

_____

(b)

_____

(c)

_____

Comprehension

Charging by conduction or induction

Page 107

1. **(a)** induction
   (b) conduction
   (c) induction
2. **(a)** induction
   (b) induction
   (c) conduction

Positive, negative, and neutral objects

Vocabulary	
amount of charge	electroscope
attract	increase
conduction	induction
contact forces	laws of static charge
decrease	neutral
distance between objects	repel
electric force	type of charge

Use the terms in the vocabulary box to fill in the blanks. Each term may be used more than once. You will not need to use every term.

1. A(n) _____ is a push or pull between charged objects.
2. The _____ state that like charges _____ and opposite charges _____. Charged objects are attracted to _____ objects.
3. The electric force that acts on any pair of objects depends on the _____ and _____ on the objects and on the _____.
4. If you increase the amount of charge on objects, you _____ the electric force. If you _____ the distance between objects, you decrease the electric force.
5. A device that can detect the presence of charge is the _____.
6. If the leaves of an electroscope become charged, they will _____ each other.
7. If a charged rod is brought close to an electroscope and then removed, the electroscope will become _____.
8. Charging by _____ occurs when objects touch and an electric charge is transferred from one object to the other. A(n) _____ can be used to demonstrate this.
9. Charging by _____ occurs when objects are charged without touching. A(n) _____ can be used to demonstrate this.
10. Neutral objects are attracted to charged objects because they are charged by _____.

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Cloze Activity
Positive, negative, and neutral objects
Page 108

1. electric force
2. laws of static charge, attract, repel
3. Either order is acceptable: type of charge, distance between objects
4. increase, decrease
5. electroscope
6. repel
7. neutral
8. conduction, electroscope
9. induction, electroscope
10. induction