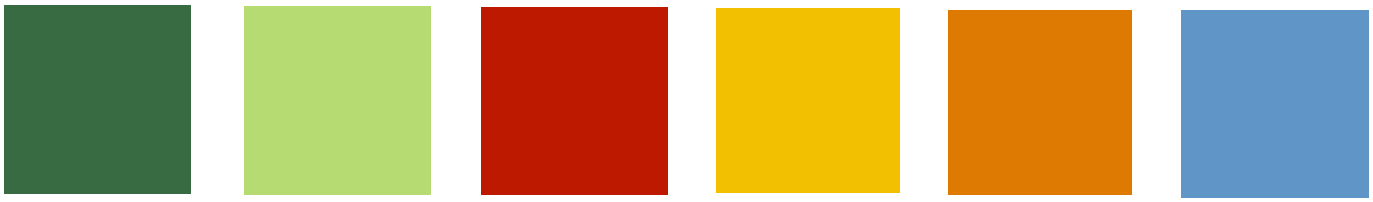


Balloons and Static Electricity

Time of Lesson: 50 minutes – 1 hour with optional 30 minutes of acting out atoms (for 8th Grade)

Content Standards Addressed in Lesson:

6.6A compare metals, nonmetals, and metalloids using physical properties such as luster, conductivity, or malleability (Reporting Category 1 – Supporting Standard)

8.5A describe the structure of atoms, including the masses, electrical charges, and locations, of protons and neutrons in the nucleus and electrons in the electron cloud (Reporting Category 1 – Readiness Standard)

8.5B identify that protons determine an element's identity and valence electrons determine its chemical properties, including reactivity (Reporting Category 1 – Readiness Standard)

8.5C interpret the arrangement of the Periodic Table, including groups and periods, to explain how properties are used to classify elements (Reporting Category 1 – Readiness Standard)

NSES (1996) **Grades 5-8 – Content Standard B**

- A substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample. A mixture of substances often can be separated into the original substances using one or more of the characteristic properties.

Scientific Investigation and Reasoning Skills Addressed in Lesson:

6.2A and 8.2A plan and implement comparative and descriptive investigations by making observations, asking well-defined questions, and using appropriate equipment and technology

6.2E and 8.2E analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.

6. 3 A and 8.3A in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing

6.3B and 8.3B use models to represent aspects of the natural world such as an atom, a molecule, space, or a geologic feature

NSES (1996) **Grades 5-8 – Content Standard A**

- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.

I. Student Prerequisite Skills/Understandings

1. The difference between a conductor and an insulator.

2. Examples of conductors and insulators.

II. Objectives: Students will be able to

1. Understand that similarly charged particles (proton-proton and electron-electron) repel each other while oppositely charged particles (proton-electron) attract each other and how electrons are transferred between two atoms.
2. Differentiate between electricity and static electricity.
3. Distinguish between the properties, in relation to the spread out and transfer of charges between conductors and insulators.
4. Plan an investigation with a partner using an electroscope and various samples of materials.

III. Supplies Needed

- Engagement:
  - One balloon
  - One cereal tied to a 1 ft of kite string
- Explore Atom Class Model:
  - Neutron job cards (amount will vary based on number of students)
  - Proton job cards (amount will vary based on number of students)
  - Electron job cards (amount will vary based on number of students)
- Explore (per pair of students):
  - One computer capable of running PhET simulation
  - Two 1cm by 4 cm aluminum foil strips
  - One bare metal paperclip
  - One note card large enough to cover mouth of jar
  - Three inches of tape
  - A small sample of each of the following:
    - glass
    - nylon (stocking)
    - aluminum
    - paper
    - steel
    - rubber balloon
    - styrene (Styrofoam plate)
    - plastic wrap
- Elaborate:
  - Clay model of a water molecule
  - Pipe
  - Stream of water (either use faucet or cup with hole in bottom)

5E Organization

Engage – Introduction to Charge (5 minutes)

Content Focus: How do two charged objects interact?

Teacher demos what happens when a charged balloon is brought in proximity to cereal on a string. Students make predictions and attempt to justify the phenomenon.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• What do you think will happen when I place this balloon next to the cereal? • What observations can you make about what is happening?	• Why do you think this is happening?

✓ **Checkpoint:** Students can describe what they just observed.

Explore – Introduction to Atom (20 minutes – For 8th grade)

Content Focus: 8.5A describe the structure of atoms, including the masses, electrical charges, and locations, of protons and neutrons in the nucleus and electrons in the electron cloud
8.5B identify that protons determine an element's identity and valence electrons determine its chemical properties, including reactivity
8.5C interpret the arrangement of the Periodic Table, including groups and periods, to explain how properties are used to classify elements
Investigation Skills: 8.3B use models to represent aspects of the natural world such as an atom, a molecule, space, or a geologic feature

Each student will be assigned the role of either a proton, neutron, or electron and the class will model two atoms to demonstrate electron interaction between atoms. Use the Periodic Table to determine which elements are being modeled. Have a few students (as electrons) move to the other atom to demonstrate how atoms can become positively or negatively charged.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• What atoms can we make? • Does the atom have a charge? • (During modeling) First, let's talk to the electrons close to the nucleus. How easy is it for you to see the other particles? • What about the outer electrons, could you interact easily with the electrons in the other atom? Why? • When an atom has more electrons than protons what charge does it have? • When an atom has more protons then electrons, what charge does it have? • What would happen if two electrons from this	• What is an atom? • What particles exist within an atom? • On the periodic table, how many protons does _____ have? Electrons? Neutrons? • How many protons does the atom have in its nucleus? Neutrons? • How many electrons should be in the first shell? Second? • What charge do protons have? Electrons? Neutrons?

atom **(point to atom you are referring to)** moved to the other atom **(point to atom you are referring to)**? • What particle would transfer between the atoms the easiest? • Why do you think some atoms hold onto their electrons more tightly than others?	

Teacher points out that atoms containing a charge are called "ions".

✓ **Checkpoint:** Students can explain how an atom can become charged (specifically, what particle is moving).

Explore – *Balloon and Static Electricity* PhET Simulation and Electroscope Experiment (20 minutes)

Content Focus: Compare metals, nonmetals, and metalloids using physical properties such as luster, conductivity, or malleability.
Investigation Skills: Use simulation to model aspects of the natural world. Analyze data to formulate reasonable explanations and communicate valid conclusions supported by the data. Use computers to conduct an investigation.

Students begin computer simulation (see: http://phet.colorado.edu/en/simulation/balloons) in pairs and are given 5 minutes for open play. Pass out "Balloons and Static Electricity PhET Worksheet" and allow 10 minutes to complete. Once completed, computers may be stored. Pass out the worksheet "My Electroscope".

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• How does this simulation model how charges interact? • What happens to the electrons (minus signs) on the wool sweater as you put the balloon near it? • Are the electrons transferred or just attracted? Why do you think this is the case? • What happens when you release the balloon? • Would a changed balloon be attracted to a neutral surface like the wall? • What happens if you have two balloons, consider the initial charges of the balloons, and experiment without the wall? How do the charges react with each other?	• How does this simulation model the relationship between these properties? • How can we transfer charges? • If the balloon does not let charge move easily, is it a conductor or an insulator?

✓ **Checkpoint:** Students have completed simulation.

Explain what an electroscope is and allow students time to build their electroscope (discuss any safety hazards, ex. the paper clip will pop the balloon if brought too close). Explain to students that they will be making observations on what materials will produce a charge when rubbed together.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• What could we look at in our electroscope to see how much charge has been transferred? • What could we look at in our electroscope to see how much charge has been transferred? • If the balloon does not let charge move easily, is it a conductor or an insulator?	• What do you think we could study using our electroscope? • How is a conductor different from an insulator?

✓ **Checkpoint:** Students have tested all materials with their electroscopes.

Explain (10 minutes)

Content Focus: Compare metals, nonmetals, and metalloids using physical properties such as luster, conductivity, or malleability.
Reasoning Skills: Analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends. Analyze, evaluate, and critique scientific explanations by using experimental and observational testing.

Teacher leads a whole group discussion of the students' findings using the computer simulation and electroscope experiment.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• How do you think the amount of charge relates to how much the foil moves? Why? • For the experiment with the balloons, which did you find to interact the most with the balloon? The least? What does that tell you about the materials? • Did you ever get different results if you tried the material twice? Why do you think that happened? • Is it possible to tell what type of charge is building up on the electroscope? Why or why not?	• What do our results tell us? • What do you think of when you hear the word static? • What is electricity? • What happened when electrons were added to the foil? What happened to the two pieces? • What do you know about how charges react with similarly charged particles? What about particles that are dissimilar? • Based on the experiences that you've had today, exploring with the computer simulation and using the electroscope, what do you think static electricity is? What evidence do you have?

✓ **Checkpoint:** Students are able to communicate their results to the class and engage in a group discussion.

Teacher makes connections to real life by describing lightening and how static electricity can be used when painting cars.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• Based on what you know about static electricity, how do you think it relates to lightning? • How do you think charging the body of a car and paint could help the paint stick to the car?	• Would you want the charges to be the same or different?

✓ **Checkpoint:** Students are able to use gathered knowledge to form new conclusions.

Elaborate (5-10 minutes)

Investigation Skills: Compare metals, nonmetals, and metalloids using physical properties such as luster, conductivity, or malleability.

Teacher leads a group discussion of how static electricity can cause an interaction between a water stream and a balloon.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• What do you think will happen if I take this charged balloon and put it next to the stream of water? What is happening? Why do you think this is happening?	• If the pipe is positively charged, which side of the water molecule would be attracted to the balloon? • What if the balloon was negatively charged, which side of the water molecule would be attracted to the pipe?

✓ **Checkpoint**: Students can describe how a charged balloon may interact with water on a basic level.

Evaluate

Use evaluations in attached documents.

Name: _____

Balloons and Static Electricity

Learning Objectives: Students will be able to

- Explain how similarly and dissimilarly charged objects interact.

1) Play with the simulation for five minutes. Be prepared to "share out" what you discover!

2) Fill in the table based on your investigations.

How can you…	Explain	Draw your final picture!
…make the balloon stick to the sweater?		
…make two balloons stick to the sweater?		
…make two balloons move apart?		

3) How can you make the balloon(s) stick to the sweater strongly?

Name: _____

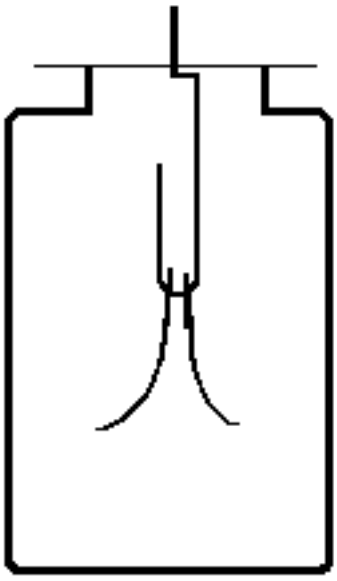
My Electroscope

Materials:

- Glass jar
- Strip of aluminum foil
- Index card
- Paperclip
- Tape

Procedure:

1. Cut two foil strips 1 cm x 4 cm
2. Open the paperclip to form a shape with a hook (see image on right)
3. Push the hook through the middle of the index card and tape it so that it is at right angles to the card.
4. Lay the two foil strips on top of one another and hang them on the hook by pushing the hook through them.
5. Lay the card over the jar so that the strips hang inside (see picture below)



Name: _____

Electroscope Experiment

How will you determine how much charge is transferred from one material to the other using your electroscope? Explain in complete sentences.

_____

_____

_____

Predictions

Question	Your Prediction	Your Explanation
What material do you think will attract the most electrons?		
What do you think will happen when a conductor and a conductor are rubbed together?		
What do you think will happen when an insulator and a conductor are rubbed together?		
What do you think will happen when an insulator and an insulator are rubbed together?		

STOP! CHECK WITH YOUR TEACHER BEFORE GETTING YOUR MATERIALS!

Procedure: Test six pairs of materials and order them by how much of a reaction you measure with your electroscope. You may need to wipe your balloon with a wet paper towel between trials.

Results:

Pair 1: Balloon and _____

Did the foil leaves move apart? (circle) yes no

Pair 2: Balloon and _____

Did the foil leaves move apart? (circle) yes no

Pair 3: Balloon and _____

Did the foil leaves move apart? (circle) yes no

Pair 4: Balloon and _____

Did the foil leaves move apart? (circle) yes no

Pair 5: Conductor and Insulator

_____ and _____

Did the foil leaves move apart? (circle) yes no

Pair 6: Any two materials you want!

_____ and _____

Did the foil leaves move apart? (circle) yes no

Order Pairs from Least to Most Reactive – write on sticky notes and post on board

_____ _____ _____ _____ _____ _____

Concluding Questions:

1. Draw what you think the charges look like on your electroscope.

2. Is it possible to determine the sign (+ or -) or charge with an electroscope? Why or why not?

Name: _____

Show off what you know!

1. What is the difference between electricity and static electricity?

_____

_____

2. Charges on an insulator tend to
   a. stay where they are placed.
   b. distribute evenly throughout the insulator.
   c. go away after a few minutes.
   d. none of the above.

3. Charges on a conductor tend to
   a. stay where they are placed.
   b. distribute evenly throughout the conductor.
   c. go away after a few minutes.
   d. none of the above.

4. After rubbing your socks on carpet, you touch a metal door nob and experience a shock. This is because

   a. you accumulated charge by rubbing your feet across the floor.
   b. friction makes charges.
   c. the metal door nob is an insulator.
   d. no charge is transferred.

5. Draw an electroscope before a charge is added and after a charge is added. How do you know a charge was added? Explain.

Teacher Note: This is an optional pre and post assessment.

Name:_____

Balloons and Static Electricity Pre/Post Evaluation

Static electricity is formed by:

a) plugging a device in.
b) stopping electricity by turning a device off.
c) transferring electrons from one material to another.
d) extracting protons from atoms.

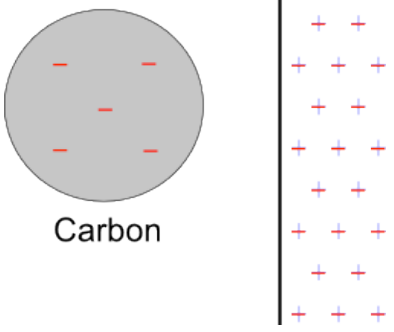
If static electricity is transferred to a conductor, the charges will:

a) stay where they are initially placed.
b) spread out over the conductor.
c) be repelled by the conductor.
d) be attracted to the other charges.

If two negatively charged balloons get close to one another, they will:

a) not affect each other.
b) increase in charge.
c) tend to move closer together.
d) tend to move further apart.

When the carbon ion below gets close to a surface made of an insulator, what will happen to the charges in the surface?



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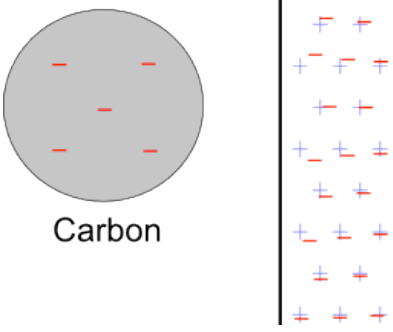

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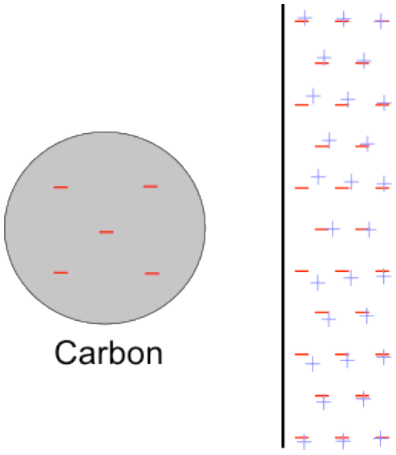

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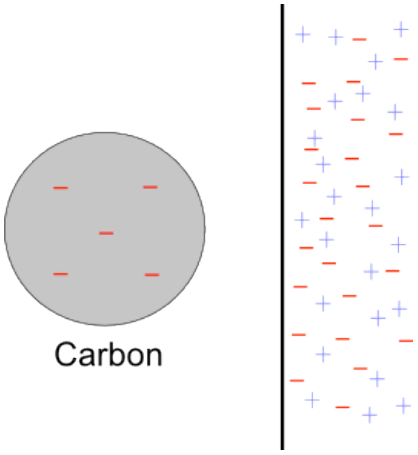


d)

When you rub your socks on a carpet and reach for a doorknob in the winter, sometimes you feel a shock. Why?

a) The doorknob is a part of the electrical system, so you temporarily feel a shock just the same as if touching an electrical wire.
b) In the winter seasons, electrical activity increases, so you feel shocks more.
c) The charge that built up on your body balances with the conductive doorknob.
d) The dry air transfers electricity to your body which then goes to the doorknob. The carpet actually has no effect.

Name: _____

Balloons and Static Electricity

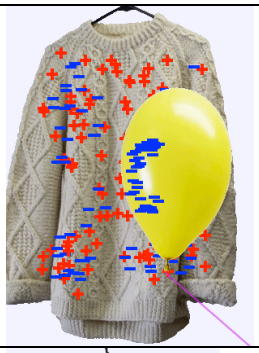
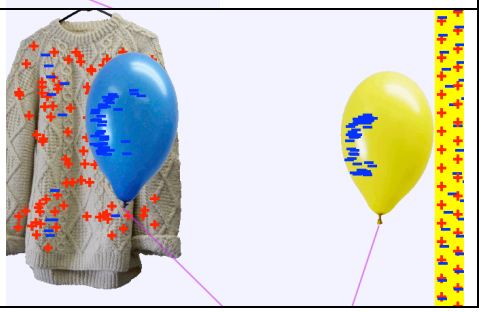
KEY

Learning Objectives: Students will be able to

- Explain how similarly and dissimilarly charged objects interact.

1) Play with the simulation for five minutes. Be prepared to "share out" what you discover!

2) Fill in the table based on your investigations.

How can you…	Explain	Draw your final picture!
…make the balloon stick to the sweater?	Rub the balloon on the sweater. Drag it to the wall and it will go towards the sweater	
…make two balloons stick to the sweater?	Rub both balloons against the sweater. The two balloons cannot be on top of each other.	
…make two balloons move apart?	Rub the balloons against the sweater and then place the balloons next to each other.	

3) How can you make the balloon(s) stick to the sweater strongly?

By rubbing the balloons lots of times against the sweater, more charges will transfer to the balloons.

KEY

Procedure: Test six pairs of materials and order them by how much of a reaction you measure with your electroscope. You may need to wipe your balloon with a wet paper towel between trials.

Results:

Pair 1: Balloon and aluminum foil

Did the foil leaves move apart? (circle) yes no

Pair 2: Balloon and paper

Did the foil leaves move apart? (circle) yes no

Pair 3: Balloon and glass

Did the foil leaves move apart? (circle) yes no

Pair 4: Balloon and plastic wrap

Did the foil leaves move apart? (circle) yes no

Pair 5: Conductor and Insulator
steel and glass

Did the foil leaves move apart? (circle) yes no

Pair 6: any two materials you want!

Styrofoam and nylon

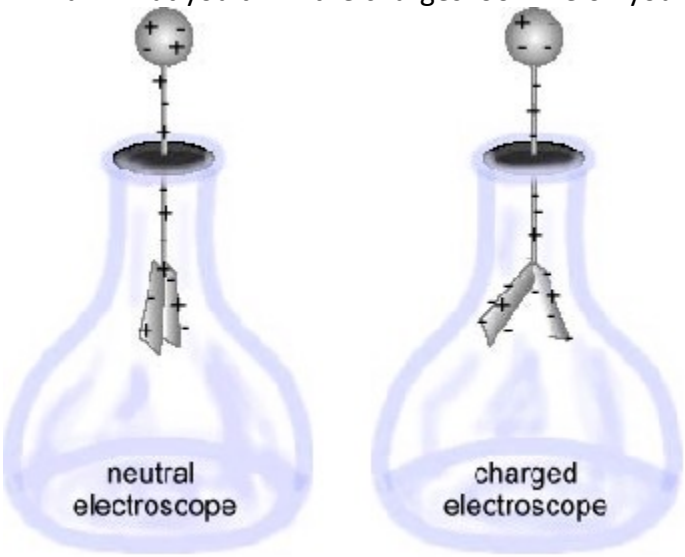
Did the foil leaves move apart? (circle) yes no

Order Pairs from Least to Most Reactive

Steel+glass Styrofoam+nylon B+Al foil B+P W B+glass B+paper

Concluding Questions:

1. Draw what you think the charges look like on your electroscope.



2. Is it possible to determine the sign (+ or -) or charge with an electroscope? Why or why not?

No – both will cause the foil sheets to repel

Name: _____

Show off what you know!

KEY

1. What is the difference between electricity and static electricity?

Electricity is the movement of charge and static electricity is the build up of charge.

2. Charges on an insulator tend to

a. stay where they are placed.
b. distribute evenly over the surface of, or over the insulator.
c. go away after a few minutes.
d. none of the above.

3. Charges on a conductor tend to

a. stay where they are placed.
b. distribute evenly over the surface of, or over the conductor.
c. go away after a few minutes.
d. none of the above.

4. After rubbing your socks on carpet, you touch a metal door nob and experience a shock. This is because

a. you accumulated charge by rubbing your feet across the floor.
b. friction makes charges.
c. the metal door nob is an insulator.
d. no charge is transferred.

5. Draw an electroscope before a charge is added and after a charge is added. How do you know a charge was added? Explain.

Any charge applied to the pieces of foil will spread out as much as possible. Since both ends of foil will be charged the same, they will repel. This is true for both positive and negative charges.

Teacher Note: This is an optional pre and post assessment.

Balloons and Static Electricity Pre/Post Evaluation

KEY

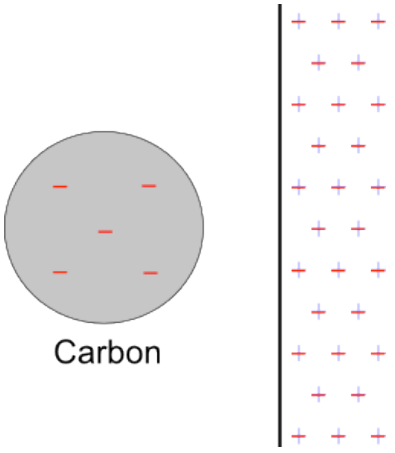
(learning goal # - for teacher reference!)

1. Static electricity is formed by: (2)
   a) plugging a device in.
   b) stopping electricity by turning a device off.
   c) transferring electrons from one material to another.
   d) extracting protons from atoms.

2. If static electricity is transferred to a conductor, the charges will: (3, 1)
   a) stay where they are initially placed.
   b) spread out over the conductor.
   c) be repelled by the conductor.
   d) be attracted to the other charges.

3. If two electrons get close to one another, they will: (1)
   a) not affect each other.
   b) increase in charge.
   c) tend to move closer together.
   d) tend to move further apart.

4. When the carbon ion below gets close to a surface made of an insulator, what will happen to the charges in the surface?



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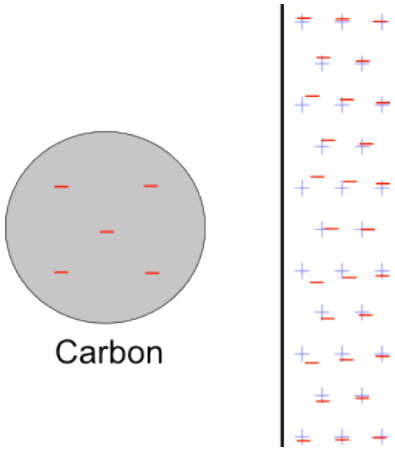

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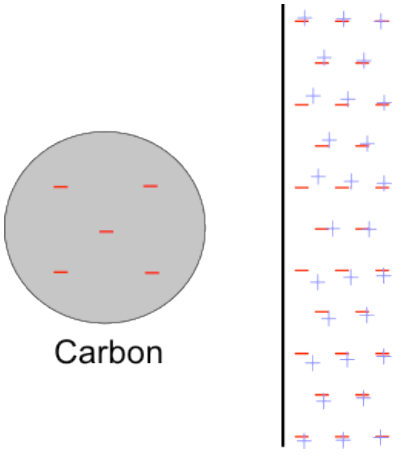

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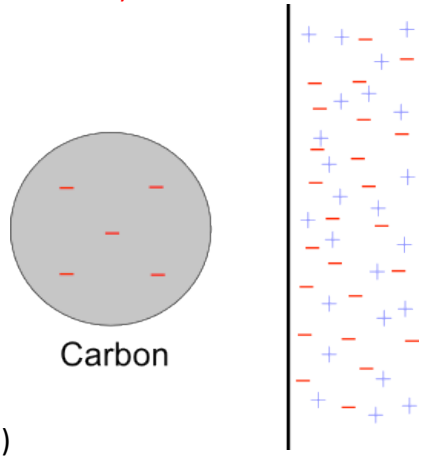

d)

5. When you rub your socks on a carpet and reach for a doorknob in the winter, sometimes you feel a shock. Why?
   a) The doorknob is a part of the electrical system, so you temporarily feel a shock just the same as if touching an electrical wire.
   b) In the winter seasons, electrical activity increases, so you feel shocks more.
   c) The charge that built up on your body balances with the conductive doorknob.
   d) The dry air transfers electricity to your body which then goes to the doorknob. The carpet actually has no effect.