UTeach Outreach

College of Natural Sciences
THE UNIVERSITY OF TEXAS AT AUSTIN

Electroscope Lesson

Lesson created by: UTeach Outreach
Date of lesson: Spring 2015
Description of the class: 4-6th grade, students in pairs
Length of lesson: 30-40 minutes
Source of the lesson:
TEKS addressed:
(5) Matter and energy. The student knows that matter has measurable physical properties and those properties determine how matter is classified, changed, and used. The student is expected to:

> (A) classify matter based on physical properties, including mass, magnetism, physical state (solid, liquid, and gas), relative density (sinking and floating), solubility in water, and the ability to conduct or insulate thermal energy or electric energy;

(6) Force, motion, and energy. The student knows that energy occurs in many forms and can be observed in cycles, patterns, and systems. The student is expected to:

> (A) explore the uses of energy, including mechanical, light, thermal, electrical, and sound energy;

I. Overview

The purpose of this lesson is to have students explore charges through the use of different materials. By using an electroscope, students will be able to make observations and see whether an object has a charge.

II. Objectives

1. Demonstrate how the charges between the cereal and balloon react towards one another
2. Define an atom and its three major components
3. Define an electroscope and its uses
4. Measure the charges of some objects using the electroscope
5. Introduce conductors and insulators and explain how they work
6. Using the electroscope, study static electricity

III. Resources, materials and supplies (per bin/teaching pair)

- Cereal
- Strings
- Rubber balloons
- Foil sheets
- Paperclip
- Wet paper towel
- Nylon
- Plastic wrap

- Electroscope (included in the worksheet)
- Any two materials of your choice

IV. Advanced Preparation:

Make sure to have balloons blown up and a cereal must be on a string, before the lesson begins.

V. Supplementary worksheets, materials and handouts

- “My Electroscope” worksheet
- “Try It” worksheet
- “How to Build Your Own Electroscope” instruction sheets
- picture of an atom
- periodic table

VI. Background information

College Level

An electroscope is a common demonstration apparatus used by physics teachers to illustrate electrostatic principles of charging and charge interactions. The electroscope is most commonly used as a charge-detecting device.

Elementary Level

Atoms are the basic building blocks of matter that make up everyday objects. A desk, the air, and even people are made up of billions and billions of atoms. Look at the tip of a pencil. It contains a universe made of atoms.

There are three parts of an atom: Electrons, Protons and Neutrons.

VII. Possible Misconceptions

- The number of neutrons determines the atom
- Neutrons are negative
- Neutrons contribute a charge
- An electroscope allows us to see whether an object has electricity

VIII. Vocabulary & Definitions:

College Level

- proton- a stable subatomic particle occurring in all atomic nuclei, with a positive electric charge equal in magnitude to that of an electron, but of opposite sign.
- neutron- a subatomic particle of about the same mass as a proton but without an electric charge, present in all atomic nuclei except those of ordinary hydrogen.
- electron - a stable subatomic particle with a charge of negative electricity and a very small mass compared with that of a neutron or proton, found in all atoms.
- atom- A unit of matter; the smallest unit of a chemical element.

- ion- an atom or molecule with a net electric charge due to the loss or gain of one or more electrons.
- conductor- substance that allows charge to flow freely through its atomic structure.
- insulator-Any material that keeps energy such as electricity, heat, or cold from easily transferring through is an insulator (ex: wood, plastic, rubber, and glass)

Elementary Level

- proton- a particle that has a positive(plus sign) charge
- neutron- a particle that has no charge (neutral)
- electron- a particle that has a negative(minus) charge
- atom- smallest form of matter
- ion- atom that has a charge
- conductor- a material through which electric current can pass (ex: metals)
- insulator- A material that does not easily transmit energy

IX. Safety Considerations:

Please be aware when handling the paperclip that will be supporting the foil sheets in each of the electroscopes because it is sharp. Balloon may pop if placed near the paperclip or any other sharp objects

X. Question of the Day

How are charges applied to objects?

ENGAGEMENT		Time: 5 minutes
What the Teacher Will Do	Probing Questions	Student Responses Potential Misconceptions
Pair kids. Hand one partner a piece of cereal on a string. Hand the other a filled balloon. *Charge the balloon by rubbing it against your hair.* *Now, slowly bring the balloon near the cereal. Observe what happens.* Cereal should move towards the balloon. Teacher note: the balloon may stick to both the string and the cereal. If you remove the string, the		

ENGAGEMENT		Time: 5 minutes
What the Teacher Will Do	Probing Questions	Student Responses Potential Misconceptions
students find it more interesting to spin the cereal by moving the balloon slowly over the cereal. *Right, the cereal is moving towards the balloon.* *Something is happening with the charges on the balloon and on the cereal. Today, we're going to explore charges through the use of different materials.*	1. What do you guys see happening? 2. Why do you think this is happening?	1. The cereal is moving! 2. Charges! I don't know. MC: The balloon is sticky.

EXPLORATION		Time: 20 minutes
What the Teacher Will Do	Probing Questions	Student Responses Potential Misconceptions
Show image of an atom. Show students the periodic table.	1. What is an atom? 2. What particles exist within an atom? 3. On the periodic table, how many protons does _____ have? Electrons? Neutrons? 4. How many protons does the atom have in its nucleus? Neutrons? 5. What determines the identity of the atom? 6. What charge do	1. The smallest form of matter 2. Electrons, protons and neutrons. 3. Answers vary based on element selected. 4. Answers vary based on element selected. 5. The number of protons. MC: The number of neutrons. 6. Positive, negative, no

EXPLORATION		Time: 20 minutes
What the Teacher Will Do	Probing Questions	Student Responses Potential Misconceptions
Now, we are going to study different materials using an electroscope. Write the word electroscope on the board. *An electroscope allows us to see whether an object has a charge.*	protons have? Electrons? Neutrons? 7. When an atom has more electrons than protons what charge does it have overall? 8. When an atom has more protons then electrons, what charge does it have? 9. What would happen if two electrons from this atom (point to atom you are referring to) moved to the other atom (point to atom you are referring to)? 10. What is the new charge on this atom? That atom? 11. What particle would transfer between the atoms the easiest?	charge. MC: neutrons are negative. 7. A negative charge. 8. A positive charge. 9. One atom would have a positive charge and the other would have a negative charge. 10. Various answers. 11. The electrons! MC: Note that all of the particles are constantly moving but the electrons are on the outer edge of the

EXPLORATION		Time: 20 minutes
What the Teacher Will Do	Probing Questions	Student Responses Potential Misconceptions
		atom so they are easiest to move.
	12. How do you know the charge?	12. By considering how many electrons and protons you have. MC: Neutrons contribute a charge.
	13. What is the name for an atom that has a charge?	13. Ion.
If students say electricity, ask about how they have studied electricity in the past and contrast the apparatus (i.e. there are no wires, batteries, light bulb, etc.) *I am handing out a worksheet for your experiment.* *You will be making observations on what materials will produce a charge when rubbed together. You will be ordering them by how much of a reaction you observe from your electroscope.* *To measure the charge on an object, move the object of study close to the conductor, paper clip, supporting the foil and see if the two pieces of foil separate.* *There are a few things you need to know before you can*		

EXPLORATION		Time: 20 minutes
What the Teacher Will Do	Probing Questions	Student Responses Potential Misconceptions
start your experiment. A safety note is that the end of the paperclip that supports your foil sheets in each of your electroscopes is sharp. Do not push your balloon onto the paperclip or you may pop your balloon. You will be given one balloon only for this experiment, so if you pop it you will be unable to complete your experiment. Charge may build up on your balloon so wipe it down periodically with a wet paper towel. Pass out "My Electroscope" worksheet. *You will need to answer the first question on your worksheet before we will give you your materials: "How will you determine how much charge is transferred from one material to the other?"* Once student show you their hypotheses, you can give them their materials and the handout that describes how to make the electroscope. *Now that we've built our electroscopes, we will be making observations using your electroscope.* *Conductors easily transfer*	14. How is a conductor different from an insulator?	14. In a conductor, electrons can move easily.

EXPLORATION		Time: 20 minutes
What the Teacher Will Do	Probing Questions	Student Responses Potential Misconceptions
charge (electrons) and insulators do not. It is important to remember that only negative charges (electrons) move. *On a conductor, all of the charges will spread out over the surface of the conductor.*	15. Why do you think a conductor is used to support the foil?	15. To allow for the transfer of electrons.
	16. If the balloon does not let charge move easily, is it a conductor or an insulator?	16. Insulator.
	17. Will the charges on the balloon move or stay in place?	17. Stay in place.
	18. What do you think will happen over time to the charges being added to the balloon?	18. There will be too many charges.
Great! The balloon is an insulator, so any charge on the balloon will stay in place. It becomes hard to move any excess charge on the balloon once you start rubbing different materials on it.	19. How could we modify our experiment to get better results?	19. Conduct several trials. Use different materials.
Pass out the "Try It" worksheet and give students ten minutes to collect make their observations.		

EXPLANATION		Time: 10 minutes
What the Teacher Will Do	Probing Questions	Student Responses Potential Misconceptions
Let's discuss our results.	1. What happened when a charged object was near the electroscope? 2. How do you think the amount of charge relates to how much the foil moves? Why? 3. For the experiment with the balloons, which did you find to react the most with the balloon? The least? 4. What does that tell you about the materials? 5. With the conductor-insulator reaction, what happened? Why do you think that happened? 6. Did you ever get different results if you tried the material twice? Why do you think that happened? 7. What do you know about how charges react with similarly charged particles? What about particles	1. The foil split apart. 2. With more charge the foil moves more. 3. Nylon. Plastic Wrap. 4. One is easier to transfer charges (electrons) the other is not. 5. Static build up! Because the conductor easily transfers electrons and the insulator holds on to them. 6. Yes, charge build up. 7. Similarly charged particles repel and dissimilar charged particles do not.

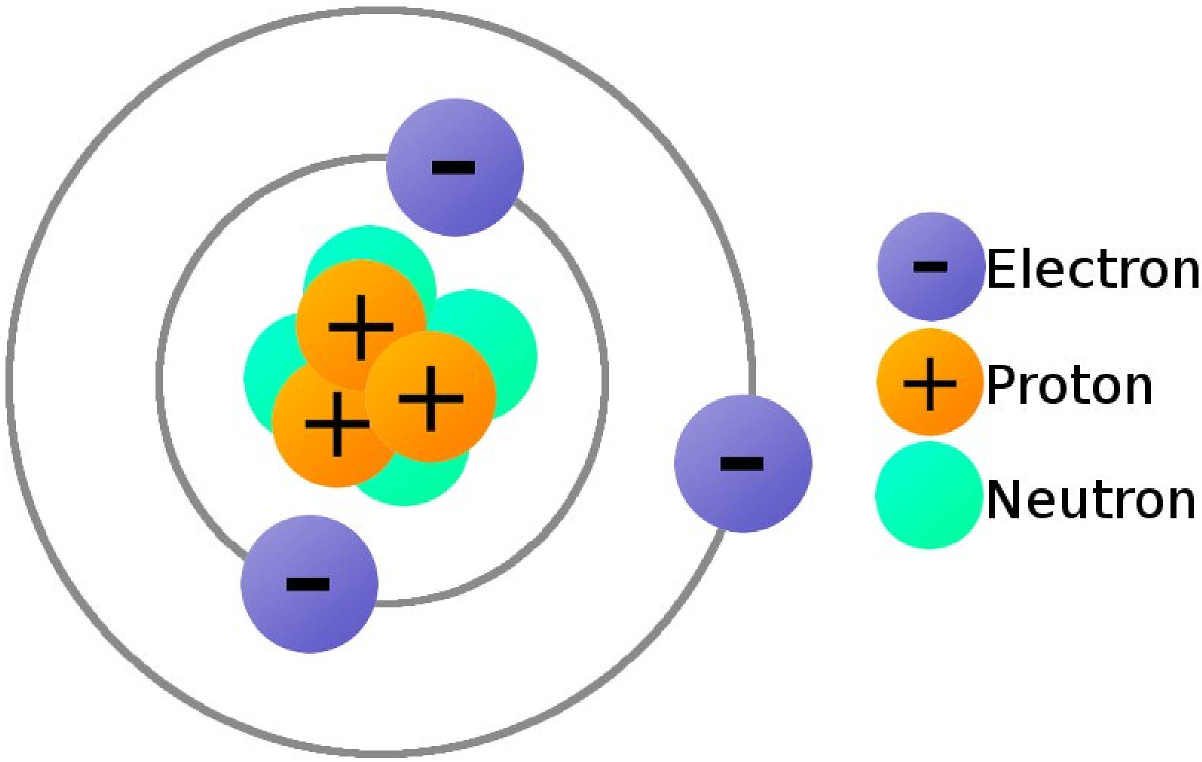
EXPLANATION		Time: 10 minutes
What the Teacher Will Do	Probing Questions	Student Responses Potential Misconceptions
Similarly charged particles repel. This is true for electrons and electrons or protons and protons. Write on board, if needed. *Dissimilar charged particles attract.*	that are dissimilar? 8. Is it possible to tell what type of charge is building up on the electroscope? Why or why not?	8. No, because an electroscope just shows that charge is present not necessarily whether it is positive or negative
Good, the electroscope can't tell us what type of charge is present. It can only tell us IF there is a charge present.	9. What do you think of when you hear the word static?	9. Noise. Not moving.
Static means that something isn't moving. Today we've seen various examples of static electricity.	10. What is electricity? 11. How have you explored electricity before?	10. The movement of charge. 11. With circuits, light bulbs, etc.
We didn't use any of those materials today, but we did study static electricity. I'm going to give you a few minutes to discuss the following question. Give students a few minutes to discuss with their partner. Select a few pairs to share what they have discussed.	12. Based on your knowledge and the experiences that you've had today using the electroscope, what do you think static	12. The build up of charges! With the electroscope the foil leaves separated when there was a charge. Like when

EXPLANATION		Time: 10 minutes
What the Teacher Will Do	Probing Questions	Student Responses Potential Misconceptions
If we call it static electricity, it must mean that electricity doesn't move – well, not quite, but close. *We only call something "electricity" if the charged particles are moving, but if the only reason the charged particles aren't moving is because there isn't a good path for them to follow, we call it static electricity. After the static electricity completely discharges, the charged particles are again in balance.* *When we were working with our electroscope we were studying static electricity. All or most of the charge from the objects we rubbed together were transferred to the electroscope.*	electricity is? What evidence do you have?	someone shocks you.

EVALUATION		Time: 5 minutes
What the Teacher Will Do	Probing Questions	Student Responses Potential Misconceptions
The important point about static electricity is that the charged particles are moving from one point to another point – there isn't a circular path like when using a battery to power something. Static electricity just moves from one point to another. This is good		

EVALUATION		Time: 5 minutes
What the Teacher Will Do	Probing Questions	Student Responses Potential Misconceptions
to know if you'd like to build up static charge to shock your brother, sister or friend. *Static electricity is used when painting cars. This helps the paint stick more evenly.* *The spray paint nozzle can be charged and the car can be given the opposite charge. The paint droplets are then attracted to the car and can cause less of a mess and a more even coat.* *A good example of powerful static electricity in nature is lightning.* *Lightning is caused by the movement of the clouds in the wind builds up static electricity until it discharges into another cloud or the ground. That is to say that all of the "built up" charge is transferred.*	1. How do you think charging the body of a car and paint could help the paint stick to the car? 2. Based on what you know about static electricity, how do you think it relates to lightning?	1. Have them be different charges! 2. Charges build up and then rapid discharge.

Model of an Atom



Periodic Table of the Elements

B = Solids　　Hg = Liquids　　Kr = Gases　　Pm = Not found in nature

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.00794																	2 He 4.002602
3 Li 6.941	4 Be 9.012182											5 B 10.811	C 12.0107	7 N 14.00674	8 O 15.9994	9 F 18.9984032	10 Ne 20.1797
11 Na 22.989770	12 Mg 24.3050											13 Al 26.581538	14 Si 28.0855	15 P 30.973761	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.955910	22 Ti 47.867	23 V 50.9415	24 Cr 51.9961	25 Mn 54.938049	26 Fe 55.845	27 Co 58.933200	28 Ni 58.6534	29 Cu 63.545	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.92160	34 Se 78.96	35 Br 79.504	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	40 Zr 91.224	41 Nb 92.90638	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.90550	46 Pd 106.42	47 Ag 196.56655	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.90447	54 Xe 131.29
55 Cs 132.90545	56 Ba 137.327	71 Lu 174.967	72 Hf 178.49	73 Ta 180.94.79	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.56655	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.58038	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	103 Lr (262)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (269)	111 Rg (272)	112 Cn (277)	113 Uut (277)	114 Uuq (277)	115 Uup (277)	116 Uuh (277)		118 Uuo (277)

57 La 138.9055	58 Ce 140.116	59 Pr 140.50765	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.92534	66 Dy 162.50	67 Ho 164.93032	68 Er 167.26	69 Tm 168.93421	70 Yb 173.04
89 Ac 232.0381	90 Th 232.0381	91 Pa 231.035888	92 U 238.0289	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)

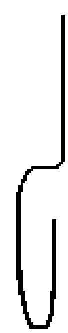
Try it!
1. Make the balloon stick to the sweater.

2. Make two balloons stick to the sweater.

3. Make the balloons go apart.

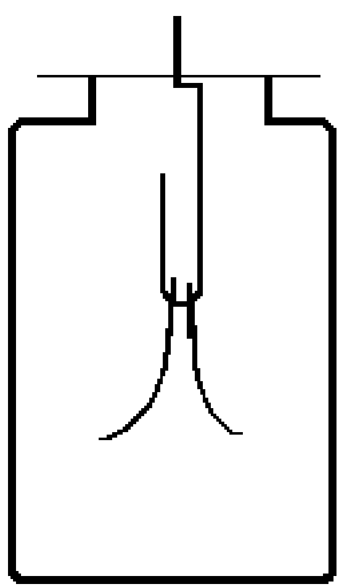
4. Make the balloon(s) stick to the sweater strongly.

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: ________________________________

My Electroscope

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?		

Name: ______________________________ Date: ______________________________

Try it!

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.

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 ___________________________

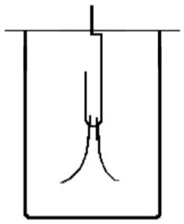
Did the foil leaves move apart? (circle) yes no

Order pairs from least to most reactive – write on sticky notes and post on the table chart.

________ ________ ________ ________ ________ ________

How to build your own electroscope!

1. Cut two strips of aluminum foil 1 cm x 4 cm
2. Open a paperclip and form the shape in the picture
3. Push the tip of the paperclip through the index card and tape it securely
4. Lay the aluminum strips on top of each other and slide them onto the paperclip
5. Lay the card over a clear glass or jar
6. Your electroscope is ready to test for static electricity!



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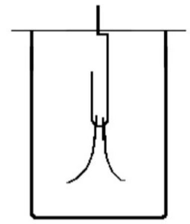

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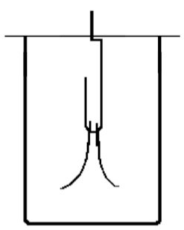

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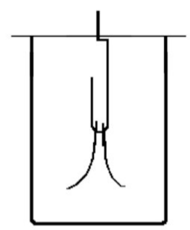

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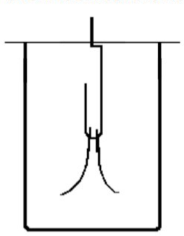

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