The Nature of Electricity

Teacher's Guide
High/Middle School

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A Message from our Company . . .

Dear Educator:

Thank you for your interest in the educational videos produced by the *Visual Learning Company*. We are a Vermont-based, family owned and operated business specializing in the production of quality educational science videos and materials.

We have a long family tradition of education. Our grandmothers graduated from normal school in the 1920's to become teachers. Brian's mother was an elementary teacher and guidance counselor, and his father was a high school teacher and superintendent. This family tradition inspired Brian to become a science teacher, and to earn a Ph.D. in education, and lead Stephanie to work on science education programs at NASA.

In developing this video, accompanying teacher's guide, and student activities, our goal is to provide educators with the highest quality materials, thus enabling students to be successful. In this era of more demanding standards and assessment requirements, supplementary materials need to be curricular and standards based - this is what we do!

Our videos and accompanying materials focus on the key concepts and vocabulary required by national and state standards and goals. It is our mission to help students meet these goals and standards, while experiencing the joy and thrill of science.

Sincerely,

Brian and Stephanie Jerome

National Standards Correlations

National Science Education Standards

(Content Standards: 5-8, National Academy of Sciences, c. 1996)

Science as Inquiry - Content Standard A:

As a result of activities in grades 5-8, all students should develop:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science - Content Standard B:

As a result of their activities in grades 5-8, all students should develop an understanding of:

- Transfer of Energy

Benchmarks for Science Literacy

(Project 2061 - AAAS, c. 1993)

The Physical Setting - Energy Transformation (4E)

By the end of the 8th grade, students should know that:

- Electrical energy is the attraction or repulsion between charges.

The Physical Setting - Forces of Nature (4G)

By the end of the 12th grade, students should know that:

- There are two kinds of charges- positive and negative. Like charges repel each other, opposite charges attract.

- Different kinds of materials respond differently to electric forces. In conducting materials such as metals, electric charges flow easily. At very low temperatures, some materials become superconductors and offer no resistance to the flow of current.

Student Learning Objectives

Upon viewing the video and completing the enclosed student activities, students should be able to do the following:

- Identify the major components of an atom, including neutrons, protons, and electrons;
- Define the term *electric charge;*
- Discuss the rule of electric charge: "Unlike charges attract each other and like charges repel each other";
- Understand static electricity;
- Differentiate between three methods of acquiring charge: friction, conduction, and induction;
- Understand the function of an electroscope;
- Discuss the function and formation of lightning;
- Understand how a battery produces electricity; and
- Differentiate between the function and types of conductors and insulators.

Assessment

Preliminary Test:

The Preliminary Test, provided in the Student Master section, is an assessment tool designed to gain an understanding of student preexisting knowledge. It can also be used as a benchmark upon which to assess student progress on the objectives stated on the previous pages.

Video Review:

The Video Review, provided in the Student Masters section, can be used as an assessment tool or as a student activity. There are two main parts. The first part contains questions titled "You Decide" that can be answered during the video. The second series of ten questions consists of video review questions to be answered at the conclusion of the video.

Post-Test:

The Post-Test, provided in the Student Masters section, can be utilized as an assessment tool following student completion of the video and student activities. The results of the Post-Test can be compared against the results of the Preliminary Test to assess student progress.

Introducing the Video

Discuss and define the term *electricity* as a class. Next, divide students into small groups. Ask each group to list examples of electricity that they use in their everyday life. Ask one representative from each group to write the lists on the board and then discuss the answers as a class. Next, ask each group to discuss what they know about electric charge and to provide examples of electric charge that they may have encountered. Remind them to consider such terms as *protons, electrons*, and *static electricity*. Come together as a class and discuss these examples. Allow the lists to remain on the board during the video. Upon the conclusion of the program, ask students to discuss any new information they may have learned from the video.

Video Viewing Suggestions

The Student Master "Video Review" is provided for distribution to students. You may choose to have your students complete this Master while viewing the program or to do so upon its conclusion.

The program is approximately 20-minutes in length and includes a ten-question video quiz. Answers are not provided to the Video Quiz on the video, but are included in this teacher's guide. You may decide to grade student quizzes as an assessment tool or to review the answers in class.

The video is content-rich with numerous vocabulary words. For this reason you may want to periodically stop the video to review and discuss new terminology and concepts.

Student Assessments and Activities

Assessment Masters:

- Preliminary Test
- Video Review
- Post-Test

Student Activity Masters:

- Spinning Straws
- A Snake's Static Electricity
- Calculating Electric Charge
- The Model Atom
- Vocabulary of Electricity

Video Script: *The Nature of Electricity*

1. By this point in the day you have used one of the most important and useful commodities harnessed by science in human history.
2. Do you know what it is? Here are some clues:
3. You may have used it to help you wake up this morning, . . .
4. ...or to guide your way in your house, . . .
5. ...or perhaps to heat the water with which you shower, . . .
6. ...or to cook your breakfast, . . .
7. ...or to refrigerate the milk you put on your cereal, . . .
8. ...or to start the vehicle that drove you to school.
9. It even provides the energy to power the machinery to display this program.
10. This vitally important source of energy is electricity.
11. During the next few minutes, we are going to discuss some of the characteristics of electricity . . .
12. . . . and see how humans have harnessed electricity and made it such an important part of our daily lives.
13. **Graphic Transition - What is Electric Charge?**
14. Electricity is believed to have existed since the beginning of time on Earth in the form of lightning.
15. This bolt of lightning can pack millions of volts of electricity.
16. Just what is electricity – how is it formed and what is its atomic make-up?
17. The answer lies in the smallest known whole particle of matter – the atom.
18. This is a diagram of an atom magnified thousands of times. This is an atom of carbon.
19. As you can see, the carbon atom is made of other smaller particles.
20. In the center of the atom, or nucleus, are particles called neutrons**,** seen here in green, and protons**,** seen here in red.
21. Neutrons have a neutral charge. But protons carry a positive charge, as indicated by a plus sign.
22. Orbiting the nucleus are smaller particles called electrons. Electrons carry a negative charge, indicated by a negative sign.
23. The concept of positive and negative charges was determined by Benjamin Franklin when he conducted his early experiments with electricity in the 1700's.
24. **Graphic Transition – Electric Charges and Force**
25. **Electric charge** is not something you can see, but you can observe the effects of the electric charge.
26. It is possible for atoms to have an overall positive charge or an overall negative charge.
27. The charge of particles plays a very important role in how they react with one another.
28. You Decide!
29. How do you think these oppositely charged particles will react to each other?
30. Charged particles that have opposite charges tend to exhibit a force of attraction**,** causing them to pull toward each other.
31. This can be seen by these two small spheres, where one has a negative charge and the other has a positive charge,....
32. ...or with the negatively charged end of one magnet and the positively charged end of the other magnet. They are attracted to each other.
33. But when objects have the same charge, they exhibit a force that repels or pushes against each other.

Script

This is called repulsion.

34. This is shown here where a negatively charged end of the magnet repels the negatively charged end of another magnet.
35. These concepts are summarized by the statement – "Unlike charges attract each other, and like charges repel each other."
36. **Graphic Transition - Static Electricity**
37. You Decide!
38. What force causes this balloon to stick to the wall without the use of tape or glue?
39. If you answered that the force is related to electric charges, then you are correct. Let's see how this works.
40. In stable atoms, the number of protons in the nucleus with a positive charge balances the number of electrons orbiting with a negative charge.
41. In the case of this atom of nickel, there are 28 protons in the nucleus balanced by 28 electrons orbiting the nucleus.
42. The overall charge is zero. It can be said that the atom has a neutral charge.
43. An **ion** is an atom that has gained or lost electrons.
44. For example, in the case of an atom of nitrogen, seen here, seven protons in the nucleus are balanced by seven outer electrons.
45. Here you see the nitrogen atom gaining three electrons, so it now has an overall negative charge.
46. In our example of the balloon, the balloon had a neutral charge.
47. But when it was rubbed against this student's head, it gained electrons and the atoms in the balloon became negatively charged ions.
49. When placed near the wall, the negatively charged atoms in the balloon are attracted to the positively charged atoms in the wall, causing them to stick together.
50. This is a form of static electricity. Static electricity involves the build up of static or non-moving charges.
51. **Graphic Transition – Charging Objects**
52. You Decide!
53. How could you move these small pieces of paper without actually touching them?
54. Here is a clue – you can use this plastic rod.
55. By rubbing the plastic rod with this piece of woolen cloth, the plastic rod gains electrons and becomes negatively charged.
56. When drawn toward the paper, the opposite charges in the rod and paper cause the paper to move or to be drawn toward the rod.
57. The method by which the rod became charged was friction**.** Charging via friction occurs when objects are rubbed together and electrons move from one object to another.
58. The balloon shown earlier was charged as a result of friction between the balloon and the student's head.
59. Let's look at some other ways objects can acquire a charge.
60. Right now, this copper wire has a neutral charge
61. But when the copper wire is connected to the battery, it becomes charged.
62. The process by which the wire acquired a charge is called conduction.

Script

63. In conduction, an object acquires charges from direct contact with another object. In other words, charges flow from one object to another or transmit a charge.
64. Many objects made of metal, such as this steel lightning rod, allow electricity to flow easily and are referred to as conductors. We will talk more about conductors later.
65. The third method of charging objects is via induction.
66. In the process of induction, objects become charged without touching each other.
67. Let's see how this works by first charging this comb. This can be accomplished by having this student brush her hair, thus charging the comb.
68. By brushing her hair, the comb acquires an overall negative charge.
69. Now watch closely as the negatively charged comb is brought closely to these small pieces of neutrally charged paper. Notice how they move. The reason they move is because the negatively charged comb caused the electric charge in the paper to become rearranged.
70. **Graphic Transition - Demonstrating Charges in Action**
71. This is an instrument called an electroscope. An electroscope demonstrates the effects of charges.
72. The outside container is a glass flask. Inside the flask are metal leaves attached to a metal rod. As you recall, metal is a good conductor of electricity.
73. Right now the metal leaves are uncharged and are hanging straight down.
74. This is a rubber rod that has a negative charge.
75. You Decide!
76. What do you think will happen to the metal leaves when the rubber rod touches the electroscope?
77. As you can see, the metal leaves repel each other. Why?
78. The charge traveled from the rubber rod down to the metal leaves, which also became negatively charged.
79. Because both leaves had the same negative charge, they repelled each other. The rod transferred the negative charge via the process of conduction.
80. This is a glass rod that has an overall positive charge.
81. You Decide!
82. What do you think will happen when it comes in contact with the electroscope?
83. As you can see, it also causes the metal leaves to separate or repel each other.
84. The positive charge travels down the metal rod to the metal leaves that acquire the positive charge.
85. Like charges repel each other.
86. **Graphic Transition - Lightning and Thunder**
87. If you get a little scared during an electric storm, you might have good reason.
88. Each year 100 people are killed and 7500 forest fires are ignited by lightning in the United States alone. Lightning, due to its incredible electrical strength, can be very dangerous.
89. Let's take a look at how these electrical charges are formed.
90. Quite often, powerful electrical storms are the result of very large thunderclouds. This cloud, for example, towers thousands of feet into the sky.
91. In these types of clouds, strong winds often create updrafts and downdrafts, where particles of water and ice create friction that causes certain regions of the cloud to become charged.
92. Most often, the bottom part of the cloud becomes negatively charged.
93. This in turn creates a positively charged shadow on the ground.
94. You Decide!

Script

What happens when the build-up of charges becomes great?

95. When the build-up of the charges becomes great, the electric charge is discharged.
96. In the case of lightning, the discharge occurs very quickly, in about 1/10,000 of a second, and can be seen as a lightning bolt.
97. **Graphic Transition – Moving Charges**
98. How does the light bulb stay lit? There must be a continual supply of electricity. How is this created?
99. To create moving electric charges, you need something to continually supply charged particles.
100. Some sources include batteries, as seen here, . . .
101. ...or electric generators, seen here,...
102. ...or even photocells, seen on this calculator.
103. Let's take a quick look at a battery to see how it works to create a continual supply of electricity.
104. A battery produces electrical energy from chemical energy.
105. Through a variety of materials inside a battery, a chemical reaction occurs that releases movable electrical charges. We often refer to this as current electricity.
106. In batteries, there are two different metal rods called electrodes.
107. Each electrode has a different charge. This electrode has a positive charge and this one has a negative charge.
108. You Decide! This battery is not providing a flow of electricity right now.
109. What can we do to create a flow of electric charge?
110. That's right, if we connect the electrode with a wire, the charged particles will flow from one electrode to the other electrode.
111. This wire is conducting enough flowing charged particles, or electricity, to light this small light bulb.
112. **Graphic Transition – Conductors and Insulators**
113. What makes it possible to touch this live electric cord and not get a shock?
114. The answer lies in the material used to cover the live electric wire inside.
115. Most electric wires are covered with rubber, a material that does not allow electricity to easily flow through it.
116. Materials such as rubber, wood, and glass are called insulators. Covering electric wire with an insulator makes them safer for use in our homes.
117. But inside the cord is a material that allows electricity to flow easily. The material inside the cord is called copper.
118. Most metals are good conductors of electricity. A conductor is a material through which electrical charges can easily flow.
119. Chances are the wiring in your home is made of copper.
120. Water is a good conductor and that is why it is a good idea to stay away from water during an electric storm.
121. **Graphic Transition – Summing Up**
122. During the past few minutes, we have taken a look at many of the different characteristics of electricity.
123. We have seen how electric charges are formed, and....
124. ...how electric charges may attract or repel each other.
125. We have seen how static electricity is formed and how different objects become charged...
126. ...via friction, induction, and conduction.
127. We also took a look at how lightning is formed...

Script

128. ...and how current electricity is created.
129. Finally, we studied the importance of insulators and conductors.
130. So the next time you use electricity in your home or school, take a minute to think about how electricity is created and functions in our everyday life. You may just appreciate the wonders of electricity a little bit more!

Video Quiz

Fill in the correct word when you hear this tone _____. Good luck and let's get started.

1. Electricity is an important form of _____.
2. Small particles called _____ orbit an atom's nucleus.
3. Like charges exhibit the force of _____.
4. _____ involves the build-up of non-moving charges.
5. Objects through which electricity readily flows are called _____.
6. _____ involves an object acquiring a charge without contact.
7. An _____ is an atom that has gained or lost electrons.
8. Batteries use _____ energy to produce electrical energy.
9. A lightning bolt is a quick _____ of electric charge.
10. Rubber is an example of an _____.

Answers to Student Assessments

Preliminary Test

1. lightning
2. atom
3. ion
4. repulsion
5. electrons
6. electrodes
7. insulator
8. static electricity
9. copper
10. conductors
11. False
12. True
13. True
14. True
15. False
16. True
17. False
18. True
19. False
20. True

Video Review

You Decide:

A. Oppositely charged particles will attract each other.
B. static electricity
C. A negatively charged plastic rod will attract the positively charged paper.
D. The metal leaves repel each other.
E. The glass rod causes the metal leaves to repel each other.
F. When the build-up of charges becomes great, the electric charge is discharged.
G. Connect the electrode with a wire, causing the charged particles to flow from one electrode to another.

Video Quiz:

1. energy
2. electrons
3. repulsion
4. static electricity
5. conductors
6. induction
7. ion
8. chemical
9. discharge
10. insulator

Post Test

1. False
2. True
3. True
4. False
5. True
6. True
7. False
8. True
9. False
10. True
11. insulator
12. static electricity
13. ion
14. electrodes
15. electrons
16. repulsion
17. lightning
18. conductors
19. copper
20. atom

Answers to Student Activities

Spinning Straws

Conclusions: Answers will vary. Friction was used to charge the comb. Induction was illustrated by placing the charged comb against the side of the jar. You experience friction and induction when you walk across a carpet and then touch a doorknob, receiving a shock!

A Snake's Static Electricity

Conclusions: The tissue paper spiral should rise toward the pen. Rubbing the pen with the silk piece demonstrates friction. The pen acquired an overall negative charge after being rubbed with the silk. The negative charge of the pen attracts the positive charge of the tissue paper spiral, causing the spiral to rise toward the pen.

Calculating Electric Charge

Part I:

1. -2
2. 0
3. 29
4. 5
5. 15

Part II:

A. Add 2 electrons to the 1st energy level.
B. Add 2 electrons to the 1st energy level and 4 electrons to the 2nd energy level.
C. Add 2 electrons to the 1st energy level and two to the 2nd energy level.

The Model Atom

Conclusions: Sketches will vary. Two electrons (green balls) would need to be removed to illustrate a charge of +2. Three electrons (green balls) would need to be added to the outside of the nucleus to exhibit a charge of -3.

Vocabulary Lesson

1. atom, d
2. electroscope, b
3. ion, e
4. static electricity, f
5. attraction, c
6. electrons, h
7. induction, i
8. insulators, a
9. conduction, g
10. electric charge, j

Assessment and Student Activity Masters

Name_____

Preliminary Test

Directions: Fill in the blank with the correct word. A list of possible answers is provided at the bottom of the page.

1. It is believed that electricity has existed since the beginning of earth in the form of _____.

2. Electrons orbit the nucleus of an _____.

3. An _____ is an atom that has gained or lost electrons.

4. Objects with the same charge exhibit _____.

5. Induction involves the rearrangement of _____.

6. Two metal rods called _____ can be found in all batteries.

7. Rubber is used to cover electrical wire because it is an _____.

8. The build-up of static charges is called _____ _____.

9. _____ wiring is commonly used in the electrical circuitry of your home because it is a good conductor.

10. _____ are objects through which electricity can readily flow.

copper	molecule
lightning	insulator
electrons	static electricity
ion	atom
electrodes	repulsion
lead	conductors

Name_____

Preliminary Test

Directions: Decide whether the answer is True (T) or False (F).

11. A balloon sticking to a wall is an example of current electricity. T F

12. The effects of different charges can be demonstrated by an electroscope. T F

13. Electrical charges built up in thunderclouds are discharged through lightning. T F

14. A battery produces electrical energy from chemical energy. T F

15. Lightning results when like charges exist in a cloud and on the ground. T F

16. Oppositely charged particles attract each other. T F

17. Objects through which electricity can readily flow are called inductors. T F

18. Insulators are objects through which electricity cannot readily flow. T F

19. Water is a bad conductor of electricity. T F

20. The overall charge of a neutral atom is zero. T F

Name_____

Video Review

Directions: During the course of the program answer the "You Decide" questions as they are presented. Answer the Video Quiz questions at the end of the video.

You Decide:

A. How do you think these oppositely charged particles will react to each other? Answer: _____

B. What force causes this balloon to stick to the wall without the use of tape or glue? Answer: _____

C. How could you move these small pieces of paper without actually touching them? Answer: _____

D. What do you think will happen to the metal leaves when the rubber rod touches the electroscope? Answer: _____

E. What do you think will happen when the glass rod comes in contact with the electroscope? Answer: _____

F. What happens when the build-up of charges becomes great? Answer: _____

G. What can we do to create a flow of electric charge? Answer: _____

Video Quiz:

1. Electricity is an important form of _____.

2. Small particles called _____ orbit an atom's nucleus.

3. Like charges exhibit the force of _____.

4. _____ involves the build-up of non-moving charges.

5. Objects through which electricity readily flows are called _____.

6. _____ involves an object acquiring charge without contact.

7. An ____ is an atom that has gained or lost electrons.

8. Batteries use _____ energy to produce electrical energy.

9. A lightning bolt is a quick _____ of electric charge.

10. Rubber is an example of an _____.

Name_____

Post Test

Directions: Decide whether the answer is True (T) or False (F).

1. Lightning results when like charges exist in a cloud and on the ground. T F

2. The overall charge of a neutral atom is zero. T F

3. A battery produces electrical energy from chemical energy. T F

4. Water is a bad conductor of electricity. T F

5. The effects of different charges can be demonstrated by an electroscope. T F

6. Electrical charges built up in thunderclouds are discharged through lightning. T F

7. Objects through which electricity can readily flow are called inductors. T F

8. Oppositely charged particles attract each other. T F

9. A balloon sticking to a wall is an example of current electricity. T F

10. Insulators are objects through which electricity cannot readily flow. T F

Name_____

Post Test

Directions: Fill in the blank with the correct word. A list of possible answers is provided at the bottom of the page.

11. Rubber is used to cover electrical wire because it is an _____.

12. The build-up of static charges is called _____ _____.

13. An _____ is an atom that has gained or lost electrons.

14. Two metal rods called _____ can be found in all batteries.

15. Induction involves the rearrangement of _____.

16. Objects with the same charge exhibit _____.

17. It is believed that electricity has existed since the beginning of earth in the form of _____.

18. _____ are objects through which electricity can readily flow.

19. _____ wiring is commonly used in the electrical circuitry of your home because it is a good conductor.

20. Electrons orbit the nucleus of an _____.

copper	lead
molecule	insulator
electrons	static electricity
lightning	atom
ion	repulsion
electrodes	conductors

Name_____

Spinning Straws

Objective:
In this lab you will observe the acquisition of charge via friction and induction.

Background:
Most objects can acquire a positive or negative charge. When you walk across a rug in a dry room, your body can become negatively charged. When your hand draws near objects, such as a doorknob, your negatively charged hand creates a positively charged region on the door knob. You receive a shock when the build up of charges is discharged. Charge may be acquired in a variety of ways. One way is via **conduction**. In conduction, one object transfers a charge to a second object with which it is in contact. A second method of charge acquisition is **friction**. With friction, charge is transferred between two objects when they are rubbed together. An object can also acquire a charge via **induction,** in which the objects do not come in contact with one another. Rather, the charges of two objects rearrange themselves when the objects are brought near each other. Let's see these methods of charge acquisition at work!

Materials:

Glass jar (medium size)	Wool cloth
Fine thread	Rubber comb
2 Straws	Scissors

Procedure:
1. Cut one of the soda straws to a length that will fit horizontally in the glass jar.
2. Tie a piece of fine thread around the full length straw and lay the straw over the top of the jar. Adjust the length of the string so that it hangs a few centimeters above the bottom of the jar.
3. Tie the hanging piece of thread to the shorter straw. Lay the full length straw across the top of the jar, allowing the shorter straw to hang horizontally in the jar.
4. Vigorously rub the comb with the wool cloth and hold it up to the side of the jar.
5. Repeat this process, holding the comb up to different areas of the jar each time. Observe what happens when the comb is dragged around the jar.

Conclusions:
Describe your observations. How was friction used as a method of charge acquisition? How was induction illustrated as a second method of charge acquisition? Can you think of any examples of how you use friction and induction as methods of charge acquisition?

Name_____

A Snake's Static Electricity

Objective:
In this lab you will use the power of static electricity to charm a snake.

Background:
How many of you have taken off a sweater and seen your hair stand up straight, or have rubbed a balloon against your hair and watched it stick to the wall? These are classic examples of **static electricity**. In order to understand static electricity, we must begin at the level of the atom. Each atom has **protons** and **neutrons** in the nucleus which are balanced by **electrons** orbiting the nucleus. When electrons are gained, the atom becomes negatively charged. When they are lost, the atom becomes positively charged. Any atom that gains or loses electrons becomes an **ion**. Let's take the balloon example. When a balloon is rubbed against someone's head, it gains electrons and becomes negatively charged. When it is placed in contact with the wall, the negative charge of the balloon is attracted to the positive charge of the wall, causing the balloon to stick. This is static electricity - a build up of non-moving charges.

Materials:

Tissue paper (large sheet)	Plastic pen
Piece of silk (handkerchief size)	Scissors
Metal cookie sheet	Metric ruler

Procedure:
1. Divide into small groups of two or three students. Draw a circle with a 20-cm diameter on the large sheet of tissue paper. Make sure the tissue paper does not tear. Cut out the circle you have drawn.
2. Using a pen, draw a spiral that begins at the center of the circle and extends to the outer margins of the circle.
3. Cut along the spiral so that you end up with a continuous piece of tissue paper. Place the spiral on the cookie sheet.
4. Briskly rub the plastic pen with the piece of silk. Place the end of the pen directly above the tissue paper spiral. Lift the pen to observe how static electricity can charm a snake!

Conclusions:
Describe your observations. What form of charge acquisition was illustrated by rubbing the pen with the silk cloth? Describe how static electricity works in this example.

Name_____

Calculating Electric Charge

Part I:

Background:

The **atom** plays an important role in electricity. Smaller particles existing within an atom play key roles in the development of electric charges. The center of an atom is called the **nucleus**. Within the nucleus are small particles called **protons** and **neutrons**. Protons carry a positive charge, while neutrons have a neutral charge. The number of protons and neutrons within a nucleus is always equal. Particles called **electrons** orbit the nucleus and carry a negative charge. In a neutral atom, the number of protons equals the number of electrons, causing the overall charge to be zero. Yet atoms may gain or lose electrons, becoming charged **ions**. If an atom gains electrons, the overall charge becomes negative because there are more negatively charged particles (electrons) than positively charged particles (protons). If an atom loses electrons, it becomes positively charged because there are more positive protons than negative electrons. Charges are indicated by placing a plus or minus sign before the value of the charge. For example, an atom with two more electrons than protons has a -2 charge.

Directions: Use the information provided above to answer the following questions.

Questions:

1. A nickel atom has 28 protons and 30 electrons. What is the overall charge of this ion?

2. An atom of boron has five protons and five electrons. What is the overall charge of this atom?

3. A cobalt atom has 27 protons and a charge of -2. How many electrons orbit the nucleus of this ion?

4. An atom of oxygen has 8 protons and a charge of +3. How many electrons orbit the nucleus of this ion?

5. An atom of phosphorous has 16 electrons and a charge of -1. How many protons are in the nucleus of this ion?

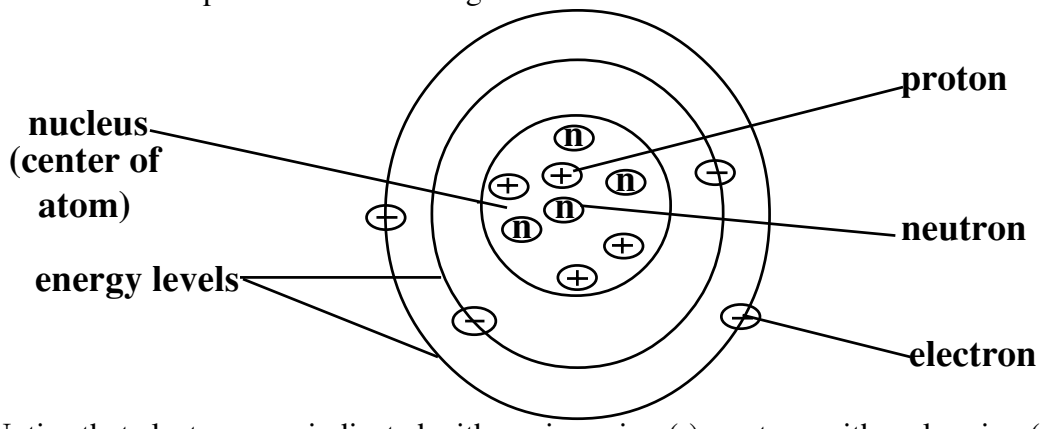
Part II:

Background: As you have learned, electrons orbit the nucleus in an **electron cloud**. Because they are energy-filled particles, electrons are in constant motion and therefore do not remain in one place. Sometimes they might orbit near the nucleus, while other times they might orbit farther away. Therefore, an electron cloud is a space in which electrons are likely to be found. Although an electron is constantly moving about, it is confined to a specific area that depends on the amount of energy it carries. Electrons are arranged in energy levels surrounding the nucleus. Electrons with low energy are located in energy levels near the nucleus, while those with high energy are located in energy levels farther away from the nucleus. Each energy level can only hold a specific number of electrons. The level closest to the nucleus can hold 2 electrons, the second level can hold 8 electrons, the third can hold 18 electrons, and so on.

Name_____

Calculating Electric Charge (cont.)

Here is an example of a common diagram of an atom.



Notice that electrons are indicated with a minus sign (-), protons with a plus sign (+) and neutrons with a lowercase *n*. This atom has a neutral charge because there are an equal number of protons and electrons.

Directions: Below are three incomplete diagrams of ions with their individual charges. Complete the diagrams by adding the number of electrons needed to satisfy the assigned charge.

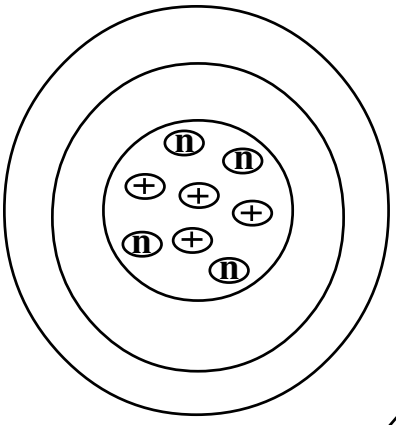


Diagram A: +2

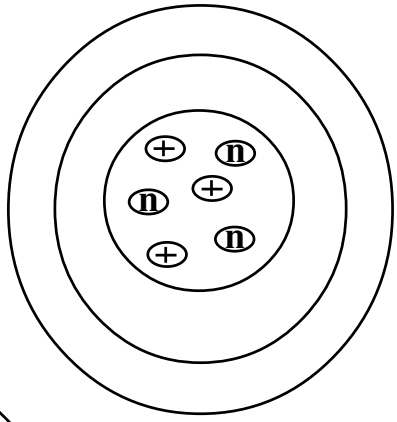


Diagram B: -3

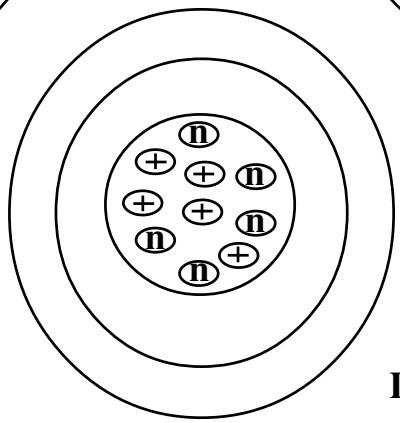


Diagram C: +1

Name_____

The Model Atom

Objective:
In this activity you will build a model atom to gain a better understanding of electric charge.

Background:
The **atom** is the smallest whole particle of matter. The atom is much too small to be seen by the naked eye but scientists have used very powerful microscopes to determine atomic structure. An atom consists of three smaller particles called **protons, neutrons**, and **electrons**. Protons and neutrons are found in equal numbers in the nucleus of the atom. Electrons orbit the nucleus in an **electron cloud**. Both protons and neutrons have a property called **charge**. Protons are positively charged and electrons are negatively charged. Neutrons are neutral and carry no charge. In a neutral atom, there is an equal number of protons and electrons. When an atom suddenly gains or loses electrons, it becomes a charged particle called an **ion**. Let's build our own model of an atom!

Materials:
Modeling clay - red, green, and blue
Tooth picks
Periodic Table

Procedure:
1. Find the element oxygen on the Periodic Table. The atomic number of oxygen is 8, meaning there are eight protons, eight electrons, and eight neutrons. This is the atom you will model.
2. Using the red clay, roll six small balls. These will be the protons.
3. Using the blue clay, roll six small balls. These will be the neutrons.
4. Create the nucleus by pressing the proton and neutron balls together into a single large ball.
5. Using the green clay, create six balls much smaller than the ones in the nucleus.

Name_____

The Model Atom

6. Break 3 toothpicks in half. Place the 6 toothpick halves around the formed nucleus. Place the small green balls on the other end of the toothpick. These represent the orbiting electrons.

Conclusions:
Draw a sketch below of the model atom you have created. Label positively charged particles with a plus (+) sign, negatively charged particles with a minus (-) sign, and neutrons with a lowercase *n*. How would you alter your model if the oxygen atom gained a charge of +2? How would you alter your model if the oxygen atom gained a charge of -3?

Name_____

Vocabulary of Electricity

Directions: Unscramble the following vocabulary words and match each word with its correct definition.

___ 1. moat

___ 2. spoeelecrtco

___ 3. noi

___ 4. citsta lectrieytic

___ 5. ttractiona

___ 6. srontceel

___ 7. cutniodin

___ 8. rotaslusin

___ 9. nuctiodonc

___ 10. crticlee garehc

a. objects through which electricity does not readily flow

b. instrument used to observe electric charge

c. force exhibited by unlike charges

d. smallest known whole particle of matter

e. atom which has gained or lost electrons

f. build-up of non-moving charges

g. process of acquiring a charge from direct contact with another object

h. small particles which orbit the nucleus of an atom

i. process of acquiring charge without direct contact with another object

j. property of an object which could give rise to either attraction or repulsion