Electricity

Grade Level or Special Area: Eighth Grade Science
Written by: Aida Peterson, Clear Lake Middle School, Denver, Colorado
Length of Unit: Twelve lessons (approximately 12 days; one day = 50 minutes)

I. ABSTRACT

In this unit students will investigate electricity. Through lecture, note-taking, demonstrations, and laboratory investigations, the students will learn about static electricity and electric discharge and the role they play in everyday life. They will learn about conductors and insulators, parallel and series circuits, and how batteries work. This will give them an understanding of electricity; what is it and how it works.

II. OVERVIEW

A. Concept Objectives
   1. Develop an awareness of measuring quantities associated with energy forms (for example: electrical charge, current, voltage), comparing series and parallel circuits, using various materials in a simple circuit and showing the difference between conductors and insulators (adapted from *Colorado Science Model Content Standards, Standard 2.2*)

B. Content from the *Core Knowledge Sequence*
   1. 8th Grade Science: Electricity (p. 199)
      a. Basic terms and concepts (review from grade 4):
         i. Electricity is the flow of electrons in a conductor.
         ii. Opposite charges attract, like charges repel.
         iii. Conductors and insulators
         iv. Open and closed circuits
         v. Short circuit: sudden surge in amperage due to the reduction of resistance in a circuit; protection from short circuits is achieved by fuses and circuit breakers
         vi. Electrical safety
      b. Electricity as the flow of electrons
         i. Electrons carry negative charge; protons carry positive charge
         ii. Conductors: materials like metals that easily give up electrons
         iii. Insulators: materials like glass that do not easily give up electrons
      c. Static Electricity
         i. A static charge (excel or deficiency) creates an electric field.
         ii. Electric energy can be stored in capacitors (typically two metal plates, one charged positive and one charged negative, separated by an insulating barrier). Capacitor discharges can release fatal levels of energy.
         iii. Grounding drains an excess or makes up a deficiency of electrons, because the earth is a huge reservoir of electrons. Your body is a ground when you get a shock of static electricity.
         iv. Lightning is a grounding of static electricity from the clouds.
      d. Flowing electricity
         i. Electric potential is measured in volts.
         ii. Electric flow or current is measured in amperes: 1 ampere = flow of 1 coulomb of charge per second (1 coulomb = the charge of 6.25 billion billion electrons).

iii. The total power of an electric flow over time is measured in watts.
iv. The unit of electrical resistance is the ohm. Ohm's law: watts = amps x volts. And the corollaries: amps = watts/volts; volts = watts/amps.

C. Skill Objectives
1. Students will take notes on electric charge and electricity.
2. Students will take notes on electrical energy.
3. Students will take notes electric current.
4. Students will take notes on electric circuits.
5. Students will work in a cooperative group.
6. Students will make observations and collect data.
7. Students will analyze the results from an experiment.
8. Students will write a conclusion about what they have learned from the experiment.
9. Students will practice safety rules during a laboratory investigation.
10. Student will demonstrate their understanding of the static electricity and electrical energy sections by completing a quiz.
11. Student will demonstrate their understanding of the electric current and electric circuits sections by completing a quiz.
12. Students will demonstrate their knowledge and understanding of the electricity unit by taking a unit test.

III. BACKGROUND KNOWLEDGE

A. For Teachers
1. Physical Science. *Holt Science and Technology*
2. ScienceSaurus: A Student Handbook

B. For Students
None

IV. RESOURCES

A. List of laboratory materials needed for each lab is included before each lesson

V. LESSONS

Lesson One: Electric Charge and Electricity Notes (50 minutes)

A. *Daily Objectives*
1. Concept Objective(s)
a. Develop an awareness of measuring quantities associated with energy forms (for example: electrical charge, current, voltage), comparing series and parallel circuits, using various materials in a simple circuit and showing the difference between conductors and insulators (adapted from *Colorado Science Model Content Standards, Standard 2.2*)
2. Lesson Content
a. Basic terms and concepts (review from grade 4):
i. Electricity is the flow of electrons in a conductor.
ii. Opposite charges attract, like charges repel.
iii. Conductors and insulators
iv. Open and closed circuits
v. Short circuit: sudden surge in amperage due to the reduction of resistance in a circuit; protection from short circuits is achieved by fuses and circuit breakers

vi. Electrical safety

b. Electricity as the flow of electrons
   i. Electrons carry negative charge; protons carry positive charge
   ii. Conductors: materials like metals that easily give up electrons
   iii. Insulators: materials like glass that do not easily give up electrons

c. Static Electricity
   i. A static charge (excel or deficiency) creates an electric field.
   ii. Electric energy can be stored in capacitors (typically two metal plates, one charged positive and one charged negative, separated by an insulating barrier). Capacitor discharges can release fatal levels of energy.
   iii. Grounding drains an excess or makes up a deficiency of electrons, because the earth is a huge reservoir of electrons. Your body is a ground when you get a shock of static electricity.
   iv. Lightning is a grounding of static electricity from the clouds.

3. Skill Objective(s)
   a. Students will take notes on electric charge and electricity.

B. *Materials*
1. Overhead projector
2. Transparencies of Notes on Electric Charge and Electricity, Appendix A (pp. 1, 2 and 3)
3. Science notebook (students')
4. Colored pencils or colored markers (students')
5. Pencil, pen, ruler and eraser (student's supplies needed to take notes with)
6. Four balloons
7. A clean blackboard or dry wall space

C. *Key Vocabulary*
1. Proton—positively charged particle
2. Electron—negatively charged particle
3. Electric field—a region around a charged particle that exerts a force on other charged particles
4. Conductor—material in which charges can move easily
5. Insulator—a material in which charges cannot easily move
6. Static electricity—the buildup of electric charges in an object
7. Electric discharge—the loss of static electricity as charges move off an object
8. Electrostatic force—force between charged objects

D. *Procedures/Activities*
1. Blow four balloons up. Tell the students that you constructed an imaginary shelf on the blackboard.
2. One by one rub the balloons carefully against your sleeve or shirt, as if cleaning the dust off them, then stick them to the blackboard in a horizontal row.
3. Ask them to explain how you are able to do that. Guide them to talk about how rubbing the balloon results in static electricity that makes the balloons able to stick to the board
4. Tell them that static electricity is a type of electricity and ask them what they think electricity is. Let them share their answers. Then tell them today they will be learning about and taking notes about electric charge and electricity.
5. Ask the students to get out their science notebooks, pencil or pen, colored pencils or markers and their ruler and eraser.

6. Remind them that they should try to be as neat as possible in their notebook, so that they may use it later to get the information easily.
7. Remind them that in order to make it easier to access the information in their notes, the students will be skipping lines wherever there is spacing on the overhead notes, they will be writing their headings in color and they will be putting a box around each vocabulary word in color.
8. Allow the students to get their notebook and supplies ready.
9. Use transparencies of Appendix A to give the students the notes.
10. As you put the transparencies on the overhead, talk briefly about what the students are writing.
11. Allow the students to copy the notes. Remind them to use color and skip lines where appropriate.
12. Collect and grade the notebooks.

E. *Assessment/Evaluation*

1. Collect and grade science notebook for neatness and completeness. Use Appendix M, Rubric for Grading Science Notebook, to grade the notes.

Lesson Two: The Magnetic Ruler Lab (50 minutes)

A. *Daily Objectives*

1. Concept Objective(s)
   a. Develop an awareness of measuring quantities associated with energy forms (for example: electrical charge, current, voltage), comparing series and parallel circuits, using various materials in a simple circuit and showing the difference between conductors and insulators (adapted from *Colorado Science Model Content Standards, Standard 2.2*)
2. Lesson Content
   a. Static Electricity
      i. A static charge (excel or deficiency) creates an electric field.
      ii. Electric energy can be stored in capacitors (typically two metal plates, one charged positive and one charged negative, separated by an insulating barrier). Capacitor discharges can release fatal levels of energy.
      iii. Grounding drains an excess or makes up a deficiency of electrons, because the earth is a huge reservoir of electrons. Your body is a ground when you get a shock of static electricity.
      iv. Lightning is a grounding of static electricity from the clouds.
3. Skill Objective(s)
   a. Students will work in a cooperative group.
   b. Students will make observations and collect data.
   c. Students will analyze the results from an experiment.
   d. Students will write a conclusion about what they have learned from the experiment.
   e. Students will practice safety rules during a laboratory investigation.

B. *Materials* (per group of four students)

1. Plastic ruler
2. Handkerchief or piece of cloth
3. Short thin strip of paper
4. Copy of Appendix B, The Magnetic Ruler Lab (for each student)

C. *Key Vocabulary*

No new vocabulary

D. *Procedures/Activities*
   1. Tell the students that today they will be doing an experiment to find out if electricity could exert a force.
   2. Pass a copy of The Magnetic Ruler Lab, Appendix B, p. 1 to each student.
   3. Group the students in groups of four. Allow the students to read the lab within their group to figure out what they will be doing.
   4. While the students are reading their lab handouts, pass out a tray containing the materials needed for the lab to each group of four students.
   5. Allow the students to work on the lab in their groups while you circle around the room to check that students are on task and to answer any questions they may need answered.
   6. Allow the students to answer the questions in the lab within their group. Then pick up the lab handout to be graded.

E. *Assessment/Evaluation*
   1. Evaluate the students' lab reports using Appendix N, Rubric for Grading Science Labs.

Lesson Three: Electrical Energy Notes (50 minutes)

A. *Daily Objectives*
   1. Concept Objective(s)
      a. Develop an awareness of measuring quantities associated with energy forms (for example: electrical charge, current, voltage), comparing series and parallel circuits, using various materials in a simple circuit and showing the difference between conductors and insulators (adapted from *Colorado Science Model Content Standards, Standard 2.2*)
   2. Lesson Content
      a. Basic terms and concepts (review from grade 4):
         i. Electricity is the flow of electrons in a conductor.
         ii. Opposite charges attract, like charges repel.
         iii. Conductors and insulators
         iv. Open and closed circuits
         v. Short circuit: sudden surge in amperage due to the reduction of resistance in a circuit; protection from short circuits is achieved by fuses and circuit breakers
         vi. Electrical safety
      b. Electricity as the flow of electrons
         i. Electrons carry negative charge; protons carry positive charge
         ii. Conductors: materials like metals that easily give up electrons
         iii. Insulators: materials like glass that do not easily give up electrons
   3. Skill Objective(s)
      a. Students will take notes on electrical energy.

B. *Materials*
   1. Overhead projector
   2. Transparencies of Notes on Electric Charge and Electricity, Appendix C (pp. 1 and 2)
   3. Science notebook (students')
   4. Colored pencils or colored markers (students')
   5. Pencil, pen, ruler and eraser (student's supplies needed to take notes with)

C. *Key Vocabulary*
   1. Electrical energy—the energy associated with moving charges

2. Electric current—a continuous flow of charge
3. Cell—device that produces an electric current by converting chemical energy into electrical energy
4. Battery—made of several cells and also converts chemical energy to electrical energy
5. Electrolyte—a mixture of chemicals that conducts a current in a cell
6. Electrodes—made from two different conducting materials that are in contact with the electrolyte and through which charges enter or exit
7. Wet cells—cells that contain liquid electrolytes
8. Dry cells—cells that contain solid or paste-like electrolytes

D. *Procedures/Activities*

1. Ask the students where the electricity they use in their houses comes from. Let them come up with answers to share. Then ask them what electricity is. Let them think of answers and share them with the class.
2. Tell them that today they will be learning about and taking notes on electrical energy.
3. Ask the students to get out their science notebooks, pencil or pen, colored pencils or markers and their ruler and eraser.
4. Remind them that they should try to be as neat as possible in their notebook, so that they may use it later to get the information easily.
5. Remind them that in order to make it easier to access the information in their notes, the students will be skipping lines wherever there is spacing on the overhead notes, they will be writing their headings in color and they will be putting a box around each vocabulary word in color.
6. Allow the students to get their notebook and supplies ready.
7. Use transparencies of Appendix C to give the students the notes.
8. As you put the transparencies on the overhead, talk briefly about what the students are writing.
9. Allow the students to copy the notes. Remind them to use color and skip lines where appropriate.
10. Collect and grade the notebooks.

E. *Assessment/Evaluation*

1. Collect and grade science notebook for neatness and completeness. Use Appendix M, Rubric for Grading Science Notebook, to grade the notes.

Lesson Four: Electricity From a Lemon Lab (50 minutes)

A. *Daily Objectives*

1. Concept Objective(s)
   a. Develop an awareness of measuring quantities associated with energy forms (for example: electrical charge, current, voltage), comparing series and parallel circuits, using various materials in a simple circuit and showing the difference between conductors and insulators (adapted from *Colorado Science Model Content Standards, Standard 2.2*)
2. Lesson Content
   a. Basic terms and concepts (review from grade 4):
      i. Electricity is the flow of electrons in a conductor.
      ii. Opposite charges attract, like charges repel.
      iii. Conductors and insulators
      iv. Open and closed circuits

v. Short circuit: sudden surge in amperage due to the reduction of resistance in a circuit; protection from short circuits is achieved by fuses and circuit breakers
vi. Electrical safety

b. Electricity as the flow of electrons
i. Electrons carry negative charge; protons carry positive charge
ii. Conductors: materials like metals that easily give up electrons
iii. Insulators: materials like glass that do not easily give up electrons

3. Skill Objective(s)
a. Students will work in a cooperative group.
b. Students will make observations and collect data.
c. Students will analyze the results from an experiment.
d. Students will write a conclusion about what they have learned from the experiment.
e. Students will practice safety rules during a laboratory investigation.

B. *Materials* (per group of four students)
1. A Copper strip and a Zinc strip (electrodes)
2. Two copper wire lengths
3. 0.2-V bulb in a bulb holder or a galvanometer
4. Copy of Appendix D, Electricity From a Lemon Lab (for each student)

C. *Key Vocabulary*
No new vocabulary

D. *Procedures/Activities*
1. Tell the students that today they will be making a wet cell using a lemon.
2. Pass a copy of Appendix D, Electricity From a Lemon Lab, to each student.
3. Group the students in groups of four. Allow the students to read the lab within their group to figure out what they will be doing.
4. While the students are reading their lab handouts, pass out a tray containing the materials needed for the lab to each group of four students.
5. Allow the students to work on the lab in their groups while you circle around the room to check that students are on task and to answer any questions they may need answered.
6. Allow the students to answer the questions in the lab within their group. Then pick up the lab handout to be graded.

E. *Assessment/Evaluation*
1. Evaluate the students' lab reports using Appendix N, Rubric for Grading Science Labs.

Lesson Five: Electricity Quiz 1 (50 minutes)

A. *Daily Objectives*
1. Concept Objective(s)
a. Develop an awareness of measuring quantities associated with energy forms (for example: electrical charge, current, voltage), comparing series and parallel circuits, using various materials in a simple circuit and showing the difference between conductors and insulators (adapted from *Colorado Science Model Content Standards, Standard 2.2*)

2. Lesson Content
a. Basic terms and concepts (review from grade 4):
i. Electricity is the flow of electrons in a conductor.
ii. Opposite charges attract, like charges repel.

iii. Conductors and insulators
iv. Open and closed circuits
v. Short circuit: sudden surge in amperage due to the reduction of resistance in a circuit; protection from short circuits is achieved by fuses and circuit breakers
vi. Electrical safety

b. Electricity as the flow of electrons
i. Electrons carry negative charge; protons carry positive charge
ii. Conductors: materials like metals that easily give up electrons
iii. Insulators: materials like glass that do not easily give up electrons

c. Static Electricity
i. A static charge (excel or deficiency) creates an electric field.
ii. Electric energy can be stored in capacitors (typically two metal plates, one charged positive and one charged negative, separated by an insulating barrier). Capacitor discharges can release fatal levels of energy.
iii. Grounding drains an excess or makes up a deficiency of electrons, because the earth is a huge reservoir of electrons. Your body is a ground when you get a shock of static electricity.
iv. Lightning is a grounding of static electricity from the clouds.

3. Skill Objective(s)
a. Student will demonstrate their understanding of the static electricity and electrical energy sections by completing a quiz.

B. *Materials*
1. Copy of Appendix E, Electricity Quiz 1, for each student
2. Writing utensil

C. *Key Vocabulary*
No new vocabulary

D. *Procedures/Activities*
1. Tell students that today they will be taking a quiz over the notes they have taken in Lesson One and Lesson Three.
2. Pass out a copy of Appendix E, Electricity Quiz 1, to each student.
3. Allow the students to work on their quiz and circle the room to monitor.
4. Collect the papers to grade.

E. *Assessment/Evaluation*
1. Evaluate students' knowledge of the electricity unit so far by grading their quiz.

Lesson Six: Electric Current Notes (50 minutes)

A. *Daily Objectives*
1. Concept Objective(s)
a. Develop an awareness of measuring quantities associated with energy forms (for example: electrical charge, current, voltage), comparing series and parallel circuits, using various materials in a simple circuit and showing the difference between conductors and insulators (adapted from *Colorado Science Model Content Standards, Standard 2.2*)

2. Lesson Content
a. Flowing electricity
i. Electric potential is measured in volts.

ii. Electric flow or current is measured in amperes: 1 ampere = flow of 1 coulomb of charge per second (1 coulomb = the charge of 6.25 billion billion electrons).
iii. The total power of an electric flow over time is measured in watts.
iv. The unit of electrical resistance is the ohm. Ohm's law: watts = amps x volts. And the corollaries: amps = watts/volts; volts = watts/amps.

3. Skill Objective(s)
   a. Students will take notes electric current.

B. *Materials*
1. Overhead projector
2. Transparencies of Notes on Electric Current, Appendix F (pp. 1, 2 and 3)
3. Science notebook (students')
4. Colored pencils or colored markers (students')
5. Pencil, pen, ruler and eraser (student's supplies needed to take notes with)

C. *Key Vocabulary*
1. Current—the rate at which charge passes a given point
2. Direct current—a current where the charges always flow in the same direction
3. Alternating current—a current where the charges continually switch from flowing in one direction to flowing in the reverse direction
4. Voltage—the difference in energy per unit charge as a charge moves between two points in the path of a current
5. Resistance—the opposition to the flow of electric charge
6. Electric power—the rate at which electrical energy is used to do work

D. *Procedures/Activities*
1. Tell the students that so far they have learned about how electrical energy can be generated. Today they will learn more about electric current and about the electrical energy that they use in their homes.
2. Ask the students to get out their science notebooks, pencil or pen, colored pencils or markers and their ruler and eraser.
3. Remind them that they should try to be as neat as possible in their notebook, so that they may use it later to get the information easily.
4. Remind them that in order to make it easier to access the information in their notes, the students will be skipping lines wherever there is spacing on the overhead notes, they will be writing their headings in color and they will be putting a box around each vocabulary word in color.
5. Allow the students to get their notebook and supplies ready.
6. Use transparencies of Appendix F to give the students the notes.
7. As you put the transparencies on the overhead, talk briefly about what the students are writing.
8. Allow the students to copy the notes. Remind them to use color and skip lines where appropriate.
9. Collect and grade the notebooks.

E. *Assessment/Evaluation*
1. Collect and grade science notebook for neatness and completeness. Use Appendix M, Rubric for Grading Science Notebook, to grade the notes.

Lesson Seven: Regulate the Current with a Pencil Lab (50 minutes)

A. *Daily Objectives*

1. Concept Objective(s)
   a. Develop an awareness of measuring quantities associated with energy forms (for example: electrical charge, current, voltage), comparing series and parallel circuits, using various materials in a simple circuit and showing the difference between conductors and insulators (adapted from *Colorado Science Model Content Standards, Standard 2.2*)
2. Lesson Content
   a. Flowing electricity
      i. Electric potential is measured in volts.
      ii. Electric flow or current is measured in amperes: 1 ampere = flow of 1 coulomb of charge per second (1 coulomb = the charge of 6.25 billion billion electrons).
      iii. The total power of an electric flow over time is measured in watts.
      iv. The unit of electrical resistance is the ohm. Ohm's law: watts = amps x volts. And the corollaries: amps = watts/volts; volts = watts/amps.
3. Skill Objective(s)
   a. Students will work in a cooperative group.
   b. Students will make observations and collect data.
   c. Students will analyze the results from an experiment.
   d. Students will write a conclusion about what they have learned from the experiment.
   e. Students will practice safety rules during a laboratory investigation.

B. *Materials* (per group of four students)

1. Long pencil
2. 6-V battery
3. Three pieces of wire with alligator clips at both ends
4. 6-V light bulb
5. Light bulb holder
6. Copy of Appendix G, Regulate the Current with a Pencil Lab (for each student)

C. *Key Vocabulary*

No new vocabulary

D. *Procedures/Activities*

1. Tell the students they have learned how materials conduct current well; but what are their names. Let the students come up with conductors. And other materials do not conduct current well; what are their names. Let the students come up with insulators. Other materials conduct some current but not very much and these are called semi-conductors. Today you are going to find out if pencil lead is a conductor, semi-conductor or insulator of current.
2. Pass a copy of Appendix G, Regulate the Current with a Pencil Lab, to each student.
3. Group the students in groups of four. Allow the students to read the lab within their group to figure out what they will be doing.
4. While the students are reading their lab handouts, pass out a tray containing the materials needed for the lab, to each group of four students.
5. Allow the students to work on the lab in their groups while you circle around the room to check that students are on task and to answer any questions they may need answered.

6. Allow the students to answer the questions in the lab within their group. Then pick up the lab handout to be graded.

E. *Assessment/Evaluation*

1. Evaluate the students' lab reports using Appendix N, Rubric for Grading Science Labs.

Lesson Eight: Electric Circuits Notes (50 minutes)

A. *Daily Objectives*

1. Concept Objective(s)
   a. Develop an awareness of measuring quantities associated with energy forms (for example: electrical charge, current, voltage), comparing series and parallel circuits, using various materials in a simple circuit and showing the difference between conductors and insulators (adapted from *Colorado Science Model Content Standards, Standard 2.2*)
2. Lesson Content
   a. Basic terms and concepts (review from grade 4):
      i. Electricity is the flow of electrons in a conductor.
      ii. Opposite charges attract, like charges repel.
      iii. Conductors and insulators
      iv. Open and closed circuits
      v. Short circuit: sudden surge in amperage due to the reduction of resistance in a circuit; protection from short circuits is achieved by fuses and circuit breakers
      vi. Electrical safety
   b. Flowing electricity
      i. Electric potential is measured in volts.
      ii. Electric flow or current is measured in amperes: 1 ampere = flow of 1 coulomb of charge per second (1 coulomb = the charge of 6.25 billion billion electrons).
      iii. The total power of an electric flow over time is measured in watts.
      iv. The unit of electrical resistance is the ohm. Ohm's law: watts = amps x volts. And the corollaries: amps = watts/volts; volts = watts/amps.
3. Skill Objective(s)
   a. Students will take notes on electric circuits.

B. *Materials*

1. Overhead projector
2. Transparencies of Notes on Electric Circuits, Appendix H (pp. 1 and 2)
3. Science notebook (students')
4. Colored pencils or colored markers (students')
5. Pencil, pen, ruler and eraser (student's supplies needed to take notes with)

C. *Key Vocabulary*

2. Electric circuit—a complete, closed path through which electric charges flow
3. Load—device that uses electrical energy
4. Switch—device used to open and close a circuit
5. Series—a circuit in which all parts are connected in a single loop
6. Parallel—a circuit in which different loads are located on separate branches

D. *Procedures/Activities*

1. Ask the students if this has ever happened to them. They're sitting around the Christmas tree and all of a sudden all the lights on the tree go out. What made all

the lights go out? Let them come up with answers to share. Guide them to talk about open vs. closed circuits. So in order for the lights to go out the circuit must have been opened. Talk about what may cause the circuit to be opened (burnt light bulb). Ask them how come when one light bulb goes out in a room, the rest of the bulbs in a house don't usually go all out too. Let them come up with explanations to share.

2. Tell them today they will be taking notes on different types of circuits.
3. Ask the students to get out their science notebooks, pencil or pen, colored pencils or markers and their ruler and eraser.
4. Remind them that they should try to be as neat as possible in their notebook, so that they may use it later to get the information easily.
5. Remind them that in order to make it easier to access the information in their notes, the students will be skipping lines wherever there is spacing on the overhead notes, they will be writing their headings in color and they will be putting a box around each vocabulary word in color.
6. Allow the students to get their notebook and supplies ready.
7. Use transparencies of Appendix H to give the students the notes.
8. As you put the transparencies on the overhead, talk briefly about what the students are writing.
9. Allow the students to copy the notes. Remind them to use color and skip lines where appropriate.
10. Collect and grade the notebooks.

E. *Assessment/Evaluation*

1. Collect and grade science notebook for neatness and completeness. Use Appendix M, Rubric for Grading Science Notebook, to grade the notes.

Lesson Nine: The Dimmer and Brighter Bulbs Lab (50 minutes)

A. *Daily Objectives*

1. Concept Objective(s)
   a. Develop an awareness of measuring quantities associated with energy forms (for example: electrical charge, current, voltage), comparing series and parallel circuits, using various materials in a simple circuit and showing the difference between conductors and insulators (adapted from *Colorado Science Model Content Standards, Standard 2.2*)
2. Lesson Content
   a. Basic terms and concepts (review from grade 4):
      i. Electricity is the flow of electrons in a conductor.
      ii. Opposite charges attract, like charges repel.
      iii. Conductors and insulators
      iv. Open and closed circuits
      v. Short circuit: sudden surge in amperage due to the reduction of resistance in a circuit; protection from short circuits is achieved by fuses and circuit breakers
      vi. Electrical safety
   b. Flowing electricity
      i. Electric potential is measured in volts.
      ii. Electric flow or current is measured in amperes: 1 ampere = flow of 1 coulomb of charge per second (1 coulomb = the charge of 6.25 billion billion electrons).
      iii. The total power of an electric flow over time is measured in watts.

iv. The unit of electrical resistance is the ohm. Ohm's law: watts = amps x volts. And the corollaries: amps = watts/volts; volts = watts/amps.

3. Skill Objective(s)
   a. Students will work in a cooperative group.
   b. Students will make observations and collect data.
   c. Students will analyze the results from an experiment.
   d. Students will write a conclusion about what they have learned from the experiment.
   e. Students will practice safety rules during a laboratory investigation.

B. *Materials*
1. Battery (dry cell)
2. Battery holder
3. Two 1.2-V bulbs with bulb holders
4. Four lengths of copper wire
5. Copy of Appendix I, The Dimmer and Brighter Bulbs Lab, for each student

C. *Key Vocabulary*
No new vocabulary

D. *Procedures/Activities*
1. Tell the students that today they are going to do an experiment to learn about the properties of parallel and series circuits and to find out whether it is better to connect circuits in parallel or in series.
2. Pass a copy of Appendix I, The Dimmer and Brighter Bulbs Lab, to each student.
3. Group the students in groups of four. Allow the students to read the lab within their group to figure out what they will be doing.
4. While the students are reading their lab handouts, pass out a tray containing the materials needed for the lab, to each group of four students.
5. Allow the students to work on the lab in their groups while you circle around the room to check that students are on task and to answer any questions they may need answered.
6. Allow the students to answer the questions in the lab within their group. Then pick up the lab handout to be graded.

E. *Assessment/Evaluation*
1. Evaluate the students' lab reports using Appendix N, Rubric for Grading Science Labs.

Lesson Ten: The Balloon Fuse Lab (50 minutes)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Develop an awareness of measuring quantities associated with energy forms (for example: electrical charge, current, voltage), comparing series and parallel circuits, using various materials in a simple circuit and showing the difference between conductors and insulators (adapted from *Colorado Science Model Content Standards, Standard 2.2*)
2. Lesson Content
   a. Basic terms and concepts (review from grade 4):
      i. Electricity is the flow of electrons in a conductor.
      ii. Opposite charges attract, like charges repel.
      iii. Conductors and insulators
      iv. Open and closed circuits

v. Short circuit: sudden surge in amperage due to the reduction of resistance in a circuit; protection from short circuits is achieved by fuses and circuit breakers
vi. Electrical safety

b. Flowing electricity
i. Electric potential is measured in volts.
ii. Electric flow or current is measured in amperes: 1 ampere = flow of 1 coulomb of charge per second (1 coulomb = the charge of 6.25 billion billion electrons).
iii. The total power of an electric flow over time is measured in watts.
iv. The unit of electrical resistance is the ohm. Ohm's law: watts = amps x volts. And the corollaries: amps = watts/volts; volts = watts/amps.

3. Skill Objective(s)
a. Students will work in a cooperative group.
b. Students will make observations and collect data.
c. Students will analyze the results from an experiment.
d. Students will write a conclusion about what they have learned from the experiment.
e. Students will practice safety rules during a laboratory investigation.

B. *Materials*
1. Small balloon, aluminum foil
2. Simple switch
3. Strong 6-V battery or five 1.2-V D-batteries
4. 6-V bulb with bulb holders
5. Five lengths of copper wire
6. Steel wool
7. Copy of Appendix J, The Balloon Fuse Lab, for each student

C. *Key Vocabulary*
No new vocabulary

D. *Procedures/Activities*
1. Tell the students that today they are going to build a model of a fuse to learn how it works to protect them from house fires.
2. Pass a copy of Appendix J, The Balloon Fuse Lab, to each student.
3. Group the students in groups of four. Allow the students to read the lab within their group to figure out what they will be doing.
4. While the students are reading their lab handouts, pass out a tray containing the materials needed for the lab, to each group of four students.
5. Allow the students to work on the lab in their groups while you circle around the room to check that students are on task and to answer any questions they may need answered.
6. Allow the students to answer the questions in the lab within their group. Then pick up the lab handout to be graded.

E. *Assessment/Evaluation*
1. Evaluate the students' lab reports using Appendix N, Rubric for Grading Science Labs.

Lesson Eleven: Electricity Quiz 2 (50 minutes)

A. *Daily Objectives*

1. Concept Objective(s)
    a. Develop an awareness of measuring quantities associated with energy forms (for example: electrical charge, current, voltage), comparing series and parallel circuits, using various materials in a simple circuit and showing the difference between conductors and insulators (adapted from *Colorado Science Model Content Standards, Standard 2.2*)
2. Lesson Content
    a. Basic terms and concepts (review from grade 4):
        i. Electricity is the flow of electrons in a conductor.
        ii. Opposite charges attract, like charges repel.
        iii. Conductors and insulators
        iv. Open and closed circuits
        v. Short circuit: sudden surge in amperage due to the reduction of resistance in a circuit; protection from short circuits is achieved by fuses and circuit breakers
        vi. Electrical safety
    b. Flowing electricity
        i. Electric potential is measured in volts.
        ii. Electric flow or current is measured in amperes: 1 ampere = flow of 1 coulomb of charge per second (1 coulomb = the charge of 6.25 billion billion electrons).
        iii. The total power of an electric flow over time is measured in watts.
        iv. The unit of electrical resistance is the ohm. Ohm's law: watts = amps x volts. And the corollaries: amps = watts/volts; volts = watts/amps.
3. Skill Objective(s)
    a. Student will demonstrate their understanding of the electric current and electric circuits sections by completing a quiz.

B. *Materials*

1. Copy of Appendix K, Electricity Quiz 2, for each student
2. Writing utensil

C. *Key Vocabulary*

No new vocabulary

D. *Procedures/Activities*

1. Tell students that today they will be taking a quiz over the notes they have taken in on electric current and electric circuits.
2. Pass out a copy of Appendix K, Electricity Quiz 2, to each student.
3. Allow the students to work on their quiz and circle the room to monitor.
4. Collect the papers to grade.

E. *Assessment/Evaluation*

1. Evaluate students' knowledge of the electricity unit so far by grading their quiz.

Lesson Twelve: Electricity Unit Test (50 minutes)

A. *Daily Objectives*

1. Concept Objective(s)
    a. Develop an awareness of measuring quantities associated with energy forms (for example: electrical charge, current, voltage), comparing series and parallel circuits, using various materials in a simple circuit and

showing the difference between conductors and insulators (adapted from *Colorado Science Model Content Standards, Standard 2.2*)

2. Lesson Content
    a. Basic terms and concepts (review from grade 4):
        i. Electricity is the flow of electrons in a conductor.
        ii. Opposite charges attract, like charges repel.
        iii. Conductors and insulators
        iv. Open and closed circuits
        v. Short circuit: sudden surge in amperage due to the reduction of resistance in a circuit; protection from short circuits is achieved by fuses and circuit breakers
        vi. Electrical safety
    b. Electricity as the flow of electrons
        i. Electrons carry negative charge; protons carry positive charge
        ii. Conductors: materials like metals that easily give up electrons
        iii. Insulators: materials like glass that do not easily give up electrons
    c. Static Electricity
        i. A static charge (excel or deficiency) creates an electric field.
        ii. Electric energy can be stored in capacitors (typically two metal plates, one charged positive and one charged negative, separated by an insulating barrier). Capacitor discharges can release fatal levels of energy.
        iii. Grounding drains an excess or makes up a deficiency of electrons, because the earth is a huge reservoir of electrons. Your body is a ground when you get a shock of static electricity.
        iv. Lightning is a grounding of static electricity from the clouds.
    d. Flowing electricity
        i. Electric potential is measured in volts.
        ii. Electric flow or current is measured in amperes: 1 ampere = flow of 1 coulomb of charge per second (1 coulomb = the charge of 6.25 billion billion electrons).
        iii. The total power of an electric flow over time is measured in watts.
        iv. The unit of electrical resistance is the ohm. Ohm's law: watts = amps x volts. And the corollaries: amps = watts/volts; volts = watts/amps.
3. Skill Objective(s)
    a. Students will demonstrate their knowledge and understanding of the electricity unit by taking a unit test.

B. *Materials*
1. Copy of Appendix L, Electricity Unit Test, for each student
2. Writing utensil
3. Calculator

C. *Key Vocabulary*

No new vocabulary

D. *Procedures/Activities*
1. Tell students that today they will be taking a test over the notes they have taken and labs they have done during the electricity unit.
2. Pass out a copy of Appendix L, Electricity Unit Test, to each student.
3. Allow the students to work on their test and circle the room to monitor.

4. Collect the tests to grade.

E. *Assessment/Evaluation*

1. Evaluate students' knowledge and understanding of the electricity unit by grading their tests.

VI. CULMINATING ACTIVITY

A. Appendix L—Electricity Unit Test

VII. HANDOUTS/WORKSHEETS

A. Appendix A: Electric Charge and Electricity
B. Appendix B: The Magnetic Ruler Lab
C. Appendix C: Electrical Energy
D. Appendix D: Electricity From a Lemon Lab
E. Appendix E: Electricity Quiz 1
F. Appendix F: Electric Current
G. Appendix G: Regulate The Current with a Pencil Lab
H. Appendix H: Electric Circuits
I. Appendix I: The Dimmer and Brighter Bulb Lab
J. Appendix J: The Balloon Fuse Lab
K. Appendix K: Electricity Quiz 2
L. Appendix L: Electricity Unit Test
M. Appendix M: Rubric for Grading Science Notebook
N. Appendix N: Rubric for Grading Science Labs

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Electric Charge and Electricity

All matter is composed of very small particles called atoms. Atoms are made of even smaller particles called protons, neutrons, and electrons.

Protons (p^+) are positively charged
Electrons (e^-) are negatively charged
Neutrons (n) are neutral

A **charged object** is one that has gained or lost electrons. A charged object exerts a force—a push or a pull—on other charged objects.

Electrostatic force—force between charged objects

The law of electric charges—states that like charges repel and opposite charges attract

Electric field—a region around a charged particle that can exert a force on another charged particle

Ways an object may become charged:

1. **Friction**—rubbing an object may cause electrons to move between the two objects being rubbed.
2. **Conduction**—Electrons are transferred by direct contact.
3. **Induction**—charges in an uncharged object are rearranged without direct contact with a charged object.

Electroscope—a device used to determine if an object has a charge

Conductor—a material in which charges can move easily

- Most metals are good conductors
- Tap water is a conductor, that's why you avoid using electrical devices near water.

Insulator—a material in which charges cannot easily move.

- Plastic, rubber, glass, wood, and air are all insulators

Static Electricity—the buildup of electric charges in an object

Electric Discharge—the loss of static electricity as charges move off an object

- When you walk on a carpet with rubber-soled shoes, negative charges build up in your body. When you touch a metal doorknob, the negative charges in your body move quickly to the doorknob. Because the electric discharge happens quickly, you feel a shock.

- Lightning is a dramatic example of electric discharge

Lightning Rod—a pointed rod connected to the ground by a wire to provide an easy path for the electric charge to travel to the Earth and not cause damage to buildings.

Name: _____ Period: _____ Date: _____

The Magnetic Ruler

Purpose: **T**o investigate whether static electricity can be considered a force

Materials: plastic ruler, handkerchief, short thin strip of paper

Procedures:

1. Make a small roll (about 2 cm diameter) from the strip of paper, so that it can roll over a smooth surface.
2. Take the ruler in one hand and the handkerchief in the other, and rub the ruler with it vigorously.
3. Approach the paper roll slowly until it moves, then move it away from the roll (try to keep pace with the rolling of the paper).

Analysis and Conclusion:

1. What initiated the attraction of the paper to the ruler?

2. Is the ruler or the paper magnetic?

3. Can static electricity be considered a force? Explain

4. Where did the initial energy originate?

The Magnetic Ruler (Answer Key)

Analysis and Conclusion:

1. What initiated the attraction of the paper to the ruler?

   The ruler is charged with an excess of negative charges and approaching the uncharged roll of paper, the latter gets attracted to the ruler. Almost anything can be rubbed and charged; some materials are easier to charge than others. The paper roll is attracted to the charged ruler, because the opposite charge is being induced in the paper, and an attraction occurs.

2. Is the ruler or the paper magnetic?

   Static electricity charges with their attraction and repulsion properties are often confused with magnetic properties. These are two separate and distinct entities. The first is obtained by the removal or addition of electrons by mechanical means (rubbing), and the latter by sorting or arranging the randomly distributed magnetic fields of the tiny particles (dipoles) of the material in one direction.

3. Can static electricity be considered a force? Explain

   Any attraction resulting in a movement of an object shows that a force is involved; thus electrostatic energy is a force. This can easily be observed, where the paper cylinder rolls form one end of the table to the other, as a result of the attraction of the charged ruler.

4. Where did the initial energy originate?

   The rubbing of the ruler was chemical energy in your body changed into mechanical energy, turned into static electricity.

(adapted from Invitations to Science Inquiry by Tik L. Liem, p. 236)

Electrical Energy

Electrical Energy—the energy associated with moving charges

Electric current—a continuous flow of charge

Energy—ability to do work

Law of Conservation of Energy—states that energy cannot be created or destroyed, but can be converted from one form to another

Cell—device that produces an electric current by converting chemical energy into electrical energy

Battery—is made of several cells and also converts chemical energy to electrical energy

Electrolyte—a mixture of chemicals that conducts a current in a cell

Electrodes—the part of a cell through which charges enter or exit—made of two different conducting materials that are in contact with the electrolyte

Types of Cells:

1. **Wet cells**—contain liquid electrolytes (ex: car battery)
2. **Dry cells**—contain electrolytes that are solid or paste-like (ex: cells used in flashlights and radios)

Why does the electric current exist between the two electrodes?

A chemical reaction causes a difference in charge between the two electrodes. This difference in charge causes the electrons to start flowing creating an electric current.

This difference in charge is called the **potential difference** and is expressed in volts (V)

The greater the potential difference, the greater the current produced.

Name: _____ Period: _____ Date: _____

Electricity From a Lemon

Purpose: To light a bulb with a lemon

Materials: A Copper strip and a Zinc strip (electrodes), two copper wire lengths, 0.2-V bulb in a bulb holder or a galvanometer

Procedures:

1. Make a small nail hole in the end of the metal strips.
2. Insert the copper and zinc strips into the lemon vertically, about 2 cm apart from each other.
3. Connect the wires to each of the electrodes and connect one of the other ends to one terminal of the bulb holder.
4. Get ready with the other loose end of the wire to touch the open terminal of the bulb.
5. Touch the terminal with the loose end of the wire for short moments at time. (The current is so weak that you will not get electrocuted)

Observations: What did you observe?

Analysis and Conclusion:

1. Where does the current come from?

2. What is current electricity?

3. Can we use other metals to make electricity with the lemon?

4. Would two strips of the same metal produce electricity?

5. What other fruit can be used instead of a lemon?

Electricity From a Lemon (Answer Key)

Analysis and Conclusion:

1. Where does the current come from?

   The source of the electron flow in this case is the combination of copper and zinc strips in the citric acid of the lemon. Zinc has more of a tendency to lose electrons compared to copper, and thus connected through the wires and light bulb, the electrons flow from the zinc to the copper strip.

2. What is current electricity?

   Current electricity is a flow of electrons through a completed circuit of conductors.

3. Can we use other metals to make electricity with the lemon?

   Other metal pairs that could be used to develop potential differences are: copper and silver, copper and iron, copper and magnesium.

4. Would two strips of the same metal produce electricity?

   No because two strips of the same metal would not have a potential difference and therefore the electrons will not flow between them.

5. What other fruit can be used instead of a lemon?

   Other fruit that could replace a lemon are, orange, grapefruit.

(adapted from Invitations to Science Inquiry by Tik L. Liem, p. 261)

Name: _____ Period: _____ Date: _____

Electricity Quiz 1

1. Describe how an object is charged by friction

2. Compare charging by conduction and induction

3. What is static electricity?

4. How is the shock you receive from a metal doorknob similar to a bolt of lightning?

5. Name the parts of a cell, and explain how they work together to produce an electric current.

Electricity Quiz 1 (Answer Key)

1. Describe how an object is charged by friction

   When objects are rubbed together, friction transfers electrons between them. Objects losing electrons become positively charged, while objects gaining electrons become negatively charged.

2. Compare charging by conduction and induction

   Charging by conduction involves direct contact between objects, while charging by induction does not. With conduction, electrons flow between objects that are touching each other. With induction, electrons migrate within objects so that the sides of the objects nearest each other are oppositely charged.

3. What is static electricity?

   Static electricity is the build up of electric charge on an object. Examples are clothes sticking together after being in the drier, or you getting shocked when you walk on the carpet and touch the doorknob on a dry day.

4. How is the shock you receive from a metal doorknob similar to a bolt of lightning?

   Both the shock you receive from a metal doorknob and a bolt of lightning are examples of electric discharge.

5. Name the parts of a cell, and explain how they work together to produce an electric current.

   A cell is made of an electrolyte and two electrodes. Chemical reactions in the electrolyte leave extra electrons on one electrode and strip them from the other. If the charged electrodes are connected with a wire, electric charges will flow between them.

Electric Current

Current—the rate at which charge passes a given point. The higher the current is, the more charge passes the point each second.

- Unit of current—the **ampere** (A)—**amp** for short.
- Symbol—the letter I

Types of Electric Current

- **Direct current** (DC)—a current where the charges always flow in the same direction. (Ex: batteries)

- **Alternating current** (AC)—a current where the charges continually switch from flowing in one direction to flowing in the reverse direction. (Ex: current from outlets in your home)

Voltage—the difference in energy per unit charge as a charge moves between two points in the path of a current—another word for potential difference.

Unit of Voltage—**Volts** (V)
Symbol—V

The higher the voltage is, the more energy is released per charge. The current depends on the voltage. The greater the voltage is, the greater the current

Resistance—the opposition to the flow of electric charge.

Unit of resistance—**Ohms** (Ω)
Symbol—R

Resistance is like electrical friction—the higher the resistance of a material, the lower the current.

- An object's resistance depends on the object's material, thickness, length and temperature.
- The resistance of insulators is so high that electric charges cannot flow in them.
- Thick and short wires have less resistance.
- The resistance of metals increases as temperature increases.

The relationship between current, voltage and resistance can be expressed with the following equation:

Ohm's Law

$$\text{Current (A)} = \frac{\text{Voltage (V)}}{\text{Resistance } (\Omega)}$$

Electric Power—the rate at which electrical energy is used to do work.

- Unit of power—**watt** (W)
- Symbol—P

Name: _____ Period: _____ Date: _____

Regulate the Current with a Pencil

Purpose: to investigate how resistance affects current

Materials: long pencil, 6-V battery, three pieces of wire with alligator clips at both ends, 6-V light bulb, light bulb holder

Procedures:

1. Cut the wood of the pencil away to expose the lead
2. Connect the three wire leads with the alligator clips as follows:
    a. From the pencil point to one pole of the light bulb.
    b. From the other pole of the light to one terminal of the battery.
    c. From the other terminal of the battery to the open exposed pencil lead (free moving end of the wire).
3. Hold the fee end of the third wire lead and slide the alligator clip over the exposed pencil lead. Observe the light bulb!

Observations:

What happened?

Analysis and Conclusion:

1. Is pencil lead a conductor of current electricity?

2. What did the light bulb glow dimmer and brighter?

3. What did we have to do in order to make the bulb glow dimmer?

4. Do you think there is more or less resistance for the current to flow through pencil lead compared to copper wire?

Regulate the Current with a Pencil (Answer Key)

Analysis and Conclusion:

1. Is pencil lead a conductor of current electricity?

   Pencil lead is a semi-conductor of current electricity. This means that not all electrons can flow through, thus the voltage is hereby reduced.

2. Why did the light bulb glow dimmer and brighter?

   The longer the length of the pencil lead in the circuit, the more the resistance for the electrons to flow through, and so the lower the voltage, with the result that the bulb glows dimmer.

3. What did we have to do in order to make the bulb glow dimmer?

   By sliding the free end of the wire closer to the stationary end of the pencil (pencil point), this resistance gets less and thus it gets easier for the electrons to flow, resulting in a brighter glow of the bulb. As we slide the wire farther from the end of the pencil (pencil point), the resistance increases and the bulb glows dimmer.

4. Do you think there is more or less resistance for the current to flow through pencil lead compared to copper wire?

   A very long metal wire will have the same effect as the short pencil lead. A variable resistance—a resistance that be changed at will—is called a rheostat. Rheostats are applied in dimmer switches, stove and over temperature controls, and other appliances requiring current flow regulators.

(adapted from Invitations to Science Inquiry by Tik L. Liem, p. 254)

Electric Circuits

Electric circuit—a complete, closed path through which electric charges flow

Load—a device that uses electrical energy

Switch—a device used to open and close a circuit

Types of circuits

- **Series**—a circuit in which all parts are connected in a single loop.

  a. The charges must flow through each part and can only follow one path.

  b. All the loads share the same current.

  c. If one load is broken or missing, the other loads will not work.

Parallel—a circuit in which different loads are located on separate branches

a. The loads in parallel circuit do not have the same current in them.

b. If one of the loads is broken or missing, it does not affect the other loads.

Safety

Broken wires or water can cause electrical appliances to short-circuit. A **short circuit** occurs when charges bypass the loads in the circuit. When the loads are bypassed, the resistance of the circuit drops, and the current in the circuit increases. If the current increases too much, it can produce enough heat to start a fire.

Most electrical appliances, all automobiles and homes are protected with fuses. These fuses can let a certain amount of electricity pass through them. When a sudden surge of electrical flow occurs the fuse or circuit breakers open the circuit so that the strong current stops and does not cause damage.

Name: _____ Period: _____ Date: _____

The Dimmer and Brighter Bulbs

Purpose: To investigate parallel and series circuits

Materials: battery (dry cell), battery holder, two 1.2-V bulbs with bulb holders, four lengths of copper wire

Procedures:

1. Take a battery in its holder and two bulbs in their holders and connect them in series.
2. Turn one of the bulbs loose in the socket. Record your observations.
3. Change the circuit and connect the wires in parallel. Record your observations
4. Now turn on of the bulbs loose in its socket. Record your observations.

Observations:

1. What happens in step 2?

2. What happens in step 3?

3. What happens in step 4?

Analysis and Conclusions:

1. Why are the bulbs in the first circuit glowing dimly?

2. Why are the bulbs in the second circuit glowing brightly?

3. What is the reason that both bulbs are turned off when only one is turned loose in its socket in the first circuit?

4. Why does the second bulb stay on in the second circuit, when one bulb is turned off?

5. What type of circuit would we have in our home?

The Dimmer and Brighter Bulbs (Answer Key)

Observations:

1. What happens in step 2?

   Both light bulbs are turned off.

2. What happens in step 3?

   The light bulbs glow brighter.

3. What happens in step 4?

   Only the light bulb that is loosened is turned off.

Analysis and Conclusions:

1. Why are the bulbs in the first circuit glowing dimly?

   A glowing bulb is an electric circuit gives a certain resistance to the electron flow in the circuit. In the series circuit, the bulbs follow one after another in one wire, adding to the resistance in the current flow, and thus dimming the glow of the bulb.

2. Why are the bulbs in the second circuit glowing brightly?

   In a parallel circuit, each bulb is connected directly to the battery and therefore received all the voltage from the battery, which means that it has more current going through it, which makes it glow brightly.

3. What is the reason that both bulbs are turned off when only one is turned loose in its socket in the first circuit?

   In a series circuit (first circuit), the light bulbs were connected to each other in one loop. When one light bulb was loosened, this caused the circuit to open. An electric current may only flow through a closed circuit.

4. Why does the second bulb stay on in the second circuit, when one bulb is turned off?

   In the parallel circuit, each bulb is individually connected to the battery, independent from each other. If one bulb is loosened, the other bulb is still connected to a closed circuit and therefore will remain glowing.

5. What type of circuit would we have in our home?

   The type of circuit used in our homes is the parallel circuit. Otherwise, if a light bulb were burnt in one room, all the light bulbs in the house would not work. An example of a series and parallel circuit is found in the Christmas lights. Those with one wire in between the bulbs are wired in series, whereas those with two wires between the bulbs have a parallel circuit.

(adapted from Invitations to Science Inquiry by Tik L. Liem, p. 254)

Name: _____ Period: _____ Date: _____

The Balloon Fuse

Purpose: To find out how fuses work

Materials: small balloon, aluminum foil, simple switch, strong 6-V battery or five 1.2-V D-batteries, 6-V bulb with bulb holders, five lengths of copper wire, steelwool

Procedures:

1. Blow up the balloon. Cut two strips of aluminum foil and tape one strand of steelwool between the two strips against the balloon.
2. Use the copper wire to complete the circuit. Use the first copper wire to connect one aluminum foil to one terminal of the battery.
3. Use the second copper wire to connect the other terminal of the battery to one side of the light bulb.
4. Use the third copper wire to connect the other side of the light bulb to the other aluminum foil to complete the circuit. Record what happens.
5. Connect the fourth wire to one side of the switch and the fifth wire to the other side of the switch. Connect the switch to the light bulb in parallel. (i.e. connect the fourth wire about two cm off the wire on the left of the light bulb, and connect the fifth wire about two cm off the wire on the right of the light bulb)
6. Push the switch down to close it. Record what happens.

Observations:

1. What happens in step 4?

2. What happens when the switch is closed?

Analysis and Conclusions:

1. What made the balloon pop when the switch was pushed?

2. What is a short circuit?

3. Which way would electricity rather flow, through the switch or the bulb?

4. Why did the light go out after the balloon popped?

The Balloon Fuse (Answer Key)

Analysis and Conclusions

1. What made the balloon pop when the switch was pushed?

   The single strand of steelwool had the function of the fuse wire. When pushing the switch shorted the circuit, a sudden surge of electric current was flowing though the circuit causing the single strand of steelwool to heat up. As this strand of steelwool was taped against the balloon, it melted the rubber and burst it.

2. What is a short circuit?

   A short circuit occurs when charges bypass the loads in the circuit. When the loads are bypassed, the resistance of the circuit drops, and the current in the circuit increases. If the current is too much, it can produce enough thermal energy to start a fire.

3. Which way would electricity rather flow, through the switch or the bulb?

   Through the switch because the resistance is less.

4. Why did the light go out after the balloon popped?

   With the steel wool strand broken, the circuit with which the bulb is wired is thus incomplete, and so the light stays out.

(adapted from Invitations to Science Inquiry by Tik L. Liem, p. 257)

Name: _____ Period: _____ Date: _____

Electricity Quiz 2

1. What is electrical current?

2. How does increasing the voltage affect the current?

3. Name and describe the three essential parts of a circuit.

4. Compare and contrast series and parallel circuits.

5. How do fuses and circuit breakers protect your home against electrical fires?

Electricity Quiz 2 (Answer Key)

1. What is electrical current?

   Electric current is the continuous flow of charge caused by the motion of electrons.

2. How does increasing the voltage affect the current?

   Increasing the voltage increases the current.

3. Name and describe the three essential parts of a circuit.

   Energy source—provides electrical energy. The load—any device that uses the electrical energy to do work. The wires—connect the energy source to the load.

4. Compare and contrast series and parallel circuits.

   Series circuits—all parts are connected in a single loop. Parallel circuit—the loads are attached to the circuit on different branches.

5. How do fuses and circuit breakers protect your home against electrical fires?

   Fuses and circuit breakers create gaps in a circuit when the current gets too high, preventing charges from flowing, thus breaking the circuit and preventing overheating and fires.

Name: _____ Period: _____ Date: _____

Electricity Unit Test

Vocabulary: Fill in the blank with the correct word.

1. A _____ converts chemical energy into electrical energy. (*battery or electroscope*)
2. Charges flow easily in a(an) _____. (*insulator or conductor*)
3. _____ is the opposition to the flow of electric charge (*electric power or resistance*)
4. Lightning is a form of _____. (*static electricity or electric discharge*)
5. A _____ is a complete, closed path through with charges flow. (*circuit or resistor*)

Multiple Choice: Circle letter of the correct statement.

1. If two charges repel each other, the two charges must be
   a. positive and negative.
   b. positive and positive.
   c. negative and negative.
   d. (b) or (c)

2. A device that can convert chemical energy to electrical energy is a
   a. lightning rod.
   b. cell.
   c. light bulb.
   d. All of the above.

3. Which of the following wires has a lowest resistance?
   a. a short, thick copper wire at 25^{o}C
   b. a long, thick copper wire at 35^{o}C
   c. a long, thin copper wire at 35^{o}C
   d. a short, thick iron wire at 25^{o}C

4. An object becomes charged when the atom in the object gain or lose
   a. protons.
   b. neutrons.
   c. electrons.
   d. All of the above

5. A device used to protect buildings from electrical fires is a(an)
   a. electric meter.
   b. circuit breaker.
   c. fuse.
   d. both (b) and (c)

6. In order to produce a current from a cell, the electrodes of the cell must
   a. have a potential difference.
   b. be in a liquid.
   c. be exposed to light.
   d. be at two different temperatures.

7. What type of current comes from the outlets in your home?
   a. direct current
   b. alternating current
   c. electric discharge
   d. static electricity

Short Answers

1. List and describe the three essential parts of a circuit.

2. Name the parts of a cell, and explain how they work together to produce an electric current.

Math in Science: Use Ohm's Law to solve the following problems:

1. Find the current produced when a voltage of 60 V is applied to a resistance of 15 Ω.

2. What is the resistance of an object if a voltage of 40 V produces a current of 5 A?

Electricity unit test (Answer Key)

Vocabulary: Fill in the blank with the correct word.

1. A _____ converts chemical energy into electrical energy. (***battery*** *or electroscope*)
2. Charges flow easily in a(an) _____. (*insulator or* ***conductor***)
3. _____ is the opposition to the flow of electric charge (*electric power or* ***resistance***)
4. Lightning is a form of _____. (*static electricity or* ***electric discharge***)
5. A _____ is a complete, closed path through with charges flow. (***circuit*** *or resistor*)

Multiple Choice: Circle letter of the correct statement.

1. If two charges repel each other, the two charges must be
   a. positive and negative.
   b. positive and positive.
   c. negative and negative.
   d. (b) or (c)

2. A device that can convert chemical energy to electrical energy is a
   a. lightning rod.
   b. cell.
   c. light bulb.
   d. All of the above.

3. Which of the following wires has a lowest resistance?
   a. a short, thick copper wire at 25°C
   b. a long, thick copper wire at 35°C
   c. a long, thin copper wire at 35°C
   d. a short, thick iron wire at 25°C

4. An object becomes charged when the atom in the object gain or lose
   a. protons.
   b. neutrons.
   c. electrons.
   d. All of the above

5. A device used to protect buildings from electrical fires is a(an)
   a. electric meter.

b. circuit breaker.
c. fuse.
d. <u>both (b) and (c)</u>

6. In order to produce a current from a cell, the electrodes of the cell must
a. <u>have a potential difference.</u>
b. be in a liquid.
c. be exposed to light.
d. be at two different temperatures.

7. What type of current comes from the outlets in your home?
a. direct current
b. <u>alternating current</u>
c. electric discharge
d. static electricity

Short Answers

1. List and describe the three essential parts of a circuit.

Energy source—provides electrical energy. The load—any device that uses the electrical energy to do work. The wires—connect the energy source to the load.

2. Name the parts of a cell, and explain how they work together to produce an electric current.

A cell is made of an electrolyte and two electrodes. Chemical reactions in the electrolyte leave extra electrons on one electrode and strip them from the other. If the charged electrodes are connected with a wire, electric charges will flow between them.

Math in Science: Use Ohm's Law to solve the following problems:

1. Find the current produced when a voltage of 60 V is applied to a resistance of 15 Ω.

I = V/R = 60 V/ 15 Ω = 4 A

2. What is the resistance of an object if a voltage of 40 V produces a current of 5 A?

R = V/I = 40 V/ 5 A = 8 Ω

Appendix M

Rubric for Grading Science Notebook

Category	Outstanding (4)	Satisfactory (3)	In Progress (2)	Non-Proficient (1)	Total Points	Score
Content	Contains all content given in class	Contains most content given in class	Contains some content given in class	Contains little content given in class	/4	
Neatness	Neat and easy to read and follow. Used color to highlight important terms	Neat and used some color	Somewhat messy and used color only occasionally	Messy, hard to read and follow. Did not use color to highlight important terms	/4	
				Total	/8	

Appendix N

Rubric for Grading Science Labs

Category	Outstanding (4)	Satisfactory (3)	In Progress (2)	Non-Proficient (1)	Total Points	Score
Hypothesis	Follows correct form and shows outstanding reasoning	Follows correct form and shows basic reasoning	Somewhat follows correct form and shows some reasoning	Doesn't follow correct form and shows no reasoning	**/4**	
Procedure	Follows procedure correctly, independently and in a timely manner	Follows procedure correctly with some assistance and in a timely manner	Follows procedure with frequent assistance, and not in a timely manner	Doesn't follow procedure and turns in late	**/4**	
Observations	Records data and observations while performing the procedure	Records most data and observations while performing the procedure	Records most data and observations after performing the procedure	Records data and observations after performing the procedure	**/4**	
Conclusion	Answers all questions at the end of the lab correctly	Answers 75% of the questions at he end of the lab correctly	Answers less than 75% of the questions correctly	Did not answer any of the questions at the end of the lab correctly	**/4**	
Neatness	Lab report is typed, neat and easy to follow	Lab report is neat	Lab report is somewhat messy	Lab report is messy and hard to follow	**/4**	
				Total	**/20**	