ENERGY EDUCATION

EnergyRight® Solutions for Youth

energyright® solutions for youth

TVA

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Introduction

The EnergyRight® Solutions for Youth (ERSY) Program was developed specifically as an educational outreach service for educators with lesson plans designed for public, private, STEM and home schools as well as community groups. It aligns with state learning standards for math, science and reading, aiming to help children in third through fifth grades learn about the environment and how to use energy wisely. Third, fourth and fifth grades were chosen because at this age, the child's desire to share school experiences with parents/guardians is high, as is the adult’s willingness to participate in their child’s education. The child’s engagement is also maximized at this age, due in part to limited sports team participation, club participation and involvement in other extracurricular activities that typically occurs in upper grades.

EnergyRight Solutions for Youth lesson plans comply with state learning standards for the seven states served by the Tennessee Valley Authority (TVA) for grades three (3), four (4) and five (5). Applicable state learning standards are listed on each lesson plan, along with recommendations for the amount of time to spend covering certain parts of a given lesson, depending on the size of the group. In addition, each lesson plan lists needed materials if the educator elects to engage a group in recommended experiments.

The lesson plans cover three areas—Energy Fundamentals, Forms of Energy and Energy Use & Delivery—and were developed for teachers, parents and group leaders. They were designed to help students gain an age-appropriate, informed view of energy and how to use it wisely in language that is easy to understand. Lesson plans can be “mixed and matched” to meet specific course objectives and can be used multiple times over the course of an entire academic year.

Acknowledgements

The EnergyRight® Solutions for Youth program was developed by a team of local power companies and representatives from the Tennessee Valley Public Power Association (TVPPA) and the Tennessee Valley Authority (TVA). The program consists of lesson plans designed for public, private, STEM and home schools, as well as community groups such as Scouts, Brownies, 4-H, etc. The target audience is 8 – 11 year olds in the third, fourth and fifth grades. The primary goal of the program is to educate our youth about the wise use of energy and to encourage them to generate conversations at home about using energy wisely.

TVA would like to thank the following people for contributing to the development of the EnergyRight Solutions for Youth Program.

The Work Group was commissioned by the TVPPA Energy Services Committee in 2012. Work Group members participated in research, concept development and program development:

- Benita Owens, Joe Wheeler Electric Membership Corporation, Trinity, Alabama
- Laura Sparks, North Georgia Electric Membership Corporation, Ft. Oglethorpe, Georgia
- Lynn Clark, Hopkinsville Electric System, Hopkinsville, Kentucky
- Sheila Smith, 4-County Electric Power Association, Columbus, Mississippi
- Terry Kemp, Starkville Electric Department, Starkville, Mississippi
- Anita French, Benton County Electric System, Camden, Tennessee
- Jamie Creekmore, Cleveland Utilities, Cleveland, Tennessee
- Mitch Cain, Appalachian Electric Cooperative, New Market, Tennessee
- Wyatt Glover, Paris Board of Public Utilities, Paris, Tennessee
- Michelle Johnson, PES Energize, Pulaski, Tennessee
- Phillip Burgess, TVPPA
- Danette Scudder, TVPPA
- Dawna Aragon, TVA
- LK Browning, TVA
- Jerry Cargile, TVA

The Program Contributors were recruited by local power companies to provide the educator's perspective on program development. They provided guidance on how lesson plans should be structured, offered suggestions on resources to be included and proofread final lesson plans:

- Stacy Warren, Brownwood Elementary, Scottsboro, Alabama
- Nicole Bradbury, Home School Teacher, Alabama
- Cecelia Culver, Girl Scouts of North-Central Alabama
- Paige Buckner, New Hope Elementary School, Dalton, Georgia
- Dr. Cheryl Thomasson, Murray County Schools, Georgia
- Kelly Jackson, 4-H Contributor, Kentucky
- Heather Lancaster, Christian County Public Schools, Kentucky
- Karla Mitchener, Starkville Academy, Starkville, Mississippi
- Kary McClure, Cherokee County Schools, North Carolina
- Susan Severs, Crockett Elementary School, Brentwood, Tennessee
- Julie Binder, St. Mary's Episcopal School, Memphis, Tennessee
- Janine Wine, Home School Teacher, Tennessee
- Dawn Farner, Longview Elementary School, Spring Hill, Tennessee
- Chris McElraft, Stonewall Jackson Elementary School, Bristol, Virginia

The Education & Outreach Advisors are serving an 18-month term engaged in helping their local power company peers use the Education & Outreach Online Toolkit, which includes the newly developed EnergyRight Solutions for Youth Program:

- Vicki Watts, Scottsboro Electric Power Board, Scottsboro, Alabama
- Lynn Clark, Hopkinsville Electric System, Hopkinsville, Kentucky
- Stan Acy, Starkville Electric Department, Starkville, Mississippi
- Marilyn Means, Southwest TN Electric Membership Corporation, Brownsville, Tennessee
- Jamie Creekmore, Cleveland Utilities, Cleveland, Tennessee
- Mitch Cain, Appalachian Electric Cooperative, New Market, Tennessee
- Michelle Johnson, PES Energize, Pulaski, Tennessee

Again, TVA would like to thank all who contributed to this program's development. We are excited about the opportunity to help people use energy wisely.

Introduction to Lesson Plan Format

EnergyRight® Solutions for Youth is a new program for the Fall of 2014. At first release, it consists of 21 lesson plans in three categories: Energy Fundamentals, Forms of Energy and Energy Use & Delivery. Lessons are designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after-school programs and others) are encouraged to use them as well. Each lesson is designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows through the years, this allows them to make informed decisions as a good citizen or civic leader.

Lesson plans are suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The “Modeling” Section contains teaching content. • While in class, students can do “Guided Practice,” complete the “Recommended Item(s)” and any additional guided practice items the teacher might select from “Other Resources.” • NOTE: Some lesson plans do and some do not contain “Other Resources.” • At home or on their own in class, students can do “Independent Practice,” complete the “Recommended Item(s)” and any additional independent practice items the teacher selects from “Other Resources” (if provided in the plan).
Average class size, student ability, and class length	• The “Modeling” Section contains teaching content. • While in class, students complete “Recommended Item(s)” from “Guided Practice” section. • At home or on their own in class, students complete “Recommended Item(s)” from “Independent Practice” section.
Larger class size, lower student ability, and/or shorter class length	• The “Modeling” Section contains teaching content. • At home or on their own in class, students complete “Recommended Item(s)” from “Independent Practice” section.

Lesson Plan Format

I. Anticipatory Set

An attention grabber is a short video, a cute poem or an essential question designed to help an educator relate the topic to real-life.

II. Modeling

This is what the teacher will TEACH - can be a lecture, PowerPoint, etc.

III. Checking for Understanding

Lesson Plans contain several suggestions for checking for understanding.
These suggestions correlate with Bloom’s Taxonomy (higher levels of thinking).
Teachers can ask questions to informally assess understanding.

IV. Guided Practice

This is a “guided” activity. After the teacher meets his or her objectives for a particular lesson, the students are given the opportunity to complete an activity (worksheet, game, etc.) with the guidance of the teacher.

V. Independent Practice (at-home activities to engage the person(s) that pays the electric bill)

Practice is done on students’ own initiative, often at home. This could be an in-class activity, a quiz, homework, etc. that the student completes independently.

VI. Assessment

Teachers can use this section if assessment is desired. In addition, the independent practice can be used as an assessment.

VII. Materials Needed

Here you will find links to experiments, videos and games to reinforce learning. Each lesson plan contains a list of supplies needed to complete experiments.

VIII. Closing the Lesson

This section contains an essential question that the teacher can use in closing the lesson.

Feedback

The EnergyRight® Solutions for Youth Program lesson plans were first launched in the Fall of 2014. Feedback on the materials is very important to the ongoing effectiveness of the program. Any and all feedback is appreciated.

What did you like/dislike about the lesson plan content?

What did you like/dislike about the worksheets and answer keys?

What could be added or deleted from the materials to make the program more effective?

What feedback do you have about how the content related to your state's curriculum standards? (Please specify your state: ___________________)

Would you suggest the program to other educators? Why or why not?

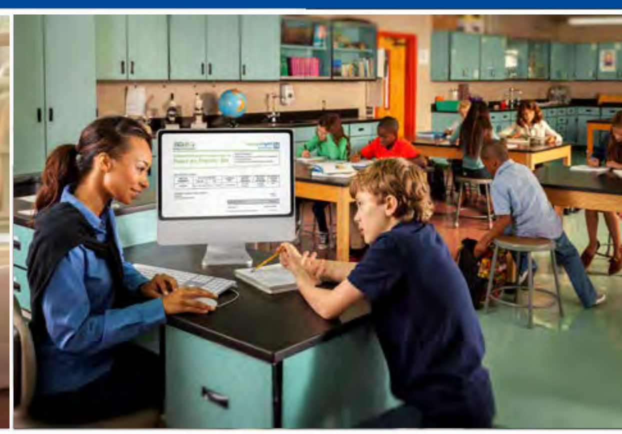
What additional feedback/suggestions do you have?

Please return feedback form to your local power company.

ENERGY EDUCATION

LESSON PLAN SET 1

Energy Fundamentals



energyright® solutions for youth

TVA

Set 1: Energy Fundamentals

ENERGY FUNDAMENTALS – LESSON PLAN 1.1

Forces and Motion

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Describe force.**
- **Understand and describe types of forces, including gravitational force and frictional force.**

Public School System Teaching Standards Covered

State Science Standards
- AL GLE 3.4.1 3rd
- GA S4P3 4th
- KY SC-P-ET-U-1 3rd
- MS GLE 10.a 5th
- NC 3.P.1 3rd
- NC 5.P.1 5th
- VA 3.2 3rd

Common Core Language Arts/Reading
- KY 3.RI.1,2, and 8 3rd
- AL RI.3.1 and 2 3rd
- GA ELA.CC4.RI.1,2,and 8 4th
- CCR.R.10 5th
- Integration and Knowledge of Ideas-Cluster 7, 8, 9 NC 5th
- Key Ideas and Details-Cluster 1,2, 3 NC 3rd

Common Core Mathematics
- 3.OA.A.3-Al, KY, NC 3rd
- 4.OA.A.3-GA 4th

I. Anticipatory Set (Attention Grabber)

Essential Question

How do objects move?

Videos

Forces and Motion Video (1 min 27 seconds): https://www.youtube.com/watch?v=MztWyY9z1jY

Force and Motion Video (3 min 53 seconds) https://www.youtube.com/watch?v=8iKhLGK7HGk

Energy and Work Videos (many to choose from): http://www.neok12.com/Energy-and-Work.htm

II. Modeling (Concepts to Teach)

Additional Information

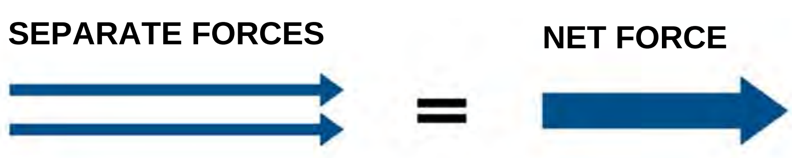
http://www.physicsclassroom.com/Physics-Tutorial/Newton-s-Laws

Forces

A force is defined as a push or pull. When a person writes, for example, he or she exerts a force on the pencil because the person is pushing or pulling it across the paper.

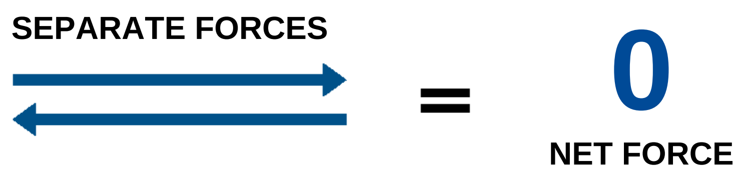
Two equal forces acting in the same direction

If two people are pushing a table across the floor in the same direction, the two forces are added together. Adding these two forces together is called the net force. In the case of the two people pushing the table, the net force is unbalanced. When there is an **unbalanced force** there is a force that changes an object's motion or causes it to



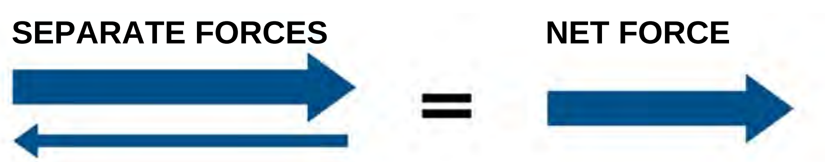
accelerate. This can be shown with arrows; the wider arrow is the stronger of the forces.

Two equal forces acting in the same direction
When the forces are equal and act in opposite directions, they balance each other out. There is no net force in this case. Using the example of two people pushing on a table, if there is a person on each of the opposite ends of the table and they are both pushing on the table with an equal amount of force, they balance each other out to



a zero net force. This means the table will not accelerate.

Two unequal forces acting in opposite directions
When there are separate forces that are not equal and one force is more powerful than the other, they will not balance out to zero net force. Because there is one force stronger than the other, the weaker force is not strong enough to balance the other force. They are pushing in opposite directions, but one of them is pushing with a greater force. The motion will occur in the direction that the stronger force is moving. If two people are pushing on opposite ends of the table and one is pushing with more force, the table will accelerate in the direction that the person with the stronger force is moving. If one person is pushing the table, there is another force to examine: **friction force**. Friction force works against the applied force. If the force applied overcomes the friction force, then



there is a net force on the table and it will move.

A **net force** is required to cause changes in motion (speed or direction). If an object is at rest, a net force is required to put it into motion. If an object is in motion, a net force is required to slow it down/bring it to rest. This change in motion is called acceleration. When an object increases its speed/direction (velocity) it is called

Types of Forces

Contact Forces
- Frictional Force*
- Tension Force
- Normal Force
- Air Resistance Force
- Applied Force
- Spring Force

Action-at-a-Distance Forces
- Gravitational Force*
- Electrical Force
- Magnetic Force

Note that action-at-a-distance forces are the ones required by state standards for grades 3-5 and are defined below. Definitions of the other forces listed can be found at ***http://www.physicsclassroom.com/class/newtlaws/Lesson-2/Types-of-Forces***

***Gravitational Force**

The force of gravity is a result of a massively large object, such as the earth or moon, attracting to it other objects that have mass. By definition, an object's weight is due to the impact of gravitational force. This is NOT to be confused with an object's mass or size. An object's weight changes depending on the gravitational pull exerted on it. A person's weight on the moon is less than their weight on Earth because the moon is less massive and exerts less gravitational force. Their mass, however, never changes.

$F_{grav} = m * g$
where g = 9.8 N/kg (on Earth)
and m = mass (in kg)

***Frictional Force**

Friction is the name given to the force that acts between materials that are moving past each other. Friction happens because of irregularities in the surfaces of sliding objects. Some surfaces have more irregularities than others and therefore cause more friction when objects slide over them. The friction force works against the applied force and must be overcome in order to move an object from rest. In addition, the friction force also slows a moving object so that it will eventually come to rest. If friction were absent, a ball moving horizontally would move forever.

acceleration, when an object decreases its speed/direction (velocity) it is called ***deceleration***.

Measuring Forces

Forces can be measured using a **spring scale** (force meter). Spring scales contain a spring connected to a metal hook. The spring stretches when a force is applied to the hook. The bigger the force applied, the longer the spring stretches, thereby resulting in a larger reading.

FORCE METERS

The unit of force is called the **Newton**, and it has the symbol **N**. So

100 N is a bigger force than 5 N.

III. Checking for Understanding

REMEMBER	What is an unbalanced force? What is a unit of force called? How is force measured? (Class discussion)
UNDERSTAND	Explain force using your own words. (Class discussion)
APPLY	Apply your knowledge of a force and explain how something moves, accelerates, and decelerates. (Class discussion)
ANALYZE	Explain an unbalanced force. What is the result of a force being applied to an object? What kind of force creates a net force? (Class discussion)
EVALUATE	How must our force overcome frictional force to create a net force? (Class discussion)
CREATE	How would you create movement? (Class discussion)

Teachers can ask students these questions to determine understanding of concepts.

IV. Guided Practice Ideas

Recommended Items

Newton's First Law Using Balls (see below)

Experiments

Newton's First Law of Motion Experiment Using Balls: **http://www.metrofamilymagazine.com/July-2012/Simple-Science-Experiments-Newtons-First-Law-of-Motion/**

Games

Forces in Action Game: **http://www.bbc.co.uk/bitesize/ks2/science/physical_processes/forces_action/play/**

Activity

- Rolling a Ball: Teachers ask students to apply force to ball, putting ball into motion.
- Teachers start a game of tug-of-war and add students on each side to help demonstrate pull force and net force.

Practice that uses math/reading standards:

- Math: Equation for force (Force = Mass x Acceleration) **http://www.softschools.com/quizzes/science/force_mass_acceleration/quiz389.html**

- Reading: Article about force and motion, students write summary: http://www.accuteach.com/files/2nd/science/Force-and-Motion-Reading-Comprehension.pdf?

V. Independent Practice Ideas

Recommended Item

At-home Activity: Find Push & Pull Forces at Home Worksheet and Answer Key provided

Other Resources

Personal Practice

Writing Activity: Teachers write the following question on the board and ask students to copy and answer the question on a sheet of paper: Describe force in your own words.

Practice That May Involve Parents or Guardians

At-home Activity: Find Push & Pull Forces at Home Worksheet and Answer Key provided

VI. Assessment

This item provides a check for understanding so teachers can easily determine whether concepts need to be reinforced. This item can be graded, if a grade is desired.

- Find Push & Pull Forces at Home Worksheet and Answer Key provided

VII. Materials Needed

The following materials are needed for the "Recommended Items" in Guided Practice & Independent Practice sections.

- Soccer ball, basketball, or any bouncy ball
- Smaller bouncy ball (tennis ball or racquet ball)
- Assortment of other balls of various sizes for further experimentation

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

How do objects move?

WORKSHEET FOR FORCES AND MOTION LESSON 1.1

NAME: ______________________

Find Push & Pull Forces at Home

Objective: Students will be able to understand and describe force, acceleration, and deceleration.

1. **What types of forces can be used to open your bedroom door?**

   ____

   ____

   ____

   ____

2. **Draw and label an example of a force being applied to push an object (use arrows to explain how force is moving):**

3. **Draw and label an example of a force being applied to pull an object (use arrows to explain how force is moving):**

4. Explain the difference between ***acceleration*** and ***deceleration***.

5. How does friction interact with objects?

Answer Key

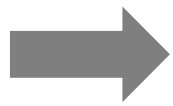
ANSWER KEY FOR WORKSHEET: FIND PUSH & PULL FORCES AT HOME

1. What types of forces can be used to open your bedroom door?

Ex. Pull the handle to open the door or push the door open.

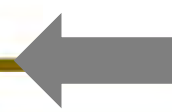
2. Draw and label an example of a force being applied to push an object (use arrows to explain how force is moving):

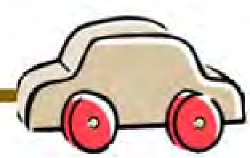
Example



3. Draw and label an example of a force being applied to pull an object (use arrows to explain how force is moving):

Example





4. Explain the difference between acceleration and deceleration.

Ex. Acceleration = object increases its velocity; Deceleration = object decreases its velocity

5. How does friction interact with objects?

Ex. Friction works against the applied force and must be overcome in order to move an object at rest.

ENERGY FUNDAMENTALS – LESSON PLAN 1.2

Newton's First Law of Motion

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

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Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Describe motion.**
- **Describe what causes changes in motion.**
- **Identify the characteristics of objects in motion.**

Public School System Teaching Standards Covered

State Science Standards

- AL GLE 3.4.1 3rd
- AL 3.PS.4 3rd
- AL 4.PS.4 4th
- AL 5.PS.6 5th
- GA S4P3 4th
- KY 3.PS.2.A 3rd
- NC 3.P.1 3rd
- NC 5.P.1 5th
- TN SPI 0307.11.1 3rd
- TN SPI 0407.11.2 4th
- TN SPI 0507.11.3 5th
- VA 4.2 4th

Common Core Language Arts/Reading

- AL RI.3.1 and 2 3rd
- GA ELA.CC4.RI.1,2,and 8 4th
- KY 3.RI.1,2, and 8 3rd
- CCR.R.10 5th
- NC Integration and Knowledge of Ideas-Cluster 7, 8, 9 5th
- NC Key Ideas and Details-Cluster 1,2, 3 3rd

I. Anticipatory Set (Attention Grabber)

Essential Question

What must happen in order for objects to move? Stop moving?

Videos

Newton's First Law of Motion Video (3 minutes and 39 seconds):
http://www.youtube.com/watch?v=OHw80HXSuAQ

II. Modeling (Concepts to Teach)

Isaac Newton (a 17th century scientist) put forth a variety of laws that explain why objects move (or don't move) as they do. These three laws have become known as Newton's Three Laws of Motion.

Newton's First Law of Motion states that objects at rest tend to stay at rest and objects in motion tend to stay in motion unless a net force acts on the object. This is referred to as **inertia**. Inertia is an object's resistance to changes in motion. Another way to put this is "objects tend to keep doing what they are already doing" unless acted upon by a net force.

This explains why a person shifts forward when a car comes to a sudden stop. Even though the car is coming to a stop due to an unbalanced force working on it, there is no such force acting on the rider in the car. Without a net force acting on the rider, the rider continues to do what he/she was already doing (moving forward) until a net force acts upon him/her. This net force would be provided by a seat belt, which eventually brings them to a stop, too. What about when the car is at rest and then a net force acts on it? The car is set into motion, but there was no net force applied to the rider, so the rider stays at rest and is pulled back into his/her seat.

The more mass an object has, the more inertia it has. For example, if an object like an elephant sits in a wagon and an object like a mouse sits in another wagon, the elephant wagon will need more net force to set it into motion from rest (accelerate it) than the mouse wagon. Once the elephant wagon is in motion, it will require more net force to slow it down (decelerate it) than the mouse wagon. Mass and inertia are directly proportional. The more mass an object has, the more inertia it has, and the less mass an object has, the less inertia it has.

Additional Information

http://science.howstuffworks.com/innovation/scientific-experiments/newton-law-of-motion1.htm

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	Restate Newton's First Law of Motion. (Class discussion)
UNDERSTAND	Explain Inertia. (Class discussion)
APPLY	Together, make a list of everyday events that use Newton's First Law of Motion. (Teachers can list these on the board with help from students.).
CREATE	Compose a story involving Newton's First Law of Motion providing examples that illustrate students' understanding. (Teachers can ask students to write their stories on a sheet of paper.)

IV. Guided Practice Ideas

Recommended Items

Inertia Egg Drop (see below)
Ball Bounce Experiment (see below)

Experiments

- Inertia Egg Drop: **http://www.stevespanglerscience.com/lab/experiments/egg-drop-inertia-trick**
- Ball Bounce Experiment: **http://www.metrofamilymagazine.com/July-2012/Simple-Science-Experiments-Newtons-First-Law-of-Motion/**
- Penny on a Card Experiment: **http://www.metrofamilymagazine.com/July-2012/Simple-Science-Experiments-Newtons-First-Law-of-Motion/**

V. Independent Practice Ideas

Recommended Item: Inertia Worksheet

- Inertia Worksheet and Answer Key provided
- Journal (if the students have a journal): Teachers write the following questions on the board and ask students to copy and answer the questions in their journals: What puts objects into motion? How do they stop? What if there was never a force that stopped the object from moving?

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if grades are desired.

- Inertia Worksheet and Answer Key provided
- Journal (if completed as Independent Practice, as shown above)
- Essential Question (see below)

VII. Materials Needed

The following materials are needed for the **Inertia Egg Drop** in “Recommended Items” in the Guided Practice Ideas section.

- Cardboard tube
- Pie pan
- Eggs
- Water
- A large drinking glass
- Tray (optional)
- Coloring tablets (optional)

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

What must happen in order for objects to move? Stop moving?

WORKSHEET FOR NEWTON'S FIRST LAW OF MOTION LESSON 1.2

Inertia

NAME: ______________________

Objective: Students will be able to describe motion, describe the changes motion causes, and identify the characteristics of objects in motion.

1. **Give an example of an object resisting a change in motion.**

____

____

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2. **Draw and label two objects with different masses:**

3. **How are inertia and mass related?**

____

____

____

____

4. **Define *inertia* in your own words.**

____

5. **How did Isaac Newton influence the field of science?**

Answer Key

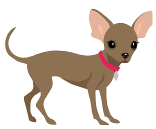
ANSWER KEY FOR WORKSHEET: INERTIA

1. Give an example of an object resisting a change in motion.

Ex. A chair sliding across a floor, pressing against keys on a keyboard, etc.

2. Draw and label two objects with different masses:

Example



3. How are inertia and mass related?

Ex. The more mass an object has, the more inertia the object has.

4. Define *inertia* in your own words.

Ex. An object will continue acting as it is until a force persuades it to move.

5. How did Isaac Newton influence the field of science?

Ex. Isaac Newton discovered a set of laws that explain why objects move as they do.

ENERGY FUNDAMENTALS – LESSON PLAN 1.3

Newton's Second Law of Motion

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Explain Newton's Second Law of Motion.**
- **Describe what causes an object to accelerate.**
- **Use Newton's Second Law equation, Force = mass x acceleration ($F = m \times a$), to solve word problems.**
- **Understand $F = m \times a$ can be used to solve for a ($a = F \div m$). Use this equation to find acceleration in word problems.**

Public School System Teaching Standards Covered

State Science Standards

- GA S3CS7 3rd
- KY 3.PS.2 3rd
- MS 9.a 4th
- NC 3.P.1.1 3rd
- NC 3.P.1.2 3rd
- NC 5.P.1.4 5th
- TN GLE 0307.11.2 3rd
- TN GLE 0507.10.1 5th
- TN GLE 0507.11.3 5th
- TN SPI 0507.11.1 5th

Common Core Language Arts/Reading

- GA ELA.CC4.RI.1,2,and 8 4th
- KY 3.RI.1,2, and 8 3rd
- CCR.R.10 MS 5th
- NC Integration and Knowledge of Ideas-Cluster 7, 8, 9 5th
- NC Key Ideas and Details-Cluster 1,2, 3 3rd

Common Core Mathematics

- 3.OA.A.3-KY, NC, TN 3rd
- 3.OA.4, 5, 7, 8 TN 3rd

I. Anticipatory Set (Attention Grabber)

Essential Question

What makes objects accelerate?

Display a block of foam and a brick; ask “Which do I have push harder, or apply more force, to make it move?” “Which do you think will go fastest?”

II. Modeling (Concepts to Teach)

Newton’s Second Law of Motion states that the acceleration produced by a net force on an object is directly proportional to the magnitude of the net force, is in the same direction as the net force, and is inversely proportional to the mass of the body. This means that whatever alteration is made to the net force, the same change will occur with the acceleration. Double, triple, or quadruple the net force, and the acceleration will do the same. On the other hand, whatever alteration is made of the mass, the opposite or inverse change will occur with the acceleration. Double, triple or quadruple the mass, and the acceleration will be one-half, one-third or one-fourth its original value. If both the net force and the mass are both doubled, then the acceleration will be unchanged.

Newton’s Second Law: **http://www.youtube.com/watch?v=nO7XeYPi2FU**

$a = F_{net} \div m$

or

$F_{net} = m \times a$

A semi-truck is a good example of a massive vehicle. In order to change its motion, a large net force must be applied. A go-kart is a good example of a less massive vehicle. In order to change its motion, only a small net force must be applied. This explains the need for “Runaway Ramps” on mountainous roads. Large vehicles have a hard time slowing down and need alternatives to change their motion.

Newton's Second Law of Motion: Acceleration is produced when a force acts upon a mass. The greater the mass (of the object being accelerated) the greater the amount of force needed (to accelerate the object).

The second law states that force equals mass times acceleration or $F = m \times a$. For example, the amount of force needed to move a 1,000kg object at 5 meters per second is 5,000 Newtons.

Read more: http://www.ehow.com/facts_5515989_example-newtons-three-laws-motion.html

SIMPLY: Pushing or pulling an object produces acceleration, a change in the speed of motion. Believe it or not, acceleration mean can be a slow-down OR a speed-up. The heavier the object, the more force it takes to make the object speed up or slow down. It takes more strength to push a bowling ball one foot than it does to push a marshmallow the distance of one foot.

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	What does Newton's Second Law of Motion state? (Class discussion)
UNDERSTAND	Explain Newton's Second Law of Motion in your own words. (Class discussion)
APPLY	What is needed to cause an object to accelerate? Would a bowling ball and a marble roll at the same speed if pushed with the same force? Which would be faster? Which would stop sooner? (Class discussion)
ANALYZE	Read: **http://teachertech.rice.edu/Participants/louviere/Newton/law2.html**, the first two of Newton's Three Laws of Motion. Compare and contrast Newton's First Law of Motion with the Second Law using a Venn diagram. **http://www.learninggamesforkids.com/graphic_organizers/writing/venn-diagram.html**
EVALUATE	Would more force be needed to stop a school bus or a Smart Car? A paper airplane or a Frisbee? (Class discussion)

IV. Guided Practice Ideas

Recommended Items

Comet Cratering and Hot Wheels Experiments (see below)

Experiments

- **Comet Cratering**: **http://www.imcpl.org/kids/blog/?p=8871** to see $F = m \times a$ in action.
  This experiment keeps the acceleration the same/consistent by dropping all 3 marbles from the same distance ($F = m \times a$, the a is the same). What is changing (the variable) is the mass of the object, thereby changing the force and making the craters larger in the bottom of the pan. Students should find that the larger the marble (the larger the mass), the larger the crater (the force it landed with was larger). Example to teach: $m \times a = F$, so when m is changed, there is a different answer. For example, if $a = 5$ in $m \times a = F$, if mass is 3, the force would be 15 Newtons because $3 \times 5 = 15$. But if mass is 4, the force would be 20 Newtons. The F, the a, and the m all affect each other. So to cause acceleration, mass or force needs to act on the acceleration. Students can use this experiment to show that if the mass is larger, the force will also be larger (using principals of multiplication). $F = m \times a$

Force ($F = m \times a$)	Mass	Acceleration
F = 15 Newtons	3	5
F = 20 Newtons	4	5
$F = x$ Newtons	m	a

- **Hot Wheels Experiment**: **http://www.ehow.com/list_6952612_second-law-motion-experiments.html**
- **Spring Loaded and Toy Truck Ramp Project**: **http://www.ehow.com/list_6158774_science-newton_s-second-law-motion.html**
- **Drop a rock and a crumpled piece of paper from standing on top of a desk. Which lands first? Why?** **http://www.hometrainingtools.com/a/newton-s-laws-of-motion-science-projects**
- Use this formula ($F = m \times a$) to measure force. Let's do an experiment with this formula: **http://www.racemath.info/forcesandpressure/what_is_f=ma.htm**.
  Apply/Analyze: If the acceleration is larger, what will happen to the force in the experiment? For instance, what if some marbles were dropped higher than others, giving them more room and more time to accelerate? What would be seen in the widths of the craters, as made by the force of the marbles? Try it and see.

  Find out what happens when the force is the same, but the mass is different: Students can try it with a ping pong ball and a baseball. If the same force is applied to roll each one, which one accelerates faster? ($a = F \div m$). The smaller the mass, the more it can accelerate.

  Apply/Evaluate: If $F = m \times a$, what is the math equation for a? ($a = F \div m$) For m? ($m = F \div a$) Students can do example problems solving for each equation. Use examples from **http://share.nanjing-school.com/sciences/files/2013/02/8Sci_FM_2ndLawWS-1fdv8aq.pdf**

V. Independent Practice Ideas

Recommended Items: Venn diagram; Poster/skit/story

- Journal on results of experiment (if the students have a journal). Teachers ask students to record the results of their experiment in their journals.
- Create an experiment that proves Newton's Second Law as true. Teachers can ask students to brainstorm ideas and teachers write them on the board. Students can conduct the experiments if materials are available.
- Complete a Venn diagram comparing Newton's First Law of Motion and Newton's Second Law. **http://www.learninggamesforkids.com/graphic_organizers/writing/venn-diagram.html**
- Create a poster, perform a skit, or write a story that explains Newton's Second Law of Motion.
- Acceleration Worksheet and Answer Key provided
    - Newton's Second Law of Motion Worksheet: http://share.nanjing-school.com/sciences/files/2013/02/8Sci_FM_2ndLawWS-1fdv8aq.pdf

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if grades are desired.

- Acceleration Worksheet and Answer Key provided
- Journal (if completed as Independent Practice, as shown above)
- Venn diagram (if completed as Independent Practice, as shown above)
- Poster (if completed as Independent Practice, as shown above)

VII. Materials Needed

The following materials are needed for the Essential Question in the Anticipatory Set and the **Comet Cratering Experiment** in the Guided Practice Ideas section.

- Foam brick and real stone/brick, balls (Essential Question, Anticipatory Set)
- 3 marbles of different sizes, rulers, etc. (Comet Cratering experiment, Guided Practice)

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

What makes objects accelerate?

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WORKSHEET FOR NEWTON'S SECOND LAW OF MOTION LESSON 1.3

Acceleration

NAME: ______________________

Objective: Students will be able to explain Newton's Second Law of Motion, describe what causes an object to accelerate, and provide examples of objects with different masses.

1. **How does net force impact acceleration?**

____

____

____

____

2. **What is needed for an object to accelerate?**

____

____

____

____

3. **Would more force be needed to stop a motorcycle or a semi-truck? Why?**

____

____

____

____

4. Draw and identify an object that is more or less massive than you. Would you need more or less force to move it?

5. Explain Newton's Second Law in your own words.

Answer Key

ANSWER KEY FOR WORKSHEET: ACCELERATION

1. **How does net force impact acceleration?**

   Ex. Whatever alteration is made to the net force being exerted upon an object, the same will be true for the acceleration of that object.

2. **What is needed for an object to accelerate?**

   Ex. Acceleration is produced when a force acts upon a mass.

3. **Would more force be needed to stop a motorcycle or a semi-truck? Why?**

   Ex. More force would be needed to stop a semi-truck because it has more mass than a motorcycle.

4. **Draw and identify an object that is more or less massive than you. Would you need more or less force to move it?**

   Example
   More mass is needed to move me than to move the cup.

5. **Explain Newton's Second Law in your own words.**

   Ex. A net force is required to move any object. The more mass an object has, the more net force is required to make it move.

ENERGY FUNDAMENTALS – LESSON PLAN 1.4

Newton's Third Law of Motion

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Explain Newton's Third Law of Motion.**
- **Compare Newton's Three Laws of Motion.**
- **Contrast Newton's Three Laws of Motion.**
- **Provide examples of Newton's Third Law of Motion in real life.**

Public School System Teaching Standards Covered

State Science Standards

- AL 3.PS.4 3rd
- AL 4.PS.4 4th
- GA S3P1 3rd
- GA S3CS7 3rd
- GA S4P3 3rd
- KY PS.1 3rd
- KY PS.2 3rd
- KY 3.PS2.1 3rd
- MS GLE 9.a 4th
- NC 3.P.1.1 3rd
- TN GLE 0307.10.1 3rd
- TN GLE 0307.10.2 3rd
- TN SPI 0307.11.1 3rd
- TN SPI 0307.11.2 3rd
- TN GLE 0407.10.1 4th
- TN GLE 0507.10.2 5th

Common Core Language Arts/Reading

- CCSS.ELA-Literacy.RI.3.8 TN, KY, NC, AL, GA 3rd

I. Anticipatory Set (Attention Grabber)

Essential Question

When we bounce a tennis ball, why does it come back up and not stay sitting on the ground? The same law that explains why rockets launch explains why the tennis ball bounces back up. We'll learn Newton's Third Law of Motion today.

Videos

Newton's Third Law of Motion Video: http://www.youtube.com/watch?v=DNbjL8gr1iM

II. Modeling (Concepts to Teach)

Newton's Third Law of Motion states that for every action force there is an equal, but opposite reaction force. Forces always exist in pairs. These are called action-reaction force pairs. Whenever two objects interact they exert a force on each other. When a person sits in a chair, that person applies a force down onto the chair and the chair applies a force up on him/her. These forces are equal in magnitude, but opposite in direction.

Experiment with pushes, changes in force, and differences in mass:
Students find a partner. Each set of partners stands facing one another with feet together. With their hands, have students push each other. Or, use a plastic toy fish and demonstrate the push and pull forces of swimming. Use various forces, and watch reactions. Look for Newton's Third Law (action-opposite and equal reaction), and also Newton's Second Law (force and mass affect acceleration, therefore a smaller person accelerates faster, and more force would be needed to accelerate more mass, etc.)

Show video:
http://studyjams.scholastic.com/studyjams/jams/science/forces-and-motion/action-and-reaction.htm

Consider the propulsion of a fish moving through water. A fish uses its fins to push water backwards. But a push on the water will only serve to accelerate the water. Since forces result from mutual interactions, the water must also be pushing the fish forwards, propelling the fish through the water. The size of the force on the water equals the size of the force on the fish; the direction of the force on the water (backwards) is opposite the direction of the force on the fish (forwards). For every action, there is an equal (in size) and opposite (in direction) reaction force. Action-reaction force pairs make it possible for fish to swim.

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	Newton's Third Law of Motion explains the action - reaction force pairs. (Teachers can write the question on the board and discuss with the class.)
UNDERSTAND	Explain Newton's Third Law of Motion in your own words. (Class discussion)
ANALYZE	Compare and contrast all three of Newton's Laws of Motion using a Venn diagram. **http://www.readwritethink.org/files/resources/printouts/Venn3Circles.pdf**
CREATE	Compose a drawing with captions that explains Newton's Third Law of Motion. (Teachers can ask students to draw their pictures on a sheet of paper. Ex: a swimming fish, sitting in a chair, riding a bicycle, jumping on a trampoline.)

IV. Guided Practice Ideas

Recommended Items

Hero's Engine and Newton's Cradle (see below)

Experiments

- Hero's Engine: **http://www.education.com/science-fair/article/newton-law-motion-action-reaction/**
  - Newton's Cradle: Teachers show Newton's Cradle video demonstrating Newton's Third Law of Motion. (Approximately 1 minute). **https://www.youtube.com/watch?v=2Y7jBKENvfA**

NEWTON'S CRADLE

- Balloon Propeller: **http://www.kiwicrate.com/projects/Balloon-Propeller-Newtons-Third-Law-/331**
- Skate Ball: Have a student or the teacher stand still in roller skates and throw a ball. What happens? The person will roll in the opposite direction as the ball.

V. Independent Practice Ideas

Recommended Items: Venn diagram; Poster/skit/story

- Create a poster illustrating and diagramming Newton's Third Law of Motion (ex: sitting in chair, bicycling, fish swimming, rocket launching, running, skating, swinging by pumping your legs, etc.).
- Journal on results of experiment (if the students have a journal). Teachers ask students to record the results of their experiment in their journals.
- Venn diagram comparing all of Newton's Three Laws of Motion (or the two of their choice). **http://www.learninggamesforkids.com/graphic_organizers/writing/venn-diagram.html**

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- Quiz: **http://teachertech.rice.edu/Participants/louviere/Newton/law1.html** (this has a quick review, followed by an online quiz)

Other assessment ideas: http://westernreservepublicmedia.org/ubiscience/images/newton_summative.pdf
http://www.physicsclassroom.com/class/newtlaws/Lesson-4/Newton-s-Third-Law

VII. Materials Needed

The following materials are needed for the **Hero's Engine Experiment** in "Recommended Items" in the Guided Practice section.

- Plastic cup
- 2 plastic bendable straws
- String
- Craft knife
- Water and sink
- Modeling clay

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

When we bounce a tennis ball, why does it come back up and not stay sitting on the ground?

ENERGY FUNDAMENTALS – LESSON PLAN 1.5

Work-Energy Relationships

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Define work.**
- **Explain energy.**
- **Define and explain kinetic energy.**
- **Define and explain potential energy.**
- **List examples of both kinetic and potential energy.**

Public School System Teaching Standards Covered

State Science Standards

- AL GLE 5.4.1 5th
- GA S.4.P3 4th
- KY 3-PS-2-2 3rd
- KY 4-ET-U-3 4th
- KY SC-5-ET-U-1 4th
- MS 4.PS.2.c 4th
- MS 9.a 4th
- MS 9.b 4th
- MS 5.PS.2.c 5th
- NC 4.P.3.1 4th
- NC 5.P.1.1 5th
- TN 0407.10.1 4th
- TN SPI 0507.12.3 5th
- TN 0507.12.3 5th

Common Core Mathematics

- 3.OA.A.3-KY 3rd
- 4.OA.A.3-NC, TN, KY, MS, GA 4th
- 5.OA.A.3-NC, TN, MS, AL 5th

I. Anticipatory Set (Attention Grabber)

Essential Question

What is work and how is it done?

Videos

Energy and Work Videos: http://www.neok12.com/Energy-and-Work.htm
Potential Energy – Wile E Coyote Video: https://www.youtube.com/watch?v=Jnj8mc04r9E
Kinetic and Potential Energy Song and Video: http://www.youtube.com/watch?v=vl4g7T5gw1M

II. Modeling (Concepts to Teach)

Energy wasn't understood very well during the lifetime of Isaac Newton. Today, the concept of energy is ingrained in all branches of science. Most of the energy here on Earth originated from the sun and can be transformed into many different types of energy. And, in order for work to be done, there needs to be a source of energy.

Work is defined as applying a force over a certain distance:

$$\text{Work done} = \text{force} \times \text{distance moved}$$
$$W = F \times d$$

For instance, work is done on books when a person carries them up stairs. If there are more books (more force required), then more work is done. If there are more stairs to climb (more distance traveled), then more work is done. Work is directly proportionate to both force and distance – as one increases, so does the other. **In order to say that work is done on the books, the force applied and the distance traveled have to be in the same direction** (holding books **up** and moving them **up**.) If the books were simply carried across the room, the work is not done on the stack of books. Work is done, just not on the stack of books!

Work is measured in units of **Joules** (J), after James Joule. 1 Joule is defined as the amount of work done when 1 Newton of force is applied over the distance of 1 meter.

Energy can be classified as either Potential Energy or Kinetic Energy.

Potential Energy (stored energy)

An object may store energy by virtue of its position. The energy that is stored and held in readiness is called Potential Energy (PE). Due to the fact that the energy is in a stored state, it can be used to do work.

Types of Potential Energy (PE)

1. **Elastic PE** – A stretched or compressed spring can release its stored energy to do work. Example: Launching a rock with a slingshot. The more the elastic rubber band is stretched, the more energy is stored and the more work can be done on the rock.
2. **Gravitational PE** – An elevated position (against the force of gravity) of an object allows it to do work. A boulder on top of a hill has stored energy. The higher it is, the more PE it has and the more work it can do.
3. **Chemical PE** – Chemical bonds that hold molecules together store energy. When the molecules are broken down through the process of combustion or digestion, the stored energy is released.

Kinetic Energy (energy in motion)

If an object moves, then by virtue of that motion it is capable of doing work.

Types of KE

1. **Vibrational** – This is the kinetic energy that is caused when an object is vibrating, or experiencing vibrational movement. An example of this would be a cell phone that vibrates. The cell phone will move slightly when accepting a call, and thus the energy created from its vibrations is kinetic vibrational energy.
2. **Rotational** – This is energy that is caused when an object is undergoing a rotational motion or movement. The wheel on a moving bicycle has kinetic rotational energy. Another example is the earth. As it rotates on its axis, the earth is in a constant state of kinetic rotational energy.
3. **Translational** – This is the kinetic energy that is most commonly discussed. It's the energy that occurs when an object is moving from one place to another. For example, a football that has just been kicked has translational kinetic energy.

Energy is measured in Joules, too.

In the process of doing work, an object producing the work exchanges energy with another object on which the work is done. Therefore, work equals energy.

ENERGY EDUCATION

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	What unit of measurement is used when measuring work and energy? (Class discussion)
UNDERSTAND	Which type of energy does the rock have when it is sitting at the top of the hill? What must be done for the rock to roll down the hill? When the rock is rolling down the hill, what type of energy does it have now? (Class discussion)
APPLY	Illustrate how work would be done on a classroom object. (Ex. Teacher or student lifts an object from the floor to table height.)
ANALYZE	Using a Venn diagram, compare and contrast potential and kinetic energy. **http://www.learninggamesforkids.com/graphic_organizers/writing/venn-diagram.html**
CREATE	Construct a drawing of something that might make work easier. (Teachers can ask students to draw their pictures on a sheet of paper. Ex. Ramp, pulley, etc.)

IV. Guided Practice Ideas

Recommended Items

Plastic Cup Bottle Launcher Experiment (see below)

Experiments

- **Plastic Cup Bottle Launcher Experiment**: **http://frugalfun4boys.com/2011/10/19/make-a-plastic-cup-rocket-launcher/**
- **Paper Plate Marble Track Experiment**: **http://frugalfun4boys.com/2012/09/05/paper-plate-marble-track/**
- **Magic Rollback Can Experiment**: **https://www.stevespanglerscience.com/lab/experiments/magic-rollback-can-sick-science**
- **Toy Experiment** to show potential to kinetic energy: **http://littleshop.physics.colostate.edu/tenthings/WhatIsEnergy.pdf**

Games

http://discoverykids.com/games/build-a-coaster/

V. Independent Practice Ideas

Recommended Item

At-Home Scavenger Hunt: Students find household items with potential energy (see below)

Other Resources

Personal Practice

Potential vs. Kinetic Energy Worksheet and Answer Key provided

Practice That May Involve Parents or Guardians

- At-Home Scavenger Hunt: Students find 5 things in their home that have potential energy and list them on a sheet of paper. (Ex. A stretched rubber band, a ball at the top of the stairs, etc.)
- At-Home Activity: Are there more things in your home with potential energy or kinetic energy? Students observe things in their home and write one or two sentences on a sheet of paper describing their conclusion.

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if grades are desired.

- Potential vs. Kinetic Energy Worksheet and Answer Key provided
- Experiments found in section IV. Guided Practice

VII. Materials Needed

The following materials are needed for the **Plastic Cup Bottle Launcher Experiment** in "Recommended Items" in the Guided Practice Ideas section.

- 2 plastic cups
- Tape
- Two rubber bands

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

What is work and how is it done?

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WORKSHEET FOR WORK-ENERGY RELATIONSHIPS LESSON 1.5

NAME: ______________________

Potential vs. Kinetic Energy

Objective: Students will be able to explain energy and define, explain and list examples of potential and kinetic energy.

1. **Define and explain kinetic energy.**

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2. **Define and explain potential energy.**

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3. **Explain how mechanical energy works.**

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4. Provide two examples of kinetic energy.

5. Explain Newton’s Third Law of Motion in your own words.

Answer Key

ANSWER KEY FOR WORKSHEET: POTENTIAL VS. KINETIC ENERGY

1. **Define and explain kinetic energy.**

   Ex. Kinetic energy is defined as energy in motion. It can be vibrational, rotational, or translational.

2. **Define and explain potential energy.**

   Ex. Potential energy is energy that is stored and held in readiness.

3. **Explain how mechanical energy works.**

   Ex. In the process of doing work, the object doing the work exchanges energy with the object on which the work is done.

4. **Provide two examples of kinetic energy.**

   Ex. A train going down the tracks, forcing a straw into a juice box, etc.

5. **Explain Newton's Third Law of Motion in your own words.**

   Ex. Newton's Third Law states that for every action force there is an equal, but opposite reaction force.

ENERGY FUNDAMENTALS – LESSON PLAN 1.6

Simple and Compound Machines

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Identify and explain simple machines and how they work.**
- **Identify and explain how compound machines work.**

Public School System Teaching Standards Covered

State Science Standards

- AL GLE 3.5.1 3rd
- AL GLE 3.5.2 3rd
- AL GLE 3.5.3 3rd
- AL GLE 5.6.2 5th
- GA S4P3 4th
- MS GLE 2.c 3rd
- NC 3.P.1 3rd
- NC 5.P.1 5th
- TN GLE 0307.T/E.1 3rd
- TN GLE 0507.T/E.1 5th
- VA 3.2 3rd

I. Anticipatory Set (Attention Grabber)

Essential Question

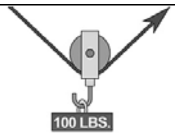
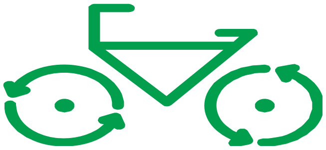
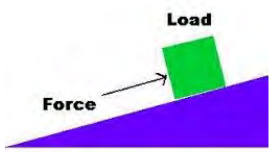
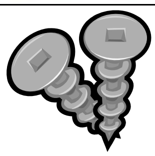
How can we make our work easier?

II. Modeling (Concepts to Teach)

A **simple machine** is defined as a machine that **makes work easier** by allowing a person to push or pull objects over increased distances. There are few to no moving parts in a simple machine. And remember, work is defined as applying a force over a distance in the same direction as the force.

There are SIX simple machines:

Additional Information: http://www.mikids.com/Smachines.htm

	Type	Example
1	**Pulley** – A pulley is a simple machine that uses grooved wheels and a rope to raise, lower or move a load.	
2	**Lever** – A lever is a stiff bar that rests on a support called a fulcrum which lifts or moves loads.	
3	**Wedge** – A wedge is an object with at least one slanting side ending in a sharp edge, which cuts material apart.	
4	**Wheel and Axle** – A wheel with a rod, called an axle, through its center lifts or moves loads.	
5	**Inclined Plane** – An inclined plane is a slanting surface connecting a lower level to a higher level. The inclined plane is simply a ramp, which uses the force of gravity to do work.	
6	**Screw** – A screw is an inclined plane wrapped around a pole which holds things together or lifts materials.	

A **compound machine** is two or more simple machines put together to do work. Unlike simple machines, compound machines have moving parts. For example, a pair of scissors is two levers moving past each other to do work. Also, the blades of the scissors are wedges (another simple machine). A bicycle is a compound machine that includes 3 simple machines: wheel and axle, gears, and a lever (the pedals). Compound machines also make work easier!

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	List the simple machines that can make work easier. List the compound machines that can make work easier. (Teachers can list these on the board with help from students.)
UNDERSTAND	How do machines make work easier? (Class discussion)
APPLY	Illustrate a simple machine. (Teacher or student demonstrates use of a simple machine such as a door stop or ramp.)
ANALYZE	If you could only have one machine (simple or compound), what would you choose and why? (Have multiple students answer or everyone write down what they would choose.)
EVALUATE	Rate the importance of simple and compound machines. What would happen if there were no machines making our work easier? (Class discussion)
CREATE	Create a drawing of a simple or compound machine that would make something you don’t like to do easier. (Students can draw a machine, such as a pulley in a tree house, on a piece of paper.)

IV. Guided Practice Ideas

Recommended Items

Simple Machine Experiment (using playground); Catapult Experiment

Experiments

- A Slide is a Simple Machine Experiment (using playground): **http://www.eia.gov/kids/resources/teachers/pdfs/SlidePrimary.pdf**
- Catapult Experiment: **http://sciencegal-sciencegal.blogspot.com/search/label/enrichment and investigation**
- Simple Machines: Levers Experiment (using playground): **http://www.eia.gov/kids/resources/teachers/pdfs/LeverElementaryActivity.pdf**
- An Energy Playground – Using Human Energy: **http://www.planetseed.com/laboratory/energy-playground**

Games

- Simple and Compound Machines: **http://schooltoolbox.weebly.com/simple--compound-machines.html**

Practice that uses math/reading skills:

- Math: Equation for force (force = mass x acceleration). Teachers can review Newton's Second Law with students: **http://www.youtube.com/watch?v=nO7XeYPi2FU**. Students can do example problems: **http://share.nanjing-school.com/sciences/files/2013/02/8Sci_FM_2ndLawWS-1fdv8aq.pdf**
- Reading: Students can read and summarize an article about force and motion: http://www.accuteach.com/files/2nd/science/Force-and-Motion-Reading-Comprehension.pdf?
-

V. Independent Practice Ideas

Recommended Items

Compound/Simple Machine Scavenger Hunt (see below)

Other Resources

Personal Practice

- Writing Activity: Teachers write the following question on the board and ask students to copy and answer the question on a sheet of paper: Explain how simple and compound machines work, in your own words.
- Create a simple machine using household items. Teachers can ask students to brainstorm ideas and teachers can write them on the board. Students can then create simple machines if materials are available. (Ex. a match box car rolls down an inclined plane and cracks an egg open.)
- Journal (if the students have a journal). Teachers write the following question on the board and ask students to copy and answer the question in their journals: Explain how machines make work easier.

Practice That May Involve Parents or Guardians

- At-home Activity: How Does Energy Work? Worksheet and Answer Key provided
- Scavenger Hunt – Simple Machines: Students find 5 simple machines in their homes and list them on a sheet of paper. (Ex. hammer, jar with a lid that screws on, etc.)
- Scavenger Hunt – Compound Machines: Students find 5 compound machines in their home and list them on a sheet of paper. (Ex. wheelbarrow, a pair of scissors, etc.)
- Build your own simple/compound machine (ex. a match box car rolls down an inclined plane and cracks an egg open).

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- How Do Machines Make Work Easier? Worksheet and Answer Key provided
- Journal (if completed as Personal Practice, as shown above)

VII. Materials Needed

The following materials are needed for the **A Slide is a Simple Machine Experiment** in "Recommended Items" in the Guided Practice section.

- 1 playground slide
- 1 long rope (25 feet)
- 1 measuring tape
- 4 heavy books
- 1 sturdy canvas bag with handles

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

How can we make our work easier?

This page is intentionally blank.

WORKSHEET FOR SIMPLE AND COMPOUND MACHINES LESSON 1.6

NAME: ______________________

How Do Machines Make Work Easier?

Objective: Students will be able to identify and explain simple and compound machines and how each type of machine works.

1. **How do machines make work easier?**

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2. **What is one type of simple machine?**

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3. **Draw an example of a wheel and axle:**

4. **Is a wheel and axle a simple machine or a complex machine? Why?**

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5. **How have machines changed with technology?**

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Answer Key

ANSWER KEY FOR WORKSHEET: HOW DO MACHINES MAKE WORK EASIER?

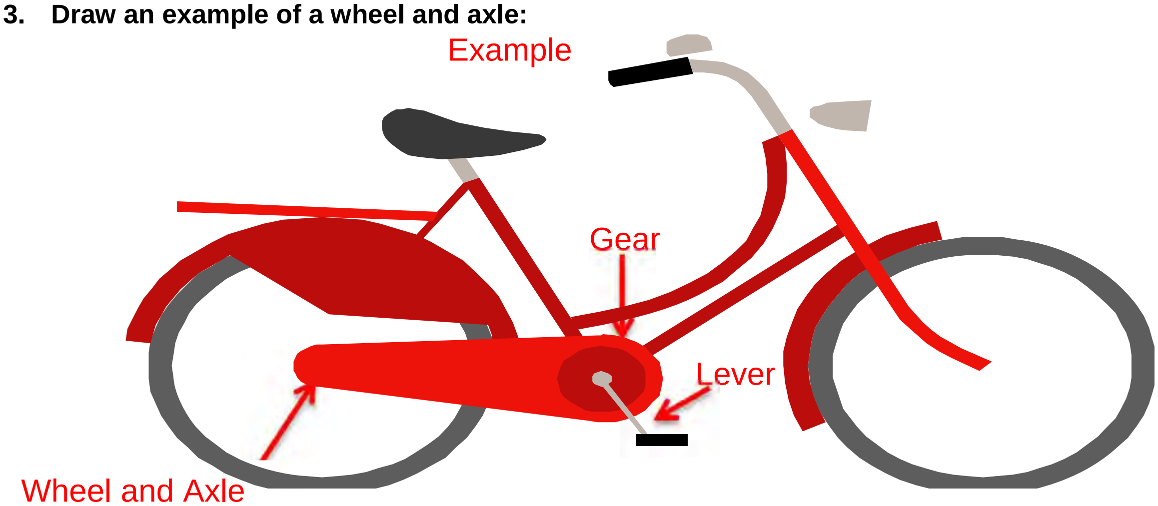
1. **How do machines make work easier?**

   Ex. Machines make work easier by applying more force to an object than a person can naturally apply.

2. **What is one type of simple machine?**

   Ex. Pulley, lever, wedge, wheel & axle, inclined plane, or screw

3. **Draw an example of a wheel and axle:**



4. **Is a wheel and axle a simple machine or a complex machine? Why?**

   Ex. Simple machine – there are few moving parts.

5. **How have machines changed with technology?**

   Ex. As technology has progressed, it has provided us with more machines that are able to do more work.

ENERGY EDUCATION

LESSON PLAN SET 2

Forms of Energy



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TVA

Set 2: Forms of Energy

FORMS OF ENERGY – LESSON PLAN 2.1

Introduction to Forms of Energy

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Explain the purpose of electrical energy.**
- **Identify different forms of energy.**
- **Define and explain both kinetic and potential energy.**
- **List forms of both kinetic and potential energy.**

Public School System Teaching Standards Covered

State Science Standards

- AL GLE 5.4.1 5th
- KY 4-ET-U-3 4th
- KY SC-5-ET-U-1 5th
- MS 9.a 4th
- MS 9.b 4th
- NC 4.P.3.1 4th
- TN 0407.10.1 4th
- TN GLE 0507.10.1 5th

Common Core Language Arts/Reading

- ELA.CC4.RI.1,2,and 8 MS, KY, TN, NC 4th
- ELA.CC.RI.1,2,and 4 KY, TN, AL 5th

I. Anticipatory Set (Attention Grabber)

Essential Question

How is energy converted into something we can see and use?

Videos

Bill Nye the Science Guy video on energy/electricity: http://www.billnye.com

II. Modeling (Concepts to Teach)

Additional Information

http://www.eia.gov/kids/energy.cfm?page=about_forms_of_energy-basics

Many things are made possible due to people's ability to use energy to do work so that they can live more comfortably. Potential energy is converted to kinetic energy in the form of heat to keep people warm in the winter. Potential energy is converted into kinetic energy in the form of electricity so that people can use their microwave ovens to make popcorn and watch a movie using a DVR player. Potential energy is converted into kinetic energy in the form of light (radiant energy) which allows one to turn on a lamp in order to read a favorite book before going to sleep at night.

There are 9 different forms of energy, but they can all be classified as either Potential Energy or Kinetic Energy:

Potential Energy	Kinetic Energy
Potential energy is stored energy and the energy of position – gravitational energy. There are several forms of potential energy.	**Kinetic energy is motion of waves, electrons, atoms, molecules, substances, and objects.**
Chemical energy is energy stored in the bonds of atoms and molecules. Batteries, biomass, petroleum, natural gas, and coal are examples of stored chemical energy. Chemical energy is converted to thermal energy when wood is burned in a fireplace or gasoline is burned in a car's engine.	**Radiant energy** is electromagnetic energy that travels in transverse waves. Radiant energy includes visible light, x-rays, gamma rays and radio waves. Light is one type of radiant energy. Sunshine is radiant energy, which provides the fuel and warmth that make life on Earth possible.
Mechanical energy is energy stored in objects by tension. Compressed springs and stretched rubber bands are examples of stored mechanical energy. **Mechanical energy can also be kinetic energy when a moving object (hammer, wind) does work.**	**Thermal energy**, or heat, is the vibration and movement of the atoms and molecules within substances. As an object is heated up, its atoms and molecules move and collide faster. Geothermal energy is the thermal energy in the Earth.
Nuclear energy is energy stored in the nucleus of an atom – the energy that holds the nucleus together. Very large amounts of energy can be released when the nuclei are combined or split apart. Nuclear power plants split the nuclei of uranium atoms in a process called **fission**. The sun combines the nuclei of hydrogen atoms in a process called **fusion**.	**Motion energy** is energy stored in the movement of objects. The faster they move, the more energy is stored. It takes energy to get an object moving, and energy is released when an object slows down. Wind is an example of motion energy. A dramatic example of motion is a car crash, when the car comes to a total stop and releases all its motion energy at once in an uncontrolled instant.
Gravitational energy is energy stored in an object's height. The higher and heavier the object, the more gravitational energy is stored. When someone rides a bicycle down a steep hill and picks up speed, the gravitational energy is being converted to motion energy. Hydropower is another example of gravitational energy, where the dam "piles" up water from a river into a reservoir.	**Sound** is the movement of energy through substances in longitudinal (compression/rarefaction) waves. Sound is produced when a force causes an object or substance to vibrate – the energy is transferred through the substance in a wave. Typically, the energy in sound is far less than other forms of energy.
	Electrical energy is delivered by tiny charged particles called electrons, typically moving through a wire. Lightning is an example of electrical energy in nature, so powerful that it is not confined to a wire.

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	List the forms of potential energy. List the forms of kinetic energy. Give examples of each form. (Teachers can list these on the board with help from students.)
UNDERSTAND	Explain the difference between potential and kinetic energy. (Class discussion)
APPLY	Illustrate potential energy being converted into kinetic energy. (Ex. light bulb → light; Teacher or student turns a light from off to on.)
ANALYZE	Using a Venn diagram, compare and contrast potential and kinetic energy. **http://www.learninggamesforkids.com/graphic_organizers/writing/venn-diagram.html**
CREATE	Create a drawing of something that would have potential and kinetic energy. Explain the difference in captions. (Teachers can ask students to draw their pictures on a sheet of paper. Ex. A ball at the top of a hill.)

IV. Guided Practice Ideas

Recommended Items

Interactive Energy Zone game (see below)

Games

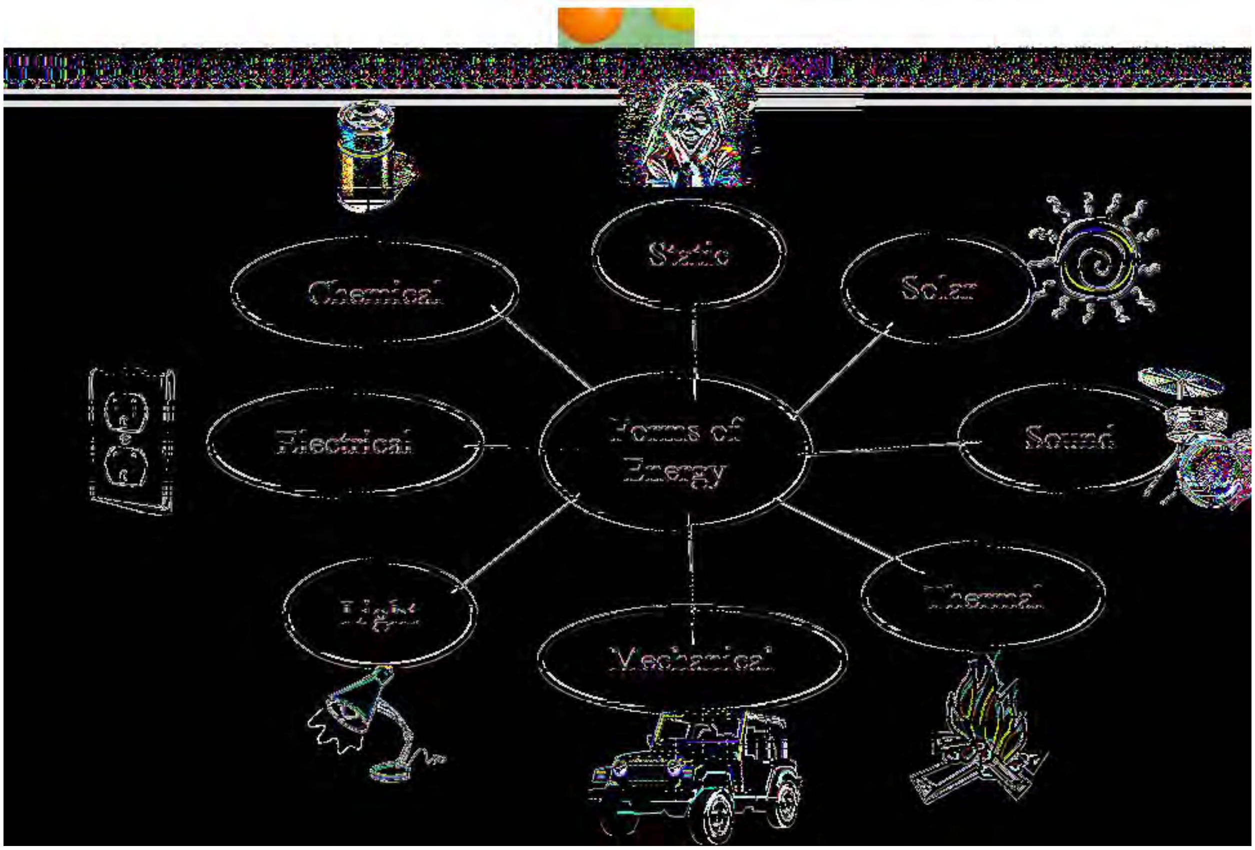
Interactive Game – Energy Zone: **http://www.kidsenergyzone.com/**

Experiments

Beginner electronics, solar energy, how to make a generator, etc.:
http://sciencewithkids.com/Experiments/Energy-Electricity-Experiments/energy-experiments.html

Other Resources

Graphic organizer: The spider graphic organizer below shows forms of energy in the center and kinds of energy as subcategories. Teachers can draw and label the 9 circles in the graphic organizer below on the board. Teachers can then list the 8 examples on the board (hair on end, sun, lamp, drum, fire, car, outlet, battery). Students can come to the board and either match the examples to the subcategory or draw pictures next to each subcategory. For example, lamp goes with light energy. The completed example with pictures is shown below.



Practice that uses reading/language arts standards

Reading: Teachers can have students read an article explaining energy and summarize it on a sheet of paper.

- http://www.nrel.gov/education/pdfs/science_energy_literacy_activities.pdf

V. Independent Practice Ideas

Recommended Item

Scavenger Hunt: Kinds of energy in your home (see below under Practice That May Involve Parents/Guardians)

Other Resources

Personal Practice

- Creative Writing Activity: Teachers write the following questions on the board and ask students to copy and answer the questions on a sheet of paper: What would the world be like if we didn't have electricity? In your opinion, what is the most important form of energy?
- Short Essay: Teachers write the following question on the board and ask students to copy and answer the question in the form of a short essay on a sheet of paper: What is the purpose of electrical energy?
- Where Does Your Electricity Come From? Worksheet: **http://www.education.com/files/219501_219600/219567/electricity-sources-functions.pdf**
- Where Does Our Electricity Come From? Video: http://education.nationalgeographic.com/education/media/where-does-electricity-come/?ar_a=1
- Electricity Worksheet: http://www.cees.org.uk/cms/uploads/pdfs/ActivitySheets-Electricity.pdf

Practice That May Involve Parents/Guardians

- Kinds of Energy in Your Home Worksheet and Answer Key provided.
- **Scavenger Hunt**: Find the different kinds of energy in your home. Students find 5 different types of energy examples in their home and list them on a sheet of paper. (Ex. mechanical energy – ink pen; light energy – flashlight, etc.)

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. This item can be graded, if desired.

- Kinds of Energy in Your Home Worksheet and Answer Key provided.

VII. Materials Needed

No materials are needed for the "Recommended Items" in Guided Practice and Independent Practice sections.

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

How is energy converted into something we can see and use?

WORKSHEET FOR INTRODUCTION TO FORMS OF ENERGY LESSON 2.1

NAME: ______________________

Kinds of Energy in Your Home

Objective: Students will be able to explain the purpose of electrical energy, identify different forms of energy, and define, explain, and list forms of kinetic and potential energy.

1. How is potential energy different from kinetic energy?

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2. Compare and contrast electric energy and motion energy.

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3. What machines in your home use energy?

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4. What kind of energy is stored in a stretched rubber band?

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5. Explain geothermal energy.

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Answer Key

ANSWER KEY FOR WORKSHEET: KINDS OF ENERGY IN YOUR HOME

1. **How is potential energy different from kinetic energy?**

   Ex. Potential energy is stored energy and the energy of position. Kinetic energy is energy in motion.

2. **Compare and contrast electric energy and motion energy.**

   Ex. Electric energy is delivered by tiny charged particles called electrons, typically moving through a wire. Motion energy is stored in the movement of objects. The faster they move, the more energy is stored. It takes energy to get an object moving.

3. **What machines in your home use energy?**

   Ex. Washer and dryer, dishwasher, refrigerator, video games, etc.

4. **What kind of energy is stored in a stretched rubber band?**

   Ex. Mechanical energy – energy is stored in the rubber band by tension.

5. **Explain geothermal energy.**

   Ex. Geothermal energy is the thermal energy in the Earth. This energy comes from the hot core deep beneath the surface of the Earth.

FORMS OF ENERGY – LESSON PLAN 2.2

The Law of Conservation of Energy

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
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Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Identify when energy is converted.**
- **List the different forms of energy.**
- **Explain why there is no loss of energy.**
- **Provide examples of energy conservation.**

Public School System Teaching Standards Covered

State Science Standards

- AL 3.2 3rd
- AL 3.13 3rd
- AL 4.1 4th
- AL 5.4.1 and 2 4th
- GA S3CS4 3rd
- GA S3PI 3rd
- GA S4CS4 4th
- GA S4P3 4th
- GA S5CS4 5th
- KY Big Idea: Motion and Forces 4th
- KY SC-EP-1.2.3 4th
- NC 3.P.1 and 3 3rd
- NC 4.P.1 and 3 4th
- NC 5.P.1 5th
- TN GLE 0307.10.1 3rd
- TN Conceptual Strand 10 3rd, 4th, 5th
- TN GLE 0407.11.3 and .4 4th
- TN GLE 0507.10.1, .2 and .5 5th
- TN SPI 0607.10.3 and 4 6th
- TN GLE 0607.10.3 6th
- VA 3.3 3rd
- VA 3.11 3rd
- VA 4.1.L 4th
- VA 4.2.c and d 4th

Common Core Language Arts/Reading

- ELA.CCSS.W.3.1 AL, TN, GA, NC 3rd
- ELA.CCSS.W.4.1 AL, TN, GA, NC, KY 4th
- ELA.CCSS.W.5.1 AL, TN, GA, NC 5th

I. Anticipatory Set (Attention Grabber)

Essential Question

How is energy used? (Students need to understand that energy is converted into different forms and that it is never lost.)

II. Modeling (Concepts to Teach)

The Law of Conservation of Energy states that the total energy in a system remains constant. So, when people say they are "using" energy, what they really mean to say is that they are "converting" energy from one form to another form. Energy is never created or destroyed, but it is transformed from one type to another. For example, when a car burns fuel (chemical potential energy) that fuel is not "used up"; it is transformed into mechanical energy that is then transformed into moving energy (kinetic energy). None of the energy is lost; it is conserved. Just the same, solar panels transform solar (radiant) energy into electrical energy and wind turbines use wind to cause the blades of the turbine to rotate, then that energy is converted into electricity. **Sometimes it looks like energy is lost, but this is usually due to a certain amount of the energy in the system transforming into heat and sound energy.**

http://www.neok12.com/Law-of-Conservation.htm
https://www.youtube.com/watch?v=LrRdKmjhOgw

When people ride a roller coaster, the following happens:
First, the car is pulled to the highest part of a track. At the top of the track, the car has potential energy. As the car rolls down the first steep slope, some of the potential energy changes into kinetic energy. At the bottom of the hill, all the potential energy has changed into kinetic energy.

When the car climbs to the top of the next hill, the kinetic energy changes back into potential energy. This process repeats itself throughout the ride. Normally, after the first hill, the car moves without outside help. Each time it coasts down a hill it gains enough kinetic energy to climb the next one. **However, some of the energy**

turns into heat in overcoming friction. For this reason, each hill in the ride is a little smaller than the one before it.

When scientists measure energy changes in a system such as a roller coaster, they find that when energy disappears in one form, an equal amount appears in another form. In other words, energy is neither created nor destroyed. It only changes form. This basic law of nature is called the law of conservation of energy.

Examples of energy transformations where energy is conserved:
http://examples.yourdictionary.com/law-of-conservation-of-energy-examples.html

- Water can produce electricity. Water falls from the sky, converting potential energy to kinetic energy. This energy is then used to rotate the turbine of a generator to produce electricity. In this process, the potential energy of water in a dam can be turned into kinetic energy, which can then become electric energy. Some of the potential energy is also converted into heat energy, due to friction and perhaps some sound energy, too.
- When playing pool, the cue ball is shot at a stationary 8 ball. The cue ball has energy. When the cue ball hits the 8 ball, the energy transfers from the cue ball to the 8 ball, sending the 8 ball into motion. The cue ball loses energy because the energy it had has been transferred to the 8 ball, so the cue ball slows down. Some of the kinetic energy is also transformed into heat energy due to friction and sound energy, too.
- Kelly ran across the room and bumped into her brother, pushing him to the floor. The kinetic energy she possessed because of her movement was transferred to her brother, causing him to move.
- When a moving car hits a parked car and causes the parked car to move, energy is transferred from the moving car to the parked car.
- When playing the lawn game bocce ball, a small ball is thrown with the intention of hitting larger balls and causing them to move. When a larger ball moves because it was hit by the small ball, energy is transferred from the small ball to the larger one.
- When Joe pushes a book across the table, the energy from his moving arm is transferred from his body to the book, causing the book to move.
- A cat sitting on the highest branch of a tree has what is known as potential energy. If he falls off the branch and falls to the ground, his potential energy is now being converted into kinetic energy.
- When kicking a football that is sitting on the ground, energy is transferred from the kicker's body to the ball, setting it in motion.
- Sam was rearranging furniture, and needed help to push the heavy sofa. His brother came over, and together they were able to lift the sofa onto sliders. This made it easy to push the sofa across the room. When Sam and his brother pushed the sofa and it slid across the wood floor, energy was transferred from the men to the piece of furniture.
- A fly ball hits a window in a house, shattering the glass. The energy from the ball was transferred to the glass, making it shatter into pieces and fly in various directions.
- Two football players collided on the field, and both went flying backwards. Energy was transferred from each player to the other, sending them in the opposite direction from which they had been running.
- Claire threw the ball and it hit her mother's vase, knocking it over. Energy was transferred from the moving

ball to the stationary vase, causing the vase to move.
- Fingers hitting piano keys transfer energy from the player's hand to the keys.
- Billy hit the punching bag, transferring energy from his arm to the stationary bag.
- The dog ran into the decorative plant and knocked it over. Energy was transferred from the moving dog to the stationary plant, causing the plant to move.
- When the car hit the road sign, the sign fell over. Energy was transferred from the moving car to the stationary sign, causing the sign to move.
- Potential energy of oil or gas is changed into energy to heat a building.
- When a bowling ball knocks over pins that had been standing still, energy is transferred from the ball to the pins.
- Beth hit the wall so hard that she put a hole in it. Energy was transferred from Beth's body to the drywall, causing it to move.

REMEMBER	Is energy created? Is energy destroyed? (Class discussion) List the forms of energy that potential energy can be transformed into. (Teachers can list these on the board with help from students. Ex. mechanical, light, etc.)
UNDERSTAND	How does energy change from stored energy to motion? (Class discussion)
APPLY	On this roller coaster, show where the cars have potential energy and where it is converted to kinetic energy. (Teacher can draw on board and discuss with class. For more information: http://www.pbslearningmedia.org/asset/mck05_int_rollercoaster/) 
ANALYZE	Explain why it seems like some energy is lost when in reality it is just being converted into different forms of energy. (Class discussion. Answer: Besides the energy changing into visible motion, some energy is converted into heat, sound, light, chemical, or mechanical energy.)
CREATE	Come up with some examples of energy being transferred from potential to kinetic energy. (Class discussion)

ENERGY EDUCATION

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

IV. Guided Practice Ideas

Recommended Items

Build a Roller Coaster

Experiments

- **Build a Roller Coaster**: http://www.msichicago.org/online-science/activities/activity-detail/activities/build-a-roller-coaster OR http://www.miamisci.org/af/sln/mummy/raceways.html
- **Transfer of Energy**: http://frugalfun4boys.com/2012/11/14/transfer-of-energy-science-experiment/
- **Dominos chain reaction** (potential → kinetic energy): http://stemactivitiesforkids.com/2016/03/16/domino-chain-reaction/

V. Independent Practice Ideas

Recommended Item: Energy Conservation Worksheet and Answer Key provided

- Energy Conservation Worksheet and Answer Key provided
- Transformation of Energy Worksheet and Answer Key provided
- Journal (if the students have a journal). Teachers write the following question on the board and ask students to copy and answer the question in their journals: Come up with an example from your everyday life of energy being converted from one form to another.
- Draw and explain: Teachers ask students to draw an object with potential energy OR kinetic energy and explain which type of energy is pictured.
- Create a story or skit: Teachers ask students to write a story on a sheet of paper or create a skit in the classroom of how energy changes forms to be utilized.

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- Energy Conservation Worksheet and Answer Key provided
- Transformation of Energy Worksheet and Answer Key provided
- Roller Coaster creation and labels (if completed **Build a Roller Coaster Experiment** in Guided Practice, as shown above).
- Journal (if completed as Independent Practice, as shown above).

VII. Materials Needed

The following materials are needed for the **Build a Roller Coaster Experiment** in “Recommended Items” in Guided Practice.

- Marbles or small balls
- About 6 feet of flexible tubing, such as ¾-inch foam pipe insulation
- Masking tape
- Plastic cup
- Scissors
- Various supports, such as boxes, paper towel tubes or books

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

How is energy used?

WORKSHEET FOR THE LAW OF CONSERVATION OF ENERGY LESSON 2.2

Energy Conservation

NAME: ______________________

Objective: Students will be able to identify when energy is converted, list the different forms of energy, restate The Law of Conservation of Energy, and provide examples of energy conservation.

1. **Give an example of energy changing form.**

   ____

   ____

2. **How can energy be converted to make electricity?**

   ____

   ____

3. **Draw three stages of energy being transferred to set a car in motion.**

4. **Restate The Law of Conservation of Energy.**

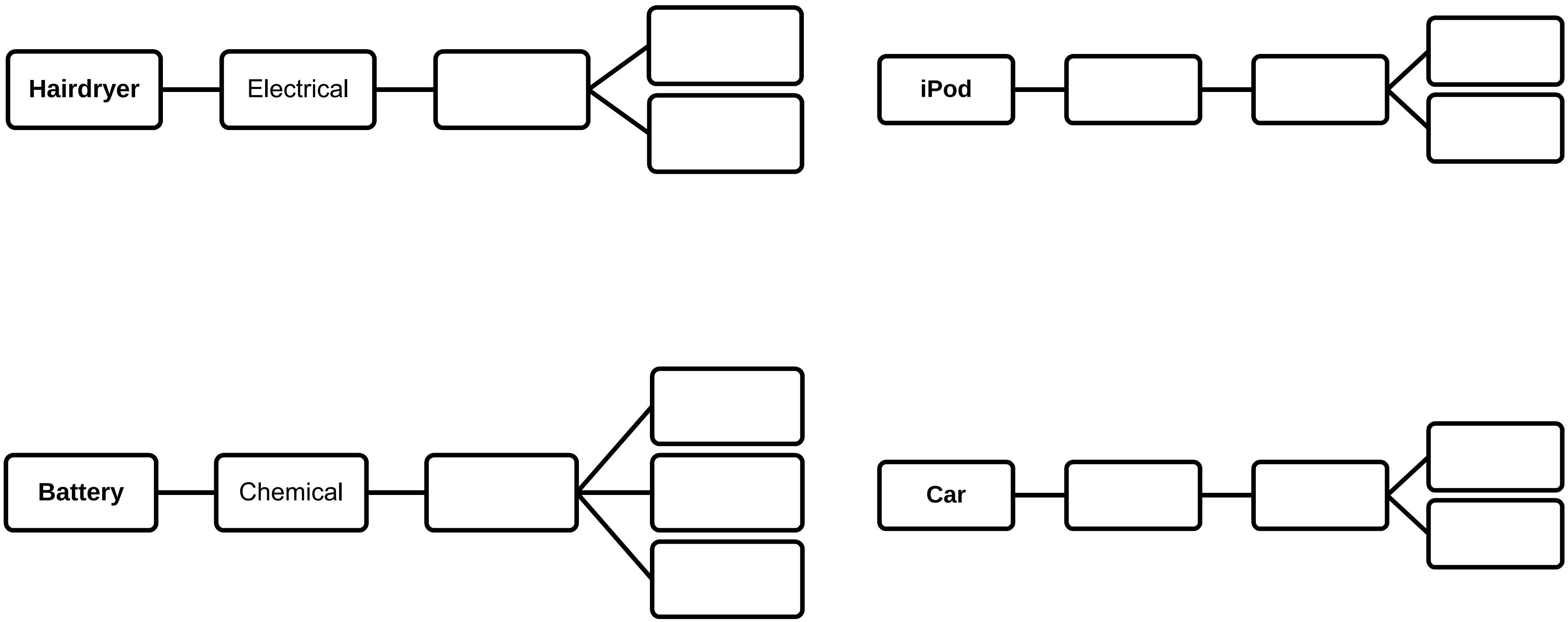
   ____

   ____

WORKSHEET FOR THE LAW OF CONSERVATION OF ENERGY LESSON 2.2 **NAME: ______________________**

Transformation of Energy

Objective: Students will be able to identify when energy is converted, list the different forms of energy, explain why there is no loss of energy, and provide examples of energy conservation.



Identify which type of energy is used in each phase of energy transformation.

Answer Keys

ANSWER KEY FOR WORKSHEET: ENERGY CONSERVATION

1. Give an example of energy changing form.

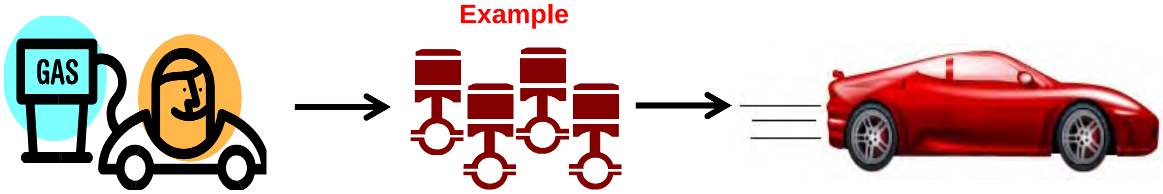
Ex. Car fuel being transferred into mechanical energy, mechanical energy from the engine being transferred into kinetic energy, thereby moving the car.

2. How can energy be converted to make electricity?

Ex. Water or wind can be used to turn turbines of a generator to create electricity.

3. Draw three stages of energy being transferred to set a car in motion.

Example

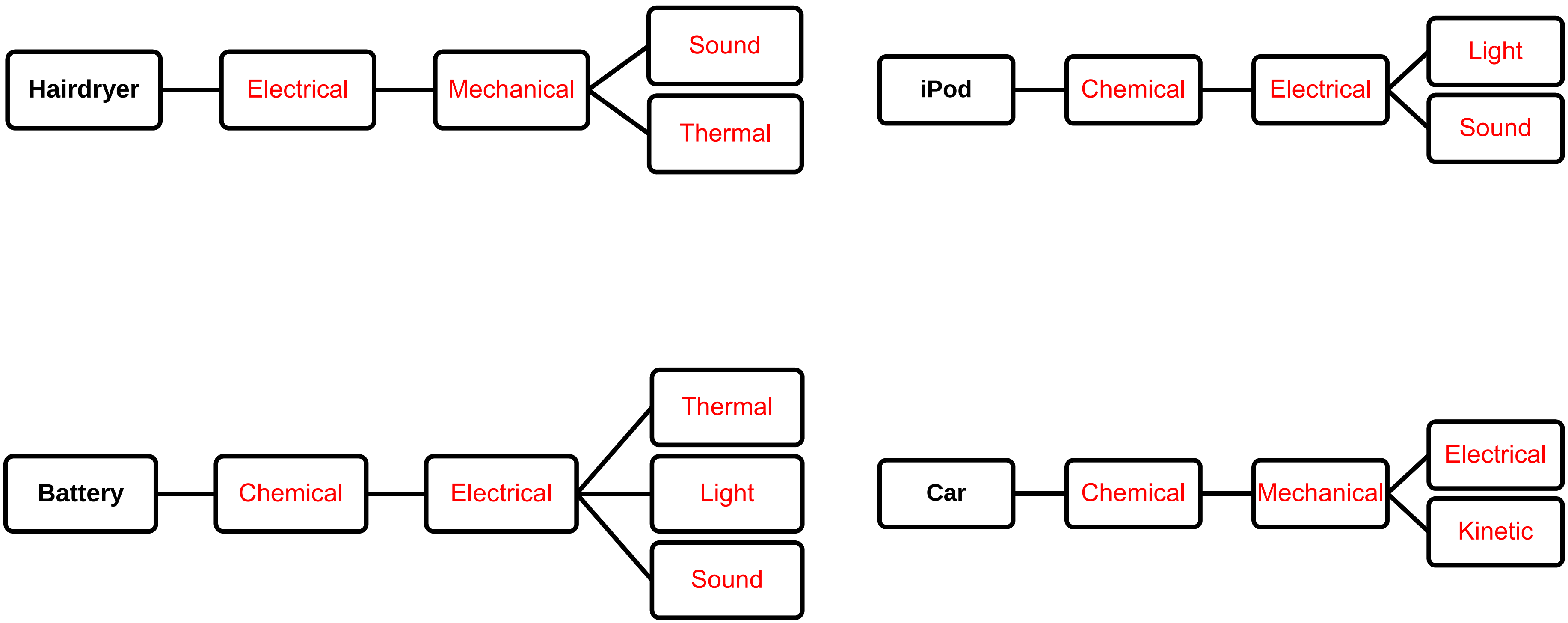


Chemical Mechanical Kinetic

5. Restate The Law of Conservation of Energy.

Ex. The Law of Conservation of Energy states that energy is never created nor destroyed, but it is transformed from one type to another.

ANSWER KEY FOR WORKSHEET: TRANSFORMATION OF ENERGY



Identify which type of energy is used in each phase of energy transformation.

FORMS OF ENERGY – LESSON PLAN 2.3

Mechanical Energy

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Identify mechanical energy.**
- **Explain the difference between potential mechanical energy and kinetic mechanical energy.**

Public School System Teaching Standards Covered

State Science Standards

- AL 3.4.1 3rd
- AL 3.4.2 3rd
- AL 4.1.1 4th
- AL 5.4.1 5th
- GA SCS5 4th
- KY 3 PS2.B 3rd
- NC 3.P.1 and 3 3rd
- NC 5.P.1 5th
- TN GLE 0307.INQ.1 and 3 3rd
- TN GLE0407.11.1 4th
- TN GLE 0407.INQ.1 and 3 4th
- TN GLE 0507.INQ.1 and 3 5th
- VA S.4.2 4th
- VA S.4.3 4th

Common Core Language Arts/Reading

- ELA.CCSS.W.4.1 AL, TN 4th
- ELA.CCSS.W.3.1 AL, NC, KY, TN 3rd
- ELA.CCSS.W.5.1 AL, GA, NC, TN 5th

I. Anticipatory Set (Attention Grabber)

Essential Question

What is mechanical energy?

Videos

Explaining the Three Types of Energy Video: http://www.youtube.com/watch?v=XU_rMVd6DkU

II. Modeling (Concepts to Teach)

Additional Information

http://www.physicsclassroom.com/class/energy/Lesson-1/Mechanical-Energy

The object that provides the force in order to do work (Remember: work equals force times distance) needs some source of energy. For example, if a person wants to do work on a set of dumbbell weights at the gym, then he/she needs to provide his/her body with food, which is chemical potential energy. It is the food that is eaten that provides the energy for the force exerted on the weights. The chemical potential energy stored in food or fuel is transformed into work. In the process of doing work, the object that is doing the work exchanges energy with the object upon which the work is done. When the work is done upon the object, that object gains energy. The energy acquired by the objects upon which work is done is known as **mechanical energy**.

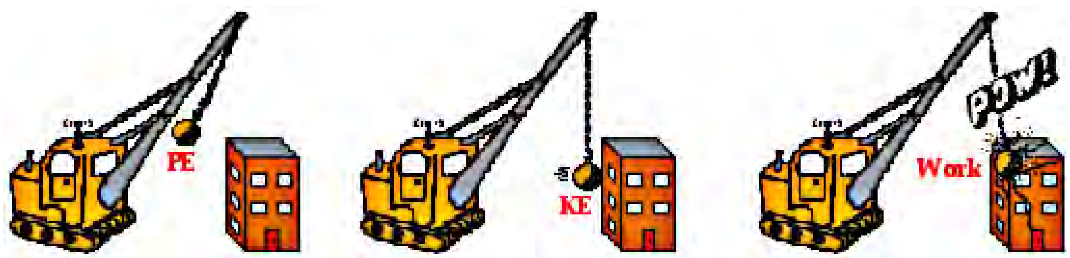
Mechanical Energy can be classified as either Potential (1) or Kinetic (2):
An object that possesses mechanical energy is able to do work. In fact, mechanical energy is often defined as the ability to do work. Any object that possesses mechanical energy – whether it is in the form of potential energy or kinetic energy – is able to do work. That is, its mechanical energy enables that object to apply a force to another object in order to cause it to be displaced.

1. **Potential Mechanical Energy**
   Sometimes mechanical energy is **stored** in objects. Tension is an example of stored mechanical energy and is **Potential Energy**. Compressed springs and stretched rubber bands are examples of this stored mechanical energy. For example, a bow is provided with stored mechanical energy that is provided by the archer when he or she pulls back on the string, putting tension on it. When the string is released, the arrow is sent flying through the air. Work is done on the arrow.

2. Kinetic Mechanical Energy

Sometimes mechanical energy is a **moving** object. A hammer pounding a nail is a good example of moving mechanical energy. A person gives energy to the hammer and then the hammer has the moving mechanical energy to do work on a nail. When the hammer moves into the nail, it pushes it into the board. Work is done on the nail. In addition, moving air (wind) exhibits moving mechanical energy when it does work on the blades of a turbine. As the blades spin, their energy is then converted to electrical potential energy.

In the diagram below, mechanical energy can be seen in both of its forms-potential and kinetic.



The massive ball of a demolition machine possesses mechanical energy – the ability to do work. When held at a height, it possesses mechanical energy in the form of potential energy. As it falls, it exhibits mechanical energy in the form of kinetic energy. As it strikes the structure to be demolished, it applies a force to displace the structure – i.e., it does work upon the structure.

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	Define mechanical energy. (Class discussion)
APPLY	Give an example of an object with POTENTIAL mechanical energy; Give an example of an object with KINETIC mechanical energy. (Class discussion)
ANALYZE	Compare and contrast potential mechanical energy and kinetic mechanical energy. (Class discussion)
CREATE	Create a drawing of mechanical energy changing from potential (stored) to kinetic (moving). (Teachers can ask students to draw their pictures on a sheet of paper. Ex: a hammer in the air and then falling to hit a nail.)

IV. Guided Practice Ideas

Recommended Items

Conversion to Mechanical Energy Experiment (see below)

Experiments

- **Conversion to Mechanical Energy**: http://www.evilmadscientist.com/2006/how-to-make-the-simplest-electric-motor/
- Mechanical Energy: http://education-portal.com/academy/lesson/what-are-the-types-of-energy.html - lesson
- Lift Light Weights: Showing biceps' potential energy converting to mechanical energy on weights. Teachers can ask students to lift a light weight, such as a book, and observe potential energy converting to mechanical.
- Wind Mill Experiment: Converting wind energy (breath) to mechanical energy (spinning wind mill). Teachers can ask students to stand and swing arms in windmill and observe potential energy converting to mechanical.
- Examples of conversion to mechanical energy: http://www.ehow.com/info_10067494_experiments-mechanical-energy-kids.html

V. Independent Practice Ideas

Recommended Item: At-home Scavenger Hunt

- **At-home Scavenger Hunt**: Students find three objects in their home that convert potential energy to kinetic mechanical energy (Ex. ink pen, bicycle, etc.) and list them on a piece of paper.
- Journal (if the students have a journal): Teachers write the following question on the board and ask students to copy and answer the question in their journals: Explain the difference between potential mechanical energy and kinetic mechanical energy.
- Venn diagram: Teacher asks students to compare potential mechanical energy to kinetic mechanical energy using a Venn diagram. (Ex. Draw two large intersecting circles. Label one circle potential mechanical energy and the other circle kinetic mechanical energy).
  http://www.learninggamesforkids.com/graphic_organizers/writing/venn-diagram.html
- At-home Activity: Teachers ask students to create something from household materials that stores mechanical energy and then goes into motion. (Ex. spring, windmill, mousetrap, etc.)

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- Journal (if completed as Independent Practice, as shown above)
- Venn diagram (if completed as Independent Practice, as shown above)
- This lesson plan doesn't include a worksheet.

VII. Materials Needed

The following materials are needed for the **Conversion to Mechanical Energy Experiment** in "Recommended Items" in Guided Practice.

- 1 drywall screw
- 1 1.5V alkaline cell
- 6 inches of plain copper wire
- 1 small neodymium disk magnet

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

What is mechanical energy?

FORMS OF ENERGY – LESSON PLAN 2.4

Chemical Energy

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Distinguish between chemical energy and other forms of energy.**
- **Identify chemical energy.**
- **List the forms of chemical energy.**

Public School System Teaching Standards Covered

State Science Standards

- TN SPI 0407.10.1 and WCS 4th
- TN GLE 0607.10.1 6th

Common Core Language Arts/Reading

- ELA.CCSS.W.4.1 4th

I. Anticipatory Set (Attention Grabber)

Essential Question

What is chemical energy and how is it used?

Videos

What is Chemical Energy? Video: http://www.eschooltoday.com/energy/kinds-of-energy/what-is-chemical-energy.html

II. Modeling (Concepts to Teach)

Chemical energy is the energy **stored** in the bonds found in molecules. It is an example of potential energy. When food is eaten, the body breaks down these molecules and the stored energy is used for the body to do work, like walking, talking, and thinking. Every molecule stores energy in its chemical bonds. Wood, natural gas, coal, and other molecules can be broken down in the process of combustion, and during this process, energy is released. That energy is then used to heat homes, to generate electricity to run appliances, and to provide light for homes at night.

Absolutely everything around, both living and non-living, natural and altered, is made of chemical molecules of one kind or another that formed from chemical reactions.

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	List the characteristics of chemical energy. (Class discussion)
UNDERSTAND	What can chemical energy be used for? (Class discussion. Answer: Many energy sources commonly used by humans are forms of chemical energy. They are usually labeled “fuels.” The way to use the chemical energy in most fuels is by burning them, as we do with wood, natural gas, gasoline, coal, and others. When these fuels burn, they give off heat.)
APPLY	What happens when dynamite explodes? What is the chemical energy converted into? (Class discussion. Answer: When dynamite explodes, its chemical energy changes very quickly into thermal and radiant (light) energy and transfers from a potential state to a kinetic state.)
ANALYZE	Compare chemical energy to mechanical energy. (Class discussion)

IV. Guided Practice Ideas

Recommended Items

Battery Life Experiment and Peanut Power Experiment (see below)

Experiments

- Battery Life Experiment – stored chemical energy: **http://www.energyquest.ca.gov/projects/battery.html**
- Peanut Power Experiment: **http://www.energyquest.ca.gov/projects/peanut.html**
- Chemical Energy in a Bottle Experiment: **http://www.education.com/science-fair/article/chemical-potential-energy/**

V. Independent Practice Ideas

Recommended Items

- **Venn diagram:** Comparing forms of energy (see below)
- **Create a list:** List examples of items that use chemical energy (ex. Batteries, gasoline, etc.) (see below)

Personal Practice

- Venn diagram: Teachers ask students to compare chemical energy with their choice of another form of energy using a Venn diagram. (Ex. Draw two large intersecting circles. Label one circle chemical energy and the other circle another energy, such as mechanical). **http://www.learninggamesforkids.com/graphic_organizers/writing/venn-diagram.html**
- Create a list: Teachers write the following question on the board and ask students to copy the question and list examples on a sheet of paper: List examples of items that use chemical energy (Ex. Batteries, gasoline, etc.)
- Journal (if the students have a journal). Teachers write the following questions on the board and ask students to copy and answer the questions in their journals: What did you learn about chemical energy? Chemical energy can do...

Practice That May Involve Parents or Guardians

- At-home Checklist: Teachers write the following question on the board and ask students to copy it on a sheet of paper. At home, students find different kinds of chemical energy and list them on the paper. What kinds of chemical energy are in your home?

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- Venn diagram (if completed as Independent Practice, as shown above)
- Create a list (if completed as Independent Practice, as shown above)
- Journal (if completed as Independent Practice, as shown above)
- This lesson plan doesn't include a worksheet.

VII. Materials Needed

The following materials are needed for the **Battery Life Experiment** in “Recommended Items” in the Guided Practice section.

- Four of the same type, size and brand flashlights
- Two D-size batteries from each of the following brands: Duracell, Energizer, Eveready and Rayovac
- Two other D-size batteries to test each flashlight and bulb before starting tests

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

What is chemical energy and how is it used?

FORMS OF ENERGY – LESSON PLAN 2.5

Light Energy & Solar Energy

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Describe how light is a form of energy and that it can be characterized as a wave.**
- **Explain how we see light, *e.g.* incandescent, fluorescent, etc.**
- **Identify different forms of light bulbs.**
- **Explain why we cannot see the entire spectrum of electromagnetic waves.**

Public School System Teaching Standards Covered

State Science Standards

- GA S4P1 4th
- NC 4.P.3.2 4th
- VA 5.3 5th

Common Core Language Arts/Reading

- ELA.CCSS.W.4.1 GA, NC 4th

I. Anticipatory Set (Attention Grabber)

Essential Question

How is energy converted into something that is visible, like light?

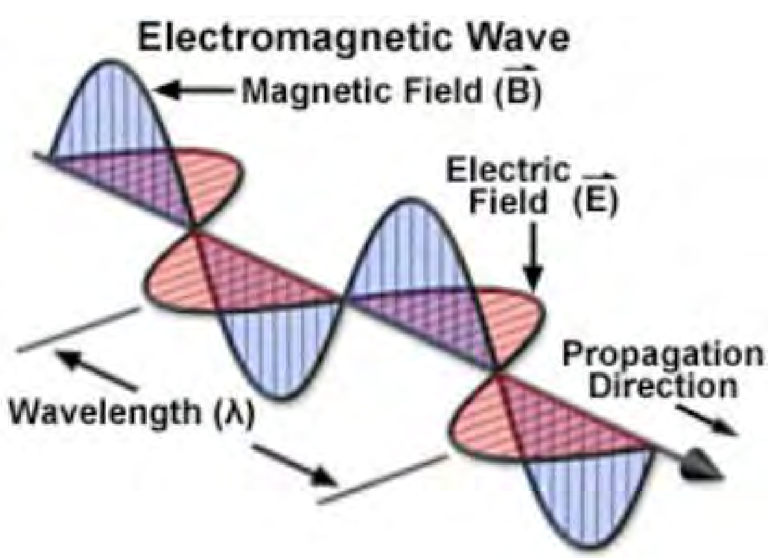
Videos

Video of Light and Color: http://pbskids.org/dragonflytv/show/lightandcolor.html
Explanation Video of Light and Color:
http://www.pbslearningmedia.org/resource/lsps07.sci.phys.energy.lightcolor/light-and-color/

II. Modeling (Concepts to Teach)

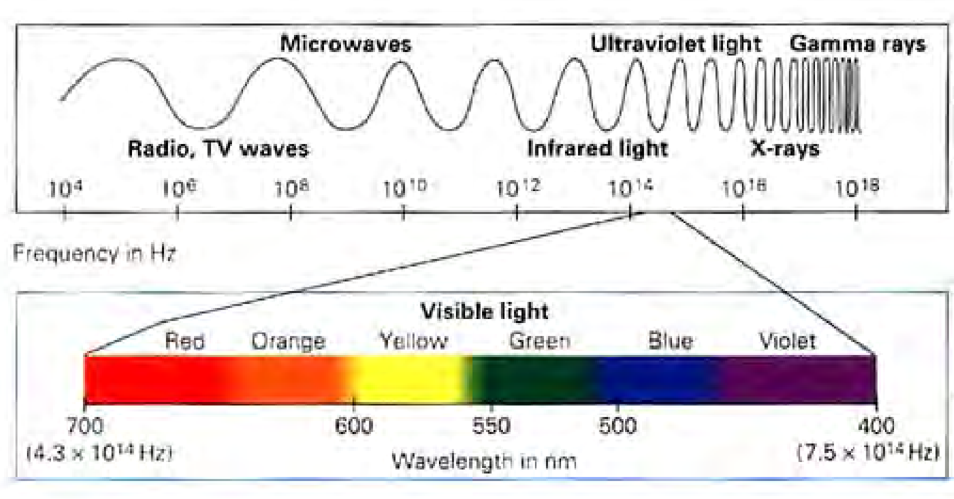
Light (Radiant) Energy is the energy of electromagnetic (EM) radiation. All light is created by vibrating electrical charges (electrons) in atoms. This wave is partly electric and partly magnetic in nature. The various types of electromagnetic radiation all share identical and fundamental wave-like properties. Every category of electromagnetic radiation, including visible light, oscillates in a periodic fashion with peaks and valleys (or troughs), and displays a characteristic **amplitude**, **wavelength**, and **frequency** that together define the direction, energy, and intensity of the radiation.

See diagram below:



Electromagnetic wave types differ in their wavelength and frequency. The electromagnetic spectrum is the range of all possible wavelengths and frequencies of electromagnetic radiation.

See EM Spectrum below:
http://web.princeton.edu/sites/ehs/laserguide/



One can notice that only a very small part of the EM Spectrum is light that humans are capable of seeing. This part of the spectrum is referred to as the Visible Spectrum and includes all of the colors that human eyes are able to see: Red, Orange, Yellow, Green, Blue, Indigo, and Violet (ROY G. BIV).

Longer and lower frequency electromagnetic waves contain less energy. For example, Radio waves, Microwaves, and Infrared Waves have less energy than Visible waves, Ultraviolet waves, X-rays, and Gamma rays.

In addition to being referred to as waves, scientists agree that light can also be considered a particle, called a photon. Photons are massless bundles of concentrated electromagnetic energy. In 1905, Albert Einstein published a theory concerning the particle-nature of light called the Photoelectric Effect. Around the same time, Max Plank discovered that light energy can only exist is certain amounts, or “chunks.” In other words, light energy is quantized.

Light Bulbs

All light is created by vibrating electrical charges (electrons) in atoms. The descriptions below will show the difference between the light created by incandescent light bulbs, compact fluorescent light bulbs, and VLED (Visible Light Emitting Diodes).

Incandescent Light Bulbs

The light energy is created by an electrical current traveling through a filament, usually made of an inert metal such as Tungsten. The filament gets hot, the electrons get excited and start to vibrate, and light radiation is emitted. In addition to light being emitted, a lot of heat is generated, too. A lot of the electrical potential energy is transformed into heat energy instead of being transformed into light energy.

CFL (Compact Fluorescent Light Bulbs): http://en.wikipedia.org/wiki/Compact_fluorescent_lamp

CFLs produce light differently than incandescent bulbs. In a CFL, an electric current is driven through a tube containing Argon and a small amount of Mercury vapor. This generates invisible Ultraviolet light that excites a fluorescent coating (Phosphor) on the inside of the tube, which then emits visible light. Very little electrical potential energy is transformed into heat. Compared to general-service incandescent lamps giving the same amount of visible light, CFLs use one-fifth to one-third the electric power, and last eight to fifteen times longer.

VLED (Visible Light Emitting Diodes) Light Bulbs: http://electronics.howstuffworks.com/led3.htm

LEDs are illuminated solely by the movement of electrons in a semiconductor material. The lifespan of an LED surpasses the short life of an incandescent bulb by thousands of hours. While LEDs are used in everything from remote controls to the digital displays on electronics, visible LEDs are growing in popularity and use thanks to their long lifetimes and miniature size. Depending on the materials used in LEDs, they can be built to shine in infrared, ultraviolet, and all the colors of the visible spectrum. But the main advantage is **efficiency**. In conventional incandescent bulbs, the light-production process involves generating a lot of heat (the filament must be warmed). This is completely wasted energy, unless one is using the lamp as a heater, because a huge portion of the available electricity isn't going toward producing visible light. LEDs generate very little heat, relatively speaking.

Capturing and Using Radiant (Solar) Energy

See National Geographic Article:
http://environment.nationalgeographic.com/environment/global-warming/solar-power-profile/

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	Electromagnetic waves are partly ___________ and partly ____________ in nature. (Answer: electric and magnetic); Do all EM waves have the same wavelength and frequency? (Answer: EM wave types differ in their wavelength and frequency. The electromagnetic spectrum is the **range** of all possible wavelengths and frequencies of electromagnetic radiation.); What are photons? (Answer: Photons are massless bundles of concentrated electromagnetic energy.) (Class discussion)
UNDERSTAND	Compare the energy levels of energy in radio waves and visible waves. (Class discussion)
ANALYZE	Explain how light is created. (Class discussion. Answer: All light is created by vibrating electrical charges (electrons) in atoms.)
CREATE	Compose a Venn diagram to compare and contrast the different types of light bulbs. **http://www.learninggamesforkids.com/graphic_organizers/writing/venn-diagram.html**

IV. Guided Practice Ideas

Recommended Items

Create a Spectrometer and Light Bulb Challenge (see below in Experiments sections)

Other Resources

- Intro PowerPoint: **http://www.astro.virginia.edu/class/whittle/astr1220/05_Light_Matter/light.pdf**

Experiments

- **Create a Spectrometer** to View Spectrum of Light Experiment: **http://www.pinterest.com/pin/450711875177725942/**
- **Light Bulb Challenge**: **http://www.pbs.org/parents/scigirls/activities/light-bulb-challenge/**
- Demonstrate efficiency of different light bulbs: **http://littleshop.physics.colostate.edu/activities/atmos1/DemonstratingEfficiency.pdf**
- Light Bulbs and Thermal Energy Experiment: **http://www.education.com/science-fair/article/heat-produced-from-light-bulbs/**

V. Independent Practice Ideas

Recommended Items

- **At-Home Scavenger Hunt: Lights in your home (see below)**
- **Electromagnetic Spectrum Worksheet and Answer Key provided**

Other Resources

Personal Practice

- Writing Activity: Teachers write the following questions on the board and ask students to copy the questions and answer them on a sheet of paper: What is light? How does light produce energy?
- Create a list: Teachers write the following question on the board and ask students to copy the question and answer it on a sheet of paper: List objects that give us light.
- Electromagnetic Spectrum Worksheet and Answer Key provided
- At-Home Scavenger Hunt: Lights in Your Home. Students find and list examples of the three different types of lights in their home (incandescent, CFL and LED lights).
- Journal (if the students have a journal). Teachers write the following question on the board and ask students to copy and answer the question in their journals: What are the three types of light bulbs? (Teachers instruct students to name them and then glue or draw pictures of each type – incandescent, CFL and LED lights).

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- Electromagnetic Spectrum Worksheet and Answer Key provided
- Journal (if completed as Independent Practice, as shown above)
- Checklist (if completed as Independent Practice, as shown above)
- Light Bulb Challenge Experiment (if completed as Guided Practice, as shown above)

VII. Materials Needed

The following materials are needed for the **Light Bulb Challenge Experiment** in “Recommended Items” in Guided Practice.

- Incandescent bulb, 60 watts
- Compact fluorescent light (CFL) bulb, 15 watts
- 1 desk lamp, shade included
- 1 Tbsp. cooking oil
- 1 dropper
- 2 half-sheets of paper
- Ruler
- 2 books of equal thickness
- Stopwatch or clock
- Paper and pencil

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

How is energy converted into something that is visible, like light?

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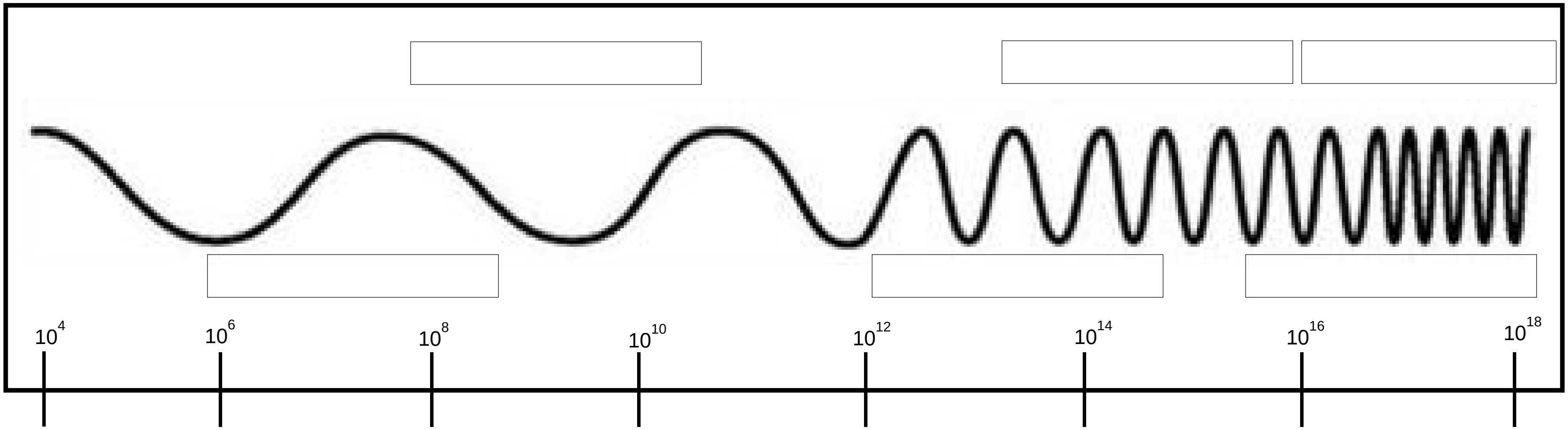
WORKSHEET FOR LIGHT ENERGY & SOLAR ENERGY LESSON 2.5

NAME: ______________________

Electromagnetic Spectrum

Objective: Students will be able to describe how light is a form of energy and that it can be characterized as a wave, explain how we see light, and identify the different types of waves in the electromagnetic spectrum.



1. Label each box of the electromagnetic spectrum.

2. Where does visible light fall on the spectrum?

____

____

____

3. Describe the way a wave moves and identify its parts.

____

____

____

4. The movement of which part of the atom creates light?

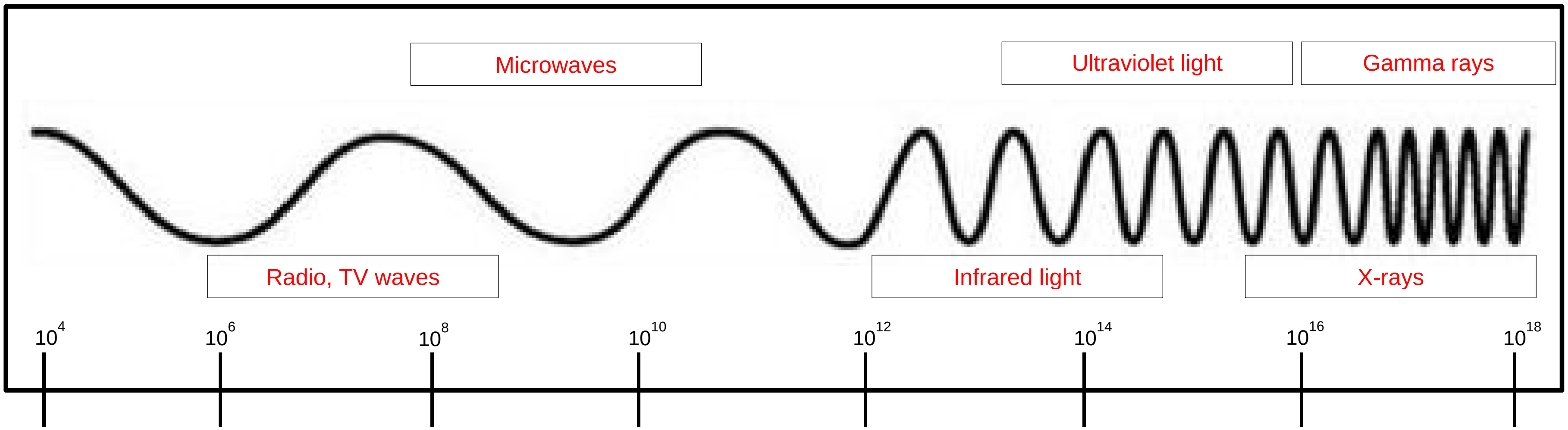
____

____

____

Answer Key

ANSWER KEY FOR WORKSHEET: ELECTROMAGNETIC SPECTRUM



1. Label each box of the electromagnetic spectrum.

2. Where does visible light fall on the spectrum?
Ex. Visible light falls between ultraviolet, x-rays and gamma rays.

3. Describe the way a wave moves and identify its parts.
Ex. A wave oscillates in a periodic fashion with peaks and valleys, and displays characteristics like amplitude, wavelength, and frequency.

4. The movement of which part of the atom creates light?
Ex. All light is created by vibrating electrical charges (electrons) in atoms.

FORMS OF ENERGY – LESSON PLAN 2.6

Nature of Light

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Explain the nature of light.**
- **Understand that light is a form of energy and that it can be characterized as a wave.**

Public School System Teaching Standards Covered

State Science Standards

- GA S4P1 4th
- KY SC-4-ET-U-4 4th
- KY SC-5-ET-U-4 5th
- NC 4.P.3.2 4th
- TN SPI 0407.10.2 4th
- TN SPI 0407.10.3 4th
- VA 5.3 5th

Common Core Language Arts/Reading

- ELA.CCSS.W.4.1 TN, KY, GA, NC 4th
- ELA.CCSS.W.5.1 KY, VA 5th

I. Anticipatory Set (Attention Grabber)

Essential Question

What is the result of light hitting an object/interacting with matter?

II. Modeling (Concepts to Teach)

Dual-Nature of Light

Light can be treated as a wave or a particle.

Speed of Light

Light travels at the very fast speed at 3.0×10^8 m/s. This why it takes 8 minutes for the sun's light to reach Earth even though the sun is 93 million miles away. It's interesting to think that when someone looks up at the sun, he/she is seeing what happened 8 minutes ago. When discussing objects in our universe that are even farther away, a light-year is used. A light-year is defined as the distance light travels in one year. So, the light from Proxima Centauri, the star nearest to our sun, takes 4.24 years to reach the Earth. It is 4.24 light years away. Imagine it! When looking at Proxima Centauri, the observer is seeing it as it was over 4 years ago! Wow!

Interaction of Light with Matter – (Light as a Wave)

A wave doesn't just *stop* when it reaches the end of the medium. Rather, a wave will undergo certain behaviors when it encounters the end of the medium. These behaviors include Reflection, Refraction, and Diffraction.

Reflection

When a light wave reaches the boundary between two media, some (or all) of the wave bounces back into the first medium. If the first medium is air and the second medium is a mirror, nearly all of the light that hits the mirror will reflect back. The angle of the light hitting the mirror (incident light), Θ_i, equals the angle of the light that is reflected, Θ_r with respect to the normal (N). This is referred to as The Law of Reflection or Snell's Law.

See this animation: http://www.physicsclassroom.com/mmedia/optics/lr.cfm

Refraction

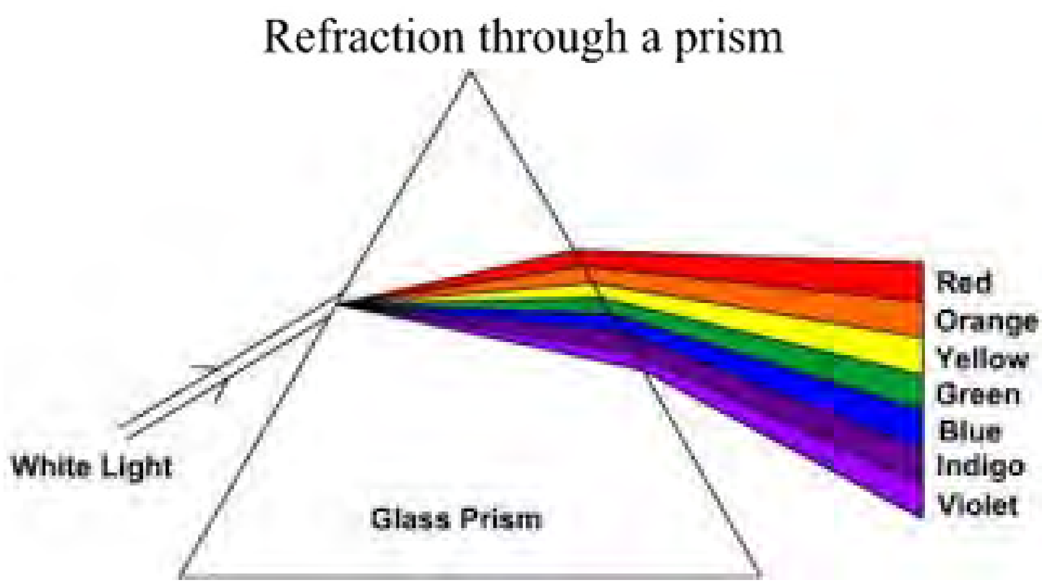
When a light wave reaches the boundary between two media, some of the light is transmitted and undergoes refraction (or bending) if it approaches the boundary at an angle. The direction of "bending" is dependent upon the index of refraction of the two media. A wave will bend one way when it passes from a medium in which it travels slowly (high index of refraction) into a medium in which it travels fast (small index of refraction); and if moving from a *fast medium* to a slow medium, the wave front will bend in the opposite direction.

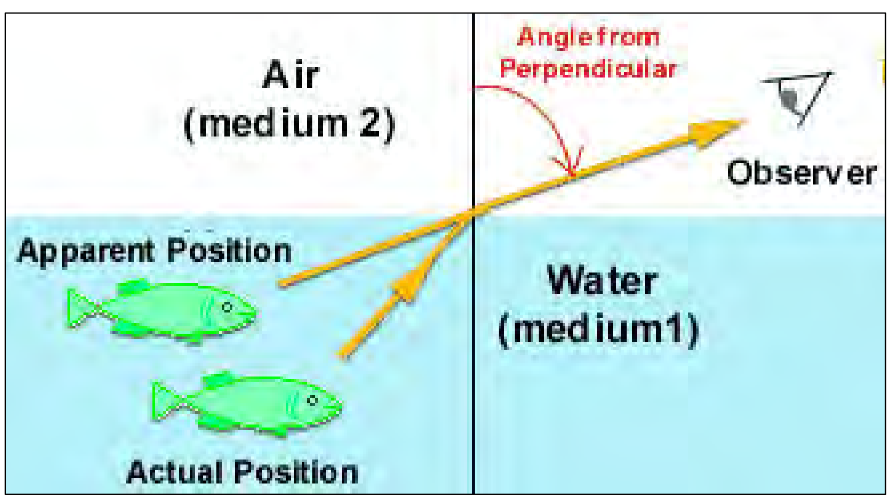
INDEX OF REFRACTION	
Medium	**Refractive Index**
Vacuum	1
Air	1.00
Water	1.33
Alcohol	1.36
Sugar Solution (80%)	1.49
Perspex	1.50
Glass	1.50 – 1.70
Diamond	2.42

Examples of Refraction:

1. There is a noticeable difference between the pencil in the empty glass and the one in the full glass of water. The one in the empty glass doesn't appear to be bent because the light from the pencil is only traveling through one medium, air. When viewing a straw in a glass of water it appears to be bent because the light from the straw travels through water (first medium) then through air (second medium). This happens because the average speed of light in water is slower in water than it is in air. The light bends away from the normal (N) as it travels from the water to the air.

2. Sunlight is composed of all the colors that appear in a rainbow: violet, blue, green, yellow, indigo, orange, and red. Each of these colors has a different range of wavelengths. As a result, each color is refracted (bent) at a different angle when sunlight enters a raindrop. Red is bent the least, violet the most. When the colors strike the far side of a raindrop, they are reflected. As they leave the raindrop and enter the air again, they are again refracted. **http://science.howstuffworks.com/rainbow-info.htm**





III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	How and when does a light wave end? (Class discussion. Answer: Never, it reflects, refracts or diffracts when it hits the end of the medium.)
UNDERSTAND	Restate the definition of reflection. Restate the definition of refraction. (Class discussion)
APPLY	What happens when light must travel through more than one medium, like air and water? (Class discussion. Answer: The light refracts or bends and this happens because the average speed of light in water is slower than it is in air. The light bends away from the normal (N) as it travels from the water to the air.)
ANALYZE	Why do you think an image is distorted in a fun house mirror? (Class discussion. Answer: Because the mirror is curved, not flat. For more information: **http://www.learner.org/teacherslab/science/light/lawslight/funhouse/funhousebackground.html**).
CREATE	Create a drawing of light reflection or refraction and label it. (Teachers can ask students to draw their pictures on a sheet of paper. Ex: a person in a mirror – reflection; a pencil in half a glass of water – refraction.)

IV. Guided Practice Ideas

Recommended Items

Create a Spectrometer; Models of Light; Bend a Straw Experiment (see below)

Experiments

- **Create a Spectrometer to View Spectrum of Light Experiment: http://www.pinterest.com/pin/450711875177725942/**
  - **Create a Spectrometer: http://www.euhou.net/index.php/exercises-mainmenu-13/classroom-experiments-and-activities-mainmenu-186/178-a-home-made-spectroscope**
- **Models of Light and Young's Experiment**: **http://www.hsphys.com/light_and_matter.html**
- **Bend a Straw Experiment: http://www.sciencekids.co.nz/experiments/strawbending.html**
- Distinguish Between Light Source and Reflectors Experiment: **http://www.teachingideas.co.uk/science/reflectors.htm**
- Playing with Mirrors Experiment: **http://www.teachingideas.co.uk/science/playingwithmirrors.htm** (how light travels)
- Reflection Investigation Experiment: **http://www.teachingideas.co.uk/science/reflectioninvestigation.htm**

V. Independent Practice Ideas

Recommended Items

- **Writing Activity: What happens when light interacts with matter?** (see below)
- **At-Home Scavenger Hunt: Reflect or Refract?** (see below)

Other Resources

Personal Practice

- Writing Activity: Teachers write the following question on the board and ask students to copy and answer the question on a sheet of paper: What happens when light interacts with matter?
- What is Light? Worksheet and Answer Key provided
- What is Light? – A Type of Energy We Can See Worksheet: **http://www.mrcollinson.ca/4 science/light and sound/4_science_light_sound_what_is_light.pdf**

Practice That May Involve Parents or Guardians

- At-Home Scavenger Hunt: Reflect or Refract? Teachers instruct students to find three objects in their home that reflect light and three objects that refract light. Write them on a sheet of paper and label them as reflect or refract. (Ex. Reflect – mirror, spoon, bell; Refract – magnifying glass, eye glasses, fish tank).

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- What is Light? Worksheet and Answer Key is provided
- Writing Activity: What happens when light interacts with matter? (if completed as Independent Practice, as shown above)
- At-Home Scavenger Hunt: Reflect or Refract? (if completed as Independent Practice, as shown above)

VII. Materials Needed

The following materials are needed for the **Bend a Straw Experiment** in “Recommended Items” in Guided Practice & Independent Practice sections.

- A glass half filled with water
- A straw
- 2 eyes (preferably yours)

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

What is the result of light hitting an object/interacting with matter?

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WORKSHEET FOR NATURE OF LIGHT LESSON 2.6 **NAME:** ______________________

What is Light?

Objective: Students will be able to explain the nature of light and understand that light is a form of energy and that it can be characterized as a wave.

1. **Explain the nature of light.**

____

____

____

____

2. **Identify and explain the part of the electromagnetic spectrum that humans can see.**

____

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____

____

3. **How does light interact with a mirror?**

____

____

____

____

4. **Identify and explain the behaviors of light encountering an object.**

5. **Draw an example of how light travels as a wave.**

Answer Key

ANSWER KEY FOR WORKSHEET: WHAT IS LIGHT?

1. **Explain the nature of light.**

   Ex. Light travels as a particle and a wave at the same time.

2. **Identify and explain the part of the electromagnetic spectrum that humans can see.**

   Ex. The part of the electromagnetic spectrum that humans can see is visible light. Humans can see only a small part of the spectrum.

3. **How does light interact with a mirror?**

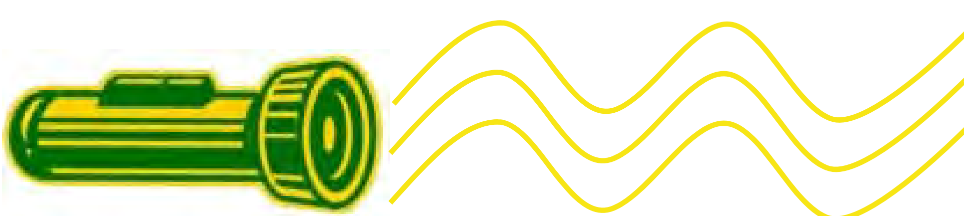
   Ex. Light reflects off the mirror back into the medium (air, water) it came from.

4. **Identify and explain the behaviors of light encountering an object.**

   Ex. When encountering an object, light will either reflect (bounce back) or refract (bend if it approaches a boundary at an angle).

5. **Draw an example of how light travels as a wave.**

Example



FORMS OF ENERGY – LESSON PLAN 2.7

Heat Energy

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Describe heat energy and its functions.**
- **Define conduction, convection, and radiation.**
- **Explain the relationship between temperature and heat.**

Public School System Teaching Standards Covered

State Science Standards

- KY 4-ET-U-5 4th
- MS 9.c 4th
- NC 3.P.3.2 3rd
- NC 5.P.3.1 5th
- TN GLE 0307.10.1 3rd
- TN GLE 0507.10.2 5th

Common Core Language Arts/Reading

- ELA.CCSS.W.3.1 NC, TN 3rd
- ELA.CCSS.W.4.1 MS, KY 4th
- ELA.CCSS.W.5.1 NC, TN 5th

ENERGY EDUCATION

I. Anticipatory Set (Attention Grabber)

Essential Question

How do objects become hotter?

Videos

Heat Video and Quiz: [http://studyjams.scholastic.com/studyjams/jams/science/energy-light-sound/heat.htm] (AWESOME explanation)

II. Modeling (Concepts to Teach)

All matter is composed of vibrating atoms or molecules. These molecules can vibrate even faster by adding kinetic energy. For example, a penny can be made warmer by hitting it with a hammer. A liquid can be made warmer by putting a flame to it. It is this movement (kinetic energy) that creates the effect that is sensed, warmth. Whenever something becomes warmer, the kinetic energy of its atoms or molecules increases. The energy that transfers from one object to another because of temperature difference between them is called **heat**. Heat is energy in transit from a body of higher temperature to one of lower temperature.

3 Ways Heat is Transferred: [http://www.energyquest.ca.gov/story/chapter01.html]

1. **Conduction** – Conduction occurs when energy is passed directly from one item to another by touching the two objects. The faster-moving molecules contact slower-moving molecules and transfer energy to them.

   The slower-moving molecules speed up and the faster-moving molecules slow down. If someone stirred a pan of soup on the stove with a metal spoon, the spoon would heat up. The heat is being conducted from the hot area of the soup to the colder area of spoon.

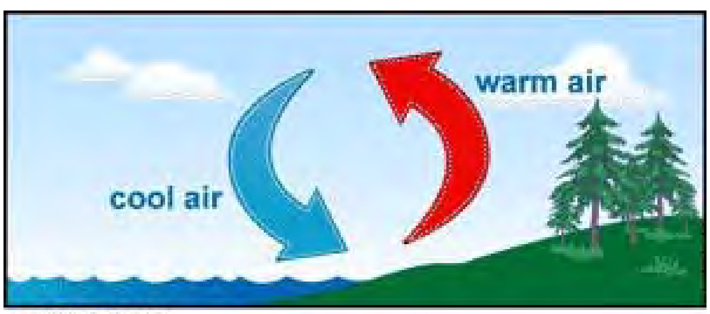
   Metals are excellent **conductors** of heat energy. Wood or plastics are not. These “bad” conductors are called **insulators**. That’s why a pan is usually made of metal while the handle is made of a strong plastic.

2. **Convection** – Convection is the movement of **gases or liquids** from a cooler spot to a warmer spot.

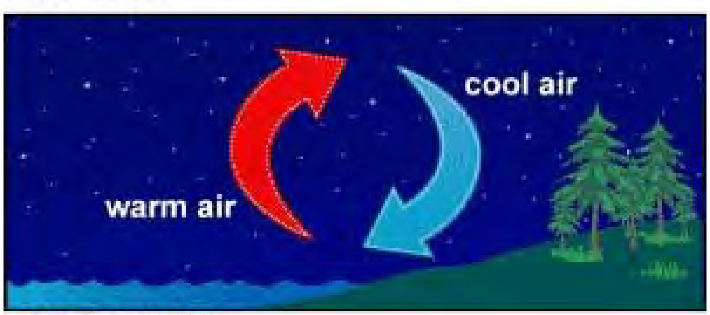
If a soup pan is made of glass, one could see the movement of convection currents in the pan. The warmer soup moves up from the heated area at the bottom of the pan to the top where it is cooler. The cooler soup then moves to take the warmer soup's place. The movement is in a circular pattern within the pan. Notice the diagram on the previous page.

During the **day**, the sun heats up both the ocean surface and the land. Water is a good absorber of the energy from the sun. The land absorbs much of the sun's energy as well. However, water heats up much more slowly than land and so the air above the land will be warmer compared to the air over the ocean. The warm air over the land will rise throughout the day, causing low pressure at the surface. Over the water, high surface pressure will form because of the colder air. To compensate, the air will sink over the ocean. The wind will blow from the higher pressure over the water to lower pressure over the land causing the sea breeze. The sea breeze strength will vary depending on the temperature difference between the land and the ocean.

At **night**, the roles reverse. The air over the ocean is now warmer than the air over the land. The land loses heat quickly after the sun goes down and the air above it cools, too. This can be compared to a blacktop road. During the day, the blacktop road heats up and becomes very hot to walk on. At night, however, the blacktop has given up the added heat and is cool to the touch. The ocean, however, is able to hold onto this heat after the sun sets. This causes the low surface pressure to shift to over the ocean during the night and the high surface pressure to move over the land. This causes a small temperature gradient between the ocean surface and the nearby land at night and the wind will blow from the land to the ocean creating the land breeze.



DAY TIME



NIGHT TIME

3. Radiation – The sun's light and heat cannot reach earth by conduction or convection because space is almost completely empty. There is nothing to transfer the energy from the sun to the earth.

The sun's rays travel in straight lines called heat rays. When sunlight hits the earth, its radiation is absorbed or reflected. Darker surfaces absorb more of the radiation and lighter surfaces reflect the radiation. So a person would be cooler if he/she wore light or white clothes in the summer.

Temperature vs. Heat

Temperature is the quantity that tells how hot or cold something is compared to a standard. Temperature is

related to the average kinetic energy of the substance. The more kinetic energy an object has the higher the temperature. Temperature can be measured using the Celsius scale, Fahrenheit scale, or the Kelvin scale.

Heat is the transfer of energy from a substance with a higher temperature to a substance with a lower temperature.

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	What are the three ways heat is transferred? (Class discussion)
UNDERSTAND	In your own words, restate the definition of heat. (Class discussion)
APPLY	Illustrate how air is heated. Explain the difference between heat and temperature. (Class discussion. Teacher may show the following video; also includes a quiz: **http://studyjams.scholastic.com/studyjams/jams/science/energy-light-sound/heat.htm**).
ANALYZE	Use a Venn diagram to compare and contrast two of the following: conduction / convection / radiation. (Ex. Draw two large intersecting circles. Label one circle conduction and the other circle convection. For more information: **http://www.learninggamesforkids.com/graphic_organizers/writing/venn-diagram.html**).

IV. Guided Practice Ideas

Recommended Items

Solar Bag Experiment (see below)

Experiments

- **Solar Bag Experiment:** http://www.stevespanglerscience.com/lab/experiments/solar-bag-experiment
- **Solar Energy Balloon Blow Up Experiment:** http://eisforexplore.blogspot.com/2013/05/solar-energy-balloon-blow-up.html?utm_source=feedburner&utm_medium=email&utm_campaign=Feed:+EIsForExplore+%28E+is+for+Explore!%29

Song

Heat Energy Song: Teachers can have students listen to this song about heat energy: http://www.youtube.com/watch?v=khZrs-UBq28&feature=share

V. Independent Practice Ideas

Recommended Item

At-Home Scavenger Hunt: Finding Heat Energy (see below)

Other Resources

Personal Practice

- What is Heat? Worksheet and Answer Key provided
- Writing Activity: Teachers write the following question on the board and ask students to copy and answer the question on a sheet of paper: How is heat used in your home?

Practice That May Involve Parents/Guardians

- At-Home Scavenger Hunt: Finding Heat Energy – Teachers instruct students to find one example of each type of heat energy in their home (conduction, convection, radiation). Write them on a sheet of paper and label them as conduction, convection or radiation. (Ex. Conduction – curling iron on hair; convection – boiling water; radiation – sun coming through window and heating up the floor).

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- Online Quiz: (if completed in I. Anticipatory Set or III. Checking for Understanding) **http://studyjams.scholastic.com/studyjams/jams/science/energy-light-sound/heat.htm**
- What is Heat? Worksheet and Answer Key is provided

VII. Materials Needed

The following materials are needed for the **Solar Bag Experiment** in “Recommended Items” in Guided Practice.

- Solar Bag
- Solar Bag String

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

How do objects become hotter?

WORKSHEET FOR HEAT ENERGY LESSON 2.7 **NAME: ______________________**

What is Heat?

Objective: Students will be able to describe heat energy and its functions, identify ways heat is transferred, and understand differences between conduction and insulation.

1. What is heat?

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2. Identify and explain the three ways heat is transferred.

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3. How is an object's temperature affected when its atoms slow down?

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4. **How do you use heat at home?**

5. **Why are cooking materials normally made of metal instead of wood or plastic?**

Answer Key

ANSWER KEY FOR WORKSHEET: HEAT ENERGY

1. **What is heat?**

   Ex. Heat is the energy that transfers from one object to another because of the temperature difference between them.

2. **Identify and explain the three (3) ways heat is transferred.**

   Ex. Conduction occurs when energy is passed from one item to another by touching the two objects. Convection is the movement of gases or liquids from a cooler spot to a warmer spot. Radiation is generated by the thermal motion of charged particles in matter.

3. **How is an object's temperature affected when its atoms slow down?**

   Ex. The temperature of the object will decrease as its particles slow down.

4. **How do you use heat at home?**

   Ex. Cook food, warm bath/shower water, heat the house, etc.

5. **Why are cooking materials normally made of metal instead of wood or plastic?**

   Ex. Metals are excellent conductors of heat energy. Wood or plastics are not. These "bad" conductors are called insulators. That's why a pan is usually made of metal while the handle is made of a strong plastic.

FORMS OF ENERGY – LESSON PLAN 2.8

Electrical Energy

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Explain the purpose of electrical energy.**
- **Describe how electricity works.**
- **Identify how electrical energy is measured.**

Public School System Teaching Standards Covered

State Science Standards
- KY SC-4-ET-U-3 4th

Common Core Language Arts/Reading
- ELA.CCSS.W.4.1 KY 4th
- ELA.CCSS.W.4.3 KY 4th

I. Anticipatory Set (Attention Grabber)

Essential Question

How is electricity created?

Videos

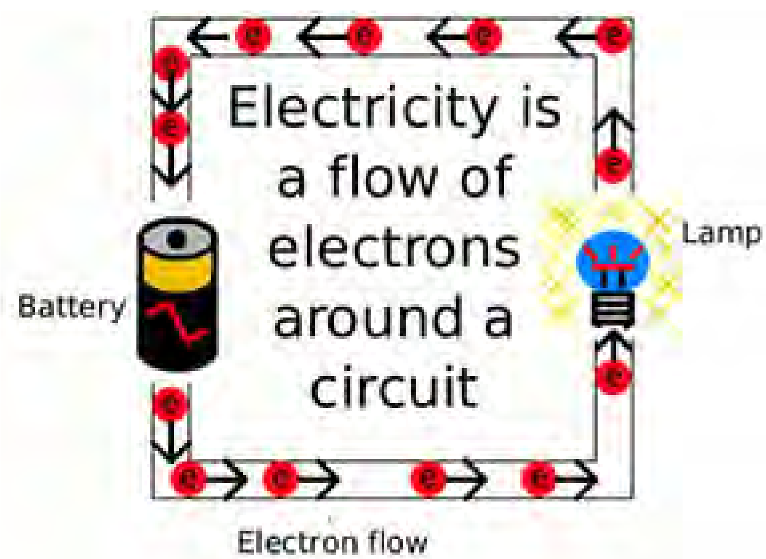
- **Short video explaining electrical energy and how it works to produce light and heat:** http://www.eschooltoday.com/energy/kinds-of-energy/what-is-electrical-energy.html

- **Bill Nye the Science Guy video on energy/electricity:** http://www.billnye.com

II. Modeling (Concepts to Teach)

When electrons are forced to move along a path in a conducting substance such as a wire, the result is energy called electricity. **Electrical energy is energy carried by moving electrons along this pathway.** Conductors of electricity do a good job of allowing the flow of electrons. Metals are good conductors and that is why most electrical circuits use metal wires. Although electricity cannot be seen, it is one of the most useful forms of energy.

http://www.petervaldivia.com/technology/electricity/moving-charges.php



Power plants do not *create* electrical energy, however. Since energy is neither created nor destroyed, according to **The Law of Conservation of Energy**, electrical energy is a result of energy transformations. For example, power plants can convert chemical energy stored in fuels into thermal energy, which evaporates water into steam, which produces mechanical energy as it moves through turbines. The turbines spin generators, which in turn produce electricity. This electrical energy is used to power lights, heaters, and appliances in homes.

Electrical energy is also seen in the form of **static electricity**. Static electricity is the build-up of charge (electrons) in one location. (Static means to “stay still”, or in “one location”.) When this build-up of charge is released, the electrons will flow giving off heat, light (lightning), and sound (thunder) in the process.

Read article: http://science.howstuffworks.com/nature/natural-disasters/lightning.htm

Electrical Potential is the potential energy a charge has due to its location in an electrical field. **Electrical potential is measured in volts** (electrical potential energy per charge). The unit “volt” is named after the Italian physicist Alessandro Volta who invented what is considered to be the first chemical battery. Since electrical potential is measured in volts, it is commonly called voltage. Voltage is the amount of potential energy between two points on a circuit.

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	What is electrical energy? How is electrical energy measured? (Class discussion)
UNDERSTAND	Explain static electricity. (Class discussion)
ANALYZE	Investigate how energy is converted into electricity. (Class discussion)
CREATE	Create a small electric circuit. (Teachers and students work together to draw a diagram of a circuit on the board or review the following online circuit exercise: **http://www.sciencekids.co.nz/gamesactivities/electricitycircuits.html**)

IV. Guided Practice Ideas

Recommended Item

Electricity Circuit Experiment (see below)

Experiments

- **Electricity Circuit Experiments**: **http://www.sciencekids.co.nz/gamesactivities/electricitycircuits.html**
- Experiments (Kids Beginner Electronics, Solar Energy, How To Make a Generator Work): **http://sciencewithkids.com/Experiments/Energy-Electricity-Experiments/energy-experiments.html**

Games

- Interactive Game – Energy Zone: **http://www.kidsenergyzone.com/**

V. Independent Practice Ideas

Recommended Items

Scavenger Hunt: Energy in Your home (see below); Electricity Worksheet and Answer Key provided

Other Resources

Personal Practice

- Writing Activity: Teachers write the following questions on the board and ask students to copy and answer the questions on a sheet of paper: What would the world be like if we didn't have electricity? In your opinion, what is the most important form of energy?
- Where Does Your Electricity Come From? Worksheet and Answer Key provided

Practice That May Involve Parents or Guardians

- Scavenger Hunt: Energy in Your Home – Teacher instructs students to find five examples of things that use electrical energy in their home. Do these products use electricity to power light, heat or motion? Write them on a sheet of paper and label if they power light, heat or motion. (Ex. Stove – heat; TV – light; Fan - motion).

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- Where Does Your Energy Come From? Worksheet and Answer Key provided
- Writing Activity (if completed as Independent Practice, as shown above)

VII. Materials Needed

- None for Electricity Circuits Experiments

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

How is electricity created?

This page is intentionally blank.

WORKSHEET FOR ELECTRICAL ENERGY LESSON 2.8 NAME: ________________________

Where Does Your Energy Come From?

Objective: Students will be able to explain the purpose of electrical energy, how electricity is used in homes, and identify how electrical energy is measured.

1. Explain the purpose of electrical energy.

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2. Why are most electrical circuits made of metal?

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3. Can we create electrical energy? Why or why not?

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4. **How do you use electricity at home?**

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5. **Explain how electricity is measured and why we measure it this way?**

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Answer Key

ANSWER KEY FOR WORKSHEET: WHERE DOES YOUR ENERGY COME FROM?

1. **Explain the purpose of electrical energy.**

   Ex. Electrical energy exists when electrons are forced to move along a path in a conducting substance such as a wire. Although electricity cannot be seen, it is one of the most useful forms of energy.

2. **Why are most electrical circuits made of metal?**

   Ex. Metals are conductors of electricity and they do a good job of allowing the flow of electrons.

3. **Can we create electrical energy? Why or why not?**

   Ex. Since energy is neither created nor destroyed according to The Law of Conservation of Energy, electrical energy is a result of energy transformations.

4. **How do you use electricity at home?**

   Ex. Watching television, playing video games, using the microwave, etc.

5. **Explain how electricity is measured and why we measure it this way?**

   Ex. Electrical potential is measured in volts, which is the potential electrical energy per charge.

FORMS OF ENERGY – LESSON PLAN 2.9

Renewable and Non-Renewable Energy

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The “Modeling” Section contains teaching content. • While in class, students can do “Guided Practice,” complete the “Recommended Item(s)” and any additional guided practice items the teacher might select from “Other Resources.” • NOTE: Some lesson plans do and some do not contain “Other Resources.” • At home or on their own in class, students can do “Independent Practice,” complete the “Recommended Item(s)” and any additional independent practice items the teacher selects from “Other Resources” (if provided in the plan).
Average class size, student ability, and class length	• The “Modeling” Section contains teaching content. • While in class, students complete “Recommended Item(s)” from “Guided Practice” section. • At home or on their own in class, students complete “Recommended Item(s)” from “Independent Practice” section.
Larger class size, lower student ability, and/or shorter class length	• The “Modeling” Section contains teaching content. • At home or on their own in class, students complete “Recommended Item(s)” from “Independent Practice” section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Identify, explain, and provide examples of both renewable and non-renewable energy sources.**
- **Discover ways to conserve energy.**
- **Evaluate their families’ use of energy.**
- **Understand the benefits and disadvantages of using renewable resources.**

Public School System Teaching Standards Covered

State Science Standards

- AL GLE 3.1.3 3rd
- AL GLE 3.3 3rd
- MS 9.c 4th
- KY SC-5-ET-U-2 5th
- TN SPI 0407.7.2 and WCS 4th

Common Core Language Arts/Reading

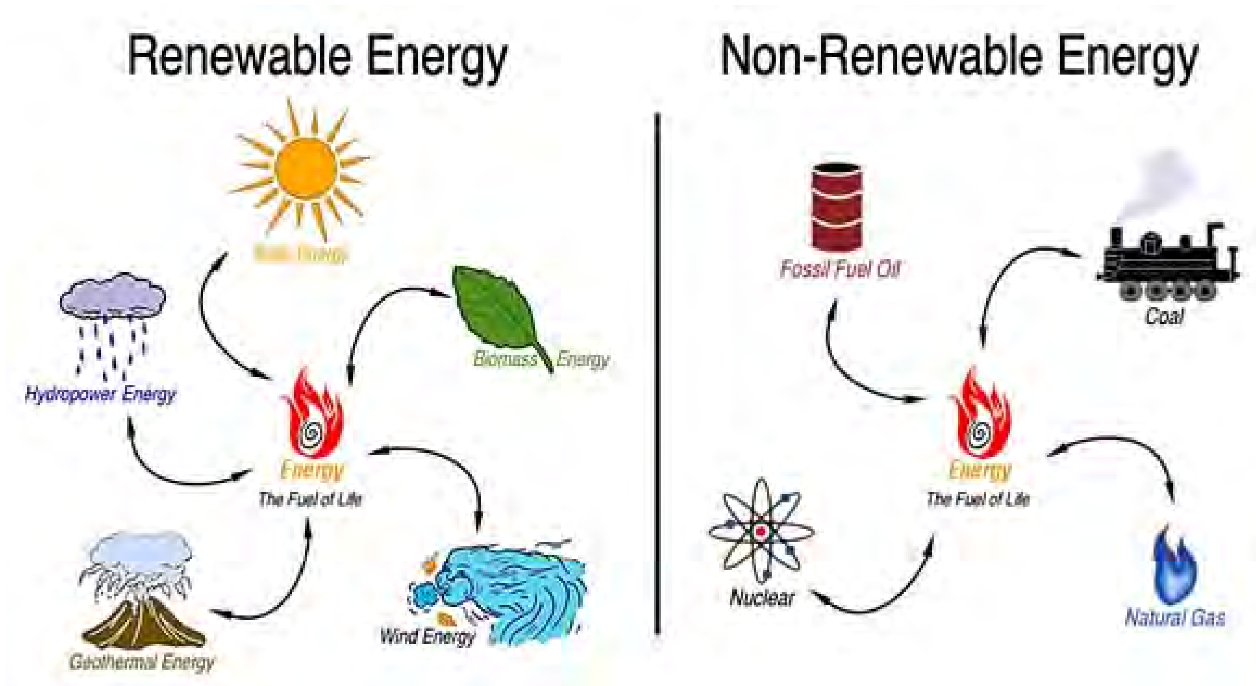
- ELA.CCSS.W.4.1 MS, TN 4th
- ELA.CCSS.W.5.1 KY 5th
- ELA.CCSS.W.3.1 AL 3rd

I. Anticipatory Set (Attention Grabber)

Essential Question

How can we be sure to never run out of energy?

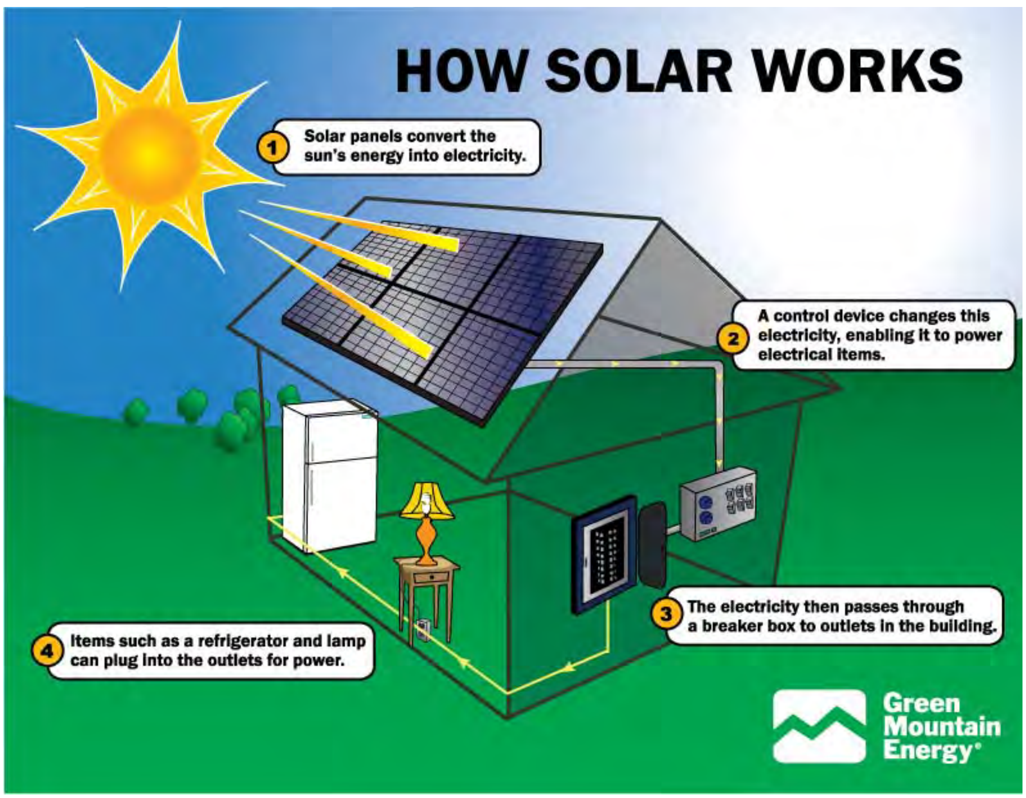
II. Modeling (Concepts to Teach)



A natural resource is given by nature and can be used as a source of energy. A **renewable natural resource** is one that can be renewed, or replenished in a reasonable amount of time (in years or a human-life span), once it has been used. Renewable energy is generated from natural sources (sun, wind, rain, tides, and vegetation) and can be generated again and again when needed. It is generally replenished naturally. For example, trees are a renewable resource because once a tree is removed and used, a new tree can grow in its place. Additional information is available at **http://www.tva.gov/renewable/**.

Types of Renewable Natural Resources

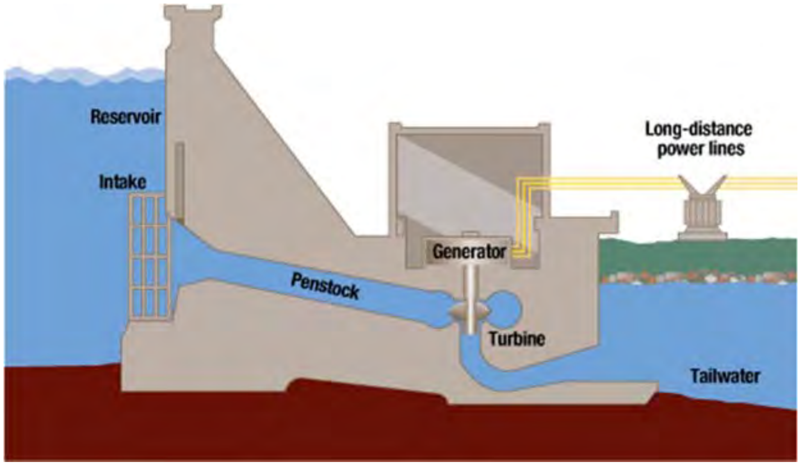
1. **Solar Energy** – The sun's light contains energy in the form of electromagnetic waves. Usually, when light hits an object the energy turns into heat, like the warmth felt while sitting in the sun. But when light hits certain materials, like silicon, the energy turns into an electrical current instead, which can then be harnessed for power. This was discovered earlier in history when Einstein explained the Photoelectric Effect and proposed that light can act like a particle, as well as a wave. For more information, see **http://www.tva.gov/greenpowerswitch/solar.htm** and **http://www.tvakids.com/electricity/solar.htm**.



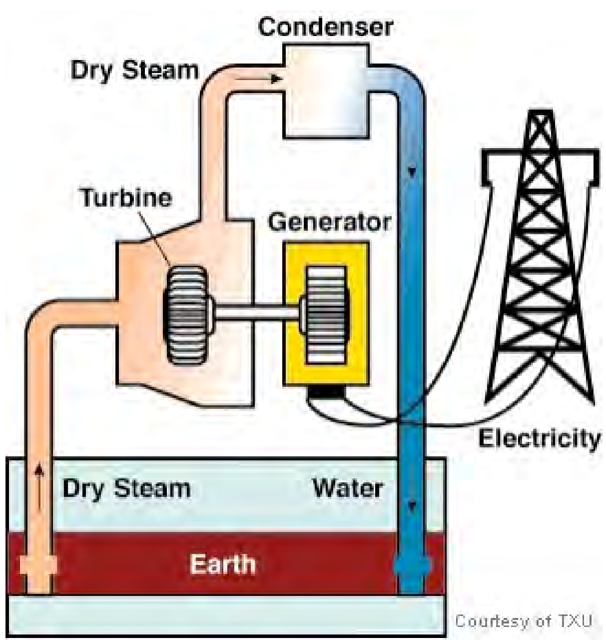
A WORKING SCHEME OF HOW SOLAR WORKS

Image source: lerablog.org

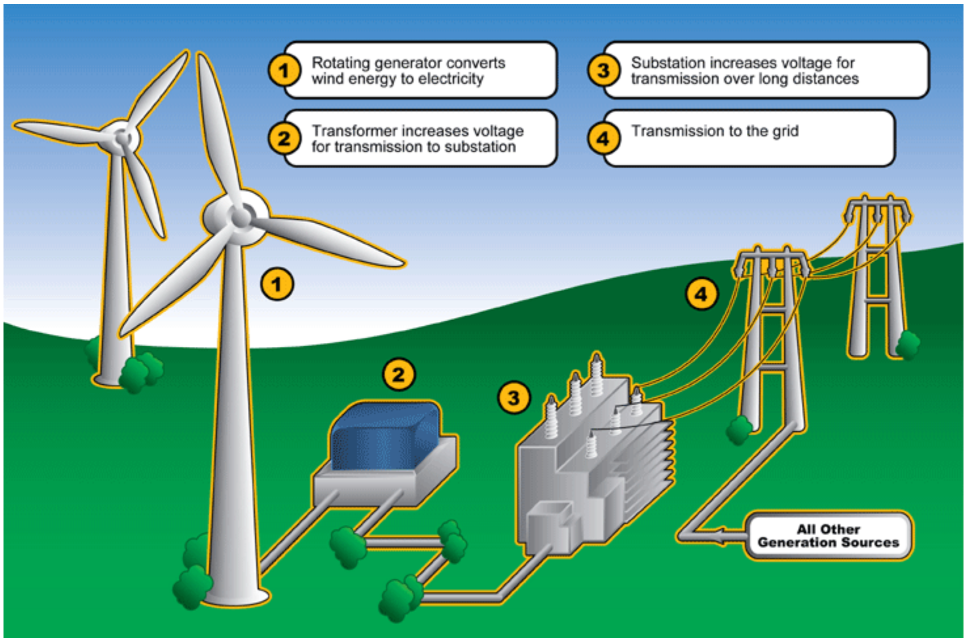
2. **Hydroelectric Energy** – Hydroelectric plants use falling water from a dam to turn the turbine of a generator. The generator then produces electricity. **http://water.usgs.gov/edu/hyhowworks.html** or **http://www.tvakids.com/electricity/hydro.htm, http://www.tva.com/power/hydro.htm**



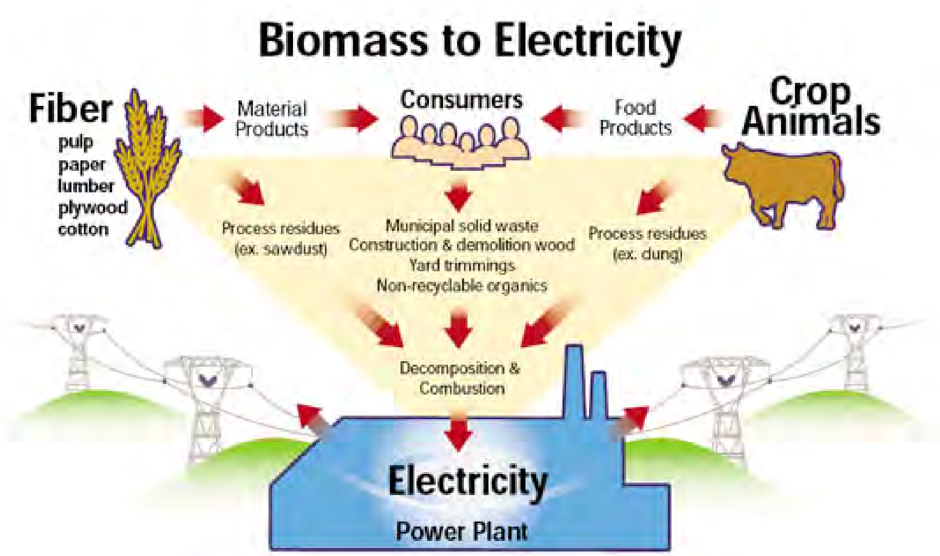
3. **Geothermal Energy** – from the Greek words *geo*, or "earth," and *therme*, meaning "heat." Deep inside the Earth lies hot water and steam that can be used to heat homes and businesses and generate electricity cleanly and efficiently. The steam is used to drive turbines of a generator and the generator produces electricity. **http://www.tvakids.com/electricity/geothermal2.htm**



4. **Wind Energy** – The energy of the wind is transferred to the turbines of the generator and the generator produces electricity. Wind turbines use the momentum of moving air to quietly turn large blades that are attached to the shaft of an efficient electric generator. **http://www.tvakids.com/electricity/wind.htm**



5. **Biomass Energy** – Biomass is matter usually thought of as garbage. This matter includes things like leaves, tree branches, leftover crops, wood chips, and bark. It can even include animal manure and old tires.



The biomass is then placed into a furnace and burned, or the methane gas in a liquid or gaseous state from algae or rotting / decomposing materials is captured. The heat generated is used to boil water. The steam from the boiling water is used to turn turbines and generators to produce electricity.

A **non-renewable natural resource** is one that has specific conditions that made them (like fossilized plant matter converting into coal), and can take many generations to reproduce. Sometimes the conditions are not likely to occur again so they are limited in supply and once used cannot be re-generated within a short span of time. Non-renewable sources exist in the form of natural gas, oil, and coal. For example, fossil fuels have been percolating beneath the Earth for hundreds of millions of years, and once they're gone, they're going to take millions more years to replenish.

Types of Non-Renewable Natural Resources

1. **Coal Energy** – Coal is the product of millions of years of pressure on organic matter from plants buried underground. According to Energy Information Administration, coal-burning power plants are the number one

source of electricity in the U.S., and burning coal is an inexpensive way to generate electricity compared to many renewable sources. However, burning coal produces greenhouse gases, which scientists believe is contributing greatly to global warming. **http://www.tvakids.com/electricity/fossil.htm**

2. **Oil Energy** – Crude Oil is referred to as Liquid Petroleum. It is used for gasoline, heating oil, and diesel fuel. In addition, manufacturers utilize oil for such products as plastics and industrial chemicals.

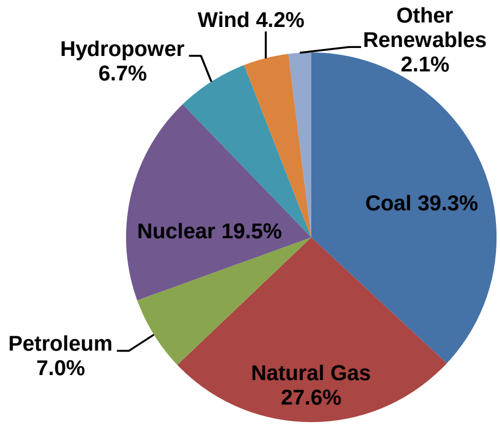
3. **Natural Gas Energy** – Natural gas reserves often share space with underground oil reserves, so the two

non-renewable resources are often extracted at the same time. Consumers use it as cooking fuel, to heat houses, and sometimes as vehicle fuel. It is also used to generate 27.6% of the U.S. electricity. It would take many generations, perhaps millions of years, to replenish natural gas.
http://www.tvakids.com/electricity/combustion.htm

4. **Nuclear Energy** – Nuclear energy makes use of Uranium-235, a radioactive chemical naturally found in the earth. This radioactive substance undergoes decay and in the process releases a great deal of heat. The heat is then used to create steam; that steam is used to turn a turbine in a generator. The generator produces the electricity. There are no greenhouse gases released in this process. However, there are radioactive byproducts that must be stored safely because they are an environmental hazard. It is considered a non-renewable form of energy because it takes real manipulation to split an atom.
http://www.tvakids.com/electricity/nuclear.htm

U.S. NET ELECTRICITY GENERATION BY ENERGY SOURCE (2013)

Source: Energy Information Administration (EIA), Monthly Energy Review, May 2014, Table 7.2a, 2014.
http://www.eia.gov/totalenergy/data/monthly/ - electricity



The above chart shows the percent of electricity generation by energy source. Most power is now generated from coal, natural gas, and nuclear plants. If time permits, teachers can go over each source in the pie chart.

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	List the renewable energy sources. List the non-renewable sources of energy. (Teachers can list these on the board with help from students. Ex. Renewable – solar, wind, etc.)
UNDERSTAND	Explain the difference between a renewable and a non-renewable energy source. (Class discussion)
ANALYZE	Categorize a list of sources of energy (water, wind, coal, natural gas, etc.) into the correct categories of renewable and non-renewable energy. (Class discussion)
EVALUATE	Debate the pros and cons of using non-renewable energy. (Class discussion)
CREATE	Create a brochure that persuades people in your community to conserve energy. (Teachers instruct students to create a brochure on a piece of paper. http://www.education.com/activity/article/make_a_fun_brochure_fourth/)

IV. Guided Practice Ideas

Recommended Items

Shoebox Solar Oven (see below)

Class Activities

- **Classroom exercise:** Separate classroom board with a line. Put Renewables title on one side and Non-Renewables title on the other side. Teachers have students draw the different types of energy to tape or post on the board. At the end of the lesson, hand out a piece of paper to each child to write down and/or draw the types of energy in their respective categories of renewable and non-renewable energy. Children can take the paper home to teach adults in the household.
- **Field trip:** If school location permits, consider a field trip to a hydropower dam or Raccoon Mountain Pump Storage plant visitor center. Raccoon Mountain is a Pump Storage Plan that uses power to pump water at night, and then uses water to generate electricity during the day. Discuss how a Pump Storage Plant like Raccoon Mountain fits. Is it a renewable or non-renewable or hybrid (both)?

Experiments

- **Shoebox Solar Oven Experiment** **http://www.ehow.com/how_6303306_make-oven-school-project-shoebox.html**
- **Power From Water Experiment**: **http://www.education.com/science-fair/article/water-produce-energy/**
- **Hydropower: The Final Experiment**: **http://blogs.cas.suffolk.edu/mattersofsci/2012/05/03/hydropower-the-final-experiment/**
- **Create a Windsock Experiment** (Duke Energy) **http://www.duke-energy.com/pdfs/wind-power-education-for-kids.pdf**
- **Sun Angles and Solar Power Experiment** **http://www.kidwind.org/**

Games

- Interactive Game – Save the World: **http://www.wonderville.ca/asset/save-the-world**

Other Resources

Practice that uses math/reading standards:

- Wind Energy Math: Measure the sweeping area of a wind turbine **http://www.kidwind.org/**
- Class-wide debate between renewable and non-renewable energy sources. Teachers facilitate a classroom debate about the pros and cons of using renewable vs. non-renewable energy.

Other activities and knowledge sites:

http://learn.kidwind.org/teach
http://www.greenprophet.com/2010/04/green-legos-solar-cars-and-wind-powered-lego-robots/
http://www.sciencekids.co.nz/sciencefacts/energy/windenergy.html

V. Independent Practice Ideas

Recommended Items

See the Wind; At-Home Checklist: Renewable Energy at Home (see below)

Other Resources

Personal Practice

- Wind Power Worksheets: All four worksheets listed below are available at the following Duke Energy address: **http://www.duke-energy.com/pdfs/wind-power-education-for-kids.pdf**
  - Wind Power Crossword Puzzle
  - Create Your Own Wind Turbine – connect the dots and color
  - Wind Maze
  - T/F, Fill in the Blank Worksheet
- Venn diagram: Teachers ask students to compare wind energy with their choice of another form of renewable energy using a Venn diagram. (Ex. Draw two large intersecting circles. Label one circle wind energy and the other circle another renewable energy, such as solar). **http://www.learninggamesforkids.com/graphic_organizers/writing/venn-diagram.html**
- Journal (if the students have a journal). Teachers write the following question on the board and ask students to copy and answer the question in their journals: How is the use of different energy (renewable and non-renewable) going to impact society long and short term?

Practice That May Involve Parents or Guardians

- At-Home Activity: See the Wind (kite, streamers, string, and balloon) **http://www1.eere.energy.gov/education/pdfs/wind_seethewind.pdf**
- At-Home Checklist: Renewable Energy at Home – Teachers write the following question on the board and ask students to copy it on a sheet of paper. What renewable energy sources does your home use?
- At-Home Activity: Teachers write the following question on the board and ask students to copy it on a sheet of paper. How could you include more renewable energy in your home?

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- Journal (if completed as Independent Practice, as shown above)
- Wind Power Worksheets (if completed as Independent Practice, as shown above)
- Venn diagram (if completed as Independent Practice, as shown above)

VII. Materials Needed

The following materials are needed for the “Recommended Items” in Guided Practice & Independent Practice sections.

- Shoebox with a lid
- Black paper or black paint
- Ruler
- Knife or box cutter
- Craft glue
- Plastic wrap
- Aluminum foil
- Dowel rod

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

How can we be sure to never run out of energy?

ENERGY EDUCATION

LESSON PLAN SET 3

Energy Use and Delivery

energyright® solutions for youth

TVA

Set 3: Energy Use & Delivery

ENERGY USE AND DELIVERY – LESSON PLAN 3.1

Introduction to Electricity

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Identify the characteristics of electricity.**
- **Label an atom.**
- **Explain static electricity.**
- **Describe characteristics of each subatomic particle.**

Public School System Teaching Standards Covered

State Science Standards

- AL 4.1.1 4th
- AL 4.1.2 4th
- AL 5.2.1 5th
- AL 5.4.1 5th
- GA S5P1 5th
- GA S5P3a,b,c 5th
- KY 3-PS-2-3 3rd
- NC 3.P.3.1 3rd
- NC 4.P.1.2 4th
- NC 5.P.2.3 5th
- TN GLE 0407.12.2 4th
- TN GLE 0407.12.3 4th
- VA 4.3 4th
- VA 5.4c 5th

Common Core Language Arts/Reading

- ELA.CCSS.W.3.1 KY, NC 3rd
- ELA.CCSS.W.4.1 TN, KY, NC, AL 4th
- ELA.CCSS.W.5.1 NC, GA, AL 5th

I. Anticipatory Set (Attention Grabber)

Essential Question

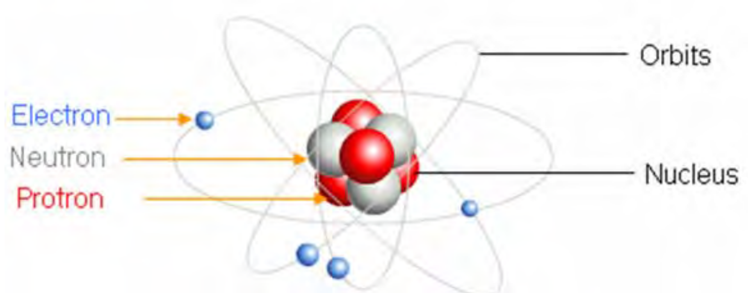
How does an electric current flow?

II. Modeling (Concepts to Teach)

Structure of the Atom

Very tiny particles, called atoms, make up all matter. Atoms are composed of subatomic particles, called protons, neutrons, and electrons. The protons and neutrons are located in the middle of the atom in what is referred to as the nucleus. Protons are positively charged and neutrons are neutrally charged. The electrons, however, are located around the outside of an atom. Electrons are negatively charged and are much smaller than protons and neutrons.

http://www.softschools.com/chemistry/atomic_structure.jsp
https://www.youtube.com/watch?v=R1RMV5qhwyE



SUMMARY OF SUBATOMIC PARTICLES		
Proton	**Neutron**	**Electron**
In nucleus	In nucleus	Outside nucleus
Tightly Bound	Tightly Bound	Weakly Bound
Positive Charge	No Charge	Negative Charge
Massive	Massive	Not very massive

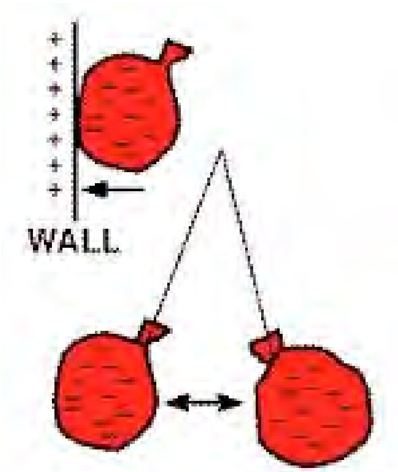
Opposite charges are attracted to each other. So, a negative charge is attracted to a positive charge and vice versa. This phenomenon is what holds an atom together. The nucleus has an overall positive charge and the electrons are negative. Therefore, the negatively charged electrons are attracted to the positively charged nucleus. The opposite is true for like charges (have the same charge – either positive or negative). Like charges repel each other. Negative-Negative repel and Positive-Positive repel. This is also true of magnets. The S and N ends are attracted to each other, but the S and S are repelled and the N and N are also repelled.

The charge of one proton is equal in strength to the charge of one electron. When the number of protons in an atom equals the number of electrons, the atom itself has no overall charge, it is neutral.

Static Electricity

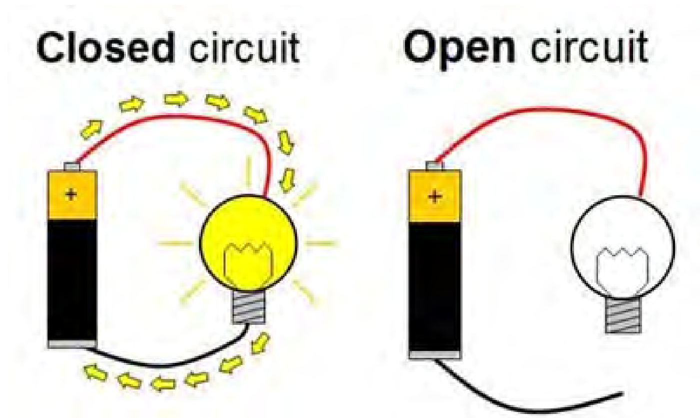
Static electricity is the result of an imbalance of charge within or on the surface of an object. This imbalance of charge is due to the transfer of electrons and the charge is located in one location. It is static (not moving). It is easy to transfer electrons from one place to another since they are located on the outside of the atoms. For example, when a person moves rubber-soled shoes across a carpet, the shoes pick up and hold onto the electrons that are scraped off of the carpet. The shoes become negatively charged. Now, if that person touches something that is a good conductor, like a door handle, the electrons will flow out of the shoes giving that person a zap! In this example, the rubber-soled shoes are a good insulator. **Insulators** are materials that hold onto electrons very tightly. The door handle is made of metal and is a good conductor. **Conductors** are materials that are composed of atoms where the electrons are loosely held together. The electrons are able to flow more easily.

If someone rubs a balloon on a wool scarf something similar will happen. The electrons (-) from the scarf will be transferred to the balloon giving it an overall negative charge. The balloon will then be attracted to objects that are positively charged, like a wall (see diagram below) and be repelled by objects that are negatively charged, like another negatively charged balloon (see diagram below).

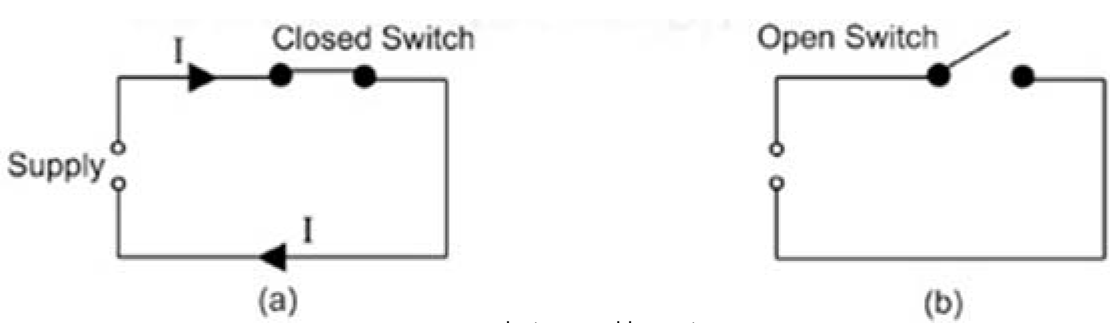


Current Electricity

Current Electricity is the flow of electrons in a pathway. The pathway is made up of a conductor, like a metal wire. The battery provides the voltage, or **electrical potential difference**, to drive the electrons from the negative electrode through the circuit and back to the positive electrode of the battery. Remember, opposite charges attract, which is why the negative electrons are attracted to the positive terminal of the battery. If the pathway is uninterrupted, then the circuit is closed and will provide energy to light up a light bulb. If there is a break in the circuit and the pathway from the negative end of the battery to the positive end of the battery is broken, the light bulb will not light up. This break would mean that it is an open circuit. (See diagram below).



This same concept is used when using an on/off switch for a circuit. The “on” position produces a closed circuit and the “off” position provides an open circuit. The on/off switch is often symbolized with an icon (see icon image below). Similarly, the (a) diagram is switched on and the (b) diagram is switched off.



www.electrosparx.blogspot.com

ENERGY EDUCATION

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	What is an insulator? What is a conductor? Explain the nature of subatomic particles. (Class discussion)
UNDERSTAND	Explain how an atom is held together. Explain static electricity. (Class discussion)
APPLY	Illustrate the attraction between two magnets. (If teacher has two magnets, show the class.)
ANALYZE	Compare and contrast an open and closed circuit. Why must the circuit be closed in order to work? (Class discussion. Teacher can turn the lights off and on as an example.)
CREATE	Create a closed circuit. (If teachers have a circuit board, show the class. If not, draw a closed circuit up on the board. Refer to images in Section II, Modeling, Current Electricity, if needed.)

IV. Guided Practice Ideas

Recommended Items

Potato Battery Experiment; Make Your Own Electric Switch Experiment (see below)

Experiments

- Potato Battery Experiment: **http://www.thedailyspud.com/2011/06/12/potato-battery/**
- Make Your Own Electric Switch Experiment: **http://highhillhomeschool.blogspot.de/2012/04/make-your-own-electrical-switch.html**
- Make a Lemon Battery Video and Experiment: **http://www.pinterest.com/pin/161637074098989761/**

Videos

- Basic Electricity for Kids Video: **http://www.youtube.com/watch?v=yHFkaeDZJWs**
- Electricity – Bill Nye the Science Guy Video: **http://www.youtube.com/watch?v=gixkpsrxk4Y**

Games

- Interactive Games: **http://resources.woodlands-junior.kent.sch.uk/revision/science/electricity.htm**

Activity

- Structure of an Atom Activity: Use different sizes and colors of marshmallows, candies, or M&Ms to represent the differences in size of subatomic particles. Glue them together to show the nucleus (protons and neutrons combined together) versus a free electron orbiting around the nucleus and how each behaves and relates to each other. Refer to Structure of an Atom in Section II, Modeling, if needed.

V. Independent Practice Ideas

Other Resources

Personal Practice

- Writing Activity: Teachers write the following questions on the board and ask students to copy and answer them on a sheet of paper. What would you do without electricity? If you could only have one thing in your home that runs on electricity, what would it be and why?

Practice That May Involve Parents or Guardians

- At-home Activity: Teachers write the following question on the board and ask students to copy it on a sheet of paper. What kinds of entertainment run on electricity in your house? What kinds of entertainment do not require electricity? (Ex. TV, video games vs. board games, sports, piano).

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- Writing Activity (if completed as Independent Practice, as shown above)
- At-home Activity (if completed as Independent Practice, as shown above)

VII. Materials Needed

The following materials are needed for the **Potato Battery Experiment** in “Recommended Items” in Guided Practice.

- Potato
- Insulated copper wire
- 1 galvanized nail
- Penny

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

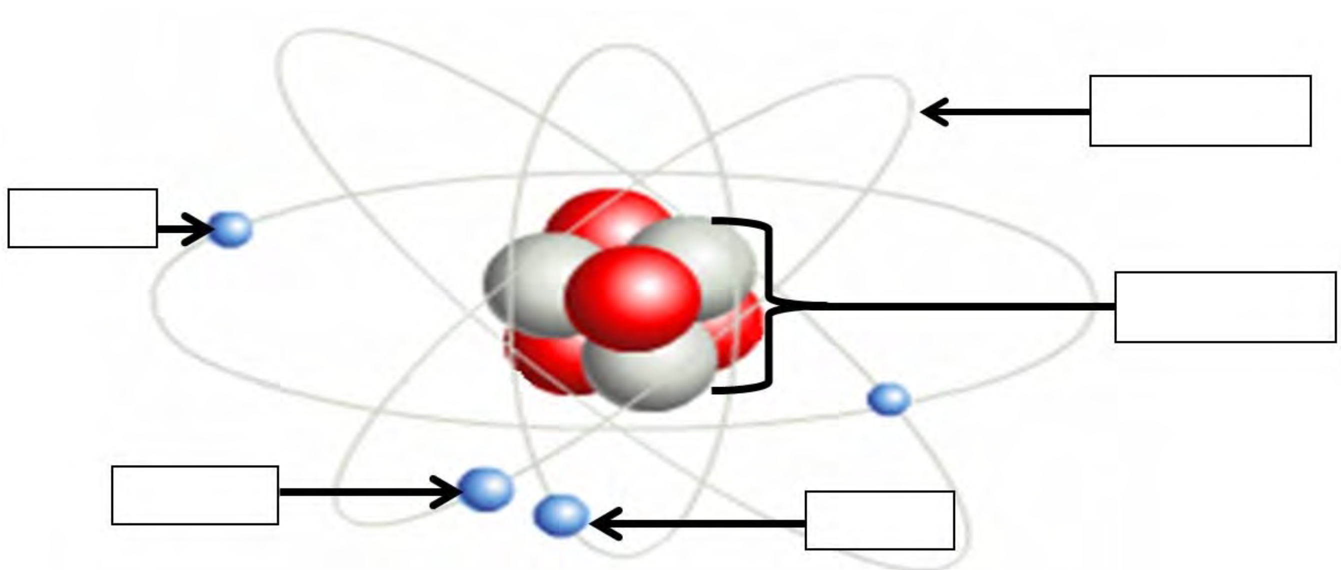
Essential Question

How does an electric current flow?

NAME: ______________________

Components of the Atom

Objective: Students will be able to label the different components of an atom.



Label the components of the atom.

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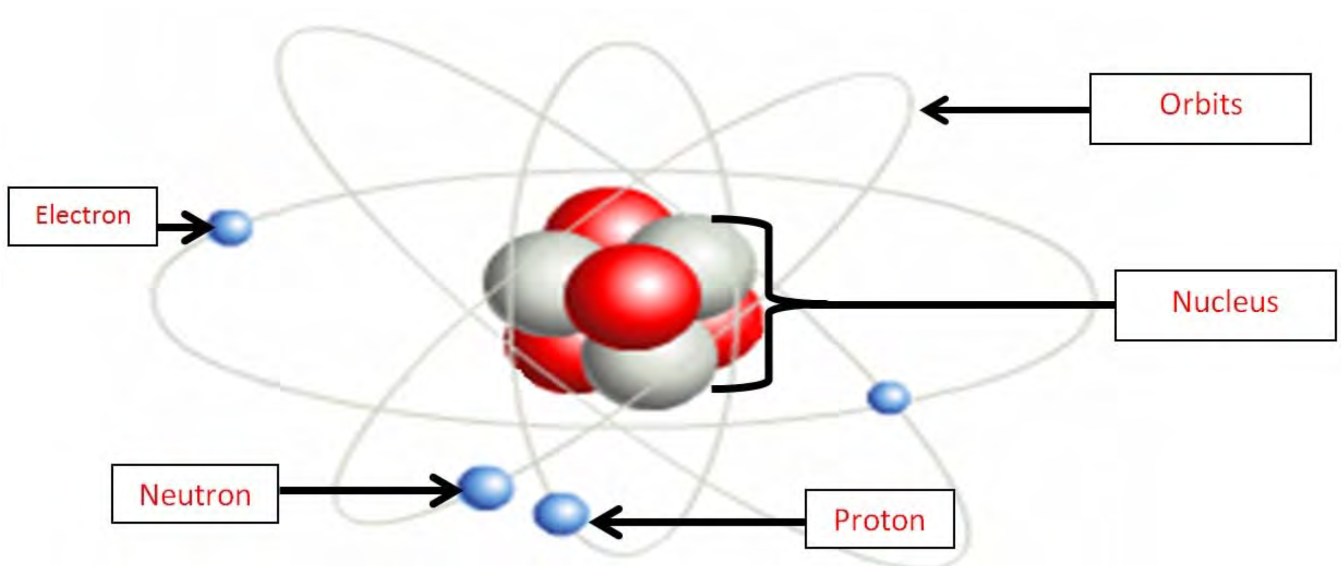
Answer Key

ANSWER KEY FOR WORKSHEET: COMPONENTS OF THE ATOM



Label the components of the atom.

ENERGY USE AND DELIVERY – LESSON PLAN 3.2

Electrical Circuits

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Describe how electricity is measured in homes (kWhs).**
  - **Use and understand math prefix kilo-.**
  - **Convert watts to kW and kW to watts.**
  - **Find kWh, using base-ten multiplication.**
  - **Solve real-world word problems using watts, kWs, and kWhs.**
- **Read a home electric meter, using place value of thousands, hundreds, tens, and ones.**
- **Explain how electricity in a closed circuit can produce heat, light, sound, and magnetic fields.**

Public School System Teaching Standards Covered

State Science Standards

- AL 4.1.1 4th
- KY-SC-P-ET-U-5 3rd
- KY-SC-P-ET-U-3 5th
- MS GLE 10b 5th
- NC 4.P.3.1 4th
- TN 0407.12.2 4th
- TN 0407.12.3 4th

Common Core Mathematics

- AL 3.NBT.1 3rd
- AL 3.NBT.2 3rd
- AL 3.NBT.3 3rd
- AL 4.MD.1 4th
- AL 4.NBT.1 4th
- AL 4.NBT.5 4th
- AL 5.NBT.1 5th
- AL 5.NBT.2 5th
- AL 5.MD.1 5th
- AL 5.MD.5 5th
- GA MCC3.NBT.3 3rd
- GA MCC4.NBT.1 4th
- GA MCC4.NBT.5 4th
- GA MCC5.NBT.1 5th
- GA MCC5.NBT.2 5th
- GA MCC5.NBT.7 5th
- GA MCC5.MD.1 5th
- GA MCC5.MD.7 5th
- KY 3.NBT.1 3rd
- KY 3.NBT.2 3rd
- KY 3.NBT.3 3rd
- KY 4.MD.1 4th
- KY 4.NBT.1 4th
- KY 4.NBT.5 4th
- KY 5.NBT.1 5th
- KY 5.NBT.2 5th
- KY 5.MD.1 5th
- KY 5.MD.5 5th
- TN 3.NBT.1 3rd
- TN 3.NBT.2 3rd
- TN 3.NBT.3 3rd
- TN 4.MD.1 4th
- TN 4.NBT.1 4th
- TN 4.NBT.5 4th
- TN 5.NBT.1 5th
- TN 5.NBT.2 5th
- TN 5.MD.1 5th
- TN 5.MD.5 5th

I. Anticipatory Set (Attention Grabber)

Essential Question

How is electricity measured?

II. Modeling (Concepts to Teach)

A circuit is a way of routing electricity along a path. Electricity derives from electrons, the negatively-charged particles in an atom, moving from one place to another, occurring almost instantly. So, when someone flips on a switch, he/she is completing a pathway or an **electric circuit**, allowing a **current**, or flow of electrons, to travel through the wires.

In order to make a circuit, the following is needed:

1. **Conductive material** (Metal wire. The wire is surrounded by rubber or plastic because those materials make good insulators. Insulators are materials through which electrons have a difficult time flowing. They protect people from dangerous flows of electricity going through the metal.)
2. **Voltage source** (battery). Voltage is the force that drives current through the circuit.
3. **Light bulb, fan, heater, buzzer, etc.**
4. **Switch** (to be able to turn it on and off).

http://science.howstuffworks.com/environmental/energy/circuit.htm

An electric circuit is, in many ways, similar to a circulatory system. Blood vessels, arteries, veins and capillaries are like the wires in a circuit. The blood vessels carry the flow of blood through a body. The wires in a circuit carry the electric current to various parts of an electrical or electronic system.

The heart is the pump that drives the blood circulation throughout the body. It provides the force or pressure for blood to circulate. The blood circulating through the body supplies various organs, like your muscles, brain and digestive system. A battery or generator produces **voltage** – the force that drives current through the circuit.

To teach to the Math and Reading/Language Arts Common Core Standards:

- Together, read the sections “Watts are like miles-per-hour” and “Watts measure power – kilowatts-per-hour measure energy” from the website: **http://www2.buildinggreen.com/blogs/what-watt-anyway-understanding-energy-and-power-metrics**
- Review (or teach) mathematical prefixes centi-, deci-, and kilo- using website: **http://www.factmonster.com/ipka/A0774340.html**. Teach: Kilowatt is 1000 watts
- For more math practice with math prefixes, go to **http://www.aaamath.com/mea212x2.html**.
- Read and model the math problems from the section “Measuring Energy” at: **http://www.explainthatstuff.com/electricity.html.**
- Electricity is measured in kilowatt-hours (kWh). Teachers copy the following explanation and examples on the board: One kWh of energy is equal to 1000 watt-hours and will power a 100 watt light bulb for 10 hours (100 watts x 10 hours = 1,000 watt-hours = 1 kWh). Teachers can refer to “So What is a Kilowatt Hour?” for additional examples to write on the board. **http://www.duke-energy.com/pdfs/MyHER What is a Killowatt-Hour Energy Chart.pdf**
  - Ceiling Fan – 75W x 1 hour = 75 watt-hours = 0.075 kWh
  - Portable heater – 1500W x 1 hour = 1500 watt-hours = 1.5 kWh
  - Microwave Oven – 1000W x 1 hour = 1000 watt-hours = 1 kWh
  - Television >50’’ Plasma – 480W x 1 hour = 480 watt-hours = 0.48 kWh
- Work similar math problems together, using properties of place value and values of 10 (Ex: 60 watts x 10 hours = 600 watt-hours = .6 kWh)

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts

REMEMBER	What do the terms watts, kW, and kWh stand for and what do they measure? (Class discussion)
UNDERSTAND	Explain what a kWh is. Work example math problems to find using values of 10 and/or 100 using multiplication and division. (ex: 40w x 100 hours = 4000 watt-hours which is = 4 kilowatt hours) (Class discussion)
ANALYZE	Why would a house or apartment use more kWs at certain times of the day than others? (Ex: Cooking dinner when everyone is home versus around 1:00 p.m. when everyone is at school or work.) (Class discussion)
EVALUATE	How could we decrease kWs at these high-energy times? (Class discussion)

ENERGY EDUCATION

IV. Guided Practice Ideas

Recommended Items

Simple Light Circuit Experiment (see below)

Experiments

- Simple Light Circuit Experiment: **http://52brandnew.com/2013/04/10/new-experience-13-the-simplest-circuit/**
- Circuit Building with Play-dough Experiment: **http://b-inspiredmama.com/2013/05/kids-circuit-building/**

Games

- Interactive Games: **http://www.sciencekids.co.nz/gamesactivities/electricitycircuits.html**

Other Resources

For Math and Reading/Language Arts Common Core Standards

- Discuss and review terms: watts, kW, and kWh. Teachers write the following on the board and review: Electricity consumption is measured in kilowatt-hours (kWh). One kWh of energy is equal to 1000 watt-hours and will power a 100 watt light bulb for 10 hours (100 watts x 10 hours = 1,000 watt-hours = 1 kWh).
- Learn to read a home electric meter. Watch "Reading your Electric Meter" video: **https://www.youtube.com/watch?v=I6UPkncvFhw** to learn more about watts and kW and kW, and how to read your home electric meter.
- Then, go to: http://c03.apogee.net/contentplayer/?coursetype=kids&utilityid=pseg&id=16240
- Work some example meter readings together, do "Meter Reader Quiz 1 and 2."
- See lesson 3.4 for explanation of how "power" is used to measure the rate of energy use and how it is related to kWh.

V. Independent Practice Ideas

Recommended Item

Home Experiment: Create a closed circuit using household items: (see below)

Other Resources

Personal Practice

- Writing Activity: Teachers write the following questions on the board and ask students to copy and answer the questions on a sheet of paper: What would happen if we had an open circuit? Why must the circuit be closed?

Practice That May Involve Parents or Guardians

- At-home Checklist: Teachers instruct students to find things in the home that produce heat, light, magnetic fields, and/or sound with electricity (one example of each). Write them on a sheet of paper and label if they produce heat, light, etc.
- Home Experiment: Create a closed circuit using household items. **http://www.youtube.com/watch?v=Rzsognkt290**
- At-Home Activity for meter reading: **https://www.youtube.com/watch?v=I6UPkncvFhw** (meter reading worksheet provided)

Grade 3

- Go to http://www.enwin.com/kids/games/meter_reader.cfm and take the challenge on reading the meters. Then, record the place value of each number.

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- At-Home Activity for meter reading (meter reading worksheet provided)

VII. Materials Needed

The following materials are needed for the **Simple Light Circuit Experiment** in "Recommended Items" in Guided Practice.

- Small Light bulb
- D battery
- Wire

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

How is electricity measured?

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ENERGY EDUCATION

energyright solutions for youth TVA

METER READING WORKSHEET FOR ELECTRICAL CIRCUITS LESSON 3.2

Meter Reading

NAME: ______________________

Instructions: For 5 consecutive days, go outside to your electric meter of your home or apartment and read it and record the kWh. Refer to the following for additional information:
https://www.youtube.com/watch?v=I6UPkncvFhw.

Day	Date	Time	kWh
Day 1 (start period)			
Day 2			
Day 3			
Day 4			
Day 5 (end period)			

How much energy did you use from the start period to the end period? (Hint: subtract end period reading from start period reading.)

____

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ENERGY USE AND DELIVERY – LESSON PLAN 3.3

Electromagnets

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

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Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Identify and explain an electromagnet.**
- **Describe the relationship between electricity and magnetism.**
- **Compare an electromagnet to a bar magnet.**

Public School System Teaching Standards Covered

State Science Standards

- GA S3P2 3rd
- GA S5P3 5th
- MS GLE 10.c 5th
- TN SPI 0407.12.1 and WCS 4th

I. Anticipatory Set (Attention Grabber)

Essential Question

What is the difference between a magnet and an electromagnet?

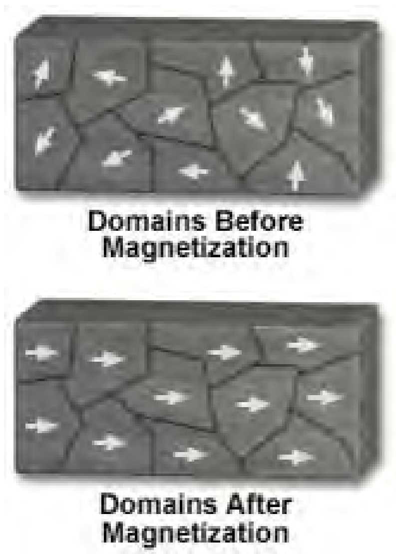
II. Modeling (Concepts to Teach)

Stockbyte/Getty Images

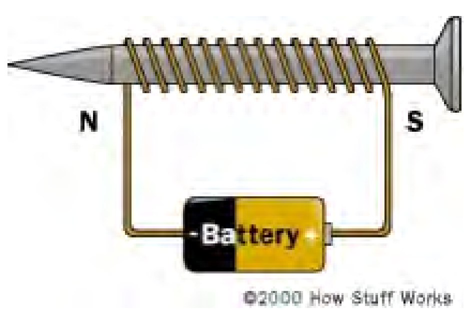
Magnets have two poles, "north" and "south," and attract iron, or materials with iron in them, like steel. Opposite poles attract and like poles repel. For example, if there are two bar magnets with their ends marked "north" and "south," the north end of one magnet will attract the south end of the other. On the other hand, the north end of one magnet will repel the north end of the other (and similarly, south will repel south). An **electromagnet** acts the same way, except it is "temporary" – the magnetic field only exists when electric current is flowing.
The magnetic field of individual iron atoms is so strong that interactions among neighboring atoms cause large

clusters of atoms to line up with each other. These clusters of aligned atoms are called **magnetic domains**. Each domain consists of billions of aligned iron atoms. When a current is sent through the wire wrapped around the iron-containing metal, the domains align so their tiny magnetic fields add to the wire's magnetic field. This creates a large magnetic field that extends into the space around the magnet. The larger the current passing through the coil, the more the domains align, and the stronger the magnetic field will be. (See diagram below)
http://www.magnet.fsu.edu/education/tutorials/magnetacademy/magnets/images/magnets-domains.jpg

So, an electromagnet is a device that creates a magnetic field through the application of electricity. It is created by wrapping a length of conductive wire, usually copper, around a piece of metal. A battery, or other voltage source,



is used to introduce a current through the wire. This creates a magnetic field around the coiled wire, magnetizing the metal as if it were a permanent magnet. It aligns all of the domains in the metal in one orientation. Electromagnets are useful because the magnet can be turned on and off by completing or interrupting the circuit.



Uses of Electromagnets

The scientist Michael Faraday discovered **electromagnetic induction**. Electromagnetic induction takes advantage of the fact that a moving electrical current creates a magnetic field and a moving magnetic field creates an electrical current. **Electric motors and generators** use the idea of electromagnetic induction. In any electrical appliance, the motor is moved by the magnetic field produced by the electric current flowing from the socket to the appliance. A generator uses the opposite principle and an outside force, normally wind, moving water, or steam, rotates a shaft, which rotates a set of magnets around a coiled wire to create an electric current. This is how electric power is generated.

A few examples of things that use electromagnets are:

- Loud speakers
- MRI machines
- Magnetic Separation
- Lifting heavy iron-containing objects

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	List the characteristics of magnetic domains. What are some uses of an electromagnet? (Class discussion)
UNDERSTAND	Predict what would happen if you didn't use a *conductor* as the connective piece between the battery and the piece of metal? (Class discussion)
APPLY	Examine the difference between a magnet and an electromagnet. (Class discussion)
EVALUATE	Give a circumstance where you would need an electromagnet instead of a regular magnet. (Class discussion)
CREATE	Create an electromagnet. (Teachers can demonstrate using the following experiment: **http://www.sciencebob.com/experiments/electromagnet.php**.)

ENERGY EDUCATION

IV. Guided Practice Ideas

Recommended Item

Build an Electromagnet (see below)

Experiments

- Build an Electromagnet: **http://www.sciencebob.com/experiments/electromagnet.php**
- Electromagnet: **http://www.lovemyscience.com/electromagnet.html**
- Experiments with Magnets: **http://my.execpc.com/~rhoadley/magindex.htm**

Games

- Electricity and Magnetism WebQuest: **http://zunal.com/webquest.php?w=123653**

Videos

- The Science Behind Magnets: **http://www.youtube.com/watch?v=MZtTVsIOA9c**
- Electricity and Magnetism Simple Electric Motor: **http://www.youtube.com/watch?v=UY7LT3qNHXI**
- What is the Magnetic Field? **http://www.sciencekids.co.nz/videos/physics/magneticfields.html**

V. Independent Practice Ideas

Recommended Item

Scavenger Hunt: Find Magnetic Fields (see below)

Other Resources

Personal Practice

- Label the Magnets Worksheet and Answer Key provided
- Venn diagram: Teachers ask students to compare a bar magnet to an electromagnet using a Venn diagram. (Ex. Draw two large intersecting circles. Label one circle bar magnet and the other circle electromagnet.) **http://www.learninggamesforkids.com/graphic_organizers/writing/venn-diagram.html**

Practice That May Involve Parents or Guardians

- At-home Scavenger Hunt: Teachers instruct students to find 5 things in the home that produce magnetic fields with electricity. Write them on a sheet of paper. (Ex. Computer, appliances, etc.)

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- Label the Magnets Worksheet and Answer Key provided
- Build an Electromagnet (if completed as Guided Practice, as shown above)
- Venn diagram (if completed as Independent Practice, as shown above)
- Scavenger Hunt (if completed as Independent Practice, as shown above)

VII. Materials Needed

The following materials are needed for the **Build an Electromagnet Experiment** in the "Recommended Items" in Guided Practice.

- Large nail (about 3 inches)
- About 3 feet of THIN COATED copper wire
- Fresh D size battery
- Some paper clips or other small magnetic objects

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

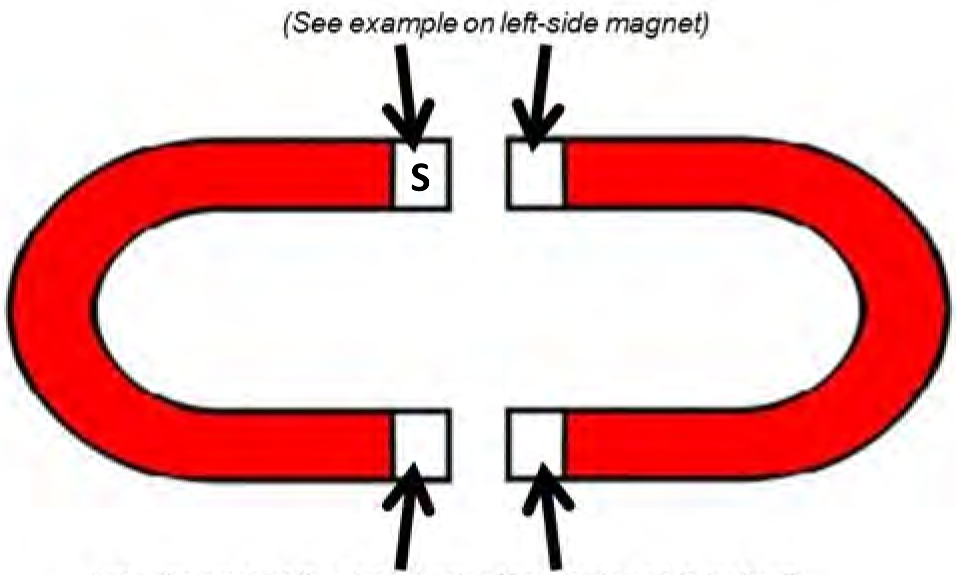
Essential Question

What is the difference between a magnet and an electromagnet?

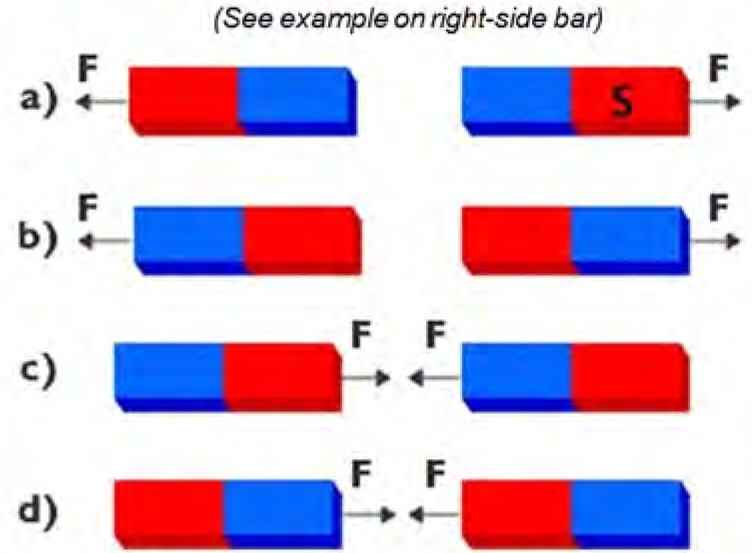
WORKSHEET FOR ELECTROMAGNETS LESSON 3.3 **NAME:** ______________________

Label the Magnets

Objective: Students will be able to identify and explain an electromagnet, describe the relationship between electricity and magnetism, and compare an electromagnet to a bar magnet.



Label the poles of the magnet using N for North and S for South, so that they attract one another.



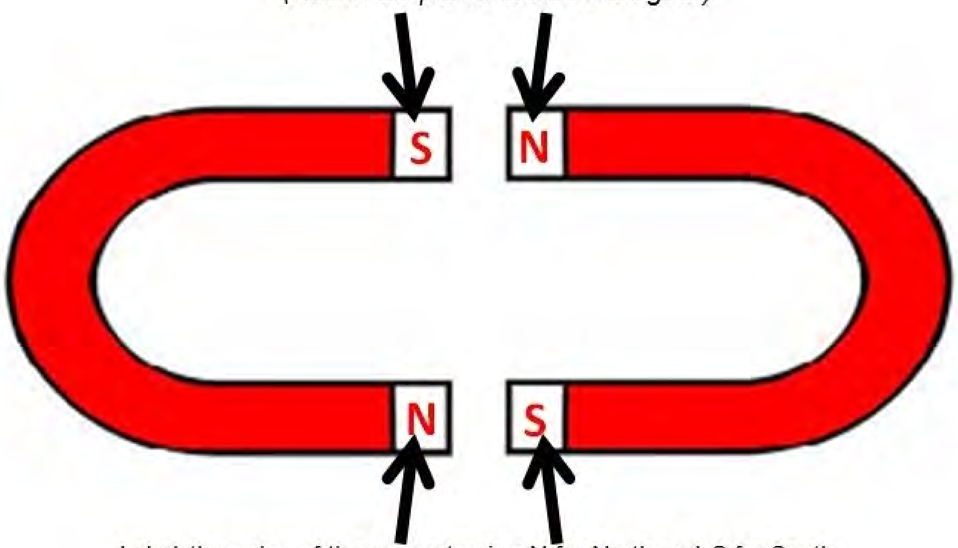
Label each pole of the magnets using N for North and S for South, according to the direction of force (F).

This page is intentionally blank.

Answer Key

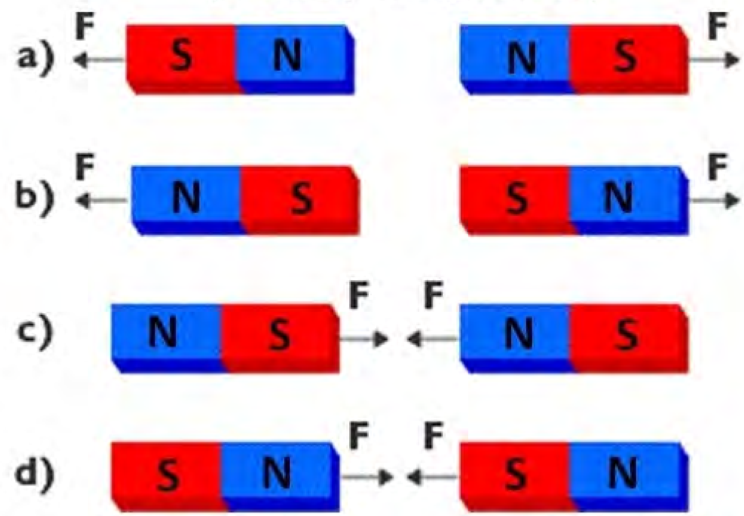
ANSWER KEY FOR WORKSHEET: LABEL THE MAGNETS

(See example on left-side magnet)



Label the poles of the magnet using N for North and S for South, so that they attract one another.

(See example on right-side bar)



Label each pole of the magnets using N for North and S for South, according to the direction of force (F).

ENERGY USE AND DELIVERY – LESSON PLAN 3.4

Energy Delivery

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Describe how energy is delivered to homes.**
- **Describe how electricity is measured in homes (kWhs).**
- **Explain what will happen when there is a power outage.**
- **List the types of power outages.**

Public School System Teaching Standards Covered

Common Core Language Arts/Reading

- GA ELACC3RI: 1,2,3,6,7,8, and 10 3rd
- GA ELACC4RI: 1,3,5, and 10 4th
- GA ELACC5RI: 1,3,5,7,9, and 10 5th
- KY ELACC3RI: 1,3,8,and 10 3rd
- KY ELACC4RI: 1,3,5,6, and 10 4th
- KY ELACC5RI: 1,3,5, and 10 5th
- TNCCRA.R.1
- TN 3.RI: 2, 3, 6, and 8 3rd
- TN 4.RI: 1,2,3,6, and 10 4th
- TN 5.RI: 1,2,5,7,and 10 5th
- VA 3.6 b, d, k 3rd
- VA 3.7 a 3rd
- VA 4.6 a, g, i, j, k 4th
- VA 5.6 a, b, h, j, k 5th

Writing

- GA ELA CC3W: 2,4, and 7 3rd
- GA ELACC4W: 2,3,4, and 7 4th
- GA ELACC5W: 2,3,4 and 7 5th
- KY ELACC3W: 2,3,4, and 7 3rd
- KY ELACC4W: 2,3,4, and 7 4th
- KY ELACC5W: 2,3,4, and 7 5th
- TN CCRAW.7
- TN 3.W: 2,4, and 7 3rd
- TN 4.W: 2,3,4, and 7 4th
- TN 5.W: 2,3,4 and 7 5th
- VA 3.9 3rd
- VA 3.11 a, b, c 3rd
- VA 4.7 c, d, g 4th
- VA 5.7 b, c, e 5th

I. Anticipatory Set (Attention Grabber)

Essential Question

How does power get into your home?

II. Modeling (Concepts to Teach)

Once the electrical energy is generated using nuclear, wind, water, or coal energy sources, that energy then needs to be delivered to households. There are three steps involved in this process:

1. **Stepping up the voltage for transmission:** The electricity that is generated must be stepped up to a higher voltage using a **transformer**. Because electricity must travel long distances from where it is generated (produced) to where it is used (homes, schools, businesses, etc.), higher voltage electricity is able to travel over longer distances more efficiently (i.e. with less loss of energy). The high voltage lines carry electricity at voltages as high as 400,000 volts many hundreds of miles to substations.

    Transformers – A transformer is an electrical device that takes electricity of one voltage and changes it into another voltage.

2. **Stepping down the voltage at the substations:** At substations, high voltage electricity is stepped-down to a lower voltage and this electricity (in different power levels) is used to run factories, streetcars, mass transit, light street lamps and stop lights, and is sent to neighborhoods.

3. **Small transformers in neighborhoods reduce the voltage even further:** The voltage is reduced further before being safely delivered to homes and businesses. From transformers, electricity travels into buildings through wires called service drops. The service drops connect to a meter box, which measures the amount of electricity being used by that consumer or household. After being measured, the electricity goes through a circuit breaker box into homes. A circuit breaker box limits the amount of electrical current flowing through the wires. When a circuit breaker (or fuse) “trips”, something is wrong with an appliance or something was short-circuited.

The picture below is of a small neighborhood transformer that steps the voltage to its final 120/240 volts before going into a house or business.

How is electrical energy consumption measured?

The unit **kilowatt-hour** is used to measure electrical energy consumption.

When we talk about powering appliances in our home with electricity, we are not usually interested in how much energy an appliance uses, but rather the ***rate* of energy use**, or in other words, how much energy per *unit time* the appliance draws. This quantity is called the "power":

Power = Energy/Time

In particular, for electrical power we use the "watt" (named after the scientist James Watt):

1 Watt = 1 Joule/Second

It is important not to confuse power and energy, although they are closely related. Just remember that power is the ***rate*** at which energy is delivered, not an amount of energy itself. With simple algebra, turn the above formula for power around to solve for energy instead, and write:

Energy = Power x Time (Kilowatt x hour)

As mentioned above, the unit **kilowatt-hour** (kWh) is used to measure electrical energy consumption. One kilowatt-hour is defined as the energy consumed by power consumption of 1 kW during 1 hour:

1 kWh = 1 kW x 1 hour

What is the energy consumed when consuming 2 kW for 3 hours? Solution: 2 kW x 3 hours = 6 kWh.
In relation to watts, 1 kilowatt (kW) equals 1,000 watts and 1 kilowatt-hour equals using 1,000 watts for one hour. See lesson 3.2 for in-depth explanation and practice for kWh and kW.

Types of Power Outages

Power outages are categorized into three different phenomena, relating to the duration and effect of the outage: **http://en.wikipedia.org/wiki/Power_outage**

1. **A transient fault** is a momentary (a few seconds) power outage typically caused by a temporary fault on a power line. Power is automatically restored once the fault is cleared.
2. **A brownout** is a drop in voltage in an electrical power supply. The term brownout comes from the dimming experienced by lighting when the voltage sags. Brownouts can cause poor performance of equipment or even incorrect operation.
3. **A blackout** refers to a total power outage in an area and is the most severe form of power outage. Blackouts, which result from or result in power stations tripping, are particularly difficult to recover from in a quick fashion. Outages may last from a few minutes to a few weeks, depending on the nature of the blackout and the configuration of the electrical network.

What happens when there's a power outage?

The electrical grid is the connection of all of the power plants with each other. One grid can be as big as half of the United States! This is convenient if there is one power plant that has a failure because neighboring power plants can increase their output to make up for the difference. This can lead to mass power outages, however, because it sometimes leads to a great deal of strain on other power plants in the power grid. If the neighboring power plants are all near their maximum capacity, they cannot handle the extra load. To prevent themselves from overloading and failing, they will disconnect from the grid as well. That only makes the problem worse, and dozens of plants eventually disconnect. This can leave millions of people without power.

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	What are some causes of power outages? (Class discussion. Teacher can list reasons on the board).
UNDERSTAND	What are the effects of power outages? Together, brainstorm what happens when there is a power outage. What are some of the effects? What happens if you are cooking dinner? Doing homework? What if the whole city loses power? What would some of the effects be? For people at work? (Class discussion)
APPLY	Go to **http://childrensbooksheal.com/2012/01/06/blackout-by-john-rocco/** and watch the book trailer for the book, “Blackout” by John Rocco. Discuss these real peoples’ experiences during a blackout in NYC. (Class discussion)
ANALYZE	Can we do anything to avoid a power outage, and what do we do if there is a power outage? Read: **http://scienceblogs.com/casaubonsbook/2009/12/08/when-the-power-goes-out/** for suggestions. (Class discussion)
EVALUATE	Evaluate the pros and cons of living with electrical power versus without. (Class discussion)

IV. Guided Practice Ideas

Recommended Items

How Power Plants Work Video; The Flow of Electricity – How Energy Gets to You (Interactive Diagram) (see below)

Videos

- How Power Plants Work Video: https://www.youtube.com/watch?v=GI7AhajfhWE
- Where Energy Comes From Video: **http://www.youtube.com/watch?v=__zB80SagIk**
- Natural Gas Power Plants Video: **http://www.youtube.com/watch?v=Em1crnEt45Q**
- Electricity Generation Video: **http://www.youtube.com/watch?v=20Vb6hlLQSg**

Field Trip

- Field Trip: If possible, teachers take students on a field trip to a local power plant.

Activities

- Interactive Diagram: The Flow of Electricity – How Energy Gets to You **http://www.fpl.com/storm/restoration_journey.shtml**
- Explanation of Electricity: **http://www.explainthatstuff.com/electricity.html**
- Voltage and Current: **http://www.fplsafetyworld.com/?ver=kkblue&utilid=fplforkids&id=16184**
- Measuring Heat Energy: **http://www.sciencebuddies.org/science-fair-projects/project_ideas/Chem_p092.shtml?from=Pinterest - procedure**
- Play charades: Teachers have students act out an "effect" of a power outage while other students guess which effect they are portraying (ex: car crashes because stoplights are out)

V. Independent Practice Ideas

Recommended Items

Parent or Guardian Interview (see below) Interview Guide provided

Other Resources

Personal Practice

- Sequence chart: Teachers ask students to write a sequence chart or draw a diagram explaining how power is transferred from the power plant to homes. Refer to The Flow of Electricity – How Energy Gets To You (Interactive Diagram): **http://www.fpl.com/storm/restoration_journey.shtml**

Practice That May Involve Parents or Guardians

- "How I Lived without Electricity" Interview and Write Up: Interview Guide provided.
  - Interview a grandparent or older person who has lived without electricity for a sizable portion of his/her life or someone who lived without electricity for some time because of the effects of a hurricane or other natural disaster.
  - Write a three paragraph paper based on interview answers about how that person lived without electricity.
- Parent or guardian interview: Interview Guide provided.
  - Students check their parents' or guardians' understanding of the things they learned in class. Refer to Section II. Modeling for detailed answers. Do they know how energy is delivered to your home? (Answer: Voltage is stepped up for transmission; Voltage is stepped down at the substations; Small transformers in neighborhoods reduce the voltage even further.) What do we typically do during a power outage?

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- "How I Lived without Electricity" Interview and Write Up (if completed as Independent Practice, as shown above)
- Parent or Guardian Interview (if completed as Independent Practice, as shown above)

VII. Materials Needed

- None

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

How does power get into your home?

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INTERVIEW GUIDE FOR ENERGY DELIVERY LESSON 3.4

NAME: ______________________

How I Lived without Electricity

Instructions: Students interview a person who has lived without electricity for a period of time. This can be a grandparent or older person who has lived without electricity for a sizable portion of his/her life or someone who lived without electricity for some time because of the effects of a hurricane or other natural disaster.

Name of Interviewee: ________________________________

1. When did you live without electricity?

   ____

   ____

   ____

2. How did you go about daily life without electricity?

   ____

   ____

   ____

3. What do you think are the advantages of electricity?

   ____

   ____

   ____

4. What are the disadvantages of electricity?

   ____

   ____

   ____

INTERVIEW GUIDE FOR ENERGY DELIVERY LESSON 3.4 **NAME:** ______________________

Parent or Guardian Interview

Instructions: Students interview a parent or guardian.

Name of Interviewee: ______________________________

1. Who provides our power?

____

____

2. How is electricity delivered to our home?

____

____

____

3. What do we typically do during a power outage?

____

____

____

4. Have you ever experienced a blackout for an extended period of time?

____

____

ENERGY USE AND DELIVERY – LESSON PLAN 3.5

Energy Efficiency

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Public School System Teaching Standards Covered

Common Core Language Arts/Reading

- AL RL.3.1 3rd
- AL RI.3.1 and 2 3rd
- AL RL.4.1 4th
- AL RI.4.1 and 2 4th
- AL RL.5.1 5th
- AL RI.5.1 and 2 5th
- GA ELA.CC3.RL.1 3rd
- GA ELA.CC3.RI.2 3rd
- GA ELA.CC4.RL.1 4th
- GA ELA.CC4.RI.1,2, and 8 4th
- GA ELA.CC5.RL.1 5th
- GA ELA.CC5.RI. 1,2, and 8 5th
- KY 3.RL.1 and 2 3rd
- KY 3.RI.1,2, and 8 3rd
- KY 4.RL.1 and 2 4th
- KY 4.RI.1,2, and 8 4th
- KY 5.RL.1,2, and 6 5th
- KY 5.RI.1,2, and 8 5th
- TN 3.CCRA.R. 1, 2, and 6 3rd
- TN 3.RI.1 and 2 3rd
- TN 4.RI.1,2, and 8 4th
- TN 4.RL. 1 and 2 4th
- TN 4.CCRA.1,2, and 6 4th
- TN 5.RI. 1, 2, and 8 5th
- VA 3.6 b, d, k 3rd
- VA 3.7 a 3rd
- VA 4.6 a, g, i, j, k 4th
- VA 5.6 a, b, h, j, k 5th

Writing

- AL W.3.1,4, and 8 3rd
- AL W.4.1,4, and 8 4th
- AL W.5.1,4, and 8 5th
- GA ELA.CC3.W.1,4, and 8 3rd
- GA ELA.CC4.W. 1,4, and 8 4th
- GA ELA.CC5.W.1,4,8,and 9 5th
- KY 3.W.1, 4, and 8 3rd
- KY 4.W.1, 4, and 8 4th
- KY 5.W. 1, 4, and 8 5th
- TN 3.CCRA.W.1, 4, and 9 3rd
- TN 4.W.1, 4, and 9 4th
- TN 4.CCRA.W. 1, 4, and 9 4th
- TN 5.W.1,4,8, and 9b 5th
- TN 5.CCRA.W. 1, 4, and 9 5th
- VA 3.9 3rd
- VA 3.11 a, b, c 3rd
- VA SOL.W.3.11 3rd
- VA 4.7 c, d, g 4th
- VA SOL.W.4.11 4th
- VA 5.7 b, c, e 5th
- VA SOL.W.4.11 5th

Performance Objectives

By the end of this lesson, students will be able to:

- **List and explain ways to conserve energy.**
- **Identify the author's purpose, which is to persuade.**
- **Write to persuade others to be more energy efficient.**
- **Identify wattage required to operate appliances or electronics, calculate the amount of electricity required to operate said items and determine the annual cost for operating things they use at home.**

I. Anticipatory Set (Attention Grabber)

Essential Question

How can we conserve energy?

Interactive

Show class the interactive pictures from this website:
http://www.valuesmoneyandme.co.uk/activities/cost_earth/cost_earth_sittingroom.html

What is wrong in the pictures? Are these people conserving energy or wasting energy? Find and click on wasteful energy examples on the website.

II. Modeling (Concepts to Teach)

Ways to Conserve Energy in Your Home

http://www.motherearthnews.com/renewable-energy/save-money-on-energy.aspx#axzz35iDH8oN9

1. **Do not heat or cool rooms that are not in use.**
2. **Turn down the heating/cooling by 1 degree Fahrenheit.** It's hard to notice the difference, and it uses much less energy.
3. **Turn down the hot water heater.** According to the Department of Energy (DOE), a water thermostat setting of 120 degrees is sufficient for most uses.

4. **Install a programmable thermostat.** This allows the use of only the energy needed to heat or cool a house when people are at home by programming different temperatures for different time periods.

5. **Dry clothes outside on a clothes line.**

6. **Do full loads of laundry** or use "express wash" so only the amount of hot water actually needed is used.

7. **Take a shower rather than a bath.** Showers typically use less hot water than baths.

8. **Prevent heat loss in the winter and heat gain in the summer by increasing insulation, filling cracks and crevices and closing window coverings during sunny days in the summer.** The Energy Star program (a government-backed program that helps protect the environment through superior energy efficiency) estimates that more than 50 percent of a home's energy use goes toward heating and cooling. Increasing the insulation in attics, walls, floors and ceilings slows the flow of air between inside and outside, making it easier to control the temperature.

9. **Unplug appliances when not in use.** The term "phantom load" (also called "vampire electronics") refers to the energy that an appliance or electronic device consumes when it is not actually turned on. According to the U.S. Department of Energy (DOE), "In the average home, 75 percent of the electricity used to power home electronics is consumed while the products are turned off."

10. **Turn off lights when not in use.**

11. **Replace incandescent light bulbs with CFLs or LEDs.** According to Energy Star, one of its qualified compact fluorescent light bulbs (CFL), which costs just a few dollars, "will save about $30 over its lifetime and pay for itself in about six months. It uses 75% less energy and lasts about 10 times longer than an incandescent bulb."

12. **Use energy efficient appliances.** Energy Star appliances use between 10% and 50% less energy and water than their conventional counterparts.

Modeling to Cover Reading/Language Arts Standards:

Read the book *Why Should I Save Energy?* by Jen Green. (To find a copy in the online library, visit: http://www.worldcat.org/title/why-should-i-save-energy/oclc/300399188)

- Ask "What was the **author's purpose** for writing this book?" (Answer: To convince or persuade us to use energy more efficiently by explaining reasons we should conserve.)
- "What was the author's main idea? What was she trying to persuade us to do?"
- "What were the reasons or details she gave to support her main idea in this persuasive book?"
- "These are all good reasons to persuade us to use energy more efficiently. Now let's learn **how.** Let's think together and brainstorm ways we can use energy more efficiently."

- Ways to Conserve Energy KWL chart: Teachers ask students to make a KWL chart of "Ways to Use Energy More Efficiently" on a sheet of paper (a table with columns for what you Know, Want, and Learned). Or teachers can pass out copies of KWL chart found here: **http://notebookingfairy.com/pixiedust/all-purpose/KWL-graphic-organizer-notebooking-page.pdf**
  - Fill in the "K" from their brainstormed list.
  - Wonder about other ways; fill in the "W" of KWL Chart.

Teach these points:

- Electricity is helpful, but it's important to use only as much as needed. Becoming more *energy efficient* can help make power plants work more smoothly, reduce costs, and more importantly, use less of the planet's resources.
- Two very easy things: People can turn off lights when leaving a room. People can turn off and unplug appliances when they are finished using them.
- Some appliances such as refrigerators need to be plugged in all the time in order to work. However, other items such as laptops or cell phone chargers do not always need to be plugged in. When they are plugged in, they use electricity even when turned off or not charging. These types of devices are called Vampire Electronics because they suck up energy! Share: https://www.youtube.com/watch?v=zgZfry82LC4
- Another thing people can do is use dishwashers, washing machines, and dryers only when they are full. Teachers ask students to explain why this energy tip is important.
- Teachers ask students about how they got to school that day. How could they have saved some gasoline? (Ex. Carpooling, riding the bus, riding a bike)
- Teachers ask students to add all these ways that were learned to use energy more efficiently to the KWL Chart.

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

IV. Guided Practice Ideas

REMEMBER	List reasons of why it is important to use energy efficiently. How did the author Jen Green convince us of this? (Class discussion).
UNDERSTAND	Fold a piece of paper in half, vertically (hot-dog bun style). On one half, list reasons WHY it's important to use energy efficiently; on the other half, list the WAYS we use energy efficiently and the actions we take to use energy efficiently. (Assessment)
APPLY AND ANALYZE	Using the lists just made, what the author Jen Green had to say, and also what was learned on the KWL chart, write a persuasive essay hoping to convince others to use energy efficiently. (Teachers ask students to write essay on a sheet of paper).
EVALUATE	What are the most important points to include when trying to convince others to use energy efficiently? (Teachers ask students to use a highlighter to highlight at least three points from each side of their list to include in their persuasive essay).

Recommended Items
Your Planet Needs You Game; You Can Make Big Changes

Games
- Your Planet Needs You Game: **http://www.energystar.gov/index.cfm?c=kids.kids_index**
- You Can Make Big Changes: **http://www.energystar.gov/index.cfm?c=kids.kids_index**
- The Energy Stars Stories: **http://www.energystar.gov/index.cfm?c=kids.kids_index**

Video
- You Have the Power Video: **https://www.youtube.com/watch?v=XTtb0khsVuM**

V. Independent Practice Ideas

Recommended Items
At-Home Checklist: 10 Simple Ways to Use Energy Wisely (Worksheet Provided) (see below);
Parent or Guardian Interview: What Could We Do To Use Energy Efficiently? (Interview Guide Provided) (see below)

Other Resources
Personal Practice
- Writing Activity: Teachers write the following question on the board and ask students to copy and answer it on a sheet of paper: What if we all used our energy more efficiently?
- Calculate Cost to Making Things Work Worksheet and Answer Key provided

Practice That May Involve Parents or Guardians
- At-home Checklist: 10 Simple Ways to Use Energy Wisely (USDE) Worksheet Provided
- Parent or Guardian Interview: What Could We Do To Use Energy Efficiently? Interview Guide Provided

Reading/Language Arts Activities:
- Writing Activity: Persuasive Essay: Follow instructions in Section III Checking for Understanding. Write a persuasive essay convincing others to use energy efficiently. This paper must also include some simple ways to accomplish the goal of using energy efficiently.

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if grades are desired.

- Writing Activity: Persuasive Essay (if completed in Section III Checking for Understanding or Section V Independent Practice as shown above)
- Folded paper: List of WHY and WAYS to Use Energy Efficiently (if completed in Section III Checking for Understanding)
- At-Home Checklist: 10 Simple Ways to Use Energy Wisely Worksheet provided (if completed in Section V Independent Practice as shown above)
- Parent or Guardian Interview: What Could We Do To Use Energy Efficiently? Interview Guide Provided (if completed in Section V Independent Practice as shown above)

VII. Materials Needed

The following materials are needed for the “Recommended Items” in Guided Practice & Independent Practice sections.

- Worksheet (provided)
- Interview Guide (provided)

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference the Performance Objectives at the top of the Lesson Plan.

Essential Question

How can we use energy efficiently?

WORKSHEET FOR ENERGY EFFICIENCY LESSON 3.5 **NAME: ____________________**

Ten Ways to Use Energy Wisely

Objective: Students will be able to understand how to minimize energy.

Take-Home Assignment: Check at least 5 boxes
Show What You Are Already Doing to be Energy Efficient

1. **Turn off the lights.** ☐
2. **Use energy-saving light bulbs.** ☐
3. **Shut off computers.** ☐
4. **Use "smart" power strips.** ☐
5. **Turn off devices when not in use (TV, game systems, etc.).** ☐
6. **Use natural light, natural heating and/or natural cooling.** ☐
7. **Unplug phone chargers when not in use.** ☐
8. **Ask who pays the electric bill; talk with her/him about ENERGY STAR® appliances.** ☐
9. **Talk with your family about programmable digital thermostats.** ☐
10. **Talk about home improvements, such as windows, doors, etc.** ☐

INTERVIEW GUIDE FOR ENERGY EFFICIENCY LESSON 3.5

NAME: ____________________

What Can We Do to Use Energy Efficiently?

Instructions: Students interview a parent or guardian.

1. What are some things we do regularly to use energy efficiently?

____

____

____

2. Are there ways we can be better about using energy efficiently?

____

____

____

3. What are some of your favorite ways to use energy efficiently? (Ex. Hang out clothes to dry; open windows; plant shady trees)

____

____

____

4. What are the advantages to using energy efficiently?

____

____

____

WORKSHEET FOR ENERGY AT HOME LESSON 3.5 **NAME: ________________________**

Calculate Cost to Make Things Work

Objective: Students will be able to identify wattage required to operate appliances or electronics, calculate the amount of electricity required to operate said items and determine the annual cost for operating things they use at home.

Find 2 appliances or electronic devices in your home and identify the amount of watts required to operate each item. Most appliances list their wattage on the back or bottom of the appliance. If wattage is not listed, use the chart below for reference. Fill in the calculation with the wattage information to get the annual cost of electricity needed to operate each item.

EXAMPLE Calculation: "I watch 1 ½ hours of TV each day."

1. (200 Watts X 1.5 Avg. daily use (hrs)) = 300 ÷ 1,000 kW = 0.3 **kWh** (Electricity needed to watch 1.5 hrs of TV)

0.3 kWh X .10 Cost of electricity per kWh = $ 0.03 **Daily cost**

0.03 Daily cost X 365 Days per year = $ 10.95 **Annual cost**

Appliance/Electronic	Watts	Appliance/Electronic	Watts
Dishwasher	2400	Computer	150
Clothes Dryer	2400	Hair Dryer	1500
Microwave Oven	650	Alarm Clock	2
Refrigerator	210	Radiator Heater	1000
Washing Machine	900	Water Heater	4800
Color TV	200	PlayStation 3	107
Video/DVD Recorder	100	Xbox 360	125
Iron	1000	Wii (WiiConnect24 enabled)	550

Appliance 2: ________

(______ Watts X ______ Avg. daily use (hrs)) = ______ ÷ 1,000 kW = ______ **kWh** (Electricity needed to use appliance)

______ kWh X .10 Cost of electricity per kWh = $ ______ **Daily cost**

______ Daily cost X 365 Days per year = $ ______ **Annual cost**

Appliance 3: ________

(______ Watts X ______ Avg. daily use (hrs)) = ______ ÷ 1,000 kW = ______ **kWh** (Electricity needed to use appliance)

______ kWh X .10 Cost of electricity per kWh = $ ______ **Daily cost**

______ Daily cost X 365 Days per year = $ ______ **Annual cost**

Appliance/Electronic	Watts	Appliance/Electronic	Watts
Dishwasher	2400	Computer	150
Clothes Dryer	2400	Hair Dryer	1500
Microwave Oven	650	Alarm Clock	2
Refrigerator	210	Radiator Heater	1000
Washing Machine	900	Water Heater	4800
Color TV	200	PlayStation 3	107
Video/DVD Recorder	100	Xbox 360	125
Iron	1000	Wii (WiiConnect24 enabled)	550

Answer Key

ANSWER KEY FOR CALCULATE COST TO MAKE THINGS WORK

Calculate Cost to Make Things Work

Objective: Students will be able to identify wattage required to operate appliances or electronics, calculate the amount of electricity required to operate said items and determine the annual cost for operating things they use at home.

Find 2 appliances or electronic devices in your home and identify the amount of watts required to operate each item. Most appliances list their wattage on the back or bottom of the appliance. If wattage is not listed, use the chart below for reference. Fill in the calculation with the wattage information to get the annual cost of electricity needed to operate each item.

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Appliance/Electronic	Watts	Appliance/Electronic	Watts
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Refrigerator	210	Radiator Heater	1000
Washing Machine	900	Water Heater	4800
Color TV	200	PlayStation 3	107
Video/DVD Recorder	100	Xbox 360	125
Iron	1000	Wii (WiiConnect24 enabled)	550

Note: Each calculation will vary based on students' selections of appliances/electronic items and average daily use

ENERGY USE AND DELIVERY – LESSON PLAN 3.6

Energy at Home

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Read and answer real world questions about an electric bill.**
- **Plot points to create a line graph representing monthly electric charges.**
- **Interpret a line graph depicting monthly electric charges.**

Public School System Teaching Standards Covered

Common Core Mathematics

- CCSS.MATH.CONTENT.3.MD.B.3
- CCSS.MATH.CONTENT.3.OA.D.8
- CCSS.MATH.CONTENT.3.OA.A.3
- CCSS.MATH.CONTENT.4.MD.A.1
- CCSS.MATH.CONTENT.4.MD.B.4
- CCSS.MATH.CONTENT.4.OA.A.3
- CCSS.MATH.CONTENT.5.MD.A.1
- CCSS.MATH.CONTENT.5.MD.B.2
- CCSS.MATH.CONTENT.5.OA.A.2

Common Core Language Arts/Reading

- CCSS.ELA-LITERACY.RI.3.1
- CCSS.ELA-LITERACY.RI.3.3
- CCSS.ELA-LITERACY.RI.3.7
- CCSS.ELA-LITERACY.RI.3.5
- CCSS.ELA-LITERACY.RI.4.3
- CCSS.ELA-LITERACY.RI.4.5 (if students do the "book report" on the electric bill)
- CCSS.ELA-LITERACY.RI.4.7
- CCSS.ELA-LITERACY.RI.5.3
- CCSS.ELA-LITERACY.RI.5.7

State Science Standards

- GA S3CS1.1.b
- GA S3CS2.a
- GA S3CS4.b
- GA S4CS1.c
- GA S4CS2.a,b, and c
- GA S5CS1.c
- GA S5CS2.a,b, and c
- GA S5CS4.b and c
- TN Science GLE0307.Inq.3
- TN Science GLE0407.Inq.3
- TN Science GLE0507.Inq.3
- KY.3-ESS3-1
- KY.3-ESS2-1
- AL.4-PS-1
- VA Science Goal 3
- VA Science Goal 4
- VA Science Goal 6
- VA 3.1.h, j, and m
- VA 4.1.a,e,i, k, and m
- VA 5.1.g, I, and k
- MS 3.1.d and e
- MS 4.1.d and e
- MS 5.1.b, d, e, g, and h

I. Anticipatory Set (Attention Grabber)

Essential Question

What does an electric bill tell us about the use of energy in a home?

II. Modeling (Concepts to Teach)

Electric Bills

- Here is an example of an electric bill. (Teachers, if possible show a bill from the local power company. However, if a local bill is not available, view this Nashville Electric Service (NES) bill): **http://www.nespower.com/PayMyBill/understandmybill2.aspx** (this example includes an explanation for each part of the bill—simply click on each section and read about it).
- If using the NES bill example, teachers read and review the Usage History Graph and ask math questions related to it, such as:
  - Which month had the highest amount of kilowatt-hours (kWh) used? Why might that be?
  - Which summer months were probably the hottest?
  - What was the amount of electricity (kilowatt-hour – kWh) used in January? What is a possible reason for the family using that much in that month?
  - How much more electricity did this family use last month than this month?

  (Note to educator: Weather has a lot to do with the amount of kWh required to keep your home comfortable. As a general rule, people use more air conditioning during summer months and that means more kWh. If the home has electric heat instead of gas, more kWh might be used in the winter.)

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts

REMEMBER	What is shown in an electric bill? (Class discussion)
UNDERSTAND	Why is the information in an electric bill important? (Class discussion)
APPLY	Looking at an electric bill, what unit of measurement is used to show how much electricity is used each month? (Class discussion) Answer: Electricity in the home is measured in kilowatt-hours (kWh) consumed on a monthly basis.
ANALYZE	Compare and contrast what months of the year may have high vs. low energy use and discuss why. (Teachers write the months of the year and seasons on the board. Together, teachers and students identify and label possible high and low energy use months and discuss why. Teacher explains that each home uses energy differently and energy use is significantly affected by weather).
EVALUATE	What can you and your family do with the usage history information (13 months of energy use) in the electric bill? (Class discussion)

IV. Guided Practice Ideas

Recommended Item

- **Math Activity** (see below)

Other Resources

Practice that uses math/reading standards:

- **Math Activity:** Calculate how much electricity you, your family, and your class use in a day. **http://teachcoal.org/energy-and-you/wp-content/uploads/2012/11/LessonPlan-HowMuchElectricity.pdf**
- Go to your utility's website and download the last twelve month usage; determine how much each kilowatt-hour used costs (total bill divided by the total number of kilowatt-hours) and explain why each month's kWh usage was different.

V. Independent Practice Ideas

Recommended Items

Personal Practice Worksheets and Answer Keys provided (see below)
Parent or Guardian Interview: Interview Guide provided. (see below)

Other Resources

Personal Practice – Worksheets and Answer Keys provided

- Read an Electric Bill Worksheet and Answer Key provided
- Graphing Monthly Electric Bills Worksheet and Answer Key provided
- Identify ways that a family can reduce energy use in each month and rank those efforts in priority of most effective in reducing the use to least effective in reducing the use. (Student writes these on a piece of paper.)

Practice That May Involve Parents or Guardians

- **At-home Scavenger Hunt**: Students find five things in their home that run on electricity and contribute to the electric bill. List them on a piece of paper. (Ex. Lamp, air conditioner, hair dryer, etc.).
- **Parent or Guardian Interview**: Teachers ask students to interview their parents/guardians on the use of electricity in their home. Interview Guide provided.
- **In-home audit**: Students go online to **www.energyrightsolutions.com**. Click on "Solutions for the Home" then "Energy Saving Tools" in the header bar and listen to the Online Energy Audit video. After listening, student should click on "Do it Yourself Energy Evaluation" and take the online energy audit using his / her home and his / her home's energy usage. Student can print off results of the audit, discuss the results with his/her family or guardian, and list actions his/her family has committed to take based on audit results.

Option

- Write a "Book Report" on your family's electric bill. Teachers instruct students to write a book report on their family's electric bill. It can include characters, setting, main idea, author, etc.

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if grades are desired.

- Read an Electric Bill Worksheet and Answer Key provided
- Graphing Monthly Electric Bills Worksheet and Answer Key provided

VII. Materials Needed

The following materials are needed for the “Recommended Items” in Guided Practice & Independent Practice sections.

- Optional: calculators

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference the Performance Objectives at the top of the Lesson Plan.

Essential Question

What does an electric bill tell us about the use of energy in a home?

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WORKSHEET FOR ENERGY AT HOME LESSON 3.6 NAME: ______________________

Read an Electric Bill

Objective: Students will be able to read and answer real world questions about an electric bill.

ELECTRICITY USAGE

METER NUMBER	BILLING PERIOD		ELAPSED TIME	CURRENT METER READING		PREVIOUS METER READING		KILOWATT HOURS USED
	FROM	TO						
658954	Dec. 13 2012	Feb. 11 2013	2.0 months	(37322 Actual	-	(36370 Actual)	=	952

CURRENT CHARGES AND CREDITS

ENERGY	$98.87
CUSTOMER CHARGE	6.92
AMOUNT DUE ➤	**$105.79**
Due Date	**March 5, 2013**
If Paid After Due Date Balance Due:	$110.73

Energy Management Information

Reading Date	Elapsed Time (Days)	kWh Used	Average Daily kWh	Total kWh Cost ($)
Feb 11, 2013	60	952	16.1	98.87
Dec 13, 2012	57	987	15.7	94.37
Oct 17, 2012	62	1165	18.8	116.30
Aug 16, 2012	61	997	16.1	102.55
Jun 15, 2012	65	1307	20.7	127.91
April 11, 2012	55	1271	21.9	124.97
Feb 15, 2012	67	1311	19.6	128.24
Dec 9, 2011	56	858	15.3	91.18

Note to Student:
Electricity used in your home is measured in kilowatt hours.
Kilowatt-hour is abbreviated as kWh.

1. Approximately how many months did this billing period cover? _________
2. How was the number of kWh determined? ____
3. What was the amount of kWh used in this billing period? ____________
4. What is the total amount of the bill? $_____________
5. What is the cost per kWh in Feb? (hint: Cost/kWh Used) ____________
6. How do you think the amount of the bill was determined?

____

____

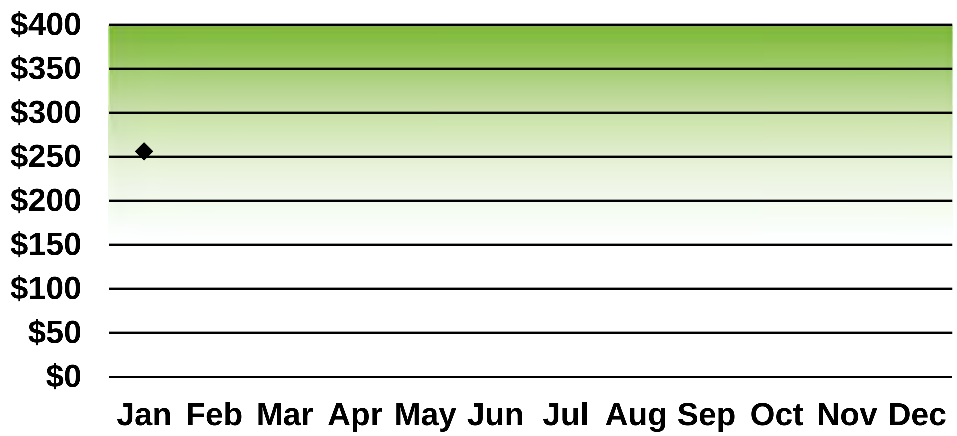
WORKSHEET FOR ENERGY AT HOME LESSON 3.6 **NAME:** ______________________

Graph Monthly Electric Bills

Objective: Students will demonstrate how to plot points to create a line graph representing monthly electric charges.

Monthly Electric Bill Graph ($)

Instructions: Plot the monthly electric bill amount on the graph based on the chart below. Then, connect the points.



Monthly Bill

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
$256	$202	$169	$154	$158	$280	$389	$354	$273	$158	$206	$272

1. **What is the *highest* bill? In what month does it occur?**

   ____

2. **What is the *lowest* bill? In what month does it occur?**

   ____

3. **List two ways to conserve energy in the *summer* months.**

   ____

   ____

4. **List two ways to conserve energy in the *winter* months.**

   ____

   ____

INTERVIEW GUIDE FOR ENERGY AT HOME LESSON 3.6 **NAME:** ______________________

Interview Guide

Instructions: Students interview parents or guardians on their use of electricity in the home.

1. What are some things we do in our family to use electricity more efficiently?

____

____

____

____

2. Do we ever waste electricity by accident?

____

____

____

____

3. Can we improve our energy efficiency? How?

____

____

____

____

Answer Keys

ANSWER KEY FOR WORKSHEET: READ AN ELECTRIC BILL

ELECTRICITY USAGE

METER NUMBER	BILLING PERIOD		ELAPSED TIME	CURRENT METER READING		PREVIOUS METER READING		KILOWATT HOURS USED
	FROM	TO						
658954	Dec. 13 2012	Feb. 11 2013	2.0 months	(37322 Actual	-	(36370 Actual)	=	952

CURRENT CHARGES AND CREDITS

ENERGY $98.87
CUSTOMER CHARGE 6.92

AMOUNT DUE ➤ $105.79

Due Date March 5, 2013

If Paid After Due Date Balance Due: $110.73

Energy Management Information

Reading Date	Elapsed Time (Days)	kWh Used	Average Daily kWh	Total kWh Cost ($)
Feb 11, 2013	60	952	16.1	98.87
Dec 13, 2012	57	987	15.7	94.37
Oct 17, 2012	62	1165	18.8	116.30
Aug 16, 2012	61	997	16.1	102.55
Jun 15, 2012	65	1307	20.7	127.91
April 11, 2012	55	1271	21.9	124.97
Feb 15, 2012	67	1311	19.6	128.24
Dec 9, 2011	56	858	15.3	91.18

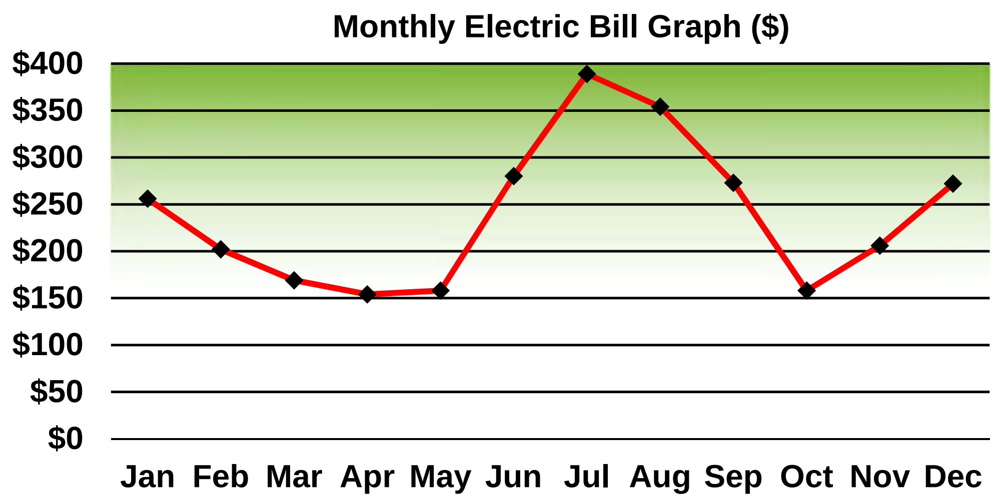
1. Approximately how many months did this billing period cover? 2 months
2. How was the number of kWh determined? Current meter reading minus previous meter reading
3. What was the amount of kWh used in this billing period? 952
4. What is the total amount of the bill? $ 105.79
5. What is the cost per kWh in Feb? (hint: Cost/kWh Used) (98.87 / 952 = 0.103)
6. How do you think the amount of the bill was determined? Energy cost + Customer Charge

ANSWER KEY FOR GRAPHING MONTHLY ELECTRIC BILLS

Graph Monthly Electric Bills

Objective: Students will demonstrate how to plot points to create a line graph representing monthly electric charges.

Instructions: Plot the monthly electric bill amount on the graph based on the chart below. Then, connect the points.



Monthly Bill

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
$256	$202	$169	$154	$158	$280	$389	$354	$273	$158	$206	$272

1. What is the *highest* bill? In what month does it occur?
   $389, July

2. What is the *lowest* bill? In what month does it occur?
   $154, April

3. List two ways to conserve energy in the *summer* months.
   Ex. Turn down A/C during the day when no one is home, plant a tree! Shade trees can help keep a home cooler in the summer

4. List two ways to conserve energy in the *winter* months.
   Ex. Turn down heat during the day when no one is home, use area rugs on hardwood floors to keep feet warm