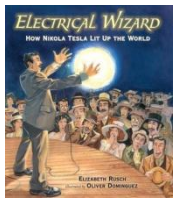
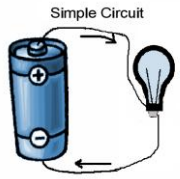
Next Generation Science Standards and Common Core Integrated Instructional Sequence Template

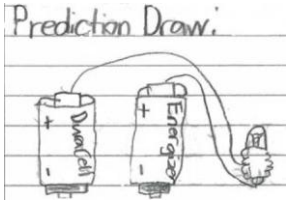
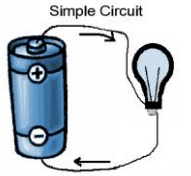
NSTA Outstanding Trade Book 	Electrical Wizard: How Nikola Tesla Lit up the World by Elizabeth Rusch [5]
NGSS Energy Performance Expectation(s) [1] **Common Core Standards** [4]	**4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.** [Assessment Boundary: Assessment does not include quantitative measurements of energy.] .. **CCSS.ELA-Literacy.RI.4.1** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. **CCSS.ELA-Literacy.RI.4.3** Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text. **CCSS.ELA-Literacy.W.4.2** Write informative/explanatory texts to examine a topic and convey ideas and information clearly **CCSS ELA- Literacy W.4.8-** Recall relevant information from experience and gather relevant information from print and digital sources; take notes **CCSS- ELA- Literacy-SL 4.1** –Engage effectively in a range of collaborative discussions (one-on-one, small groups and teacher led) with diverse partners on grade 4btopics and texts, building on others ideas, and expressing their own ideas clearly.
Disciplinary Core Ideas Found in the K-12 Science Framework **ELA Big Idea**	• Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. (4-PS3-2) ▪ Readers and writers use different sources to gather information and write knowledgably about a topic (e.g., summarizing main ideas and conveying complex ideas clearly and accurately).

Science and Engineering Practices	**Practice required to meet the performance expectations:** • Using evidence from observations **Additional Practices used in sequence:** • Constructing Explanations • Obtaining information from multiple sources
Capacities of Literate Individuals	Value Evidence Build on Content Knowledge Respond to Purpose, Audience, and Task
Nature of Science	Scientists ask questions about the world around them. They search for evidence to support the answers to their questions.
Cross-Cutting Concepts	**Energy and Matter**: Energy can be transferred in various ways and between objects. **Cause and Effect:** Cause and effect relationships are routinely identified and used to explain change.
Essential Question (s)	***How is direct current used to transfer energy to produce light?*** ***How did Nikola Tesla explore alternating current as a means of energy transfer?*** ***How did he share this idea with the world?*** ***What scientific characteristics allowed Nikola to carry out his plan?***
Learning Intentions Students will make observations and provide evidence that energy can be moved from place to place by electric currents. Students will diagram and explain how energy can be moved by electric currents in two ways, by direct and alternate currents. Students will respond to questions in writing and by engaging in collaborative discussion. Students will write an informational text in response to the essential question. Students will integrate information and constructing an alarm for a lunch box that will demonstrate their understanding of how energy can be transferred using an electric current and explain how this work is different than Tesla's .	**Assessments:** Science notebooks containing scientific drawings and notes demonstrating how energy is transferred by a direct electric current. Ongoing formative assessment of student written and oral responses occurs. The informational composition responding to the prompt, which addresses the essential question. Teachers evaluate the students' informational composition with a comprehensive rubric. Expectations for this composition should be clearly communicated to students prior to beginning the task. Performance task-See below; supplemental materials

Classroom Environment	It is essential to create a safe classroom climate in which risk taking, confusion, and productive struggle is expected. Students must be comfortable asking for help and learning from their errors or misconceptions.
Teacher Background Information	**Concept Explanation:** A simple circuit consists of three minimum elements that are required to complete a functioning electric circuit: a source of electricity (battery), a path or conductor, on which electricity flows (wire), and an electrical resistor (lamp), which is any device that requires electricity to operate. The illustration below shows a simple circuit, containing one battery, two wires, and a bulb. The flow of electricity is from the high energy (+) terminal of the battery through the bulb (lighting it up), and back to the low energy , the negative (-) terminal, in a continual flow called direct electric current. Notice the current only moves in one direction; that is why it is called direct current.  Energy always flows from high energy to low energy. The trade book: *Electrical Wizard: How Nikola Tesla Lit Up The World*, contains a great deal of general academic vocabulary, as well as domain specific vocabulary. Additionally, the author uses very descriptive and sometimes figurative language. When planning, examine the complex vocabulary closely. Determine which words may require explicit instruction and which may be discerned from contextual analysis. You may teach various terms prior to reading using strategies such as, semantic webbing and morphological analysis. This allows students have a general understanding of important terms upfront, so they may focus cognitive effort to understanding the main ideas during reading. www.textproject.org [6] offers useful strategies for teaching academic language. Reinforce the idea that students should not agonize over every tricky term, while emphasizing the importance of understanding those terms that are essential to understanding the main messages. *Sample academic vocabulary terms to consider for discussion and explicit instruction:* **Illuminated, Generator, turbine, triumph, toiled, unfathomable…** Nikola gazed, mystified, as electrical bolts ricocheted across the sky. (p.1) Enchanted by the sparking halo his hands had conjured… (p.1)
Student Prerequisite Knowledge	• Students should have knowledge about Thomas Edison and his work before the text is introduced. A useful resource for this is *Timeless Thomas: How Edison Changed Our Lives* by Gene Baretta.[3] • Students should have basic knowledge of the concept of energy A popular resource is the book *Energy Makes Things Happen* (Let's-Read-and-Find-Out Science 2) by Kimberly Brubaker Bradley • Students should understand the structure of informational text. Teachers can use mentor texts and modeling, during shared reading and writing experiences, to help students understand this structure.

Possible Student Beliefs and Misconceptions	Students may think of energy as: • having “human-like” characteristics [The thinking might include energy being connected to food, and health] • found only in fuels. • Only as stationary--sitting and waiting to be found and used.

Energy Concept Progression (Appendix E NGSS)				
Disciplinary Core Ideas	K-2	3-5	6-8	9-12
PS3.B ***Transfer and Conservation of Energy***		Moving objects contain energy. The faster the object moves, the more energy it has. **Energy can be moved from place to place by moving objects, or through sound, light, or electrical currents. Energy can be converted from one form to another form.**	Kinetic energy can be distinguished from the various forms of potential energy. Energy changes to and from each type can be tracked through physical or chemical interactions. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter.	The total energy within a system is conserved. Energy transfer within and between systems can be described and predicted in terms of fields or interactions of particles. _____ *Systems move toward stable states.*

Instructional Sequence of Learning Events, and Opportunities	
Day 1-Engage:	
What the Teacher is Doing	**What the Students are Doing**
Assessing Prior Knowledge: Teacher hands out pre-assessment.(30 minutes) **Teacher sets the stage by beginning the lesson with the lights off. Teacher flicks the switch and says,** "where did the light come from? In your science notebook, 1. Explain how you think electricity produced this light. 2. Make a scientific drawing that illustrates your thinking”  3. "When you have finished join the scientists' meeting circle." (30 minutes)	Students complete pre-assessment. Students explain and produce scientific drawings to represent their thinking. Students share their explanations and drawings.
Day 2-Explore: Scientific Investigation	
What the Teacher is Doing	**What Students are Doing**
Teacher sets the stage; **Teacher Says**: “Take a few minutes to explore the following materials: battery, bulb, wire, and bulb holder. As you work with them, I want you thinking about energy. Where is the energy and how does it move. In your notebook, draw a closed circuit, which will light a bulb." *Teacher asks probing questions and provides support when necessary:* What does a battery do? What have you tried? Have you tried it another way?  **Help Students understand the Concept:** A simple circuit consists of three minimum elements that are required to complete a functioning electric circuit: a source of electricity (battery), a path or conductor, on which electricity flows (wire), and an electrical resistor (lamp), which is any device that requires electricity to operate. The illustration below shows a simple circuit, containing one battery, two wires, and a bulb. The flow of electricity is from the high energy (+) terminal of the battery through the bulb (lighting it up), and back to the low energy , the negative (-) terminal, in a continual flow called direct electric current. Notice the current only moves in one direction; that is why it is called direct current. Energy always flows from high energy to low energy. (30 minutes)	Students manipulate the materials provided to attempt to light the bulb. Students keep track of manipulations in their science notebooks. Students record a short written explanation of direct current and produce an accompanying scientific drawing that illustrates the concept. Students engage in collaborative discussion to create a Venn Diagram that compares the similarities and differences between DC and AC.

Introduce the informational text. Read the *Scientific Notes*: *The Difference Between AC and DC"* section, located in the back of the book: Electrical Wizard: How Nikola Tesla Lit up the World by Elizabeth Rusch. This piece helps students build upon their knowledge about direct currents by exploring alternating current as an alternate method of transferring energy. **View the video:** http://www.diffen.com/difference/Alternating_Current_vs_Direct_Current#Video_comparing_Alternating_and_Direct_Current 3 minutes [2] Teacher asks for a response to the following task: **Teacher says: "**Reread the *Scientific Notes*: *The Difference Between AC and DC"* section. Use this information, along with the information you gained from the video, to diagram and explain the difference between direct and alternating current." [*In a direct current, energy flows in only one direction. In an alternating current, electricity flows back and forth in reversing direction. The voltage of direct current is not changed as it travels. Alternating current voltage can be transformed so that it can travel hundreds of miles. Alternating current allows energy to be used more efficiently.]* (30 minutes)	Students compose a written explanation, accompanied by a scientific drawing, that explains how direct and alternating currents operate. **Formative Assessment/Exit Ticket**: Return to the question, "where did the light come from? Now that you have built upon your previous knowledge, revise your response in your science notebooks. (homework)??

Day 3-5 Explain: Incorporating the Text	
What the Teacher is Doing	**What Students are Doing**
Set purpose for reading: **Teacher says,** "*this text will help us understand more about how electricity was discovered and shared with the world. Listen to find out how Nikola Tesla demonstrated his ideas about electricity to the world."* **Teacher says,** *"as we read, keep a tally of all of the examples of energy transfer."* Teacher reads story aloud to students uninterrupted.	Students keep tally marks for each instance on a whiteboard or paper.

Returning to the Text: What the Teacher and Students are Doing

In this section, teacher and students return to various sections of the text for multiple purposes, responding to text-dependent questions that help students tackle the essential questions.

Teacher says, *"Now we are going to perform a deeper analysis of the text, reading carefully to examine how Nikola Tesla explore alternating current as a means of energy transfer and shared this idea with the world? We will also explore the specific scientific characteristics that allowed Nikola to carry out his plan."*

This sequence follows a question, discussion, written response format:

Question: Teacher poses text-based question. Student (or teacher) rereads appropriate section of the text to locate evidence for response. Students have questions in their science notebooks.

Discussion*:* Students discuss possible responses to questions either in whole group or small group setting. They are collectively building knowledge. Teacher offers appropriate amount of scaffolding, using think aloud and modeling in whole group setting, and monitoring progress, probing and prompting as needed small group setting. **Note about Teacher Input:** *Use discretion in how students discuss and respond to the text-based questions. You may need to provide more scaffolding for some questions, for example, you may choose a whole group discussion format, using a think aloud process to demonstrate how to return to the text and think about the response to a question. Then, students can record their written response independently. Alternatively, in a small group discussion format, you may have students return to a particular section of the text independently to discuss the question in small groups and write their own independent responses. Judge which method is suitable based on the complexity of the question and the content.*

Written Response*:* Students respond independently in writing to the question.

Repeat this process with the entire series of text-based questions. The purpose of this series of questions is to scaffold student learning and prepare them to respond to the final written prompt. You can use this sequence to address student questions that arise as well.

<u>Possible Text-Based Questions for Student Response and Discussion:</u>
These are some examples of possible questions that scaffold student understanding of the enduring understanding/essential questions. Page numbers are provided as a scaffold for helping students locate relevant information. You may add to, omit, or adjust the list as you see fit, based on your students' needs and what happens during various transactions.

What does the author mean when she states: "Enchanted by the sparking halo his hands had conjured, Nikola wondered what other magic he could perform"(p.1) *[craft and structure]*

Nikola was amazed at the idea of him being able to produce electricity. *See scientific notes section: What happened to Macak the Cat?*

How did Nikola explore the invisible energy he discovered when he was a young boy? *[key details]*

He examined energy in nature including flowing water, flying insects and he imagined and experimented with the various forms of energy (p. 2-3)

Based on the context of the text, what is a prophecy? What did Nikola mean by "turn the power of Niagara Falls into electricity"? *[craft and structure]*

A prophecy is a view into the future, a vision of what could be accomplished. Nikola wanted to use the energy from flowing water and convert it to electricity. (p. 1-3) *[key details]*

Scientists ask questions about the world around them and search for evidence to support the answers to their questions. Use specific evidence from the text to explain how Nikola demonstrated these characteristics. *[Integrating Information]*

Enchanted by the sparking halo his hands had conjured, Nikola wondered what other magic he could perform. (p.1)
Nikola had an idea…(p.2)
He imagined giant waterwheels, pummeled by Niagara's pounding waters, spinning endlessly. (p.3)
Inspiration flashed. (p.5)
He invented a loudspeaker for phones and imagined electrical current that surged back and forth, back and forth. (p.7)
The buzzing thoughts inside Nikola's head sparked together like a lightning bolt. (p.9)
Over the next few months, Nikola conjured in his head all the parts of a new electrical system based on alternating current. (p.10)
He couldn't shake from his mind the picture of Niagara's pounding water rotating huge wheels, which would spin huge magnets, generating electricity for thousands of homes. (p.25)

Why did Nikola believe that harnessing alternating current a better option than relying on direct current to power the world? *[key details]*

It would be simpler and eliminate the sparking (p.5)
It could travel great distances more cheaply and efficiently than direct current. (p. 10)

Why did the professor suggest that Nikola would not accomplish the task of harnessing the power of electric current?

Many people have tried and failed. (p.5) *[key details]*

How did Nikola carry out his plan to share his idea of alternating current with the world? *[Integrating Information]*

He imagined electrical current surging back and forth as he:
He took a job examining telephone poles (p. 6)
He invented a loudspeaker for phones (p.7)
He worked on electrical devices designed by Thomas Edison (p.7)
He pictured everything in his mind (p.10)
He explained his idea to Thomas Edison (p.13)
He tried to raise money for his work by appealing to bankers and businessmen (p.14)
He raised enough money to build AC generators and motors.

He tested his ideas to confirm his predictions (p.17)
He illuminated the Chicago World's Fair. (p.21)
Nikola's miraculous inventions at Niagara soon electrified the trolleys, subways, and great buildings of New York City—even the blinding lights of Broadway. Not long after, electricity spread to homes and businesses across America. Eventually, Nikola Tesla's electrical wizardry illuminated the world. (p. 28)

Why does the author use terms such as "it was a miracle," and "it was like magic" to describe the sight at the Chicago World's Fair? What does this tell you about Nikola's work? *[key ideas and details; Inference connected to text]*
This was the first time the world had seen such a sight (p. 21)
One could infer that Nikola's work was fascinating, innovative, and exciting.

How did Nikola eventually fulfill his childhood prophecy? *[key ideas and details]*
Nikola applied his boyhood idea of the spinning wheel in the stream creating "invisible energy" (p. 2)
Nikola planned for two years to turn his vision of spinning wheels into a gigantic electrical project. His wooden wheel vision became the reality of turbines and generators. (p. 25-26)

How does the author use descriptive language to convince you that Nikola was a determined and imaginative individual? *[craft and structure; integrating information]*
He imagined giant waterwheels, pummeled by Niagara's pounding waters, spinning endlessly.
Nikola gazed, mystified, as electrical bolts ricocheted across the sky. (p.1)
Enchanted by the sparking halo his hands had conjured… (p.1)
Nikola made a prophecy: Someday, I will turn the power of Niagara Falls into electricity. (p.3)
A few days later, certainty washed over Nikola. He would find a way to harness the power of alternating current. (p.5)
The problem of alternating current hummed in Nikola's mind. (p.6)
He invented a loudspeaker for phones and imagined electrical current that surged back and forth, back and forth. (p. 7)
The buzzing thoughts inside Nikola's head sparked together like a lightning bolt. (p. 9)
Over the next few months, Nikola conjured in his head all the parts of a new electrical system based on alternating current. Night and day, Nikola pictured the machines, designing, testing, and fixing problems he saw. He didn't have to write anything down. He could see it all in his mind (p.10)

In the last line of the story, the author states, "And it all started with a spark". Look up the multiple meanings of the term spark in the dictionary. How does the term *spark* describe both the events and Nikola's character? *[craft and structure; key ideas and details]*
Spark describes the activity of conducting electricity and it also describes the ideas Nikola conjured in his mind.

- ***Day 5-Teacher explains:*** Now you are going to write about what you have learned. You will combine the knowledge gained from our observations and reading to write a piece of informational text. In your composition, you will answer these questions: How is direct current used to transfer energy to produce light? How did Nikola Tesla explore alternating current, as a means of energy transfer, and share this idea with the world? What scientific characteristics allowed Nikola to carry out his plan?

Students will organize notes to compose their final written composition.
Scaffold this task using an appropriate process and/or graphic organizer.

Suggested method for organization:. Have students organize notes for 2 paragraphs. The first paragraph will contain information related to the first essential question and the explore task. The second paragraph will contain information related to the second and third essential question, based on responses to text-based questions. Students will independently compose these 2 body paragraphs. Use a shared writing experience to assist students in composing the introduction and concluding paragraphs for their informative/explanatory written composition. Students will combine their body paragraphs with the introduction and conclusion to complete the composition.

Elaborate:

What Students are Doing	What the Teacher is Doing
What's Buzzing?	Performance Task "What's Buzzing?" The purpose of the performance task is the application of what students have learned in both language arts and science. This particular task includes an element of design.

Evaluate

Use appropriate rubric to evaluate:
Science Notebook illustrations, Written Composition
Performance Task: Students are asked to design & build an alarm that will demonstrate their understandings of circuits and electricity, the transfer and transformation of energy. Understanding of these concepts can also be found in the scientific drawings as well as the student responses to this question, *How is energy transferred and transformed in your alarm design?*

References

[1]4-PS-3 Energy. (2012). Retrieved March 21, 2014, from Next Generation Science Standards website.
[2] *AC vs. DC (Alternating Current VS Direct Current* [Video file]. (n.d.).
[3] Baretta, G. (2012). *Timeless Thomas: How Thomas Edison Changed Our Lives*. Henry Holt & Co.
[4] English Language Arts Standards. (2014). Retrieved from 2014 Common Core Initiative.
[5] Rusch, E. (2013). *Electrical Wizard: How Nikola Tesla Lit the World*. Somerville, MA: Candlewick; 8.11.2013.
[6] The Text Project. (2000). Retrieved 2014, from The Text Project website.

Created by: Kathy Renfrew, Elementary Science Assessment Coordinator and Lori Dolezal, Elementary Literacy Coordinator