STEM Curriculum Planning Guide

This instructional design guide serves as the template for the design and development of STEM units of instruction at the Dayton Regional STEM Center in Dayton, Ohio. The guide is anchored to the *STEM Education Quality Framework* also developed at the Dayton Regional STEM Center.

STEM Unit Title	**Room Defender**
Economic Cluster	Power & Propulsion, Sensors
Targeted Grades	3 and 4
STEM Disciplines	Science, Technology, Engineering and Mathematics
Non-STEM Disciplines	Social Studies and English Language Arts

Section I: STEM Unit Overview

Unit Overview

In this unit, students will be exploring electricity by creating a circuit that is capable of performing multiple functions independently and will market their created product. Electricity is an essential tool for modern living, and a basic understanding of circuits can empower your students. The study of electricity can lead to a better understanding of the transfer of energy from one form to another. Concepts of electrical engineering will guide students throughout their inquiry and design challenge. Students will then write persuasive presentations to gain support for their product from "experts" in a "Shark Tank" format.

Essential Question

How can people use electrical energy to solve a problem?
How can energy be transferred from one form to another?
How do circuits complete a pathway to produce light, heat or sound?

Enduring Understanding

Energy can be transformed from one form to another and can be transferred from one location to another.
Math can be used to help make economic decisions.
People use the engineering design process to help create new technologies.

Engineering Design Challenge

Many students have younger, pesky siblings that they want to keep out of their personal space and belongings. This has become a dilemma for many siblings. They cannot always be there to keep an eye on their room or belongings. The challenge is to create an alarm for a bedroom door that will alert the owner that a sibling has breached the area. The alarm will be created with a circuit and a switch that will create a sound and visual alert so that the owner will know when an intruder has entered. This will help ensure privacy! Then, each team of entrepreneurs will market their alarm system in a “shark tank” environment to persuade the investors to finance their idea.

Time and Activity Overview

Day	Time Allotment	Actvities
1	45-50 minutes	Pre-test, introduce the unit, discuss economics concepts
2	45-50 minutes	Exploring Energy
3	60 minutes	Exploring Energy Transformations
4	45-50 minutes	Exploring Circuits
5	45-50 minutes	Explore open and closed circuits, learn to diagram a circuit
6	45-50 minutes	Explain the flow of energy in a circuit
7	45-50 minutes	Explore conductors and insulators
8	45-50 minutes	Create parallel circuits, compare parallel and series circuits
9	45-50 minutes	Explore different types of switches
10	3 class periods; 45-50 minutes each	Create alarm circuits within works of art, learn and follow the engineering design process

11	45-50 minutes	Discuss persuasive writing and presentations, begin working on Shark Tank presentations
12	45-50 minutes	Polish and rehearse Shark Tank presentations
13	60 minutes	Final presentations, post-test

Academic Content Standards

Pre-requisite Knowledge & Skill	Students need to understand how to add and subtract with money. They need to know how to measure to the nearest quarter inch. Students need to be able to multiply or use repeated addition to find a total. Students need to know about author's purpose (informative and persuasive writing). Students need to know how to write a paragraph with a topic sentence, proper capitalization and punctuation. Students need to know that they should not use electricity around water.

Add Standard	**Mathematics** 
Grade/Conceptual Category	3
Domain	Number and Operations in Base Ten
Cluster	Use place value understanding and properties of operations to perform multi-digit arithmetic.
Standards	Use place value understanding to round whole numbers to the nearest 10 or 100. Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction. Multiply one-digit whole numbers by multiples of 10 in the range 10–90 (e.g., 9 × 80, 5 × 60) using strategies based on place value and properties of operations.

Add Standard	**Mathematics** 
Grade/Conceptual Category	4
Domain	Number and Operations in Base Ten
Cluster	Use place value understanding and properties of operations to perform multi-digit arithmetic.
Standards	Fluently add and subtract multi-digit whole numbers using the standard algorithm. Multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers, using strategies based on place value and the properties of operations. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models. Find whole-number quotients and remainders with up to four-digit dividends and one-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.

Add Standard	English Language Arts	
Grade	3	
Strand	Writing	
Topic	Production and Distribution of Writing	
Standard	With guidance and support from adults, produce writing in which the development and organization are appropriate to task and purpose.	

Add Standard	English Language Arts	
Grade	3	
Strand	Speaking and Listening	
Topic	Comprehension and Collaboration	
Standard	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly.	

Add Standard	English Language Arts	
Grade	3	
Strand	Speaking and Listening	
Topic	Presentation of Knowledge and Ideas	
Standard	Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.	

Add Standard	English Language Arts	
Grade	4	
Strand	Informational Text	
Topic	Integration of Knowledge and Ideas	
Standard	Explain how an author uses reasons and evidence to support particular points in a text.	

Add Standard	English Language Arts	
Grade	4	
Strand	Writing	
Topic	Production and Distribution of Writing	
Standard	Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.	

Add Standard	English Language Arts	
Grade	4	
Strand	Speaking and Listening	
Topic	Comprehension and Collaboration	
Standard	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.	

Add Standard	English Language Arts	
Grade	4	
Strand	Speaking and Listening	
Topic	Presentation of Knowledge and Ideas	
Standard	Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.	

Add Standard	Social Studies	Ohio
Grade	3	
Theme	Communities: Past and Present, Near and Far	
Strand (pk-8 only)	Economics	
Topic	Financial Literacy	
Content Standard	Making decisions involves weighing costs and benefits. A budget is a plan to help people make personal economic decisions for the present and future and to become more financially responsible.	

Add Standard	Social Studies	Ohio
Grade	3	
Theme	Communities: Past and Present, Near and Far	
Strand (pk-8 only)	Economics	
Topic	Production and Consumption	
Content Standard	A consumer is a person whose wants are satisfied by using goods and services. A producer makes goods and/or provides services.	

Add Standard	Social Studies	Ohio
Grade	3	
Theme	Communities: Past and Present, Near and Far	
Strand (pk-8 only)	Economics	
Topic	Markets	
Content Standard	A market is where buyers and sellers exchange goods and services.	

Add Standard	Social Studies	Ohio
Grade	4	
Theme	Ohio in the United States	
Strand (pk-8 only)	Economics	
Topic	Production and Consumption	
Content Standard	Entrepreneurs organize productive resources and take risks to make a profit and compete with other producers.	

Add Standard	Science	Ohio
Grade	3	
Theme	Interconnections Within Systems	
Topic	Matter and Forms of Energy	
Content Standard	Heat, electrical energy, light, sound and magnetic energy are forms of energy. --There are many different forms of energy. Energy is the ability to cause motion or create change.	

Add Standard	Science	Ohio
Grade	4	
Theme	Interconnections Within Systems	
Topic	Electricity, Heat and Matter	
Content Standard	Energy can be transformed from one form to another or can be transferred from one location to another. --Electric circuits require a complete loop of conducting materials through which an electrical energy can be transferred. --Electrical energy in circuits can be transformed to other forms of energy, including light, heat, sound and motion.	

Add Standard	Science	Ohio
Strand		
Course Content		
Content Elaboration		

Add Standard	Fine Arts	Ohio
Enduring Understanding		
Progress Points		
Grade Level		
Content Statement		

Assessment Plan

What evidence will show that students have acquired the enduring understandings for this STEM unit?

Performance Task, Projects	Engineering Design Challenge Rubric Shark Tank Presentation Rubric
Quizzes, Tests, Academic Prompts	Pre-Test Post-Test Exit Slips
Other Evidence (e.g. observations, work samples, student artifacts, etc.)	Peer-Evaluation Worksheets Notebooks
Student Self- Assessment	Self-Evaluation

Technology Integration

ADISC Technology Integration Model*

	Type of Integration	Application(s) in this STEM Unit
A	Technology tools and resources that support students and teachers in ***adjusting, adapting, or augmenting*** teaching and learning to meet the needs of individual learners or groups of learners.	Text-to-speech features in word processing Calculators Document camera Interactive whiteboard (if available)
D	Technology tools and resources that support students and teachers in ***dealing effectively with data***, including data management, manipulation, and display.	Calculators Spreadsheets Rulers
I	Technology tools and resources that support students and teachers in conducting ***inquiry***, including the effective use of Internet research methods.	Internet Crank flashlights Faraday flashlights Electrical toys Interactive whiteboard (if available)
S	Technology tools and resources that support students and teachers in ***simulating*** real world phenomena including the modeling of physical, social, economic, and mathematical relationships.	Student-created alarm systems Online simulations
C	Technology tools and resources that support students and teachers in ***communicating and collaborating*** including the effective use of multimedia tools and online collaboration.	Video cameras/video phones Google slides Interactive whiteboard (if available)
	**The ADISC Model was developed by James Rowley PhD, Executive Director of the Institute for Technology-Enhanced Learning at the University of Dayton*	

Career Connections

Career Description

Engineer
Engineers apply mathematical and scientific knowledge and skills to design and create things that people use. This includes designing, fabricating, and testing machines, structures, and materials used in everyday life. There are many fields of engineering.

Electrical Engineer
Electrical Engineers study electricity and electromagnetism and their application for practical purposes. They deal with designing, and building of electrical systems and equipment. Electrical engineers study various subfields, which include electronic engineering, computer engineering, power engineering, and telecommunications engineering.

Electronic Engineer
Electronic engineering is a subfield of electrical engineering. Electronic engineers develop, and manufacture electronic circuits and devices such as television sets, audio systems, computers, GPS devices, miniature voice recorders, and even various controllers in automobiles.

Sales Engineer
Sales engineers sell technological products or services to businesses. They must have knowledge of the products' parts and functions and must understand the scientific principles that make these products work.

Scientist
Scientists try to understand, explain, and predict the way that everything in the world behaves or acts.

Chemist
Chemist study matter, which is anything that has mass and takes up space. The field of chemistry has applications in many aspect of daily life including medicine, automobiles, energy resources, building materials, clothing, and aerospace research.

Data Scientist
A data scientist must be competent in mathematics, statistics, and computer science. The primary goal of this discipline is to use patterns in historical data in order to develop solutions that further an organization's goals.

Economists
Economists use mathematics to study the production and distribution of resources, goods, and services. They research and analyze data using various software programs, including spreadsheets, statistical analysis, and database management programs.

Section II: STEM Lesson Plan

Title of Lesson

Lesson 1: Becoming an Entrepreneur

Time Required

45-50 minutes

Materials

Appendix A: Pretest / Post-Test (1 per student)
Appendix C: Engineering Design Challenge Introduction Letter (1 per student)
Appendix D: Engineering Design Challenge Guidelines (1 per student)
Appendix E: Interactive Notebook and Exit Slips (1 per student)
Video: "Goods and Services Economics Social Studies" (4m20s): https://www.youtube.com/watch?v=MlkoZfzlfxo
Video: "Cha-Ching: Entrepreneur" (3m0s): https://www.youtube.com/watch?v=IJXBet--kvg
Optional "Goods and Services" printable task cards:
http://www.proteacher.net/discussions/showthread.php?t=255293
Computer and projector
Science Notebook
Post-it notes (4 per team)

Objectives

Students will learn about designing an alarm for their bedroom door. They will also learn about consumers, producers, entrepreneurship, profit and loss.

Learning Target: I can define and describe consumers, producers, entrepreneurs, profit and loss.

Instructional Process

Lesson Preparation:
1. Make copies of printable resources for this lesson.
2. Plan for students to work in diversely grouped teams of 3-4. Decide if these teams will be consistent throughout the unit or whether to use flexible grouping in order to create differentiated groups for the final design challenge.
3. Make an anchor T-chart for Consumer and Producers. On one side write and define Consumer. (A consumer is a person or business that buys or uses good and services). On the other side of the chart, write and define Producer. (A producer is a person or business that makes or provides good and services).

Lesson Delivery:
1. Administer Pretest, Appendix A. Allow approximately 20 minutes to complete the test. Explain to students that they most likely not know the answers to all of the questions, but they should try their best.
2. Introduce the unit by distributing copies of Appendix C: Engineering Design Challenge Introduction Letter and Appendix D: Engineering Design Challenge Guidelines. Allow students to read these or read them to the class.
3. Pull up the Consumer and Producer T-Chart on chart paper. Discuss the words and the definitions with the students.
4. Have a class discussion and write down examples under each category of consumer and producer. (You may ask the following questions to help guide students.)
   Consumer Questions:
   -How many of you have bought something from a store before?
   -What roles do you play at your school or in your community? (student council, girl/boy scouts, church group)
   -What are some goods and services you or your family use? (food, clothes, books, school supplies, etc.)
   -What other goods and services do you and your parents consume? [Cars, furniture, shoes, toys, etc.]
   Producer Questions:
   -What goods and services do you provide your family? [Wash dishes, weed garden, sweep sidewalk, make bed, feed pet, do homework, etc.]
   -Some children get paid for complete their chores. Do you have chores that you get paid to do?

5. Show the "Goods and Services Economics Social Studies" (4m20s): https://www.youtube.com/watch?v=MlkoZfzlfxo. Add any other ideas or thoughts on the Consumer and Producer Anchor T-Chart.
6. Put students into their teams and hand out 4 post-it notes. Have each team use a separate post-it note for each example: 2 for consumer and 2 for producer. Stick the notes on the anchor chart. Give about 5 minutes to allow students time for discussion and to decide placements on the chart. Alternatively, you could give each team a producer and consumer sorting activity for more practice.
7. Introduce the Interactive Notebook and instruct students will make their own T-chart in their notebooks and jot down a few ideas under the producer and consumer columns.
8. If students need more practice or you want to add to a center station, you can print and laminate the "Goods and Services" printable task cards: http://www.proteacher.net/discussions/showthread.php?t=255293.
9. Distribute copies of Appendix C: Engineering Design Challenge Introduction Letter and explain that each student is going to become an alarm system entrepreneur. There are several terms the students will most likely not know.
10. Explain that an "entrepreneur" is someone who starts and develops a business. The entrepreneur generally takes on some financial and career risk in beginning the business, but can also reap the rewards if the business is ultimately successful. Have students share what they think are the risks that an entrepreneur takes in making a new product (people will not like it, people will not buy it, the entrepreneur may lose money).
11. Discuss that anyone can become an entrepreneur and most have several important qualities to make them successful (hard working, risk-taking, innovative, willing to fail, leadership and competitiveness).
12. Show Video: "Cha-Ching: Entrepreneur" (3m0s): https://www.youtube.com/watch?v=IJXBet--kvg. The video will discuss what an entrepreneur is, as well as profits and losses.
13. Discuss the terms profit (making money) and loss (losing money). Make a list of things that the students could do to make money around the house. Also discuss things that might lose money for the students (such as breaking something and paying to replace it). Have students turn to their partner and share their ideas while you listen to collaborative discussions.
14. Check the students' T-charts in their Notebooks as an exit ticket to close the lesson.

Differentiation

Heterogeneous teams allow for differentiation
Pre-Test should be modified/accommodated to meet the needs of the individual students

Assessments

Pretest
Teacher observation
T-charts in students' notebooks

Section II: STEM Lesson Plan

Title of Lesson

Lesson 2: Energy Investigation

Time Required

45-50 minutes

Materials

Appendix E: Interactive Notebook and Exit Slips:
-Energy Lab Investigation Sheet and Exit Slip (1 per student)
Chart paper (one per class)
Optional "Forms of Energy Sort" free download:
https://www.teacherspayteachers.com/Product/Forms-of-Energy-Sort-925277 (1 per student or team)
Example of a "Froms of Energy" anchor chart if needed: http://bit.ly/energychart
Optional "Energy" review resources: http://www.eschooltoday.com/energy/kinds-of-energy/all-about-energy.html

Gather common items that relate to each of the different types of energy such as these items. Gather approximately 5 items per station. Suggestions below:
Light Energy suggestions: light bulbs, flash light, candle, picture of sun and fire
Sound Energy suggestions: musical instruments, radio, bells
Heat Energy suggestions: picture of fire, hair dryer, toaster, microwave, picture of sun and fire, pan boiling
Electrical Energy suggestions: light socket picture, battery, motor, flashlight
Magnetic Energy suggestions: different types of magnets

Objectives

Students will define energy and be able to provide examples of the different types of energy and forms.

Learning Target: I can define energy and give examples of the different types of energy and forms.

Instructional Process

Lesson Preparation:
1. Prepare the lab sheet and exit ticket if not using the printed Interactive Notebook.
2. Create 5 stations around the classroom, placing items that use the same type of energy in each station (light, sound, heat/thermal, electrical and magnetic). Do not label the types of energy represented.
   For Example:
   Station 1 (light energy)—lightbulbs, flashlight, candle, picture of sun and fire
   Station 2 (sound energy)—musical instrument, radio, bells
   Station 3 (heat/thermal energy)—fire, hair dryer, toaster, microwave, picture of sun and fire, pan boiling
   Station 4 (electrical energy)—light socket picture, battery
   Station 5 (magnetic energy)—different types of magnets

Lesson Delivery:
1. Define energy: Energy is the ability to cause motion or create change. There are two categories of energy: Potential (stored energy) and Kinetic (energy of motion). All forms of energy fall under one of these two categories.
2. Make an anchor chart on chart paper for the basic types of energy: Light, sound, heat/thermal, electrical and magnetic. The chart will have six rows with three columns. Refer to the example of a "Forms of Energy" anchor chart if needed: http://bit.ly/energychart, or optional "Energy" review resources: http://www.eschooltoday.com/energy/kinds-of-energy/all-about-energy.html
3. Distribute the Energy Lab Investigation Sheet and Exit Slip handout. In teams, have students rotate to each energy station. Explain that they will have approximately 4 minutes to list all of the items that they see on the table, decide what type of energy is being represented by examining the items on the table and discuss why they think it is the specific type of energy.
4. Have students return to their seats with their teams. Review each station. As a class, discuss what type of energy it is and how it is used. Complete the class energy chart. The students could add information into

their science notebooks at this time about each different type of energy and an example of each.

5. For independent practice, have students can complete the optional "Forms of Energy Sort" free download: https://www.teacherspayteachers.com/Product/Forms-of-Energy-Sort-925277 Show a picture of a type of energy and have the students write the type of energy.
6. In the science notebook, have students complete the Exit Slip section of Energy Lab Investigation Sheet and Exit Slip handout.

Differentiation

Higher-Level Thinking: Ask students to pick one item from today's lab and identify three different types of energy that the item could produce or be listed under. The student will justify their answer.

Assessments

Exit ticket
Science notebooks

Section II: STEM Lesson Plan

Title of Lesson

Lesson 3: Energy Types and Transformations

Time Required

60 minutes

Materials

Science Notebooks
Appendix E: Interactive Notebook and Exit Slips:
-Energy Transformations Exit Slip
Appendix F: Energy Transformation Cards (One for each station, depending on amount of items brought in)
Video: "How do energy convert? - Studi Physics" (2m41s): https://www.youtube.com/watch?v=ftj23FRS2LI

Household Items that display the different types of energy transformations. A few items to consider:
Fan
Battery
Banana
Flashlight
Radio
Guitar or musical instrument
Candle
Glow sticks
Hand warmers
Balloon
Yo-yo
Wind-up car
Rubbing your hands together
Rubber bands
Telephone
Vacuum cleaner (or picture)
Toaster (or picture)
Blender (or picture)
TV (or picture)

Objectives

Students will examine the different types of energy and explain how they transform.
Learning Target: I can examine and explain how energy transforms.

Instructional Process

Lesson Preparation:
1. Place the objects in different areas in the classroom
2. Place the Energy Transformations Cards at each station

Lesson Delivery:
1. In the students' science notebooks, have students title the top of a page "Energy Transformations." Create a T-Chart by labeling the left side: "Object" and on the right side: "Energy Produced." Watch Video: "How do energy convert? - Studi Physics" (2m41s): https://www.youtube.com/watch?v=ftj23FRS2LI. Hold a discussion about how items can produce different types of energy and also more than one type of energy.
2. Place student teams in different areas of the classroom along with the different objects that display energy transformation.
3. Give each team approximately 3-4 minutes at each station. Have them list the object(s) (on the left side). Then, as a team discuss and record all the ways the object produces energy (list the energy on the right side). Appendix F: Energy Transformation Cards may be used to help show the different types of energy.

4. After all of the students have been to every station, gather all of the students back together.
5. While the students have their science notebooks open and in front of them, discuss each item that the class visited and list all of the types of energy on the board or chart paper. If a student wrote that type of energy, they may circle the energy. (could make it a game to see who could think of the most after all of the items have been discussed)
6. Have students complete the Energy Transformations Exit Slip handout.

Differentiation

Higher-Level Thinking: Ask students to pick one item from today's lab and identify as many types of energy transformations as possible and give evidence.

Assessments

Energy Transformations Exit Slip
Check science notebooks

Section II: STEM Lesson Plan

Title of Lesson

Lesson 4: Explore Circuits

Time Required

45-50 minutes

Materials

Appendix E: Interactive Notebook and Exit Slips:
-Exploring Circuits Exit Ticket (one per student)
-Lab Sheet: Creating Circuits Trial Log (one per student)
Appendix G: Discussion & Challenge Activity Checklist (1 copy for teacher)
Video: "Schoolhouse Rock: Electricity, Electricity" (3m5s): https://www.youtube.com/watch?v=Y-k3yQe0O8w

1-gallon sized bag of circuit materials (One per pair of students or team) to include:
4 -6 Wires
1 Light bulb
1 Battery
1 Socket/Light Bulb Holder
Switches (optional)
Buzzers (optional)
Motors (optional)

Electrical tape 2-3 in. per pair of students
Chart paper
2 colors of post-it notes
Glue sticks
Interactive Notebook pages
Access to Internet & projector for video

Objectives

Students will be able to describe the parts of a circuit, and how they create a closed circuit.
Students will be able to explain why and how multiple paths make a complete circuit in a class discussion.

Instructional Process

1. As a hook into the first electricity lesson, begin class by playing the Video: "Schoolhouse Rock: Electricity, Electricity" (3m5s): https://www.youtube.com/watch?v=Y-k3yQe0O8w .
2. Explain and write today's objective on the board that the focus for the lesson is identifying parts of a circuit and explain how to create a complete circuit.
3. Distribute the Exploring Circuits Exit Ticket graphic organizer to each student. Pass out a bag of circuit materials per pair or team of students. Direct students to not touch the materials until instructed.
4. Ask students to think about the parts that they see on the table. Have students write down what they already know about these materials and what they are wondering about these materials on their graphic organizer.
5. Have each pair or team to share their thoughts that they jotted down with their partners, and then spend a couple minutes sharing those discussions as a whole class.
6. Ask the students to try to use the circuit parts to get the light bulb to light. Pass out the Lab Sheet: Creating Circuits Trial Log handout for students to place in their interactive notebooks. Explain to students how to document their efforts utilizing this sheet to keep track of their successful and unsuccessful trials.
7. Allow students time to work with the materials to get the light bulb to light. Before students begin, please caution them of possible short circuits. Instruct them to be careful if they notice the battery(s) getting warm to the touch. Short circuits can result in burns, smoke, or fire.
8. After some time, teams of students will be successful and sharing amongst teams can occur. You should see different ways in which teams have lit the bulb. If students have extra time, and have easily found a way to light the light bulb, you can give them a new challenge to light it a different way or add buzzers and motors into their current design.

9. After some time, stop students. Have a t-chart on the chart paper with one side labeled “Did Not Work” and the other side “Did Work”. Pass out two different colors of post-it notes to each group. On one color, have students write or draw a way in which the circuit did not work. On the other color, have students write or draw a way in which the circuit did work. Have teams place their post-it notes on the correct side of the chart paper.
10. Have teams explain their designs to the class, and what worked and did not work. The chart paper could be used as a guide to facilitate discussion. Use questions like “How did you get the light bulb to light? Why do you think the light bulb lit? What similarities do you see in how the light bulb lit versus when it did not light? What do you think is the key to getting the light bulb to light?”
11. Have students place all of their circuit materials back into the bags. Explain to students to first read their comments from before the lesson on each side of the graphic organizer. Ask students to add comments about what they learned from the lesson on the know side, and write their new questions on the wonder side. Have them place a check mark next to any comments that they had answered on the wonder side of the exit slip. Have students add these to their notebooks if not already included.

Differentiation

For higher learners or quick finishers, give them a challenge to find multiple ways, or paths, to light a light bulb. Also, give students buzzers and/or motors to have them discover ways in which to use them in a circuit.

Allow students to use both pictures and words in their interactive notebook activities and exit slips to reach more modes of learning.

Consider pulling a group of students together to facilitate learning by asking guided questions throughout the challenge activity if students are struggling or becoming frustrated with getting the light bulb to light accurately.

Assessments

Use Appendix G: Discussion & Challenge Activity Checklist (a checklist tool to assist in formatively assessing students during the challenge activity and discussion)
Exploring Circuits Exit Ticket
Lab Sheet: Creating Circuits Trial Log

Section II: STEM Lesson Plan

Title of Lesson

Lesson 5: Explore Circuit Diagrams

Time Required

45-50 minutes

Materials

Appendix E: Interactive Notebook and Exit Slips:
-Can You Build These Circuits?
-Circuit Diagram Exit Slip
Appendix H: Circuit Diagram Reference and Sample Circuits
Video: "Energy & Electricity in science: How does Electricity Light Up a Bulb?" (2m7s):
https://www.youtube.com/watch?v=8RDyu5x7ouE
Internet access & projector
Writing utensils
Interactive Notebook pages

Objectives

Students will be able to identify the parts of a circuit.
Students will be able to justify when a circuit is open versus closed using correct vocabulary.

Instructional Process

1. As a hook into today's electricity lesson, begin class by playing the Video: "Energy & Electricity in science: How does Electricity Light Up a Bulb?" (2m7s): https://www.youtube.com/watch?v=8RDyu5x7ouE.
2. Explain and write today's objective on the board identify parts of a circuit, and explain how to know if a circuit is open or closed.
3. Review the T-chart regarding successful and unsuccessful configurations from the previous lesson. Use guided questions to jog student's memories on the similarities of each circuit that lit up successfully.
4. Introduce the vocabulary terms: open circuits and closed circuits to students. Have students write down these terms and their definitions in their interactive notebooks. Instruct students to leave space underneath each term to revisit soon and add more information to these definitions.
   Example Definitions:
   -An open circuit is an electrical circuit that is not complete, or where the path as been interrupted or "opened" at some point so that current will not flow.
   -A closed circuit is an electrical circuit that is complete, or where the path is continuous so that current flows from one end of the path to the other.
5. Demonstrate how to diagram open and closed circuits. Have students draw these models in their interactive notebooks with appropriate labels. See Appendix H: Circuit Diagram Reference and Sample Circuits for examples. Instruct students to draw these models underneath the defined terms in their interactive notebooks.
6. Have students look back at their trial log from yesterday. Prompt them to examine their notes and drawings for when they were able to light the light bulb. Instruct students to try to diagram their successful closed circuits correctly using the method they just learned. Prompt students to remember to label their diagrams appropriately, paying close attention to their spelling of vocabulary terms.
7. As students finish their diagrams, pair up students to share diagrams with one another. Model for students an appropriate explanation using correct vocabulary. Monitor student explanations and offer feedback as necessary. Choose a few students to share their explanations with the class.
8. Pass out the circuit bag of materials from the previous day. Instruct students to use the circuit materials to create new circuits, and model these newly created circuits by diagramming them in their interactive notebooks.
9. After several minutes of creating circuits challenge them try building circuits modeled on the Can You Build These Circuits? handout in the Interactive Notebook. Give students the challenge to use the parts in their bag to create the circuits.
10. Have students complete the Circuit Diagram Exit Slip.

Differentiation

For partner work, consider using flexible grouping. For students that have difficulty with handwriting skills, pairing them with a student that is stronger in this area can help that student better organize their diagrams and notes. Use heterogeneous groupings to help your lower readiness learners learn material.

Allow higher readiness learners and fast finishers to experiment with the buzzers and switches when trying to learn diagramming open and closed circuits. Students can build on their understanding from the previous lesson.

Assessments

Interactive notebook circuit diagram sketches
Can You Build These Circuits? handout
Circuit Diagram Exit Slip
Partner work and discussion

Section II: STEM Lesson Plan

Title of Lesson

Lesson 6: Flow of Electrons in a Circuit

Time Required

45-50 min

Materials

Appendix E: Interactive Notebook and Exit Slips:
-Flow of Electrons Exit Ticket
Slide Show Video: "Current Electricity and Electrical Circuits" http://bit.ly/currentjam
Several hula hoops (or pictures of ight bulbs and pictures of a batteries)
2 different colors of post-it notes (red and green if possible, otherwise whatever is available)
*another option is to use index cards with a string attached instead of using post-it notes
Writing utensils
Interactive notebooks
2 colors of m&ms (optional)

Objectives

Students will be able to explain the flow of electrons in a circuit.

Instructional Process

1. As a hook into today's lectricity lesson, begin class by playing the optional Study Jams Slide Show Video: "Current Electricity and Electrical Circuits" Lesson: http://studyjams.scholastic.com/studyjams/jams/science/ energy-light-sound/current-electricity-elec-circuits.htm
2. Explain and write today's objective on the board: explain the flow of electrons in a circuit.
3. Ask students, "What is happening within a closed circuit that causes electricity?" Have students think-pair-share with each other their ideas.
4. Explain that electricity is made by the flow of particles called electrons. Instruct students to write down the term electron and its definition in their interactive notebooks. Example: An electron is a part of an atom that has a negative charge.
5. Ask students, "What is the antonym for the word negative?" Have students think-pair-share with each other their ideas. Listen for the use of the word positive. Use this discussion to introduce the term "protons" to students. Explain that proton is easy to remember because proton and positive both start with the letter P.
6. Instruct students to write down the term and its definition in their interactive notebooks. Example: A proton is a part of an atom that has a positive charge. Have students draw a simple diagram with a small circle inside a larger circle. Draw several + signs in the center circle and label them protons. Draw an equal number of - signs on the outer circle and label them electrons.
7. Pass out one post-it note to each student. Try to split up the two different colors evenly amongst the class so that you have two equal groups. If you have red and green post-it notes, use the red ones for electrons and green ones for protons. Have students write down the appropriate symbol on their post-it note depending if they received a "proton" or an "electron" post-it note.
8. Have students carefully stand up, push in their chairs, and place the post-it notes on their chests, or the you may use another means to identify between protons and electrons like using note cards as lanyards. Use two students to represent how positive and negative charges attract. Ask students if they have heard that "opposites attract." Have the proton and electron students stand side by side to represent that they "attract."
9. Instruct students to carefully find the opposite color post-it note to stand by to represent that protons and electrons attract.
10. As students stand in proton-electron pairs, ask them what they think happens when two electrons or two protons try to stand side by side. Have a short conversation about the term repel. Use two student that have the same color post-it note to stand on either side of the room to represent like term repel. Engage students' prior knowledge about magnets to help them understand this concept.
11. Have all of the "proton students" move across the room from one another, and the other "electron students" move across the room from one another. Allow them to represent that they repel.

12. Give two students hula hoops. Have one hoop represent the battery. Have the other hoop represent the light bulb. If hula hoops are not readily available, have one student hold a picture of a light bulb and another student hold a picture of a battery.
13. Explain that electricity is the movement of electrons only, not protons. Have the students designated as the electrons pass from the negative side of the battery to the positive side of the battery in a complete path from one hula hoop to the other. Use a circular motion as students walk around from hula hoop to hula hoop. Have the proton students stand around the perimeter of the path.
14. While students are passing through the hula hoops in a circle, take one of the hula hoops out of the circle. Have that represent an open circuit. Have the students stop moving. Reflect with the students that when the path is continuous, there is a closed circuit and the light bulb lights. Reflect with the students that when path is not continuous, there is an open circuit and the light bulb does not light.
15. Instruct the students to carefully go back to their seats, get out their interactive notebooks, and draw the path of electrons in the circuit they just acted out. Draw a model of this on the board if needed. Encourage them to use the diagramming symbols learned in the previous lesson.
16. Have students complete the Circuit Diagram Exit Slip in their Interactive Notebooks.

Differentiation

To help reach a wide variety of learning styles, instead of making each of the students a part of the circuit, a teacher might want to instead have students create a simple closed circuit with their materials bag and manipulate m&ms in a circular path to show the flow of electrons on their desks.

Assessments

Class discussion and activity
Circuit Diagram Exit Slip

Section II: STEM Lesson Plan

Title of Lesson

Lesson 7: Conductors and Insulators

Time Required

45-50 min.

Materials

Appendix E: Interactive Notebook and Exit Slips:
-Conductors/Insulators T-chart and Exit Slip
Appendix H: Circuit Diagram Reference and Sample Circuits

Bag of circuit materials, one bag for each team (same as day four)

Bag of conductor/insulator materials for each team, including one of each material below:
*These are only suggested materials. Try to select a wide variety of objects, allowing for multiple conductors and multiple insulators.

- Rubber bands
- Pennies
- Nickels
- Toothpicks
- Keys
- Paperclips
- Brass paper fasteners
- Pencil erasers
- Pieces of aluminum foil
- Glass marbles

Objectives

Students will be able to describe the differences between conductors and insulators.

Instructional Process

1. Explain to students that they will work in teams to create a circuit for the upcoming design challenge. An understanding of conductors and insulators will be important as they apply their knowledge of electricity.
2. Hand out the bags of circuit materials used previously. Instruct students to create a closed circuit to light the light bulb with their materials. Give students one more piece of wire, and have students include this wire in their circuit to still create a closed circuit.
3. Allow time students to discuss how they were able to close the circuit. Diagram a common circuit (or many circuits) used on the board. Highlight a circuit diagram that would work well for testing various materials to see if they allow electricity to flow through them. (A sample diagram is provided in Appendix H: Circuit Diagram Reference and Sample Circuits)
4. Hand out a bag of conductor/insulator materials to each team and a conductors/insulators worksheet.
5. Introduce vocabulary: Conductor: a material that allows electricity to flow through it. Insulator: a material that does not allow electricity to flow through it. Have students add these terms to their interactive notebooks.
6. Instruct students to test the materials in their bag with their circuit to determine if each material is a conductor or an insulator. In order to test to see if an object is a conductor, students will open their circuit (ideally between two wire connections) and insert the testable object. Students will then close the circuit. If the lightbulb lights, then that material is a conductor. If the light remains unlit, that material is likely an insulator. Have students document their results on their Conductors/Insulators T-chart and Exit Slip.
7. Direct students to the exit slips on the bottom of their Conductors/Insulators T-chart and Exit Slip sheet. Ask students to generalize with their partner what objects are good conductors and write down their ideas. Students should come to understand that metals make good conductors, while plastic, rubber, wood, or glass do not.

Homework: Ask students to bring in an old/broken electronic toy (with parent permission) that is no longer played with and can be taken apart. The toy may be damaged during an upcoming lesson, so do not allow students to bring in new toys. (Alternatively, teacher may choose to personally collect items that have various types of switches)

Differentiation

Utilize an online simulator to check the conductivity of various materials.
BBC online has one version at http://bit.ly/bbcsimul
Allow students to use other supplies (buzzers, motors, etc…) to create their closed circuit.

Assessments

Conductors/Insulators T-chart and Exit Slip

Section II: STEM Lesson Plan

Title of Lesson

Lesson 8: Parallel vs. Series Circuits

Time Required

45-50 min

Materials

Appendix E: Interactive Notebook and Exit Slips:
-Series and Parallel Circuits and Exit Slip
Circuit Materials Bags
Extra light bulbs (1 per team)
Extra wires
Extra batteries (if needed)

Objectives

Students will be able to identify the difference between series and parallel circuits and describe the advantages and disadvantages of each.

Learning Target: I can to identify the difference between series and parallel circuits and describe the advantages and disadvantages of each.

Instructional Process

1. Review vocabulary/concepts: closed circuit, open circuit, conductor, insulator, diagrams. This can be done by asking students for definitions or providing the definition and asking students for the key vocabulary word.
2. Ask students how they generalized the materials that created good conductors. Ensure that students understand that most conductors are metals.
3. Hand out bags of circuit materials (same as day 4, day 7). Provide students with one additional light bulb. Instruct students to use one battery source to light two light bulbs. Students may use multiple wires to create a closed circuit. Have students diagram their closed circuits in their notebooks.
4. As students complete one closed circuit, challenge them to find a different ways to create closed circuits and diagram each.
5. After students have time to explore and diagram, provide a diagram of a series circuit and instruct student teams to recreate it with their materials.
6. Hand out the Series and Parallel Circuits and Exit Slip sheet. Have students write down any disadvantages and advantages that series circuits have on their series/parallel worksheet. (Series Circuit Advantages: Easy to design, Uses less wires than parallel circuits. Series Circuit Disadvantages: If one component fails, the circuit is open, all components fail. If one light goes out, they all go out). T
7. Similarly, provide a diagram of a parallel circuit and have student teams recreate it with their materials. Again, have students record disadvantages and advantages for parallel circuits. (Parallel Circuit Advantages: Independent components-One light can go out without making all the lights go out. All lights are the same brightness. Parallel Circuit Disadvantages: Needs many wires, drains batteries faster)
8. Collect materials from students. Conclude the lesson with a class discussion on the advantages and disadvantages of series and parallel circuits. Discuss possible uses for each. Possible questions: What type of circuit do you think is used in most homes? Why do you think many children's toys use series circuits?
9. Direct students to the bottom of the Series and Parallel Circuits and Exit Slip and instruct them to complete the Exit Slip question.

Differentiation	Test the brightness of the bulbs as more and more bulbs are added in each type of circuit. Discuss what differences for each type of circuit. Allow students to use other materials (buzzers, motors, etc…) in their circuits. Challenge students to turn on only one component at a time in their parallel circuit.
Assessments	Series and Parallel Circuits and Exit Slip Formatively assess student understanding during the lesson review at the beginning of the lesson

Section II: STEM Lesson Plan

Title of Lesson

Lesson 9: Switches

Time Required

45-50 min.

Materials

Appendix E: Interactive Notebook and Exit Slips:
-Switches Exploration and Exit Slip
Appendix I: Switches
Video: "About Different Kinds Of Switches" (6m30s): https://www.youtube.com/watch?v=WGskIUxzcz8
Various items that have different types of switches (These can be from students from suggested homework, or collected by the teacher from the thrift store, garage sales, etc.). Ensure that there is at least one item per team. Items could include: flashlights (slider switch and push button), radio, toaster, power strip, cell phone.

Objectives

Students will explain how different types of switches are used to open and close circuits.

Instructional Process

1. Set up stations in the classroom. Ideally, there will be an equal number of stations as teams of students. Set up items that the students brought in as homework (toys, items that have different types of switches) at each station. Some items may need to be disassembled to reveal the switch.
2. Watch Video: "About Different Kinds Of Switches" (6m30s): https://www.youtube.com/watch?v=WGskIUxzcz8.
3. Remind students that they will be creating circuits for the design challenge and a switch will be an important component of their circuit. Hand out Switches Exploration and Exit Slip and place one team at each station. Tell students that at each station, they will be required to observe how the switch operates and attempt to determine how the switch opens and closes the circuit. Instruct students to record their findings on the their sheet, including a sketch of the switch.
4. Rotate students through each station so that every student team can explore each item.
5. After each student team has completed every station, have students return to their seats. Hold a discussion about which switches were easy to figure out how they open/close the circuit. Discuss which switches were more challenging. “Why were they challenging?”
6. If possible, explain how the different switches work. Simply, every switch will make a connection between two parts of the circuit to close the circuit.
7. Show students how to add a switch in a circuit diagram.
8. Direct students to the bottom of the Switches Exploration and Exit Slip and instruct them to complete the Exit Slip question.

Differentiation

Provide students with the circuit materials and various items to create their own switches.

Assessments

Formative assessment of exit tickets

Section II: STEM Lesson Plan

Title of Lesson

Lesson 10: Engineering Design Challenge Introduction and Construction

Time Required

3 class periods (45-50 minutes each)

Materials

Appendix B: Engineering Design Process Graphic (1 copy)
Appendix C: Engineering Design Challenge Introduction Letter (1 per student)
Appendix D: Engineering Design Challenge Guidelines (1 per team)
Appendix J: Team Career Descriptions (1 per team)
Appendix K: Team Meeting Rubric (2-3 per team)
Appendix L: Team Ideation Planner (1 per student)
Video: "The Engineering Process: Crash Course Kids #12.2" (5m16s):
https://www.youtube.com/watch?v=fxJWin195kU

Insulated copper wire, 22 gauge or thinner, such as wire seen on https://www.enasco.com/product/SB10521M
Wire strippers
D-cell Batteries (1 per team)
Motors or buzzers to produce sound (1 per team)
Light Bulbs (1 per team)

Various materials that students could use to build (Include things that you may have in your classroom that students could be able to use such as aluminum foil, construction paper, paper clips, Styrofoam, file folders, etc.)

Objectives

Students will utilize what they have learned in order to construct an alarm circuit with a parallel circuit that will include both light and sound.

Students will work collaboratively in teams using the Engineering Design Process to guide their project.

Learning Targets:
1. I can work collaboratively in a group to solve a problem.
2. I can use the Engineering Design Process in order to solve a problem.
3. I can construct a working circuit that will alert someone of intruders.

Instructional Process

Lesson Preparation:
Cut wire into several lengths, short and long, and strip the ends of the wire to allow for connectivity.

LESSON DELIVERY:
Part One:
1. Remind students of the challenge. You may want to re-read the introductory letter. (See Appendix C)
2. Pass out Appendix D: Engineering Design Challenge Guidelines and read together so that students understand the specifications and parameters.
3. Explain that students will be using something called the engineering design process to help them through this project. Show them the Video: "The Engineering Process: Crash Course Kids #12.2" (5m16s): https://www.youtube.com/watch?v=fxJWin195kU and display Appendix B: Engineering Design Process Graphic.
4. Pass out Appendix J: Team Career Descriptions. Tell students that they will have different “careers” within the project. Read the career descriptions. Make sure to emphasize that they are all still to work as a team on all components, but that the person with each particular job should be making sure to monitor that particular component, and that when the “project manager” (the teacher) meets with them, they will have to be able to answer for their specific part. You can allow students to choose their careers within the teams, or you can

assign them. This is up to the preference of the teacher.

5. Pass out tAppendix L: Team Ideation Planner. This will serve as students' brainstorming session. Give students 5-10 minutes to complete number 1. This gives students a chance to come up with their own independent idea for the challenge. After this is complete, have students meet with their teams and take turns sharing their independent design ideas. Have students make brief notes as to what each idea is in number 2. Once all team members have shared their ideas, have them discuss as a team what their team design will be. This could be one particular team member's idea, a merge of more than one idea, or even a new idea altogether after discussion.

Part 2:

1. Have students work on assembling and testing their designs. This will take several class periods to complete.
2. Meet with students each day to monitor their progress. This can be done by simply circulating the room, and visiting each team of students. Use tAppendix K: Team Meeting Rubric to take notes on how well the students are accountable for their roles. If students are struggling, this is a good time to give them "leading" questions that don't tell them how to solve the problem, but help lead them to a solution.
3. Make sure to give students 5 minutes or so at the end of each period to clean up materials.

Differentiation

Student team roles can be assigned according to student strengths. For example, the data manager position can be given to students who excel in math, while the Electrical Engineer assignment can be given to students who have exceled in knowledge of circuitry throughout the unit. Grouping students heterogeneously will allow students who are stronger in the content to exhibit leadership skills and help students who may struggle with the content.

Assessments

Formative assessment can be done while meeting with individual teams and completing the Team Rubric. These meetings will allow the teacher to assess if each student is fulfilling their specific role, as well as if the team is functioning collaboratively and utilizing content knowledge to solve the problem.

Section II: STEM Lesson Plan

Title of Lesson

Lesson 11: Shark Tank Introduction

Time Required

45-50 minutes

Materials

Appendix E: Interactive Notebook and Exit Slips:
-Persuasive Writing Graphic Organizer
Appendix M: Shark Tank Presentation Rubric (1 per student)
Video: "The Pint-Size C.E.O. | The New York Times" (7m6s): https://www.youtube.com/watch?v=k-hzNEDej0U
Team-generated products

Objectives

Students will be able to identify the author's purpose as well as utilize persuasive techniques to create their own presentation.

Instructional Process

1. Show students the Video: "The Pint-Size C.E.O. | The New York Times" (7m6s): https://www.youtube.com/watch?v=k-hzNEDej0U.This video introduces an 11 year old trying to receive funding for his bow tie business. After the video plays, discuss the following questions as a class:
   What was the presenter's purpose or goal?
   How is this the same as the author's purpose?
   What made this presentation successful?
   What could the presenter have done differently?
2. Pass out Appendix M: Shark Tank Presentation Rubric to each student. Read aloud presentation expectations and explain the rubric so they understand how it will be graded.
3. Engage student's prior knowledge from Day 1 by referring to the consumers and producers T-chart. Discuss these topics again to refresh their memory.
4. Post the following presentation suggestions on the board to remind students of their goals.
   Student considerations:
   -Use evidence to support your product
   -Explain how their product works
   -How much it costs to build
   -How much profit will be earned
   -Describe any aesthetic qualities that make it desirable
5. Tell students today they will create their own shark tank presentation in order to market their product. Refer to the goals on the board.
6. Hand out the Persuasive Writing Graphic Organizer.
7. Allow student teams time to prepare their product presentations. The focus for this time is to write a rough draft of the presentation on their graphic organizer.
8. Check in with teams to assess their progress in rough draft writing and as well as teamwork. Make suggestions along the way as necessary.

Differentiation

Flexible grouping:
Students can be grouped by writing level
Students can be heterogeneously grouped to mix levels of thinking
Small, guided group can be available for lower students with teacher guidance and assistance.
Persuasive Graphic Organizers:
Students must support their product with 3 reasons and 3 details each
Students must support their product with 2 reasons and 2 details each

Assessments

Persuasive Writing Graphic Organizers
Shark Tank Rubric
Observational Notes

Section II: STEM Lesson Plan

Title of Lesson	**Lesson 12: Rehearse Shark Tank Presentation**
Time Required	45-50 minutes
Materials	Appendix M: Shark Tank Presentation Rubric Team-generated products Note cards (5-10 per team)
Objectives	Students will be able to utilize persuasive techniques as they practice their presentation.
Instructional Process	1. Instruct students to rehearse a rough draft of their presentation as a team. 2. As students rehearse, they may edit their work and make changes to their presentation. Provide any support/ feedback needed for teams to polish their presentations. 3. Encourage students to use note cards to help each team member remember what to say to the sharks. Try to finalize the presentation by the end of class.
Differentiation	Small, guided group can be available for lower students with teacher guidance and assistance.
Assessments	Persuasive Graphic Organizers Shark Tank Rubric Observational Notes

Section II: STEM Lesson Plan

Title of Lesson	**Lesson 13: Enter the Shark Tank**
Time Required	60 minutes
Materials	Student Presentations Appendix A: Pre-/Post-Test (1 per student) Appendix N Shark Tank Judging Feedback Form (1 per judge per team) Appendix O: Self-Evaluation Form (optional: 1 per student) Appendix P: Peer-Evaluation Form (optional: 1 per student)
Objectives	Students will give a clear and persuasive presentation to the sharks.
Instructional Process	1. Allow time for teams to present their products to a panel of "Sharks." This panel should have 2 or 3 individuals on it; they will decide which product they choose to support out of all of the presentations. Have the judges fill out the form in Appendix N Shark Tank Judging Feedback Form. 2. Administer the post-test. 3. As student finish their test, have them complete the self and peer evaluations.
Differentiation	Heterogeneous grouping Read aloud test questions and answer choices
Assessments	Shark Tank Rubric Post-Test Shark Tank Judging Rubric Optional Peer Assessment

Section III: Unit Resources

Materials and Resource Master List

Science Notebook
Post-it notes (2-3 pads, various colors)
Light bulbs (3-4 per team)
Flash light (1 per team)
Candle (1)
Picture of sun (1)
Picture of fire (1)
Musical instruments (2-3)
Radio (1)
Bells (1)
Hair dryer (1)
Microwave (1)
Picture of water boiling (1)
Light socket picture (1)
Battery (AA or D) (3-4 per team)
Motor (small DC hobby motor) (1-2 per team)
Different types of magnets (4-5
Forms of energy sort, printed (http://bit.ly/energyformssort) (1 per student, optional)
Chart paper (3-4 sheets)
Energy Transformation Cards, printed (FIND THIS)
Fan (1)
Banana (1)
Glow sticks (1)
Hand warmers (1)
Balloon (1)
Yo-yo (1)
Wind-up car (1)
Rubber bands (1)
Telephone (1)
Vacuum cleaner (or picture) (1)
Toaster (or picture) (1)
Blender (or picture) (1)
TV (or picture) (1)
Gallon-sized re-sealable bag (1 per student)
Insulated Copper Wires (varied length, 4 -6 per student)
Socket/ light bulb holder (1 per team)
Switches (various types) (2-3 per team)
Buzzers (2-3 per team)
Motors (1 per team)
Electrical tape (1-2 rolls)
Red and green writing utensils (1 each per student)
Glue sticks (1 per student)
Hula hoops (2)
Index cards (2-3 packs)
String (1 roll)
Small candies (i.e. M&Ms or Skittles) (1 small pack per student)
Pennies (2-3 per team)
Nickels (2-3 per team)
Toothpicks (2-3 per team)
Keys (2-3 per team)
Paperclips (2-3 per team)
Brass paper fasteners (2-3 per team)
Pencil erasers (2-3 per team)
Pieces of aluminum foil (2-3 per team)
Glass marbles (2-3 per team)
Wire strippers (1-2 per class)
Various items that have different types of switches (These can be from students from suggested homework, or

collected by the teacher from the thrift store, garage sales, etc.) Ensure that there is at least one item per group. Items could include flashlights (slider switch and push button), radio, toaster, power strip, cell phones

Key Vocabulary

Alarm: a device that makes a loud sound as a warning or signal (Merriam-Webster online dictionary)

Atom: the smallest particle of a substance that can exist by itself or be combined with other atoms to form a molecule (Merriam-Webster online dictionary)

Battery: a device that is placed inside a machine (such as a clock, toy, or car) to supply it with electricity (Merriam-Webster online dictionary)

Buzzer: an electric device that makes a loud sound (Merriam-Webster online dictionary)
Circuit aka (Electrical Circuit): the complete path that an electric current travels along. (Merriam-Webster online dictionary)

Closed Circuit: An electric circuit providing an uninterrupted, endless path for the flow of current. (Houghton Mifflin Harcourt Publishing Company)

Conductors: a material or object that allows electricity or heat to move through it (Merriam-Webster online dictionary)

Consumer: a person who buys goods and services (Merriam-Webster online dictionary)

Diagram (a circuit): a drawing that explains or shows the parts of something (Merriam-Webster online dictionary)

Economics: a science concerned with the process or system by which goods and services are produced, sold, and bought (Merriam-Webster online dictionary)

Electrical Energy: is delivered by tiny charged particles called electrons, typically moving through a wire.

Lightning is an example of electrical energy in nature. (Energy Kids)

Electricity: a form of energy that is carried through wires and is used to operate machines, lights, etc. (Merriam-Webster online dictionary)

Electrons: very small particle of matter that has a negative charge of electricity and that travels around the nucleus of an atom (Merriam-Webster online dictionary)

Energy: usable power that comes from heat, electricity, etc. (Merriam-Webster online dictionary)

Energy transformation: or Energy Conversion is the process of changing one form of energy to another form of energy. (Wikipedia)

Entrepreneur: a person who starts a business and is willing to risk loss in order to make money (Merriam-Webster online dictionary)

Goods: is something that you can use or consume, like food or CDs or books or a car or clothes. You buy a good with the idea that you will use it, either just once or over and over again. (Social Studies for Kids)

Insulator: a material that allows little or no heat, electricity, or sound to go into or out of something (Merriam-Webster online dictionary)

Kinetic Energy: is the energy an object has due to its motion. (Physics for Kids)

Light (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. (Energy Kids)

Loss: money that is spent and that is more than the amount earned or received (Merriam-Webster online dictionary)

Magnet: a piece of material (such as iron or steel) that is able to attract certain metals (Merriam-Webster online dictionary)

Magnetic Energy: The potential energy of a magnetic field (Your Dictionary)

Market: the activities that are involved in making people aware of a company's products, making sure that the products are available to be bought, etc. (Merriam-Webster online dictionary)

Metal: a substance (such as gold, tin, or copper) that usually has a shiny appearance, is a good conductor of electricity and heat, can be melted, and is usually capable of being shaped (Merriam-Webster online dictionary)

Motor: a machine that produces motion or power for doing work (Merriam-Webster online dictionary)

Neutrons: very small particle of matter that has no electrical charge and is part of the nucleus of all atoms except hydrogen atoms (Merriam-Webster online dictionary)

Open circuit: an electric circuit through which current cannot flow because the path is broken or interrupted by an opening. (Houghton Mifflin Harcourt Publishing Company)

Parallel circuit: a closed circuit in which the current divides into two or more paths before recombining to complete the circuit. (Houghton Mifflin Harcourt Publishing Company)

Potential Energy: is the stored energy an object has because of its position or state. (Physics for Kids)

Producer: someone or something that grows or makes particular goods or products (Merriam-Webster online dictionary)

Profit: money that is made in a business, through investing, etc., after all the costs and expenses are paid: a financial gain (Merriam-Webster online dictionary)

Protons: a very small particle of matter that is part of the nucleus of an atom and that has a positive electrical charge (Merriam-Webster online dictionary)

Receptacle: a device into which an electric cord can be plugged in order to provide electricity for a lamp, television, etc. (Merriam-Webster online dictionary)

Repel: to force (something) to move away or apart (Merriam-Webster online dictionary)

Series circuit: an electric circuit connected so that current passes through each circuit element in turn without branching. (Houghton Mifflin Harcourt Publishing Company)

Services: is something that someone does for you, like give you a haircut or fix you dinner or even teach you social studies. You don't really get something solid, like a book or a CD, but you do get something that you need. (Social Studies for Kids)

Short circuit: A low resistance connection between two points in an electric circuit through which the current tends to flow rather than along the intended path. A short circuit can damage the circuit by overheating. (Houghton Mifflin Harcourt Publishing Company)

Sound Energy: 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 smaller than other forms of energy. (Energy Kids)

Switch: small device that starts or stops the flow of electricity to something (such as a lamp or a machine) when it is pressed or moved up and down (Merriam-Webster online dictionary)

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. (Energy Kids)

Technical Brief

Electrical circuits are part of a typical, ordinary everyday life.

Circuits are used to turn on anything electrical – switching on a light; answering a phone; ringing a doorbell; starting a car; turning on a flashlight.

What is a circuit?
A circuit is simply a completed connection: a connection between an electrical power source and an item that will do a form of work.

The simplest circuit would have a connection from a power source (consider a battery), through a path that allows the electricity to flow though it (a conductor), and return to the power source.

Good conductors allow electricity to flow efficiently through the path that completes a circuit. Because metals are often good conductors, many electrical wires are made out of copper. A complete circuit allows electricity to flow from the source and to return to the power source.

When a circuit is completed with no load (resistance), such as a light, buzzer, or motor, a short circuit results. A short circuit can be dangerous with high-powered batteries or power supplies. The conductors can get very hot, damage equipment, or injure people.

A circuit that is not complete doesn't allow electricity to pass through it is an open circuit.

An insulator stops the flow of electricity. The metal wires inside power cords are covered with plastic or rubber to prevent electricity flowing from energized wires to people. The plastic covering is a good insulator because it prevents electricity from flowing through it. Air is also a good insulator.

A switch, like an insulator, stops the flow of electricity in the OFF position. The switch in the ON position changes the circuit from open to closed. Switches can be found in many forms, but their function remains the same: change a circuit from open to closed. Some switches are toggle switches that are moved up and down to turn a circuit on and off. Some switches have pull chains. Some switches are like buttons that need to be pressed. A key is required to turn the ignition switch which is standard in many automobiles. An elevator button is a switch that turns on a signal to summon the elevator, open/close the doors, or to select a floor to visit. In each of these cases, the switch activates an insulator which opens or closes the circuit.

The purpose of a circuit is getting work done. A circuit is normally closed to perform a task. Common tasks include turning on a light, ringing a doorbell, starting a car, or turning on a TV. When a standard light switch is flipped to the "on" position, electrical energy is allowed to travel from the power source, through the circuit, and back to the power source. When a device such as a light bulb, doorbell, or car starter is energized by closing the circuit, work is done. With a light bulb in the circuit, the electrical energy flows through the bulb and changes from electrical energy to light (and often heat) energy. When a doorbell is in the circuit, the electrical energy is transformed into motion that makes a physical sound or vibrates a membrane to make a tone. Similarly, when a car key is turned to activate the rotary key switch in an automobile, energy flows to the starter which mechanically spins to start the car.

This is only a small sample of some of the everyday things that circuits do every day.

Safety and Disposal

Do not use electricity near water. Do not put batteries into your mouth. Do not create short circuits. Electrical components may get warm or hot. Instruct students to put them down if that happens and let you know immediately. Used batteries should not be thrown in the trash because of their negative impact on the environment. They can be recycled by many electronics stores.

References

Center for Learning in Action. (n.d.) Retrieved April 26, 2016, from http://learning-in-action.williams.edu/opportunities/elementary-outreach/science-lessons/4th-grade-energy-unit/

Changing Circuits. (2003). Retrieved March 23, 2016, from http://www.bbc.co.uk/schools/scienceclips/images/worksheet6f.gif

Circuit Symbols. (n.d.). Retrieved February/March, 2016, from http://www.jamesdewinter.com/Notes/circuitsymbols.htm

Electric Circuits Student Notebook Guide. (n.d.). Retrieved March 23, 2016, from http://amstistuff.wikispaces.com/file/view/Electric Circuits Notebook Guide.pdf

Engineering. (1). New York: Facts On File. Retrieved April 12, 2016, from http://online.infobase.com/HRC/Search/Details/281746?q=engineering

Electrical engineering. (2009). In Encyclopedia of Physical Science. New York: Facts On File. Retrieved April 12, 2016, from http://online.infobase.com/HRC/Search/Details/299729?q=electrical engineer (2012).

Sales Engineers. Occupational Outlook Handbook 2012-2013. U.S. Bureau of Labor Statistics. Retrieved from http://elibrary.bigchalk.com

Science. (1). New York: Facts On File. Retrieved April 12, 2016, from http://online.infobase.com/HRC/Search/Details/281966?q=Science

Chemistry and chemists. (2009). In Encyclopedia of Physical Science. New York: Facts On File. Retrieved April 13, 2016, from http://online.infobase.com/HRC/Search/Details/299457?q=electrical symbols (2012).

Economists. Occupational Outlook Handbook 2012-2013. U.S. Bureau of Labor Statistics. Retrieved from http://elibrary.bigchalk.com

Data scientist. (2016). Computer Desktop Encyclopedia, 1.

Curriculum Developers

Timothy Carey: author
Jessica Currin: author
Emily Frake: author
Rebekah Fultz: author
Alexa Hill: author
David Long: author
Jeanette McNally: editor
Eric Miller: author
Jenn Stormer: author

Section IV: Appendices

Appendix A: Pre-Test / Post-Test
Pre-Test / Post-Test ANSWER KEY
Appendix B: Engineering Design Process Graphic
Appendix C: Engineering Design Challenge Introduction Letter
Appendix D: Shark Tank Engineering Design Challenge
Appendix E: Interactive Notebook and Exit Slips
Appendix F: Energy Transformation Cards
Appendix G: Discussion & Challenge Activity Checklist
Appendix H: Circuit Diagram Reference and Sample Circuits
Appendix I: Switches
Appendix J: Team Career Descriptions
Appendix K: Team Meeting Rubric
Appendix L: Team Shark Tank Alarm System Ideation Session
Appendix M: Shark Tank Presentation Rubric
Appendix N: Shark Tank Judging Feedback Form
Appendix O: Self-Evaluation Form
Appendix P: Peer-Evaluation Form