

CreositySpace – Battery Builders

Activity Descriptions and Standards Alignment

General Activity Descriptions:

Below you will find brief descriptions of the hands-on science activities associated with the **Battery Builders Technology Entrepreneurship Curriculum** module. The detailed activity descriptions in the Educator Guide describes useful extensions for the older or more advanced students (e.g. on-going documented observations).

Activity 1 – Build a battery

Objective and General Description:

To teach students how the basic components of a battery work together. In this experiment, a battery made of pennies, lemon juice, and nickels. It produces voltage much like a battery, but you use pennies and nickels instead. The students will measure the voltage with the multimeter.

Materials:

Pennies, nickels, lemon juice, paper towels, plastic containers, multimeters, LEDs

Activity 2 – Materials Matter

Objective and General Description:

One of the key components of the BessTech technology is that they use silicon (think computer chips) in the electrode where other manufactures are using carbon (think graphite from pencils). In this experiment we'll look at making the coin stack battery with some different materials and determine if that improves or hinders performance.

Materials:

Pennies, nickels, dimes, bingo chips, salt water, regular water, lemon juice, paper towels, cloth squares, plastic containers, multimeters, LEDs

Education Standards

Don't see the standards for your school district? Contact us at kath@creosityspace.com and we will determine the appropriate standards alignment for your district.

Common Core ELA Standards

Grade 3

Reading Informational Text:

[CCSS.ELA-LITERACY.RI.3.1](#) Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

[CCSS.ELA-LITERACY.RI.3.2](#) Determine the main idea of a text; recount the key details and explain how they support the main idea.

[CCSS.ELA-LITERACY.RI.3.4](#) Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a *grade 3 topic or subject area*.

Writing:

[CCSS.ELA-Literacy.W.3.2](#) Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

[CCSS.ELA-Literacy.W.3.2.a](#) Introduce a topic and group related information together; include illustrations when useful to aiding comprehension.

[CCSS.ELA-Literacy.W.3.2.b](#) Develop the topic with facts, definitions, and details.

[CCSS.ELA-Literacy.W.3.2.c](#) Use linking words and phrases (e.g., *also, another, and, more, but*) to connect ideas within categories of information.

[CCSS.ELA-Literacy.W.3.2.d](#) Provide a concluding statement or section.

[CCSS.ELA-Literacy.W.3.1](#) Write opinion pieces on topics or texts, supporting a point of view with reasons.

[CCSS.ELA-Literacy.W.3.1.a](#) Introduce the topic or text they are writing about, state an opinion, and create an organizational structure that lists reasons.

[CCSS.ELA-Literacy.W.3.1.b](#) Provide reasons that support the opinion.

[CCSS.ELA-Literacy.W.3.1.c](#) Use linking words and phrases (e.g., *because, therefore, since, for example*) to connect opinion and reasons.

[CCSS.ELA-Literacy.W.3.1.d](#) Provide a concluding statement or section.

[CCSS.ELA-Literacy.W.3.4](#) With guidance and support from adults, produce writing in which the development and organization are appropriate to task and purpose. (Grade-specific expectations for writing types are defined in standards 1-3 above.)

[CCSS.ELA-Literacy.W.3.5](#) With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, and editing.

[CCSS.ELA-Literacy.W.3.6](#) With guidance and support from adults, use technology to produce and publish writing (using keyboarding skills) as well as to interact and collaborate with others.

[CCSS.ELA-Literacy.W.3.7](#) Conduct short research projects that build knowledge about a topic.

[CCSS.ELA-Literacy.W.3.8](#) Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

Speaking & Listening:

[CCSS.ELA-LITERACY.SL.3.1](#) 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.

[CCSS.ELA-LITERACY.SL.3.1.A](#) Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.

[CCSS.ELA-LITERACY.SL.3.1.B](#) Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).

[CCSS.ELA-Literacy.SL.3.1.c](#) Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others.

[CCSS.ELA-Literacy.SL.3.1.d](#) Explain their own ideas and understanding in light of the discussion.

[CCSS.ELA-Literacy.SL.3.3](#) Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.

[CCSS.ELA-Literacy.SL.3.4](#) 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.

[CCSS.ELA-Literacy.SL.3.6](#) Speak in complete sentences when appropriate to task and situation in order to provide requested detail or clarification.

Language:

[CCSS.ELA-LITERACY.L.3.1](#) Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

[CCSS.ELA-LITERACY.L.3.1.A](#) Explain the function of nouns, pronouns, verbs, adjectives, and adverbs in general and their functions in particular sentences.

[CCSS.ELA-LITERACY.L.3.2](#) Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

[CCSS.ELA-LITERACY.L.3.4](#) Determine or clarify the meaning of unknown and multiple-meaning word and phrases based on grade 3 reading and content, choosing flexibly from a range of strategies.

Grade 4

Reading Informational Text:

[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.4.2](#) Determine the main idea of a text and explain how it is supported by key details; summarize the text.

[CCSS.ELA-LITERACY.RI.4.4](#) Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a *grade 4 topic or subject area*.

[CCSS.ELA-LITERACY.RI.4.5](#) Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in a text or part of a text.

[CCSS.ELA-LITERACY.RI.4.7](#) Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.

Writing:

[CCSS.ELA-LITERACY.W.4.1](#) Write opinion pieces on topics or texts, supporting a point of view with reasons and information.

[CCSS.ELA-LITERACY.W.4.1.A](#) Introduce a topic or text clearly, state an opinion, and create an organizational structure in which related ideas are grouped to support the writer's purpose.

[CCSS.ELA-LITERACY.W.4.1.B](#) Provide reasons that are supported by facts and details.

[CCSS.ELA-LITERACY.W.4.1.C](#) Link opinion and reasons using words and phrases

[CCSS.ELA-LITERACY.W.4.1.D](#) Provide a concluding statement or section related to the opinion presented.

[CCSS.ELA-LITERACY.W.4.2](#) Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

[CCSS.ELA-LITERACY.W.4.2.A](#) Introduce a topic clearly and group related information in paragraphs and sections; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension.

[CCSS.ELA-LITERACY.W.4.2.B](#) Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic.

[CCSS.ELA-LITERACY.W.4.2.C](#) Link ideas within categories of information using words and phrases.

[CCSS.ELA-LITERACY.W.4.2.D](#) Use precise language and domain-specific vocabulary to inform about or explain the topic.

[CCSS.ELA-LITERACY.W.4.2.E](#) Provide a concluding statement or section related to the information or explanation presented.

[CCSS.ELA-LITERACY.W.4.4](#) Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.

[CCSS.ELA-LITERACY.W.4.8](#) Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.

Speaking & Listening:

[CCSS.ELA-LITERACY.SL.4.1](#) 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.

[CCSS.ELA-LITERACY.SL.4.1.A](#) Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.

[CCSS.ELA-LITERACY.SL.4.1.B](#) Follow agreed-upon rules for discussions and carry out assigned roles.

[CCSS.ELA-LITERACY.SL.4.1.C](#) Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others.

[CCSS.ELA-LITERACY.SL.4.1.D](#) Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.

[CCSS.ELA-LITERACY.SL.4.3](#) Identify the reasons and evidence a speaker provides to support particular points.

Language:

[CCSS.ELA-LITERACY.L.4.1](#) Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

[CCSS.ELA-LITERACY.L.4.1.A](#) Use relative pronouns (*who, whose, whom, which, that*) and relative adverbs (*where, when, why*).

[CCSS.ELA-LITERACY.L.4.2](#) Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

[CCSS.ELA-LITERACY.L.4.3](#) Use knowledge of language and its conventions when writing, speaking, reading, or listening.

[CCSS.ELA-LITERACY.L.4.3.A](#) Choose words and phrases to convey ideas precisely.

[CCSS.ELA-LITERACY.L.4.4](#) Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 4 reading and content, choosing flexibly from a range of strategies.

Grade 5

Reading Informational Text:

[CCSS.ELA-LITERACY.RI.5.2](#) Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.

[CCSS.ELA-LITERACY.RI.5.3](#) Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.

[CCSS.ELA-LITERACY.RI.5.4](#) Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a *grade 5 topic or subject area*.

Writing:

[CCSS.ELA-LITERACY.W.5.1](#) Write opinion pieces on topics or texts, supporting a point of view with reasons and information.

[CCSS.ELA-LITERACY.W.5.1.A](#) Introduce a topic or text clearly, state an opinion, and create an organizational structure in which ideas are logically grouped to support the writer's purpose.

[CCSS.ELA-LITERACY.W.5.1.B](#) Provide logically ordered reasons that are supported by facts and details.

[CCSS.ELA-LITERACY.W.5.1.C](#) Link opinion and reasons using words, phrases, and clauses

[CCSS.ELA-LITERACY.W.5.1.D](#) Provide a concluding statement or section related to the opinion presented.

[CCSS.ELA-LITERACY.W.5.2](#) Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

[CCSS.ELA-LITERACY.W.5.2.A](#) Introduce a topic clearly, provide a general observation and focus, and group related information logically; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension.

[CCSS.ELA-LITERACY.W.5.2.B](#) Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic.

[CCSS.ELA-LITERACY.W.5.2.C](#) Link ideas within and across categories of information using words, phrases, and clauses (e.g., *in contrast, especially*).

[CCSS.ELA-LITERACY.W.5.2.D](#) Use precise language and domain-specific vocabulary to inform about or explain the topic.

[CCSS.ELA-LITERACY.W.5.2.E](#) Provide a concluding statement or section related to the information or explanation presented.

[CCSS.ELA-LITERACY.W.5.4](#) Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.

[CCSS.ELA-LITERACY.W.5.8](#) Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.

Speaking & Listening:

[CCSS.ELA-LITERACY.SL.5.1](#) Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 5 topics and texts*, building on others' ideas and expressing their own clearly.

[CCSS.ELA-LITERACY.SL.5.1.A](#) Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.

[CCSS.ELA-LITERACY.SL.5.1.B](#) Follow agreed-upon rules for discussions and carry out assigned roles.

[CCSS.ELA-LITERACY.SL.5.1.C](#) Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.

[CCSS.ELA-LITERACY.SL.5.1.D](#) Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.

[CCSS.ELA-LITERACY.SL.5.3](#) Summarize the points a speaker makes and explain how each claim is supported by reasons and evidence.

Language:

[CCSS.ELA-LITERACY.L.5.1](#) Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

[CCSS.ELA-LITERACY.L.5.1.A](#) Explain the function of conjunctions, prepositions, and interjections in general and their function in particular sentences.

[CCSS.ELA-LITERACY.L.5.2](#) Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

[CCSS.ELA-LITERACY.L.5.3](#) Use knowledge of language and its conventions when writing, speaking, reading, or listening.

[CCSS.ELA-LITERACY.L.5.4](#) Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 5 reading and content, choosing flexibly from a range of strategies.



Common Core Math Standards (Grades 3 – 5)

Grade 3

MP.1 Make sense of problems and persevere in solving them.

MP.2 Reason abstractly and quantitatively.

3.OA.1-3 Represent and solve problems involving multiplication and division.

3.OA.7 Multiply and divide within 100.

3.MD.3 Represent and interpret data.

3.MD.5-7 Geometric measurement: understand concepts of area and relate area to multiplication and to addition.

Grade 4

MP.1 Make sense of problems and persevere in solving them.

MP.2 Reason abstractly and quantitatively.

4.OA.1-3 Use the four operations with whole numbers to solve problems.

4.MD.4 Represent and interpret data.

Grade 5

MP.1 Make sense of problems and persevere in solving them.

MP.2 Reason abstractly and quantitatively.

5.MD.2 Represent and interpret data.

5.G.1 Graph points on the coordinate plane to solve real-world problems.

Next Generation Science Standards/NY Science Learning Standards 3 - 5

Performance Expectations

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.

5-PS1-1. Develop a model to describe that matter is made up of particles too small to be seen.

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Example NGSS “Big Idea” and Topic Bundle: How is energy stored and transferred to different places within an object? (4-PS3-2, 4-PS3-4, 5-PS1-1) In this bundle we start thinking about how energy can be transferred to and stored within objects. Parallels can be drawn to how energy is stored within and transferred between the different parts of a living organism.

Science and Engineering Practices

Asking questions / defining problems;

Planning and carrying out investigations;

Analyzing and interpreting data

Experiments with making a battery, swapping out different materials and evaluating the results have students asking questions and investigating why and how things work.

Using math & computational thinking

Math word problems give students a chance to think how math is used in S&E.

Constructing explanations/designing solutions; Engaging in argument from evidence; Obtaining, evaluating, and communicating information

Challenge extensions and innovation prompts in the *Book of Ideas* - Young Inventors Journal enable students to design and support their solutions to a variety of challenges.

Connections to Nature of Science

Scientific investigations use a variety of methods; Scientific knowledge is based on empirical evidence

Entrepreneur story/presentation and hands on activities illustrate how scientific investigations are conducted and how that information is put to use.

Disciplinary Core Ideas

PS1.A Structure of matter

PS1.B Chemical reactions

PS3.B Conservation of energy and energy transfer

The activities around building a battery, switching out materials, and monitoring performance, illustrates concepts of the structure of matter, chemical reactions and energy transfer.

PS3.A Definition of energy

Videos and historical timeline give students and introduction to energy, electricity and batteries.

PS3.D Energy in chemical processes and everyday life

Writing prompts, challenge extensions and math questions have students thinking about energy in their everyday life.

ETS1.A: Defining and delimiting engineering problems

ETS1.B: Developing possible solutions

ETS1.C: Optimizing the design solution

Science and technology based writing prompts, challenge questions and group activities support the three phases of Engineering Design.

Cross Cutting Concepts

Cause and effect

The activities give the students a chance to explore the cause and effect of material and assembly changed on the performance of their batteries.

Structure and function

Entrepreneurs highlight how the structure and properties of materials can be used to perform specific functions.

Connections to Nature of Science

Science is a way of knowing; Science addresses questions about the natural and material world

Activities give firsthand experience in questioning, observing and concluding.

Science is a human endeavor

Entrepreneur story and historical timeline highlight the human aspect of science and engineering.

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology; Influence of Engineering, Technology and Science on Society and the Natural World

Introduction text, historical timeline and entrepreneur story highlight above interactions and interdependencies.

Connections to Common Core State Standards

See Previous Common Core Standards section for the ELA and Math standards addressed by these activities.

NY State Science Standards

Grades 3 & 4

STANDARD 1 - SCIENTIFIC INQUIRY:

S1.1 Ask "why" questions in attempts to seek greater understanding concerning objects and events they have observed and heard about.

STANDARD 1 - ENGINEERING DESIGN:

T1.1 Describe objects, imaginary or real, that might be modeled or made differently and suggest ways in which the objects can be changed, fixed, or improved.

T1.1a Identify a simple/common object which might be improved and state the purpose of the improvement

T1.1b Identify features of an object that help or hinder the performance of the object

T1.1c Suggest ways the object can be made differently, fixed, or improved within given constraints

T1.2 Investigate prior solutions and ideas from books, magazines, family, friends, neighbors, and community members.

T1.2a Identify appropriate questions to ask about the design of an object

T1.2b Identify the appropriate resources to use to find out about the design of an object

STANDARD 6 – INTERCONNECTEDNESS:

Models - Key Idea 2: Models are simplified representations of objects, structures, or systems, used in analysis, explanation, or design.

SCIENCE STANDARD - PHYSICAL SETTING:

4.1a Energy exists in various forms: heat, electric, sound, chemical, mechanical, light.

4.1b Energy can be transferred from one place to another.

4.1c Some materials transfer energy better than others (heat and electricity).

4.1d Energy and matter interact: water is evaporated by the Sun's heat; a bulb is lighted by means of electrical current; a musical instrument is played to produce sound; dark colors may absorb light, light colors may reflect light.

4.1g Interactions with forms of energy can be either helpful or harmful.

4.2a Everyday events involve one form of energy being changed to another.

4.2b Humans utilize interactions between matter and energy.

SCIENCE STANDARD - LIVING ENVIRONMENT:

7.1b Over time humans have changed their environment by cultivating crops and raising animals, creating shelter, using energy, manufacturing goods, developing means of transportation, changing populations, and carrying out other activities.

Grade 5

STANDARD 1 – SCIENTIFIC INQUIRY:

S2.1 Use conventional techniques and those of their own design to make further observations and refine their explanations, guided by a need for more information.

S2.1a demonstrate appropriate safety techniques

S2.1b conduct an experiment designed by others

S2.1c design and conduct an experiment to test a hypothesis

S2.1d use appropriate tools and conventional techniques to solve problems about the natural world, including: measuring, observing, and describing.

S3.1 Design charts, tables, graphs, and other representations of observations in conventional and creative ways to help them address their research question or hypothesis. **S3.1a** organize results, using appropriate graphs, diagrams, data tables, and other models to show relationships

S3.1b generate and use scales, create legends, and appropriately label axes

S3.2 Interpret the organized data to answer the research question or hypothesis and to gain insight into the problem.

STANDARD 1 – ENGINEERING DESIGN:

T1.1 Identify needs and opportunities for technical solutions from an investigation of situations of general or social interest.

T1.3 Consider constraints and generate several ideas for alternative solutions, using group and individual ideation techniques (group discussion, brainstorming, forced connections, role play); defer judgment until a number of ideas have been generated; evaluate (critique) ideas; and explain why the chosen solution is optimal.

T1.3a Generate ideas for alternative solutions

T1.4 Develop plans, including drawings with measurements and details of construction, and construct a model of the solution, exhibiting a degree of craftsmanship.

T1.5 In a group setting, test their solution against design specifications, present and evaluate results, describe how the solution might have been modified for different or better results, and discuss trade-offs that might have to be made.

STANDARD 6 – INTERCONNECTEDNESS:

Systems Thinking - Key Idea 1: Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

1.3 Describe the differences between open- and closed-loop systems.

1.4 Describe how the output from one part of a system (which can include material, energy, or information) can become the input to other parts.

Models - Key Idea 2: Models are simplified representations of objects, structures, or systems, used in analysis, explanation, or design.

STANDARD 7 – INTERDISCIPLINARY PROBLEM SOLVING:

Connections – *Key Idea 1:* The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/technology/society, consumer decision making, design, and inquiry into phenomena.

SCIENCE STANDARD - PHYSICAL SETTING:

Key Idea 3 - Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

3.1a Substances have characteristic properties. Some of these properties include color, odor, phase at room temperature, density, solubility, heat and electrical conductivity, hardness, and boiling and freezing points.

Key Idea 4 - Energy exists in many forms, and when these forms change energy is conserved

4.1c Most activities in everyday life involve one form of energy being transformed into another. For example, the chemical energy in gasoline is transformed into mechanical energy in an automobile engine. Energy, in the form of heat, is almost always one of the products of energy transformations.

4.1d Different forms of energy include heat, light, electrical, mechanical, sound, nuclear, and chemical. Energy is transformed in many ways.

4.3a In chemical reactions, energy is transferred into or out of a system. Light, electricity, or mechanical motion may be involved in such transfers in addition to heat

4.4d Electrical energy can be produced from a variety of energy sources and can be transformed into almost any other form of energy.

4.4e Electrical circuits provide a means of transferring electrical energy.

Texas Essential Knowledge and Skills

General

Knowledge and skills.

(1) Scientific investigation and reasoning. The student conducts classroom and outdoor investigations following school and home safety procedures and environmentally appropriate practices. The student is expected to:

- (A) demonstrate safe practices as described in the Texas Safety Standards during classroom and outdoor investigations, including observing a schoolyard habitat; and
- (B) make informed choices in the use and conservation of natural resources by recycling or reusing materials such as paper, aluminum cans, and plastics.

(2) Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and outdoor investigations. The student is expected to:

- (A) plan and implement descriptive investigations, including asking and answering questions, making inferences, and selecting and using equipment or technology needed, to solve a specific problem in the natural world;
- (B) collect data by observing
- (D) analyze and interpret patterns in data to construct reasonable explanations based on evidence from investigations;
- (F) communicate valid conclusions supported by data in writing, by drawing pictures, and through verbal discussion.

(3) Scientific investigation and reasoning. The student knows that information, critical thinking, scientific problem solving, and the contributions of scientists are used in making decisions. The student is expected to:

- (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;
- (D) connect grade-level appropriate science concepts with the history of science, science careers, and contributions of scientists.

Grade 3

(4) Scientific investigation and reasoning. The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to:

- (A) collect, record, and analyze information using tools.

(6) Force, motion, and energy. The student knows that forces cause change and that energy exists in many forms. The student is expected to:

- (A) explore different forms of energy, including mechanical, light, sound, and heat/thermal in everyday life;

Grade 4

(4) Scientific investigation and reasoning. The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to:

- (A) collect, record, and analyze information using tools.

(6) Force, motion, and energy. The student knows that energy exists in many forms and can be observed in cycles, patterns, and systems. The student is expected to:

- (A) differentiate among forms of energy, including mechanical, sound, electrical, light, and heat/thermal;
- (B) differentiate between conductors and insulators;
- (C) demonstrate that electricity travels in a closed path, creating an electrical circuit, and explore an electromagnetic field.

Grade 5

(5) Matter and energy. The student knows that matter has measurable physical properties and those properties determine how matter is classified, changed, and used. The student is expected to:

- (A) classify matter based on physical properties, including mass, magnetism, physical state (solid, liquid, and gas), relative density (sinking and floating), solubility in water, and the ability to conduct or insulate thermal energy or electric energy;

(6) Force, motion, and energy. The student knows that energy occurs in many forms and can be observed in cycles, patterns, and systems. The student is expected to:

- (A) explore the uses of energy, including mechanical, light, thermal, electrical, and sound energy;
- (B) demonstrate that the flow of electricity in circuits requires a complete path through which an electric current can pass and can produce light, heat, and sound;