Core Knowledge Science Program—Domain Map

Science Content
• Introduction to static electricity • Basic parts of simple electric circuits (for example, batteries, wire, bulb or buzzer, switch) • Conductive and nonconductive materials • Safety rules for electricity (for example, never put your finger, or anything metallic, in an electrical outlet; never touch a switch or electrical appliance when your hands are wet or when you're in the bathtub; never put your finger in a lamp socket; etc.) • A biography of Thomas Edison

This unit contributes to meeting or exceeding the following Next Generation Science Standards:
Standards noted with an asterisk (*) are those that incorporate engineering and design

K–2 Topic *Engineering Design*, for example: ***K-2-ETS1-2**. Develop a simple sketch, drawing, or physical model to **illustrate how the shape of an object helps it function as needed to solve a given problem.******	***Rationale:*** The study of basic electrical circuits; Thomas Edison, and his development of a lightbulb will offer students the explicit opportunity to engage in this primary grade topic of engineering and design. This unit will also explore ETS2.B (Influence of Engineering, Technology, and Science on Society) which is classified by the NGSS as a cross-cutting concept (e.g., see 4-PS3-4) and is a disciplinary core idea within the *Framework for K–12 Science Education* (page 212). These standards will be further addressed in Grade 2 as outlined below.

This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:

2-PS1-1**. Plan and conduct an investigation to **describe and classify different kinds of materials by their observable properties.	***Rationale:*** Students will have the opportunity to explore and extend their knowledge of PS1.A (Structure & Properties of Matter) in a new context during this unit while classifying materials as either conductive or nonconductive. This combines with previous learning from Kindergarten (e.g., Unit 5 re: recyclable materials and Unit 6 re: objects that are or are not attracted by a magnet) to prepare students for further study of this DCI in Grade 2 (e.g., Unit 5 *Simple Machines* where students will complete a design challenge using their knowledge of the properties of matter).

3-PS2-3. *Ask questions to determine cause and effect* ***relationships of electric*** *or magnetic* ***interactions between two objects not in contact with each other.***	***Rationale:*** Grade 1 *Introduction to Electricity,* along with several other units of the CK Science program, will engage students with the core idea PS2.B (Types of Interactions). These units include Grade 2 Unit 4 *Magnetism*, Grade 3 Unit 5 *Astronomy*, and Grade 4 Unit 3 *Electricity*. Over time, students will explore electricity, magnetism, and gravity as forces "between a pair of objects that do not require that the objects be in contact." (*Framework*, page 117) Examples of interactions that will be introduced in this unit are, for example, electrical forces between your hair and an electrically-charged balloon and/or a charged rod and small pieces of paper.
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-PS3-4.** Apply scientific ideas to design, test, and **refine a device that converts energy from one form to another**.*	The early study of electricity also offers an excellent start to the progressions for the DCIs of PS3.B (Energy Transfer) and PS3.D (Energy in Everyday Life). These ideas will be formally assessed by the NGSS in Grade 4, during which students are expected to understand that, "Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light." These ideas will be extended in Grade 1 Unit 7 *Introduction to Light & Sound,* during Grade 3 Unit 3 *Light* and Unit 4 *Sound,* as well as Grade 4 Unit 3 *Electricity*.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen the understanding of this domain.

POTENTIAL CCSS Math Connections

MP.2 Reason abstractly and quantitatively. *(K-2-ETS1-1 and K-2-ETS1-3)*

MP.4 Model with mathematics. *(K-2-ETS1-1 and K-2-ETS1-3)*

MP.5 Use appropriate tools strategically. *(K-2-ETS1-1 and K-2-ETS1-3)*

1.MD.C.4 Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another. *(K-2-ETS1-1 and K-2-ETS1-3)*

POTENTIAL CCSS ELA Connections

RI.1.1 Ask and answer questions about key details in a text. *(K-2-ETS1-1)*

W.1.6 With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. *(K-2-ETS1-1 and K-2-ETS1-3)*

W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. *(K-2-ETS1-1 and K-2-ETS1-3)*

SL.1.5 Add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings. *(K-2-ETS1-2)*

POTENTIAL Cross-Curricular Connections

Potential Link:
ELA: Sayings & Phrases—"If at first you don't succeed, try, try again." *(This saying is particularly applicable during the study of Thomas Edison's work and when learning about his approach to the process of design and invention. For example, it has been reported by a close friend of Edison's that—after nine thousand attempts to design an improved storage battery—the friend asked, "Isn't it a shame that with the tremendous amount of work you have done you haven't been able to get any results?" To which Edison replied, "Results! Why, man, I have gotten a lot of results! I know several thousand things that won't work."*
American History: Benjamin Franklin: patriot, inventor, writer *(Franklin's inventions included the lightning rod to protect houses from catching fire when struck by lightning.)*

Prior Knowledge

Core Knowledge Kindergarten Sequence
IV. Introduction to Magnetism
- Magnetism is a property of matter
- Identify familiar everyday uses of magnets (for example, in toys, in cabinet locks, in "refrigerator magnets," etc.)
- Classify materials according to whether they are or are not attracted by a magnet

VI. Taking Care of the Earth
- Some materials can be recycled (for example, aluminum, glass, paper)

CKLA Kindergarten
Domain Anthology, *Taking Care of the Earth*
- Identify common recyclable materials, including glass, plastic, aluminum, cardboard, and paper

Core Knowledge Science (Previously taught units in the CK Science program)
Kindergarten
Unit 5 *Taking Care of the Earth*
- Identify everyday objects that are made up of natural resources
- Classify resources as renewable or nonrenewable
- Classify objects as recyclable or as garbage

Unit 6 *Pushes, Pulls, and an Introduction to Magnets*
- Describe different ways magnets are used in everyday life
- Classify materials according to whether they are or are not attracted by a magnet
- Apply your knowledge of forces and magnets to solve a problem

Grade 1 Unit 5 *Matter & Its Properties*
- Describe characteristics of matter
- Identify common features found among solids (2-ESS2-3)
- Develop a method by which we can classify matter (2-PS1-1)
- Classify different kinds of matter by their observable properties (2-PS1-1)
- Describe how physical properties of matter can be measured
- Measure objects using nonstandard units
- Determine when objects should be measured in inches or feet

CKLA Grade 1 Objectives—Not Applicable

The Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history, does not include the study of electricity. In order to prepare students to meet or exceed the NGSS Grade 2 Topic Structure & Properties of Matter, this unit (as well as Grade 2 Unit 5 Simple Machines*) is critical to advance students' understanding of the physical sciences. To learn more about how and why the Listening & Learning Strand of CKLA approaches certain science content through read-alouds and ELA instruction, read more about the CKLA program.*

What Students Will Learn in Future Grades

Core Knowledge Sequence
Grade 2 Magnetism
- Magnetism demonstrates that there are forces we cannot see that act upon objects

Grade 3 Astronomy

- Gravity, gravitational pull:
  Gravitational pull of the moon (and to a lesser degree, the sun) causes ocean tides on earth
  Gravitational pull of "black holes" prevents even light from escaping

Grade 4 Electricity

- Electricity as the charge of electrons
- Static electricity
- Electric current
- Electric circuits, and experiments with simple circuits (battery, wire, light bulb, filament, switch, fuse)
- Closed circuit, open circuit, short circuit
- Conductors and insulators
- Electromagnets: how they work and common uses
- Using electricity safely

Grade 4 Chemistry—Atoms and Elements

- All matter is made up of particles too small for the eye to see, called atoms
- Scientists have developed models of atoms; while these models have changed over time as scientists make new discoveries, the models help us imagine what we cannot see
- Atoms are made up of even tinier particles: protons, neutrons, electrons
- The concept of electrical charge:
  Positive charge (+): proton
  Negative charge (-): electron
  Neutral (neither positive nor negative): neutron
  "Unlike charges attract, like charges repel" (relate to magnetic attraction and repulsion)
- Elements are the basic kinds of matter, of which there are a little more than one hundred
- There are many different kinds of atoms, but an element has only one kind of atom
- Familiar elements, such as gold, copper, aluminum, oxygen, iron
- Most things are made up of a combination of elements

Core Vocabulary

*The following list contains the core vocabulary words suggested for purposeful integration across this Grade 1 unit. **Boldfaced** terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Electricity

energy, *charge,* ***source***, *electron, static, buildup,* ***change***, *friction, positive, negative,* ***attract***, ***repel***, *opposite, alike, release, discharge, electrical,* ***current***, *path, circuit, flow, closed, series, parallel, wire, generator,* ***battery***, *cell, terminal, contact, touch, fuse, (non)conductive, insulator, conductor, switch, on, off, device, appliance, [examples of appliances that use electricity]*

Thomas Edison

engineer, ***design***, *develop, build, problem, question, laboratory,* ***investigate***, *test, trial, success, fail,* ***persistence***, *error,* ***criteria***, *invention, lightbulb, lamp, drawing, sketch,* ***model***, *transform, transfer, energy, heat, light, dark, burn, bright,* ***filament***, *bamboo, platinum, metal*

Safety with Electricity

precaution, safety, ***hazard***, *dangerous,* ***shock***, *electrocute,* ***caution***, *harmful, hurt, careful, rules, warning, habit, socket, outlet, plug, cord, wires, conductor, appliance, current, flow, metal, water, wet, lightning, storm*

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "Thomas Edison invented the electric lightbulb."
Historians agree that Edison did not invent the first electric lightbulb as others had succeeded as early 1802, almost eight decades before Edison's seminal design. He did, however, produce the first commercially-viable model of a lightbulb after his extensive experimentation to identify a long-lasting filament that was affordable and safe—a carbonized bamboo filament that replaced his earlier designs.

Misconception: "All electric currents are flows of electrons."
Electric currents are caused by the flow of any charged particle, ions, that contain an imbalance of protons or electrons. In fact, commonly used electric currents that depend on the flow of positive charged ions include fluorescent bulbs, neon signs, and battery acid. Electric currents in salt water are also due to the flow of "extra" protons.

Edison's design using carbonized Japanese bamboo, which replaced earlier models using platinum and which could "burn" for over 1200 hours, is recognized as a key development that transformed how (and for how long) humans interact with each other and their world after dark.

Misconception: "Electricity and power are the same thing."
The NRC *Framework for K–12 Science Education* points out that, "Young children are likely to have difficulty studying the concept of energy in depth—everyday language surrounding energy contains many shortcuts that lead to misunderstandings." (pg. 94) The terms *power* and *energy* have specific scientific meanings that most young students have not experienced or learned in depth. The focus of this unit will directly align with the elementary learning progressions about energy and electricity set out by the *Framework*, specifically by the disciplinary core ideas of PS2.B (Types of Interactions), PS3.B (Energy Transfer), and PS3.D (Energy in Everyday Life).

Misconception: "Batteries and generators are the source of an electric current."
This statement is an overgeneralization because batteries and generators do not supply ions or electrons, but rather ***energy*** to an electric circuit. Specifically, an electrochemical cell supplies the energy needed to move a charge from a low potential location to a high potential location. The particles that move are, in fact, found in the components of the circuits, such as the wires, *even before the battery is connected!*

Key points for instruction:
Students of all ages have difficulty accurately describing the phenomena of electricity, and energy in general (*Framework,* pages 94–96 and 128–130). The focus of this early grade unit should be on macroscopic phenomena with which young students can engage meaningfully (e.g., examples of static electricity, building and using simple electric circuits, and safety with electricity). This unit will intentionally foreshadow the technical explanations of electric currents and related vocabulary, but students are not expected to explain the exact science at this early age.

Potential Objectives for this Grade 1 Unit

The organization of the following objectives reflects the order in which they are expected to be addressed. The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Describe how electricity impacts our everyday life
- Identify actions that keep us safe around electricity
- Describe the effect of static electricity
- Describe how objects repel and attract

Middle

- Distinguish between electric charges that repel and electric charges that attract
- Compare and contrast open and closed circuits
- Classify objects as insulators or conductors
- Describe characteristics of materials that act as conductors and materials that act as insulators

End

- Describe how Thomas Edison's inventions are used today
- Identify problems that could be solved with new or improved tools
- Develop a tool (model or illustration) that can be used to solve an identified problem
- Describe how a tool can be used to solve an identified problem

Potential Big Guiding Questions

Essential Questions:

- **What kinds of materials conduct electricity?**
- **What can you do to use electricity safely?**

Re: Electricity in Everyday Life:

- Why is electricity important to us?
- How can we stay safe around electricity?

Re: Static Electricity:

- How are magnetic poles similar to electric charges?
- If two objects have the same electric charge, do you think they will attract or repel? Why?

Re: Electric Current and Circuits:

- Can an electric current flow through a gas or a liquid?
- What happens when there is a gap in a circuit?

Re: Conductors and Insulators:

- Do you think electricity can flow through any object?
- What do you notice about the material of most conductors? How are they different from materials that serve as insulators?

Re: Thomas Edison

- How do Thomas Edison's inventions resemble some of the tools and technology we use today?
- Why is persistence an important trait for scientists?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point in time the assessment would take place.

Example #1: (Middle of Unit 6)

{Evaluates Student Mastery of Objective*:* Classify objects as insulators or conductors**}**

Advance Preparation: You will need to acquire the following items in order to create a simple circuit:

- Three wires
- A battery
- A light bulb
- Several "everyday items" made up of different materials (e.g., bar of soap, copper penny, piece of silverware, wooden block, etc.)
- Pieces of folded cardstock (e.g., resembling a "table tent"). One labeled, "insulator" and the other labeled, "conductor."

Assessment Task: Set up the circuit, attaching one wire to the negative terminal (on the battery) and a separate wire to the light bulb. Attach the free ends of the two wires to one of the metal "everyday items." Ask the students to think about what they learned regarding open and closed circuits, and share what's happening. If students need support, ask questions that guide them to the realization that the light bulb glows because electricity is flowing through the (open) circuit. Now repeat the experiment with a non-metal object (e.g., wooden block).

T - Our circuit appears closed. The wires are attached to the battery, light bulb, and (object name)**. Why isn't the light turning on? What changed?** (Provide students with at least 30 second of think time, and then hear ideas.) **The object that I attached to the wires changed.**

T - (Holding up the metal object) **Electricity was able to flow through this object, but** (holding up the wooden object) **it was not able to flow through this one. When electricity is permitted to flow through an object, that object is called a conductor.** (Place the metal object on a table, visible to students, in front of the cardstock labeled, "conductor.") **If the object does not allow electricity to flow through it is called an insulator.** (Place the object by the "insulator" cardstock.)

T - We are going to "test" each of these remaining items. I need you to tell me if the object is working as a conductor or insulator and we will categorize them into their respective groups.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point of instruction where it would be delivered. Aligned NGSS are noted in parentheses.

Example #1: (Beginning of Unit 6)

{Contributes to the Objective: Describe how electricity impacts our everyday life**}**

Activity: Invite students to record the number of electrical devices they use on a daily basis. Explain that any device that runs on batteries or that is plugged into the wall uses electricity to work. Children can also record how long they use each device. Encourage children to then imagine a time before electricity was available. Remind them that none of the devices they recorded could be used before electricity was available. What would their lives be like? How might their daily routines be different? How would they

listen to music? Where would they find their entertainment? How would they read at night, wash clothes, or keep food from going bad?

Example #2: (Beginning of Unit 6)

{Contributes to the Objective: Distinguish between electric charges that repel and electric charges that attract**}**

Advance Preparation:

- **Fill multiple balloons with air (**one for you and one for every student or pair of students).
    - Before the start of the lesson, model for students how to handle balloons appropriately.
- **Acquire two magnets**

Activity: Provide each child (or pair of children) with a balloon. Ask them to touch the balloon to the classroom wall and let it go..

T - What happened? (The balloon fell to the floor.) I **want you to rub the balloon against your hair like this.** (Model then allow students approximately 10–20 seconds to do the same.). **We are going to try to place the balloon near the wall. What do you think is going to happen?** (Listen to several responses. Encourage students to explain their thinking.) **Now place your balloon near the wall.**

Children will see that the balloons stick to the wall.

T - What happened? Why do you think the balloon stuck to the wall? (Encourage students to explain their thinking.)

T - This was caused by static electricity. What do you think created the static electricity? (If students need guidance, ask them to think about what they did differently between the first time they placed the balloon by the wall and the second time--rubbing the balloon on hair.) **That built a charge on the balloon.**

Hand two students magnets.

T - What did we learn happens when we tried to place the two magnets together? Students should indicate that they repelled each other (Have students with the magnets model this effect.)

T - Similar poles repel. The balloon fell (model again) **because it and the wall exert the same charge.**

T - But after we rubbed the balloon on our hair, it stuck to the wall. What does that tell us? Students should conclude that the balloon and wall had different charges because the balloon stuck to the wall—they were attracted.

Websites & Media

YouTube video for teachers—Plastic Comb Rubbed With a Cotton Cloth Attracts Small Pieces of Paper: https://youtu.be/rtl9TyMZSP8

This short video (approximately 1.5 minutes) offers an example of a demonstration that you might conduct with your young students. Consider using this sort of anchoring event to engage them with the concept of electrical charge and static electricity.

Supplemental Trade Books

- *The Magic School Bus and the Electric Field Trip* by Joanna Cole and Bruce Degen (Scholastic, 1999) ISBN 0590446835
- *Switch On, Switch Off* by Melvin Berger (HarperTrophy, 2001) ISBN 006445097X

Recommended by the National Science Teachers Association

- Teacher Resource: *Energy—Stop Faking It! Finally Understanding Science So You Can Teach It* by William C. Robertson (NSTA, 2002) ISBN 9780873552141