Core Knowledge Science Program—Domain Map

Science Content

- Everything is made of matter
- All matter is made up of parts too small to see
- Introduction to the basic concept of atoms
- Names and common examples of three states of matter:
  solid (for example, wood, rocks)
  liquid (for example, water)
  gas (for example, air, steam)
- Water as an example of changing states of matter of a single substance: solid ice, liquid water, and gas (i.e., air and water vapor)
- Units of measurement:
  Length: centimeter, inch, foot
  Volume: gallon, quart
- Temperature: degrees Fahrenheit

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

Grade 2 Topic Structure & Properties of Matter, for example:

2-PS1-1**. Plan and conduct an investigation to **describe and classify different kinds of materials by their observable properties.

***2-PS1-4**. Construct an argument with evidence that **some changes caused by heating or cooling can be reversed** and some cannot.*

Rationale:

This unit lays a significant foundation for learning about PS1.A (Structure & Properties of Matter) which was first introduced in Kindergarten during Units 5 and 6 (e.g., sorting recyclable objects and classifying objects that are or are not attracted by a magnet). As students investigate water, they will also be preparing for the early progression of core idea PS1.B (Chemical Reactions) which sets an expectation that primary students understand, "Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible (e.g., melting and freezing)..." (*Framework*, page 110) This will be extended during Grade 2 Unit 1 *Cycles in Nature* using this Grade 1 learning as a base. The Grade 2 Topic Structure & Properties of Matter will also be explicitly addressed during Grade 2 Unit 5 *Simple Machines* during which students will engage in at least one design challenge to apply these core ideas and connect to engineering, design, and the concept of Structure & Function.

2-ESS2-3**. Obtain information to **identify where water is found on Earth and that it can be solid or liquid.	***Rationale:*** This unit—coupled with the earlier Grade 1 units *Living Things & Their Environments* (Unit 4 re: water habitats) and *Introduction to Geology (*Unit 3 re: oceans)—will directly support the core idea ESS2.C (Roles of Water in Earth's Surface Processes). Students also have the opportunity to learn about water's importance and prevalence on Earth's surface during Grade 2 Unit 1 *Cycles in Nature* when students will review where they can find water and explore the concept that most of Earth's surface is covered in water.

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. (2-PS1-2)

MP.4 Model with mathematics. (2-PS1-1) (2-PS1-2)

MP.5 Use appropriate tools strategically. (2-PS1-2)

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. (2-PS1-1),(2-PS1-2)

POTENTIAL CCSS ELA Connections

RI.1.1 Ask and answer questions about key details in a text. *(2-PS1-4)*

RI.1.3 Describe the connection between two individuals, events, ideas, or pieces of information in a text. *(2-PS1-4)*

RI.1.8 Identify the reasons an author gives to support points in a text. *(2-PS1-2 and 2-PS1-4)*

W.1.1 Write opinion pieces in which they introduce the topic or name the book they are writing about, state an opinion, supply a reason for the opinion, and provide some sense of closure. *(2-PS1-4)*

W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). *(2-PS1-1, 2-PS1-2, and 2-PS1-3)*

W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. *(2-PS1-1, 2-PS1-2, and 2-PS1-3)*

POTENTIAL Cross-Curricular Connections

Potential Links:

Mathematics: Measurement—Identify familiar instruments of measurement, such as ruler, scale, thermometer. Compare objects according to: linear measure (e.g., using non-standard units as well as inches, feet, and centimeters), weight (e.g., using non-standard units and pounds, using a balance scale), and capacity (e.g., estimate and measure capacity [volume] in cups and identify a quart and gallon).

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 Listening & Learning
Domain Anthology, *Taking Care of the Earth*

- Identify common recyclable materials, including glass, plastic, aluminum, cardboard, and pape.

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
- Identify common resources that are limited and nonrenewable
- Classify resources as renewable or nonrenewable
- Identify items that can be used over and over again
- Identify materials that can be recycle. *(2-PS1-1)*
- 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
- Describe the term *attract*
- Classify materials according to whether they are or are not attracted by a magnet
- Describe the term *repel*
- Apply your knowledge of forces and magnets to solve a problem

Grade 1

Unit 3 *Introduction to Geology*

- Describe the weather and climate of different regions of Earth
- Identify and describe landforms and bodies of water in our local area
- Develop a model that represents the landforms and bodies of water in our local area (2-EE2-2)
- Compare and contrast volcanoes and geysers
- Sort rocks based on similar features
- Describe features of metamorphic, igneous, and sedimentary rocks
- Describe how metamorphic, igneous, and sedimentary rocks are formed
- Classify rocks as metamorphic, igneous, and sedimentary

Unit 4 *Living Things & Their Environments*

- Identify dolphins, octopi, and starfish and describe their habitats*
- Identify freshwater fish (e.g., bass) and describe their habitats*
- Compare and contrast the habitats of starfish and freshwater fish
- Describe the surface of Earth
- Explain how ocean water is different from fresh water
- Identify and locate the Pacific, Atlantic, Indian, Arctic, and Southern Oceans on a map
- Identify the coast, shore, waves, and tides (high and low) of an ocean
- Define the term *current* and provide an example

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 matter and its properties**. 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
Grades 2, 3, and 4 Measurement

- linear measurement
- weight
- volume
- temperature

Grade 2 Magnetism

- Magnetism demonstrates that there are forces we cannot see that act upon objects
- Most magnets contain iron
- Lodestones: naturally occurring magnets
- Magnetic poles: north-seeking and south-seeking poles
- Magnetic field (strongest at the poles)
- Law of magnetic attraction: unlike poles attract, like poles repel
- The earth behaves as if it were a huge magnet: north and south magnetic poles (near, but not the same as, geographic North Pole and South Pole)
- Orienteering: use of a magnetized needle in a compass, which will always point to the north

Grade 2 Simple Machines

- Types of simple machines (e.g., wheel-and-axle, gears [wheels with teeth and notches], how gears work, and familiar uses such as bicycles)
- Friction, and ways to reduce friction (lubricants, rollers, etc.)

Grade 3 Sound

- Sound is caused by an object vibrating rapidly
- Sounds travel through solids, liquids, and gases
- Sound waves are much slower than light waves

Grade 4 Electricity

- Conductors versus insulators
- Electromagnets: how they work and their common uses

Grade 4 Chemistry

- atoms, molecules, and compounds
- properties of matter
- mass, volume, density, and vacuums
- elements
- solutions

Grade 5 Chemistry

- molecules and compounds
- chemical and physical changes

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.*

Matter

atom, *element, compound, molecule, electron, neutron, proton, nucleus,* ***particle***, *unit, matter,* ***substance***, *material, piece, part, component, solid, liquid, gas,* ***state***, *example, water, ice,* ***vapor***, ***(in)visible***, *steam,* ***mixture***, *combination, pure, (un)common, rare, subatomic, positive, negative, neutral, charge, electric, chemical, combine,* ***characteristic***, ***property***, ***melt***, ***freeze***, *solidify,* ***boil***, *vaporize, evaporation, condense, condensation,* ***change***, ***heat,*** *thermal, hydrogen, helium, oxygen, iron, gold, calcium, [names of other common elements and compounds]*

Properties of matter

property, ***characteristic***, *unique, different, similar, alike,* ***tool***, *instrument, unit, standard,* ***shape***, *[names of geometric shapes],* ***size***, *dimension, width, height,* ***inch***, ***foot***, *meter, centimeter,* ***ruler,*** *measuring stick, yardstick, [other words associated with length],* ***weight***, *pounds, ounces, scale, balance,* ***volume***, *space,* ***capacity***, *gallon, quart, cup, pint, liter, color, [names of different colors],* ***texture***, *feeling, sensation, rough, smooth, bumpy, slick, soft, fuzzy, [examples of materials with different textures],* ***temperature***, ***thermometer***, ***degree***, *Fahrenheit, Celsius,* ***heat***, *hot, warm, cold, cool, expand, contract,* ***pattern***, ***observe***, *measure,* ***record***, *note,* ***classify***, *communicate, present,* ***evidence***, *argument,* ***explain***, ***describe***

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: "Clouds and fog are gases." or "Visible steam/mist is an example of gas."
When in its gaseous state, water is invisible to the naked eye. Visible steam, clouds, and fog are examples of *mixtures* of invisible water vapor and small liquid water droplets that are suspended in air. Teachers and textbooks often overgeneralize the concept of "mixing clouds," formally referred to as colloids and aerosols, and inaccurately classify a steam cloud rising from a tea kettle or even fog as just a gas. The existence of water vapor in the atmosphere can be difficult for students to understand even into the middle school grades (Lee. et. al, 1993; Johnson, 1998). The focus of this Grade 1 unit should be on an introduction to water vapor as an example of the gaseous state of water. Grades 2 and 4 will provide specialized instruction to address potential misconceptions such as, "When water evaporates it ceases to exist" and "Evaporated water is still liquid, but it has changed locations." Using examples of steam and clouds can provide concrete examples of phenomena that often occur when water transitions between one state of matter and another.

Misconception: "Ice cubes give off cold."
Students often think of 'cold' as being it's own force or phenomena, rather than as the absence of heat.

Misconception: "Air and oxygen are the same thing."

Air is a mixture of gases, including nitrogen, oxygen, argon, carbon dioxide, and water vapor. The concept of mixtures, especially invisible mixtures, are abstract for students and difficult to describe and understand accurately. Teachers should plan their language of instruction carefully to avoid inadvertently reinforcing misconceptions.

Key points for instruction:

Common usage of the terms *material* and *stuff* may surface during discussions with students about matter. "Although the word *stuff* may not be accepted as a scientific word, it has tangible connotations for students and therefore is useful for developing the idea that there are different kinds of 'stuff' with different properties." (Keeley, 2013) Students may also use the term *material* to mean the component pieces of an object—for example, fabrics are made of smaller material. (Driver, et. al., 1994) Students may also classify only things that they can feel (i.e., that have "felt weight") as being matter. Many students may believe that gases are not matter because they cannot feel their weight and/or describe and classify matter based upon the weight of the samples at hand.

Consider reading more about common misconceptions and key points for instruction offered by Ohio State University's College of Education and Human Ecology: Common Misconceptions about States and Changes of Matter. The OSU project, *Beyond Penguins and Polar Bears*, is an excellent resource for teachers to learn more about misconceptions and broader implications for learning about a variety of scientific topics.

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 characteristics of matter
- Identify common features found among solids (2-ESS2-3)
- Describe characteristics of liquids (2-PS1-4 and 2-ESS2-3)
- Describe water vapor (2-PS1-4 and 2-ESS2-3)

Middle

- 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

End

- Measure objects using nonstandard units
- Determine when objects should be measured in inches or feet
- Compare the volume of pints, quarts, and gallons
- Describe how measuring the temperature helps us in our everyday lives

Potential Big Guiding Questions

Essential Questions:

- **What are physical properties of matter?**
- **How can measuring properties of matter help us describe and classify objects?**

RE: States of Matter

- How do we describe objects?
- How do you think the ice cubes (a solid) changed into a liquid?
- Where are ice cubes stored? Why do you think that is important?
- How is the shape of liquids different from solids?

RE: Measurement

- How can we measure matter?
- Why are standards of measure important?
- This object is very long/short—should we measure it in inches or feet?
- Why can't we measure water with a ruler?
- Do solids have volume?
- What are some items you may buy from the grocery store that come in gallon/quart?
- Why would we want to measure the temperature?

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: (End of Unit 5)

{Evaluates Student Mastery of Objectives*: Determine when objects should be measured in inches or feet* and *Measure objects using non-standard units***}**

Advance Preparation:

- Clearly label "measuring stations" around your classroom — items in the classroom that you would like students to measure (e.g., a pencil, a desk, a table, chart paper, eraser for a chalkboard or whiteboard, a book, etc.).
- Place in a folder/envelope approximately 9–12 non-standard "inch" measuring tools (i.e., paper cut-outs measuring one inch each) for each small group of students.
- Place in a folder/envelope approximately 4–5 non-standard "foot" measuring tools (i.e., paper cut-outs measuring one foot each) for each small group of students (Consider printing these "foot" measuring tools in a different color than the "inch" measuring tools.).
- Create an assessment handout for students to 1) identify the measuring tool used, 2) record the object's (approximate) measurements in non-standard units, and 3) describe their rationale using pictures, phrases, or sentences. **Note:** Since these are real objects around your room, the expected student answers will not measure exactly to "x" number of inches or feet. Therefore, it will be important to explain to students that their measurements are approximations. They should only include the whole number of inches or feet that fit within the object—refraining from going over.
- Acquire a notebook or note-taking sheet to record student responses/descriptions (i.e., why they decided to measure their object in feet or inches).

Task Assessment: Invite students to measure different items in the classroom in feet or inches and to use the assessment handout to record their measurements and thinking.

Provide each small group of students with both a set of "inch" measuring tools and a set of "feet" measuring tools. Assign, or ask students to select, items they wish to measure in small groups. Once students are positioned at their stations, ask them to determine if they should measure the objects in inches or feet, and then measure the items using the corresponding tools. As necessary, remind students (or model) how to line up the measuring tools in order to accurately measure the objects. As you rotate and meet with each group, ask them to explain their rationales for measuring in feet or inches. The goal is for students to recognize that items that appear to be longer (i.e., longer than one foot) can be easily measured with a longer measuring tool—in feet. Likewise, if the object appears short in length, it may be easier to try a shorter measurement tool—inches. If students try to measure long objects in inches, ask

them to think about the benefit to measuring in feet (e.g., they can measure in feet more quickly because they would need fewer "feet" than "inches" to measure the entire objects, so they are less likely to make errors, etc.). Allow students the opportunity to rotate to different stations and record their findings for various objects. Be sure to meet with each group as they work.

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: (End of Unit 5)

{Contributes to the Objective: *Measure objects using non-standard units***}**

Activity: Show the students two sets of sentence strips. Ask them to describe what they see. One set is comprised of sentence strips that are all the exact same length. The other group contains strips of different lengths.

T - What do you notice about these two groups of strips? (Students should indicate that each strip in the first pile is the same length and the lengths differ in the second pile.)

T - Let's measure the length an object, and see what happens when I measure it using units of the same length compared to units of varying lengths.

Using a long strip of paper (e.g., a sentence strip) explain that you will model how to use a measuring tool to accurately measure the length of an object. Begin by lining up the edge of the sentence strip with the edge of an object, then place a second sentence strip right up against where the first ended. Continue until you have measured the full length of the object. Ask the students to count the strips.

T - How many sentence strips did we use? That means that the object is x sentence strips long. Let's see what happens when I measure using strips of varying lengths. (Repeat the process from above.)

T - What happened? (Students should indicate that they recorded two different lengths [x sentence strips long and x sentence strips long]).

Using student volunteers, repeat this process with a different pile of sentence strips (same size as the first) and another pile with different sizes. Use this second opportunity to model how to appropriately measure objects.

T - What happened the second time? Which measurement stayed the same, which was different?

Encourage students to think about problems that might arise if people were to measure objects (e.g., furniture, building materials, property lines, etc.) using units of different lengths.

T - We are going to take turns measuring similar objects using paper clips, which are all the same length. What should happen? (Students should indicate that their measurements should all be the same)

Conduct the activity. As students work, rotate around the room to provide feedback and support. After students have had the opportunity to measure several objects, ask them to share the length of each object in paper clips. If some groups arrived at different measurements, lead students in a discussion to brainstorm how this could have happened (e.g., students may not have properly lined up the paper clips, overlapped paper clips, etc.).

Example #2: (End of Unit 5)

{Contributes to the Objective: *Compare the volume of pints, quarts, and gallons***}**

Advance Preparation: In order to complete this activity students will need to have access to water, measuring tools (i.e., cup[s], pint[s[, quart[s], and gallon[s], a writing utensil, and a recording sheet [see examples]).

1 cup	
1 pint	= _____ cups
1 quart	= _____ pints
1 gallon	= _____ quarts

Activity: Invite children to investigate the relationship between cups, pints, quarts, and gallons. Provide children with a measuring cup and a pint, a quart, and a gallon container as well as a recording sheet and writing utensil. Ask them to fill the cup with water and transfer the water to the pint. Tell them to continue this until the pint is full. Have them note the number of cups it took to fill the pint on their recording sheet. Next have them pour the water from the pint into the quart. Encourage them to fill the pint with water and transfer it to the quart until the quart is full. Again ask them to record the number of pints it took to fill the quart. They can then repeat this process to see how many quarts it takes to fill a gallon.

Websites & Media

Images of the States of Matter:

Multimedia examples of the states of matter can be powerful discussion starters that can kickstart your students' thinking. For example, macro images of snowflakes and water droplets can offer something concrete for students to connect their learning to past experiences. You might also consider connecting this unit to your students' previous study of geysers (Unit 3 *Introduction to Geology*) by using images and/or video of a geyser such as the Castle Geyser in Yellowstone National Park, to introduce or extend your discussions of gases and mixing clouds. Images and videos of high winds can also be effective examples to engage students in early discussions about invisible gases.

BrainPop Video—The States of Matter:
https://www.brainpop.com/science/matterandchemistry/statesofmatter/

Consider discussing this video with your Grade 1 students, especially the section beginning at 00:27 seconds and ending at minute 03:23. This 3-minute portion can offer your students a sneak peak into the causes of the different states of matter. While this video goes beyond the expectations of what your students will be required to explain at this grade level, it offers an excellent introduction to important vocabulary and examples that will be extended in upper elementary units, such as Grade 4 Unit 2 *Chemistry: Basic Terms & Concepts*. Be sure to consider the possible misconceptions that students may have and/or generate during this unit and craft your questions carefully to tease out what your students are thinking.

Supplemental Trade Books

- *How Big is a Foot?*, by Rolf Myller (Random House Children's Books, 1991). ISBN 0440404959
- *How Tall, How Short, How Faraway,* by David Adler (Holiday House, 1999). ISBN 0823416321
- *Room for Ripley,* by Stuart Murphy (HarperCollins, 1999). ISBN 0060276207
- *Super Sand Castle Saturday,* by Stuart Murphy (Harper Trophy, 1999). ISBN 0064467201
- *Twelve Snails to One Lizard: A Tale of Mischief and Measurement,* by Susan Hightower (Simon and Schuster, 1997). ISBN 0689804520