Grade 7 Science, Quarter 2, Unit 2.1

# Properties of Matter

## Overview

**Number of instructional days:** 15 (1 day = 50 minutes)

### Content to be learned

- Identify different substances using data about characteristic properties of matter including melting and boiling point, density, and solubility.
- Compare different substances using data about characteristic properties of matter.
- Classify different substances using data about characteristic properties of matter.
- Classify and compare substances as solids, liquids, or gases using characteristic properties.
- Classify and compare substances as metals or nonmetals using characteristic properties.
- Given a diagram, classify matter as atoms or molecules.
- Classify matter as elements or compounds.
- Use diagrams and models to show the difference between atoms and molecules.
- Explain that, when a substance undergoes physical changes, the physical appearance may change.
- Explain that, when a substance undergoes physical changes, the chemical make-up and its chemical properties do not change.

### Science processes to be integrated

- Identify and compare characteristic properties of matter.
- Classify substances.
- Use information to classify matter.
- Use models and diagrams to classify matter.
- Use models and analyze models.
- Make scientific explanations.

### Essential questions

- How can characteristic properties be used to identify a substance?
- How does a physical change result in a different physical appearance, but not a new substance?
- How are atoms and molecules different and how does the difference relate to the classification of elements and compounds?

# Written Curriculum

## Grade Span Expectations

**PS1 - All living and nonliving things are composed of matter having characteristic properties that distinguish one substance from another (independent of size or amount of substance).**

***PS1 (5-8) INQ+POC –2***

*Given data about characteristic properties of matter (e.g., melting and boiling points, density, solubility) identify, compare, or classify different substances.*

**PS1 (7-8) –2 Students demonstrate an understanding of characteristic properties of matter by …**

**2b** classifying and comparing substances using characteristic properties (e.g., solid, liquid, gas; metal, non-metal).

***PS1 (5-8) MAS –5***

*Given graphic or written information, classify matter as atom/molecule or element/compound (Not the structure of an atom).*

**PS1 (7-8) – 5 Students demonstrate an understanding of the structure of matter by …**

**5a** using models or diagrams to show the difference between atoms and molecules.

**5e** explaining that when substances undergo physical changes, the appearance may change but the chemical makeup and chemical properties do not.

## Clarifying the Standards

*Prior Learning*

In grades K–2, students identified, described, and compared properties of solids and liquids. They also made logical predictions about the changes in the state of matter when adding or taking away heat. Students used simple tools to measure and explore the property of weight.

In grades 3–4, students continued to identify, describe, and compare the properties of solids and liquids, but also added gases. They also used measures of weight to prove that the whole equals the sum of its parts and to show that the weight of an object remains the same despite a change in its shape.

In grades 5–6, students recognized that different substances have properties that allow them to be identified regardless of the size of the sample. They also classified and compared substances using characteristic properties. Students also explained that, regardless of how parts of an object are arranged, the mass of the whole is always the same as the sum of the masses of its parts.

*Current Learning*

The instructional levels appropriate for this content are developmental and reinforcement. Instruction around the structure of atoms and molecules should be at the developmental level because students have not been exposed to the structure of atoms and molecules prior to this unit. It is important to remember that students will simply be distinguishing between atoms and molecules; they are not examining the

subatomic structure of atoms. This instruction will take place in high school. Students are also being introduced to chemical changes and chemical properties. Because students have had previous instruction about the properties of matter, this instruction should begin at the level of drill and practice, however instruction about the characteristic properties of metals and nonmetals is to be provided at the developmental level.

In this unit of study, students will focus on the study of the properties of specific types of matter (metals and nonmetals) and on the structure of atoms and molecules. They will use this knowledge to learn how chemical changes are different from physical changes. Learning about chemical changes is very new to students. They have learned about physical changes since elementary school. Now that students have a solid understanding of that concept, they will learn how a chemical change in a substance will result in the characteristic properties of the new substance.

In order to meet the requirements of the standards, scientific processes must be embedded in this instruction. When learning about atoms and molecules, students will need to use models that will make it possible for them to visualize the differences between these levels of organization of matter. Models may be physical or conceptual. What is important is that students understand that atoms are arranged differently. Models will also need to be used when students learn about the differences between physical and chemical changes. When they are learning about the characteristic properties of metals and nonmetals, students will need to be able to recognize the patterns that exist as you move from examining one to the other. The periodic table is an excellent way to identify these patterns. All of the above instruction must be based in inquiry. The type of inquiry can vary.

While learning this information, students could begin with information that is somewhat familiar to them by reviewing what they know about the properties of matter. They could then transition to an examination of the periodic table to determine that materials are grouped based on their physical properties. Using the periodic table, students could then determine how the physical properties of metals are different from the physical properties of nonmetals. In order to meet the requirements of inquiry, it is important that students are not told the differences. Instead, they need to use the periodic table as a data source that they use to ask and answer questions about metals and nonmetals. In addition to this, students can also examine physical examples of metals and nonmetals to determine if the information that they collected matches actual samples of matter from both groups of substances.

When studying atoms and molecules, students can begin with the periodic table and study models of atoms and molecules that are made up of more than one atom. They can then examine models of molecules and determine what distinguishes one from the other. After students have an understanding of atoms and molecules, students can then examine physical and chemical changes to determine how the properties of the substance respond to change. Students have already studied physical changes; therefore this knowledge can be applied to their new learning about chemical changes. Because students will not be introduced to chemical symbols and formulas until grade 8, it is important to use word equations and actual demonstrations of chemical changes to help students understand and internalize this learning.

*Future Learning*

In grade 8 and high school, students will classify common elements and compounds using symbols and chemical formulas. Students will interpret symbols and formulas of chemical equations beginning with simple examples. They will use symbols and chemical formulas to show the chemical rearrangements that produce a new substance in a chemical change and will identify new substances that result from chemical change. Students will learn that, when new substances are formed due to chemical change, the properties of the new substance may be very different from the original substances. Students will use the periodic table on multiple occasions to identify elements, pure substances, and complex compounds.

## Additional Research Findings

According to the *Atlas of Science Literacy*, students commonly fail to understand that weight and volume are conserved in objects that change shape or state of matter (p. 56).

*Benchmarks for Science Literacy* states that the scientific understanding of atoms and molecules requires combining two closely related ideas: All substances are composed of invisible particles, and all substances are made up of a limited number of basic ingredients, or "elements." These ideas merge into the idea that combining particles of the basic ingredients differently leads to millions of materials with different properties (p. 75).

Finally, *Making Sense of Secondary Science* states that students in early grades maintain a continuous (non-particulate) view of chemical substances and need to understand that each element or compound can be represented as a structure or pattern of component units—atoms or molecules (p. 96).

Grade 7 Science, Quarter 2, Unit 2.2

# Forces and Motion

## Overview

**Number of instructional days:** 25 (1 day = 50 minutes)

### Content to be learned

- Determine or predict the net effect of multiple forces on the position, speed, and direction of motion of objects using data.
- Measure distance and time of a moving object.
- Use measured values to calculate speed of an object using $s = d/t$.
- Differentiate among speed, velocity, and acceleration.
- Differentiate between balanced and unbalanced forces.
- Predict and test the effect of unbalanced forces on the speed or direction of motion on an object.

### Science processes to be integrated

- Given examples, make predictions based on data.
- Use tools to measure variables.
- Use formulas to calculate.
- Explain and give/show examples to differentiate system parts.
- Collect and use experimental data to draw conclusions.

### Essential questions

- How does changing the amount of time an object takes to move a certain distance affect the speed of that object?
- How do you know an object is accelerating?
- What is the net effect on the speed or direction or both of an object when acted upon by unbalanced forces?

# Written Curriculum

## Grade Span Expectations

**PS 3 – The motion of an object is affected by forces.**

***PS3 (5-8) INQ+ POC -8***

*Use data to determine or predict the overall net effect of multiple forces (e.g. friction, gravitational, magnetic) on the position, speed, and direction of motion of objects.*

**PS3 (7-8) -8 Students demonstrate an understanding of motion by…**

**8a** measuring distance and time for a moving object and using those values as well as the relationship s=d/t to calculate speed ~~and graphically represent the data~~.

**8c** differentiating among speed, velocity, and acceleration.

**8d** making and testing predictions on how unbalanced forces acting on objects change speed or direction of motion, or both.

*Prior Learning*

In grades K–2, students showed how pushing and pulling does or does not move an object and also predicted the direction that an object will or will not move if a force is applied to it. Students also showed that different objects fall to earth unless something is holding it up.

In grades 3–4, students described a change in position relative to other objects or backgrounds. Students investigated and described that different amounts of force can change the direction or speed of an object in motion. They also extended their learning from K–2 by conducted experiments to demonstrate that different objects fall to earth unless something is holding them up.

In grades 5–6, students used data or graphs to compare the relative speed of objects. Students also added to previous learning about pushing and pulling by recognizing that a force is a push or pull. Students then explained that forces cause changes in speed or direction of motion.

*Current Learning*

Students have learned about speed in previous grades, however the use of the formula $s = d/t$ is new to students and instruction about this formula needs to begin at a developmental level. The concepts of velocity and acceleration are also new to students and instruction should be at the developmental level. Students learn about unbalanced forces for the first time.

In this unit of study, students use the formula $s = d/t$ to study the relationship between distance and time in relation to speed. Students measure the distance and time of a moving object and explain and give/show examples to differentiate between speed, velocity, and acceleration. Students also test, collect data, and predict the effect of unbalanced forces on the movement of an object.

In order to meet the requirement of the standards, inquiry and the identification of patterns of change must be embedded into student learning. When students are using the formula $s = d/t$, students must not only be able to calculate the speed of an object, but also to identify patterns in data. Some examples include being

able to predict what happens to speed if distance remains the same, but time decreases or increases. When students are learning the difference between speed, velocity, and acceleration, they must be involved in scientific inquiry. When studying about unbalanced forces, students will need to perform investigations that make it possible for them to make their own predictions and then test those predictions. It is important that students ask the questions, make the predictions, then test their predictions.

*Future Learning*

From eighth grade to high school, students will graphically represent speed and acceleration based on data. They will solve for any variable when using the formula $s = d/t$. They will learn that the acceleration of an object is proportional to the force on the object and inversely proportional to the mass of the object. They will also differentiate between mass and weight.

Students will use different reference planes to predict and/or graph the path of an object when explaining how and why that motion occurs. The movement of a free-falling object will be thoroughly investigated.

## Additional Research Findings

According to *Making Sense of Secondary Science,* learners tend to think of a force as a property of a single object, rather than as a feature of interaction between two objects (p. 149). The earlier the connections are made in proportional reasoning (speed being proportional to acceleration), the stronger the foundation for understanding in differentiation between the terms (p. 155). Students have difficulty associating a "kick" or a "throw" with a "push" (p. 150).

*National Science Education Standards* state that students in grades 5–8 associate force with motion and have difficulty understanding balanced forces in equilibrium. Students easily understand that the book is pushing down on the desk, but have difficulty understanding that the desk is pushing up on the book when forces are balanced (p. 154).

*Benchmarks for Science Literacy* states that students have no trouble believing that an object at rest stays that way unless acted on by a force, but have difficulty with the idea that an object in motion will stay in motion unless acted on by a force (p. 90).