Grade 8 Science, Quarter 2, Unit 2.1

Characteristic Properties of Matter

Overview

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

Content to be learned

- Measure the mass and volume of regular and irregular objects.
- Investigate the relationships among mass, volume, and density.
- Calculate the density by measuring mass and volume and use the relationship: $D = m/v$.
- Differentiate between mass and weight.
- Identify, compare, or classify different substances using their characteristic properties.
- Identify an unknown substance given its characteristic properties.

Science processes to be integrated

- Use measuring tools.
- Calculate for an unknown variable when given a formula.
- Identify an unknown substance based on characteristic properties.
- Communicate differences and similarities.
- Cite evidence to demonstrate understanding.
- Make scientific comparisons.
- Make scientific classifications.
- Use symbols and formulas.
- Explain cause-and-effect relationships.
- Make scientific predictions.

Essential questions

- How does measuring and calculating the density of an irregular-shaped object compare to measuring and calculating the density of a regular-shaped object?
- Why do factors in an environment cause the weight of objects to change even though the mass does not change?
- What processes could be used to identify and classify a group of unknown substances?
- If the mass of a substance remains constant while its volume increases, what happens to its density?

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-1

Investigate the relationships among mass, volume and density.

PS1 (7-8) –1 Students demonstrate an understanding of characteristic properties of matter by …

1a measuring mass and volume of both regular and irregular objects and using those values as well as the relationship D=m/v to calculate density.

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 force (e.g., friction, gravitational, magnetic) by…

8f differentiating between mass and weight.

PS1 - See above.

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 …

2a identifying an unknown substance given its characteristic properties.

Clarifying the Standards

Prior Learning

In grades K–2, students identified, described, and compared properties of solids and liquids. They used simple tools to measure and explore the property of weight.

In grades 3 and 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 and 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.

In grade 7, students used data about characteristic properties to classify and compare substances. They explained that when substances undergo physical changes, the appearance may change but the chemical makeup and chemical properties do not.

Current Learning

While the concepts for the content in this unit of study are somewhat familiar to students, how students must use that information is very new. For this reason, the majority of the instruction during this unit is at the developmental level. This is the first time that students are required to calculate density, differentiate between mass and weight, and identify unknowns using characteristic properties.

One of the most important concepts in science is density. To teach this, the student must first understand the difference between the mass and weight of an object. It is important that student mastery of the concept of mass and weight be addressed before students attempt to understand density. After students understand the difference between mass and weight, it is possible to address the concept of density. One way to address this concept is to have students compare the densities of known objects and predict which substances will float in water. Student are able to see that some objects can have the same volume but the material that they are made up of causes them to have different densities. For example, when a can of regular Coke, which is made with sugar, is placed in a container of water, it sinks. When a diet Coke is placed in a container of water, it floats because it is made with an artificial sweetener that has fewer or smaller particles per unit of volume when compared to sugar.

Students have had a great deal of experience identifying the physical properties of a substance. In this unit of study, they apply that knowledge to an understanding of the characteristic properties of a substance. Students can apply their new understanding of density as they identify substances based on their characteristic properties.

Future Learning

In high school, students will investigate and measure gases. They will predict characteristic properties of matter based on location on the periodic table. Students will demonstrate an understanding of the characteristic properties of matter by using data and advances in technology to explain how the understanding of atomic structure has changed over time. They will also identify and explain the basis for the arrangement of the elements within the periodic table and predict the relative chemical and physical properties of an element based on its location within the periodic table. Students will also further their understanding of the particle nature of matter by utilizing data to distinguish one substance from another or identify an unknown substance and determine the degree of change in pressure of a given volume of gas when the temperature changes incrementally.

Students will demonstrate an understanding of the structure of matter by comparing the three subatomic particles of atoms and their location within an atom, their relative mass, and their charge.

Additional Findings

The structure of matter is difficult for this grade span … when students first begin to understand atoms, they cannot confidently make the distinction between atoms and molecules or make distinctions that depend upon it—among elements, mixtures, and compounds, or between "chemical" and "physical" changes. An understanding of how things happen on the atomic level—making and breaking bonds—is more important than memorizing the official definitions (which are not so clear in modern chemistry anyway). Definitions can, of course, be memorized with no understanding at all. Going into details of the structure of the atom is unnecessary at this level, and holding back makes sense. By the end of grade 8, students should have sufficient grasp of the general idea that a wide variety of phenomena can be explained by alternative arrangements of vast numbers of invisibly tiny, moving parts. Possible differences in atoms of the same element should be avoided at this stage. (*Benchmarks for Science Literacy,* p. 77)

Elementary and middle school students may think everything that exists is matter, including heat, light, and electricity. Alternatively, students may believe that matter does not include liquids and gases or that they are weightless materials. With specially designed instruction, some middle school students can learn the scientific notion of matter. Middle and high school students are deeply committed to a theory of continuous matter. Although some students may think that substances can be divided up into small particles, they do not recognize the particles as building blocks, but as formed, basically continuous, substances under certain conditions. Students at the end of elementary school and beginning of middle school may be at different points in their conceptualization of a theory of matter. Although some third graders may start seeing weight as a fundamental property of all matter, many students in grades 6 and 7 still appear to think of weight simply as "felt weight"—something whose weight they cannot feel is considered to have no weight at all. Accordingly, some students believe that if you keep dividing a piece of Styrofoam, you soon obtain a piece that weighs nothing. (*Atlas for Science Literacy*, p. 54)

Students cannot understand conservation of matter and weight if they do not understand what matter is, accept weight as an intrinsic property of matter, or distinguish between weight and density.

Grade 8 Science, Quarter 2, Unit 2.2

Molecular Motion

Overview

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

Content to be learned

- Create diagrams or models that represent the states of matter at the molecular level.
- Explain the effect of increased and decreased heat energy on the motion and arrangement of molecules.
- Observe and describe the physical processes of evaporation and condensation as well as freezing and melting in terms of molecular motion and conservation of mass.

Science processes to be integrated

- Communicate differences and similarities.
- Create a diagram or model.
- Observe and explain how a change in energy can affect the motion and arrangement of molecules.
- Explain cause-and-effect relationships.
- Make scientific predictions.

Essential questions

- Why do changes in the amount of heat energy affect the motion and arrangement of molecules that make up a substance?
- How do the position and arrangement of the molecules change in different states of matter at the molecular level?
- How can molecular motion and conservation of mass be used to describe what happens as a substance goes through the physical processes of evaporation, condensation, freezing, and melting?

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+ SAE –3

Collect data or use data provided to infer or predict that the total amount of mass in a closed system stays the same, regardless of how substances interact (conservation of matter).

PS1 (7-8) –3 Students demonstrate an understanding of conservation of matter by …

3a citing evidence to conclude that the amount of matter before and after undergoing a physical or a chemical change in a closed system remains the same.

PS1 (5-8) SAE+MAS – 4

Represent or explain the relationship between or among energy, molecular motion, temperature, and states of matter.

PS1 (7-8) – 4 Students demonstrate an understanding of states of matter by …

4a creating diagrams or models that represent the states of matter at the molecular level.

4b explaining the effect of increased and decreased heat energy on the motion and arrangement of molecules.

4c observing the physical processes of evaporation and condensation, or freezing and melting, and describe these changes in terms of molecular motion and conservation of mass**.**

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.

In grades 3 and 4, students continued to identify, describe, and compare the properties of solids and liquids but also added gases. They continued to make logical predictions about changes in the state of matter and phase changes, including evaporation and condensation.

In grades 5 and 6, students differentiated among the characteristics of solid, liquid, and gases. They continue to make predictions about the effects of heating and cooling on the physical state, now including its effect on volume and mass of a substance.

In grade 7, students designed a diagram or model that represents these states of matter at the molecular level. They also compared the motion of the molecules for a material through a change of energy and temperature.

Current Learning

While the concepts for the content in this unit of study are somewhat familiar to students, how students must use that information is very new. For this reason, the majority of the instruction during this unit is at the developmental level. Students use evidence to draw conclusions about the conservation of mass, use diagrams and models to represent changes of state at the molecular level, and explain the effect of heat on the motion and arrangement of molecules.

Having already learned the different states of matter, students use and create models and diagrams to show how the atoms and molecules are arranged in each state. These models should demonstrate that students understand that as the amount of heat increases, the motion of particles that make up a substance increases. The models and diagrams should also show that this increased motion causes particles to move further apart as they bump against each other. Students apply this understanding to the processes of melting, freezing, condensation, and evaporation. While students have an understanding of the states of matter, they have never made connections between these processes and the particle nature of matter. This understanding of the arrangement of matter in different substances can serve as a basis for understanding the differences in the molecular motion during phase changes with the addition or reduction of heat energy.

Students observe and collect data regarding the physical process of melting. They measure the mass of a sample of ice before and after melting. The data from this investigation support students' understanding of conversation of mass.

Future Learning

In high school, students will deepen their knowledge of kinetic theory to the atomic and subatomic level. They will balance chemical equations and illustrate and explain conservation of matter. Students will demonstrate an understanding of the structure of matter by comparing the three subatomic particles of atoms and their location within an atom, their relative mass, and their charge. They will write formulae for compounds, develop basic (excluding transition elements) models using electron structure, and explain/model how the electron configuration of atoms governs how atoms interact with one another (e.g., covalent, hydrogen, and ionic bonding).

Additional Findings

The structure of matter is difficult for this grade span … when students first begin to understand atoms, they cannot confidently make the distinction between atoms and molecules or make distinctions that depend upon it—among elements, mixtures, and compounds, or between "chemical" and "physical" changes. An understanding of how things happen on the atomic level—making and breaking bonds—is more important than memorizing the official definitions (which are not so clear in modern chemistry anyway). Definitions can, of course, be memorized with no understanding at all. Going into details of the structure of the atom is unnecessary at this level, and holding back makes sense. By the end of grade 8, students should have sufficient grasp of the general idea that a wide variety of phenomena can be explained by alternative arrangements of vast numbers of invisibly tiny, moving parts. Possible differences in atoms of the same element should be avoided at this stage. (*Benchmarks for Science Literacy,* p. 77)

Students rarely think energy is measurable and quantifiable. Students' alternative conceptualizations of energy influence their interpretations of textbook representations of energy. (*Atlas for Science Literacy*, p. 24)

Elementary and middle school students may think everything that exists is matter, including heat, light, and electricity. Alternatively, students may believe that matter does not include liquids and gases or that they are weightless materials. With specially designed instruction, some middle school students can learn the scientific notion of matter. Middle and high school students are deeply committed to a theory of continuous matter. Although some students may think that substances can be divided up into small particles, they do not recognize the particles as building blocks, but as formed, basically continuous, substances under certain conditions. Students at the end of elementary school and beginning of middle school may be at different points in their conceptualization of a theory of matter. Although some third graders may start seeing weight as a fundamental property of all matter, many students in grades 6 and 7 still appear to think of weight simply as "felt weight"—something whose weight they cannot feel is considered to have no weight at all. Accordingly, some students believe that if you keep dividing a piece of Styrofoam, you soon obtain a piece that weighs nothing. (*Atlas for Science Literacy*, p. 54)

Students cannot understand conservation of matter and weight if they do not understand what matter is, accept weight as an intrinsic property of matter, or distinguish between weight and density. By grade 5, many students can understand qualitatively that matter is conserved in transforming from solid to liquid. They also start to understand that matter is quantitatively conserved in transforming from solid to liquid and qualitatively in transforming from solid to liquid to gas—if the gas is visible. For chemical reactions, especially those that evolve or absorb gas, weight conservation is more difficult for students to grasp. Many students cannot discern weight conservation in some tasks until they are 15 years old. The ability to conserve weight in a task involving transformation from liquid to gas or solid to gas may rise from 5 percent in 9-year-old children to about 70 percent in 14- to 15-year-old children. More complex changes such as chemical reactions, especially those where gas is absorbed or released, are still more difficult to grasp as instances of weight conservation. (*Atlas for Science Literacy*, p. 56)

Students of all ages show a wide range of beliefs about the nature and behavior of particles. They lack an appreciation of the very small size of particles; believe there must be something in the space between particles; have difficulty in appreciating the intrinsic motion of particles in solids, liquids, and gases; and have problems in conceptualizing forces between particles. Despite these difficulties, there is some evidence that carefully designed instruction carried out over a long period of time may help middle school students develop correct ideas about particles. (*Atlas for Science Literacy*, p. 58)

Middle and high school student thinking about chemical change tends to be dominated by the obvious features of the change. For example, some students think that when something is burned in a closed container, it will weigh more because they see the smoke that was produced. Further, many students do not view chemical changes as interactions. They do not understand that substances can be formed by the recombination of atoms in the original substances. Rather, students see chemical change as the result of a separate change in the original substance—or changes, each one separate, in several original substances. For example, some students see the smoke formed when wood burns as having been driven out of the wood by the flame. (*Atlas for Science Literacy*, p. 60)

Grade 8 Science, Quarter 2, Unit 2.3

Chemical Changes

Overview

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

Content to be learned

- Cite evidence to conclude that the amount of matter before and after undergoing a physical or chemical change in a closed system remains the same.
- Interpret the symbols and formulas of simple chemical equations.
- Classify common elements and compounds using symbols and simple chemical formulas.
- Use symbols and chemical formulas to show simple chemical rearrangements that produce new substances.
- Explain that when substances undergo chemical changes to form new substances, the properties of the new combinations may be very different from those of the old.

Science processes to be integrated

- Use measuring tools.
- Communicate differences and similarities.
- Cite evidence to demonstrate understanding.
- Observe and explain how a change in energy can affect a system.
- Make scientific classifications.
- Use symbols and formulas.
- Explain cause-and-effect relationships.
- Make scientific predictions.

Essential questions

- What evidence could be used to prove that mass is conserved after physical and chemical changes?
- How can chemical equations be used to show what happens to matter as a result of a chemical change?
- What happens to the characteristic properties of a substance after it undergoes a chemical change?

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) 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 …

5b classifying common elements and compounds using symbols and simple chemical formulas.

5c interpreting the symbols and formulas of simple chemical equations.

5f explaining that when substances undergo chemical changes to form new substances, the properties of the new combinations may be very different from those of the old.

5d using symbols and chemical formulas to show simple chemical rearrangements that produce new substances (chemical change).

Clarifying the Standards

Prior Learning

In grades K–2, students ***[ADD LATER]***

[ADD GRADE 3]

In grade 4, students demonstrated an understanding of physical changes by observing and describing them (e.g., freezing, thawing).

In grades 5 and 6, students distinguished between solution, mixtures, and pure substances (i.e., compounds and elements). 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.

In grade 7, students used data about characteristic properties to classify and compare substances using characteristic properties. They also used models and diagrams to show the differences between atoms and molecules, but did not study the structure of an atom. Students explained that when substances undergo physical changes, the appearance may change but the chemical makeup and chemical properties do not.

Current Learning

While the concepts for the content in this unit of study are somewhat familiar to students, how students must use that information is very new. For this reason, the majority of the instruction during this unit is at the developmental level. This is the first time that students are required to use evidence to draw conclusions about the conservation of mass, use diagrams and models to represent changes of state at the

molecular level, show the arrangement of molecules, use chemical symbols and formulas to classify substances, interpret simple chemical equations, and show the rearrangement of matter when new substances are produced.

Students need to investigate physical and chemical changes and be able to provide evidence that the amount of matter has not changed in either case. One way to approach this lesson could be to activate prior student learning by leading a discussion or providing a demonstration to show students several examples of a physical change in a substance. For example, students tear a piece of paper in half, crush some chalk, or observe some ice melt. On the chalkboard, make two columns, with one labeled *Physical Change*. Discuss the significance of the fact that in a physical change the resulting substance is still the same substance. List these three examples under Physical Change on the chalkboard. To demonstrate a chemical change, light a match and let it burn. Look closely at the remaining carbon. Pour some zinc granules into hydrochloric acid and observe the violent bubbling reaction. Emphasize that in both of these instances, new substances resulted from a chemical reaction; a different recombination of atoms and/or molecules occurred. Write the term *Chemical Change* for the other column on the chalkboard and list these two examples under it. It is important that students are asked to observe the gases that are given off in each reaction. After these demonstrations, students can be led into the new content for this unit of study by analyzing the chemical equations for simple chemical changes like the change that occurs when an Alka-Seltzer-type tablet is dissolved in water ($NaHCO_3 + H_20 \rightarrow NaOH + H_2CO_3$). Students could be given opportunities to observe this chemical change, compare the properties of the reactants and products, and use the chemical formulas and equations to prove that the atoms found in the products are the same atoms found in the reactants. To help students understand that this conservation occurs in closed systems, they need to be given opportunities to compare reactions in closed and open systems. For example, students could compare the mass of the reactants in the Alka-Seltzer reaction to the products in a sealed container and the products in an open container and then account for the differences they observe.

Students need to classify elements and compounds by using symbols, chemical formulas, and chemical equations. When given simple equations, they should be able to distinguish common atoms, elements, and molecules of substances. Using their prior knowledge of metals and nonmetals, students analyze the symbols and formulas to classify the components.

Future Learning

In high school, students will investigate and measure gases. They will predict characteristic properties of matter based on location on the periodic table. Students will deepen their knowledge of kinetic theory to the atomic and subatomic level. They will balance chemical equations and illustrate and explain conservation of matter. Students will demonstrate an understanding of the characteristic properties of matter by using data and advances in technology to explain how the understanding of atomic structure has changed over time. They will also identify and explain the basis for the arrangement of the elements within the periodic table and predict the relative chemical and physical properties of an element based on its location within the periodic table.

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