Grade 8 Science, Quarter 2, Unit 2.1

Properties of Matter

Overview

Number of instructional days: 45 (1 day = 45 minutes)

Content to be learned

- Measure the mass and volume of regular and irregular objects.
- Calculate density by measuring mass and volume and use the relationship $D = m/v$.
- Differentiate between mass and weight.
- Identify an unknown substance given its characteristic properties.
- 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.
- 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 and freezing and melting in terms of molecular motion and conservation of mass.
- 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.
- Given a formula, calculate for an unknown variable.
- Identify an unknown substance based on characteristic properties.
- Communicate differences and similarities.
- Cite evidence to demonstrate understanding.
- Create a diagram or model.
- Observe and explain how a change in energy can affect a system.
- Make scientific comparisons.
- Make scientific classifications.
- Use symbols and formulas.
- Explain cause and effect relationships.

Essential questions

- How is measuring and calculating the density of an irregularly-shaped object different from measuring and calculating the density of a regularly-shaped object?
- Why are mass and weight not the same for objects regardless of their locations?
- What evidence could be used to prove that mass is conserved after physical and chemical changes?
- What is the effect of changes in the amount of heat energy on the motion and arrangement of molecules?
- What happens to the molecular motion and amount of mass in a substance as it undergoes a change in state?
- 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) 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.

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**.**

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

Prior to grade 8, students compared the mass/ weight of objects of equal volume. They understood that the mass/weight of an object remains the same despite its shape, and that the mass/weight of the whole equals the sum of its parts. Students used scientific tools to measure weight. They understood characteristic properties of solids, liquids, and gases (including metals and nonmetals) and investigated boiling point, melting point, solubility, and density. Students observed the physical processes of change of state. In upper grades, students developed an understanding of atoms and molecules. They distinguished between solutions, mixtures, and pure substances, and saw the difference between physical and chemical change.

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 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. 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 upon which the content in this unit of study is somewhat familiar to students, the use of that information is very new. For this reason, the majority of the instruction during this unit of study will be at the developmental level. This will be the first time that students will be required to calculate density, differentiate between mass and weight, identify unknowns using characteristic properties, use evidence to draw conclusions about the conservation of mass, use diagrams and models to represent changes of state at the molecular level, explain the effect of heat on the motion and arrangement of molecules, use chemical symbols and formulas to classify substances, and interpret simple chemical equations, and to show the rearrangement of matter when new substances are produced.

Students have already learned the different states of matter and are not going to use and create models and diagrams to show how the atoms and molecules are arranged in each state. Students can apply this understanding of the arrangement of matter in different substances as a basis for understanding the differences in the densities of substances.

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. So be sure to teach mass and weight first. One way to address this concept is to have students compare the densities of known objects such as Coke and Diet Coke. When a can of Coke, which is made with sugar, is placed in a container of water, it will sink.

When a Diet Coke is placed in a container of water, it will float, because it is made with an artificial sweetener that is less dense than sugar.

Students have had a great deal of experience identifying the physical properties of a substance. In this unit of study, students will 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.

Students will 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 lead a discussion and demonstration, showing the students several examples of changes in materials (physical changes) and ask them to describe what they observed. For example, tear a piece of paper in half, crush some chalk, or observe melting ice. On the chalkboard, make two columns—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 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 will be important that students are asked to observe the gases that are given off in each of these reactions. After these demonstrations, students could be given simple chemical equations for reactions like the change that occurs when Alka-selzer is dissolved in water. Students could be given opportunities to place water in a zipper-type plastic bag, add an Alka-seltzer to the water, quickly seal the bag, and watch the bag inflate. They could then compare what they see to the equation. These are just suggestions; many other types of activities could be used.

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 sub-atomic level. Students will balance chemical equations and will illustrate and explain conservation of matter.

Additional Research Findings

According to *Benchmarks for Science Literacy*:

> 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 the 8th grade, 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 (p. 77).

Atlas for Science Literacy states:

Students rarely think energy is measurable and quantifiable. Students' alternative conceptualizations of energy influence their interpretations of textbook representations of energy (p. 24).

Elementary- and middle-school students may think everything that exists is matter, including heat, light, and electricity. Alternatively, they 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-school 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 sixth and seventh grade still appear to think of weight simply as "felt weight"—something whose weight they can't feel is considered to have no weight at all. Accordingly, some students believe that if one keeps dividing a piece of Styrofoam, one would soon obtain a piece that weighed nothing (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 fifth grade, 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% in 9-year-old children to about 70% 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 (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 (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, they 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 (p. 60).

Notes About Resources and Materials

Cyr, M., Miaoulis, I., Padilla, M. (2002). *Chemical Building Blocks*. Upper Saddle River, NJ: Prentice Hall.

- PS1-1a p 22-28
- PS3-8f p 23
- PS1-4a p44-48
- PS1-4b,c p62-70

Frank, D., Little, J., Miller, S. (2004). *Chemical Interactions*. Upper Saddle River, NJ: Prentice Hall.

- PS1-3a p26-27
- PS1-5 p17-19, 24-31, 55

Helpful websites

- Lhsgems.org

  <http://www.lhsgems.org/index.html>
- Middleschoolscience.com

  <http://middleschoolscience.com/>
- Sciencespot.net

  <http://sciencespot.net/>
- Teach.genetics.utah.edu

  <http://teach.genetics.utah.edu/content/>
- Science-class.net/

  <http://science-class.net/>
- University of Texas Health Science Center

  <http://teachhealthk-12.uthscsa.edu/curriculum/pulmonary/pulmonary.asp>
- Educator's Reference Desk

  <http://www.eduref.org/cgi-bin/lessons.cgi/Science>
- Sciencenetlinks.com

  <http://www.sciencenetlinks.com>
- Jefferson County Schools, Science Online

  <http://classroom.jc-schools.net/sci-units/matter.htm>

- RIEPS Check for Middle School Science Resources

  <http://rieps.rsmart.com/xsl-portal>