

**Context**

Matter is anything that has mass and takes up space. Elements are the simplest characteristic forms of matter and can be combined to make compounds and mixtures. Different elements, compounds, and mixtures can be identified by physical and chemical characteristics. These differences define everything around us including ourselves.

**Essential Questions**

- What is matter?
- What are elements, compounds, substances and mixtures?
- What is the difference between a physical and a chemical property?
- How are the states of matter different?
- How does matter change from one state to another?

**Enduring Understandings**

- Matter is anything that has mass and takes up space. Mass is a measurement of the amount of matter.
- Elements are the simplest particles of matter that retain certain properties, while compounds are combinations of elements.
- Different types of matter have characteristic properties which may be physical or chemical.
- A pure substance is matter with a definite and a constant composition. It is made of just one element or one compound. A mixture is a blend of two or more pure substances.
- The states of matter are solid, liquid, gas, and plasma.
- The kinetic theory of matter describes the movement of particles in matter, the amount of energy associated with the particles of matter, and states that particles are always in motion.
- Changes of state may occur when matter takes in or releases energy.

**Time**

Three to four 50-minute class periods.

**Grade Level**

Grades 6–8

**Differentiation**

Activities can be completed as one class group or can be assigned to individuals, small groups, or pairs according to ability and skill levels.

**Materials**

- Rosen Digital's [Core Concepts: Chemistry](#) database
- Supplement “States of Matter Chart”
- Index cards
- Paper and colored pencils
- Vinegar and baking soda or sugar
- Beakers or flasks
- Salt and water
- Sand
- Sawdust

- Food coloring
- Permanent marker
- Clay
- Straws

**Student Learning Objectives**

- Students will be able to define matter, mass and weight and categorize things as matter or not matter.
- Students will be able to describe and compare and contrast elements, compounds, pure substances, and mixtures.
- Students will describe properties of matter and distinguish between those that are physical and those that are chemical.
- Students will use the kinetic theory to describe the states of matter in terms of particle movement and energy as well as the energy involved in transitioning from one state to another.

**Next Generation Science Standards Addressed**

<b>MS-PS1-1.</b>	<b>Develop models to describe the atomic composition of simple molecules and extended structures.</b> [Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete description of all individual atoms in a complex molecule or extended structure is not required.]
<b>MS-PS1-3.</b>	<b>Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.</b> [Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Assessment is limited to qualitative information.]
<b>MS-PS1-4.</b>	<b>Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.</b> [Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawing and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]

**NGSS Science and Engineering Practices Addressed**

**Developing and Using Models:** Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. Develop a model to predict and/or describe phenomena. (MS-PS1-1), (MS-PS1-4)

**Obtaining, Evaluating, and Communicating Information:** Obtaining, evaluating, and communicating information in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods. Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or now supported by evidence. (MS-PS1-3)

**NGSS Crosscutting Concepts Addressed**

**Cause and Effect:** Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4)

**Scale, Proportion, and Quantity:** Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1-1)

**Structure and Function:** Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS1-3)

**Common Core ELA Standards Addressed**[RST.6-8.1](#)

Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

[RST.6-8.7](#)

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

**Introduction**

1. Introduce the concept of matter by asking students what they think matter is. Get several answers and discuss with the class.
2. Present students with cards labeled with different words and ask them to decide which represent matter and which do not. Examples of matter could include desk, rock, air, milk, the sun, salt, and a person. Examples of non-matter could include ideas, thoughts, gravity, heat, and sound.
3. Give the students the definition of matter as anything with mass and that takes up space or has volume. Ask them to reassess their answers in step 2 and discuss again as a class or in small groups.

**Elements, Compounds, Substances**

1. Define for students the terms *element*, *compound*, and *pure substance*.
  - a. Element – An element is the simplest form of matter and is made up of atoms.
  - b. Compound – A compound is a combination of two or more atoms held together by a chemical bond. A compound is formed as the product of a chemical reaction.
  - c. Pure Substance/Substance – A substance is matter that is made of just one element or just one compound.
2. Ask students if they can find objects in the room that are examples of elements, compounds, and pure substances. Have appropriate samples readily available for them to discover. If anyone picks out a mixture, introduce the concept of mixing substances and that they are no longer pure substances.

- a. elements may include metal samples like copper or zinc
  - b. compounds may include water, salt, or sugar
  - c. pure substances can be any of the above
3. Draw ball-and-stick models of basic molecules to show how compounds are made of two or more atoms of elements.
- a. Lead the class in drawing a simple compound, such as oxygen gas.
  - b. Direct the students to draw their own models of hydrogen gas, water, ammonia and methane. Guide the students as to the arrangement of atoms. Ask them to label each atom and each chemical bond holding them together.

## Properties of Matter

1. Ask students to describe the properties of the samples identified as elements or compounds in the previous section and list the discussed properties for the class.
2. Discuss physical properties and define a physical property as a trait that can be observed without changing the composition of a substance. Examples include color, size, odor, and temperature.
3. To introduce chemical properties, perform a simple demonstration of a chemical reaction. Ask students to observe and note the physical properties of the substances before they react and after. Make note of the fact that the properties changed because a new substance was created. Define a chemical property as the ability of a substance to react to create a new substance. Here are two options for a simple demonstration:
  - a. Add vinegar to baking soda in a flask or beaker.
  - b. Heat sugar in a beaker or flask over a hot plate until it caramelizes and then turns black.

## Mixtures

1. Introduce the concept of mixtures by combining salt and water. This can be done as a demonstration or by students individually or in small groups.
  - a. Ask students to make observations of properties before and after they are mixed.
  - b. Ask if they think that a reaction has occurred and why. Ask them to compare this to the vinegar and baking soda reaction to help distinguish between a chemical reaction and a mixture.
  - c. Define a mixture as a physical combination of two or more substances. Stress the difference between this and a chemical reaction. A chemical reaction produces a new substance and a mixture does not. Although they can't see the salt anymore, it is still there in the water. Stress that the salt and the water were pure substances and now they are a mixture.
2. Ask students to identify other mixtures in the room.
3. Mixtures can be separated using physical properties. Ask students to do the "[Separating Mixtures](#)" experiment from the Core Concepts: Chemistry article Chemistry and Metallurgy. It can be done individually or in small groups. Ask students to list the physical properties involved in separating out each part of the mixture.

## States of Matter

1. To introduce the states of matter and their properties ask students to use the lesson plan supplement "States of Matter Chart."
  - a. Each student fills in as many properties of each state that he or she can think of, as well as at least one example. Many students may not be familiar with plasma and may leave this blank.

