	Science
Holt, Rinehart, and Winston	**SciencePlus Technology and Society (Level Blue)**
Chapter 5	**A Case for Particles**

OVERVIEW

This chapter describes how scientists build the particle model of matter from what we know about **elements**, **compounds**, **solids**, **liquids**, and **gases**.

KEY TERMS

- **atoms:** indivisible particles that form the basic unit of an element
- **elements:** substances that can't be broken down into simpler substances by chemical means
- **molecules:** combinations of two or more atoms of the same or different elements
- **compounds:** a substance formed by the combination of two or more elements
- **solid**: a compact substance that can't be easily compressed
- **liquid:** a substance that can be compressed or poured into a container
- **gas**: a compressible substance with molecules that are far apart.

CHAPTER OUTLINE

Section 1: Constructing a case for particles

I. Scientists ask questions about matter to determine whether it is made of tiny particles.

- A. If Ice is taken out of a refrigerator, you might ask a question about where it goes when it melts.
  1. You might also ask how ice can be kept from disappearing.
- B. You might pour 50 ml of sand into one graduated 100ml cylinder and 50 ml of water into another.
  1. When the water is poured into the sand, the volume of the new mixture can be recorded.
  2. The same experiment can be repeated with 25ml of salt and 75 ml of water.
- C. Observations about the behavior of mixed substances might lead you to believe that matter is composed of tiny particles.
  1. Observations lead us to make the inference that the particles of one substance slip between the particles of another in a mixture.

Section 2: The invisible structure of matter

II. John Dalton experimented to verify the Democritus theory of atoms.

- A. 2000 years ago, Democritus proposed the theory that matter is built from tiny, indivisible particles called atoms.
- B. People were already aware that certain substances, such as gold, iron, and silver, did not break down into other substances.
  1. By 1735, alchemists added arsenic, zinc, and phosphorus to the list of basic elements.
  2. Hydrogen, nitrogen, and oxygen were discovered, as elements, between 1765 and 1775.
- C. In the 1800s, John Dalton knew that an electric current could separate water into hydrogen and oxygen.
  1. Dalton discovered that if he identified the amount of one element coming out of a quantity of water, he could predict the quantity of the other.
  2. If 16 grams of oxygen came out of a quantity of water, 2 grams of hydrogen would be produced.
- D. Based on his observations, Dalton formed physical models of water molecules out of clay.
  1. He built a 16-gram ball of oxygen and two 1-gram balls of oxygen.
- E. Dalton theorized that oxygen and hydrogen were both indivisible elements composed of "ultimate particles," and that water was a new substance formed oxygen and hydrogen combined.
  1. Dalton's "ultimate particles" resembled the atoms in the theory of Democritus.

F. Although Dalton couldn't see atoms, he made several inferences from observations about what he could see.
   1. Atoms of one element have a mass that differs from the mass of any other element.
   2. One atom of an element is identical to all other atoms of the element.
   3. An atom of one element can't be changed into an atom of another element.

III. Elements combine to form all of the compounds of substance found on Earth.

A. By the 20th century, scientists identified 92 natural elements on Earth.
   1. Elements are composed of atoms
   2. Elements can't be separated into simpler substances through chemical changes.

B. Molecules are tiny particles that combine two or more atoms of the same or different elements.
   1. Sugar, water, and carbon dioxide have molecules that combine different kinds of atoms.

C. Compounds are made from molecules that contain a combination of elements.
   1. A molecule of a compound is the smallest particle that retains the physical and chemical characteristics of the compound.

D. Chemical changes can break compounds down into elements.

Section 3: Sizes of particles

IV. If we experiment on two different compounds, we discover they may have different physical properties.

A. If we attempt to pass both sugar and starch through an egg membrane, sugar will pass, but starch will not.
   1. We might conclude that the molecules that compose sugar are smaller than the molecules that compose starch.

B. If particles are small enough to pass through openings the eye can't see, they must be very small.
   1. A great number of tiny particles are required to make even a tiny bit of matter that is visible to the eye.
   2. One drop of water contains $3x\ 10^{21}$ water molecules.

C. Some fabrics contain pores that are large enough to let water molecules through, but prevent the passage of water droplets.
   1. These fabrics will permit you to perspire and return water to the air without getting wet in the rain.

Section 4: Solids, liquids, and gases

I. Experiments can tell us about the properties of particles in solids, liquids, and gases.

A. If you push down on a syringe filled with air, you encounter resistance, but if the syringe is filled with air, there is a lot more resistance.
   1. If the syringe were filled with a solid, the syringe's plunger wouldn't move when you pushed on it.
   2. From this we can conclude that gas is the easiest form of matter to compress.

B. A liquid substance has particles that can be poured.

C. Particles in gases are far apart.

D. Particles in a solid are difficult to compress.

E. When heat is applied, a solid will melt to become liquid.
   1. When heat is applied, a liquid will evaporate to become a gas.
   2. The more heat that is present, the faster a liquid will evaporate.
   3. Heated particles move faster and diffuse more rapidly in a solution.
   4. The faster that gas particles move the more pressure they exert on the side of a container.
   5. In the absence of heat, the particles of a gas condense to form a liquid substance.