

Key Concepts

**2.1 Properties of Matter**

- Properties used to describe matter can be classified as extensive or intensive.
- Every sample of a given substance has identical intensive properties because every sample has the same composition.
- Three states of matter are solid, liquid, and gas.
- Physical changes can be classified as reversible or irreversible.

**2.2 Mixtures**

- Mixtures can be classified as heterogeneous mixtures or as homogeneous mixtures, based on the distribution of their components.
- Differences in physical properties can be used to separate mixtures.

**2.3 Elements and Compounds**

- Compounds can be broken down into simpler substances by chemical means, but elements cannot.
- If the composition of a material is fixed, the material is a substance. If the composition may vary, the material is a mixture.
- Chemists use chemical symbols to represent elements, and chemical formulas to represent compounds.

**2.4 Chemical Reactions**

- During a chemical change, the composition of matter always changes.
- Four possible clues to chemical change include a transfer of energy, a change in color, the production of a gas, or the formation of a precipitate.
- During any chemical reaction, the mass of the products is always equal to the mass of the reactants.

Vocabulary

- chemical change (p. 48)
- chemical property (p. 53)
- chemical reaction (p. 53)
- chemical symbol (p. 51)
- compound (p. 48)
- distillation (p. 47)
- element (p. 48)
- extensive property (p. 39)
- filtration (p. 46)
- gas (p. 42)
- heterogeneous mixture (p. 45)
- homogeneous mixture (p. 45)
- intensive property (p. 39)
- law of conservation of mass (p. 55)
- liquid (p. 41)
- mass (p. 39)
- mixture (p. 44)
- phase (p. 45)
- physical change (p. 42)
- physical property (p. 40)
- precipitate (p. 54)
- product (p. 53)
- reactant (p. 53)
- solid (p. 41)
- solution (p. 45)
- substance (p. 40)
- vapor (p. 42)
- volume (p. 39)

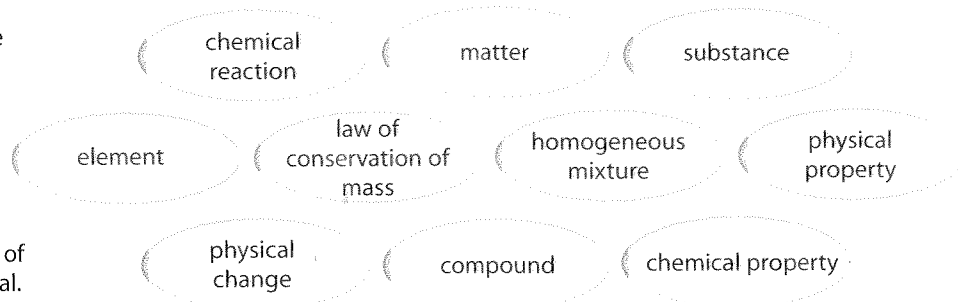
Organizing Information

Use these terms to construct a concept map that organizes the major ideas of this chapter.



Concept Map 2 Solve the Concept Map with the help of an interactive guided tutorial.

with ChemASAP



Reviewing Content

2.1 Properties of Matter

35. Describe the difference between an extensive property and an intensive property and give an example of each.
36. List three physical properties of copper.
37. Name two physical properties that could be used to distinguish between water and ethanol.
38. Name one physical property that could not be used to distinguish chlorine from oxygen.
39. What is the physical state of each of these materials at room temperature?
- | | |
|-----------|--------------|
| a. gold | b. gasoline |
| c. neon | d. olive oil |
| e. oxygen | f. mercury |
40. Fingernail-polish remover (mostly acetone) is a liquid at room temperature. Would you describe acetone in the gaseous state as a vapor or a gas? Explain your answer.
41. Compare the arrangements of individual particles in solids, liquids, and gases.
42. Use Table 2.1 to identify four substances that undergo a physical change if the temperature is reduced from 50°C to -50°C. What is the physical change that takes place in each case?
43. Explain why sharpening a pencil is a different type of physical change than freezing water to make ice cubes.

2.2 Mixtures

44. What is the difference between homogeneous mixtures and heterogeneous mixtures?
45. How many phases does a solution have? Explain your answer.
46. Classify each of the following as homogeneous or heterogeneous mixtures.
- | |
|-----------------------------|
| a. chocolate-chip ice cream |
| b. green ink |
| c. cake batter |
| d. cooking oil |
47. What is the goal of a distillation? Describe briefly how this goal is accomplished.

2.3 Elements and Compounds

48. How could you distinguish an element from a compound?
49. Describe the relationship between the three items in each of the following groups. Identify each item as an element, compound, or mixture.
- | |
|-------------------------------------|
| a. hydrogen, oxygen, and water |
| b. nitrogen, oxygen, and air |
| c. sodium, chlorine, and table salt |
| d. carbon, water, and table sugar |
50. Name the elements found in each of the following compounds.
- | |
|---|
| a. ammonia (NH ₃) |
| b. potassium oxide (K ₂ O) |
| c. sucrose (C ₁₂ H ₂₂ O ₁₁) |
| d. calcium sulfide (CaS) |
51. Not all element names come from English or Latin words. The symbol for tungsten is W from the German word *wolfram*. The symbol for mercury is Hg from the Greek word *hydragyrum*. Use the symbols W and Hg to explain the system of symbols for elements.
52. What does the formula H₂O tell you about the composition of water?

2.4 Chemical Reactions

53. Use the word equation to explain how a chemical change differs from a physical change.
- $$\text{iron} + \text{sulfur} \xrightarrow{\text{heat}} \text{iron sulfide}$$
54. Classify each of the following as a physical or chemical change. For any chemical change, list at least one clue to support your answer.
- | |
|---|
| a. A copper wire is bent. |
| b. Charcoal burns in a grill. |
| c. Bread dough rises when yeast is added. |
| d. Sugar dissolves in water. |
55. Which type of property cannot be observed without changing the composition of a substance?
56. When ammonium nitrate (NH₄NO₃) explodes, the products are nitrogen, oxygen, and water. When 40 grams of ammonium nitrate explode, 14 grams of nitrogen and 8 grams of oxygen form. How many grams of water form?

Understanding Concepts

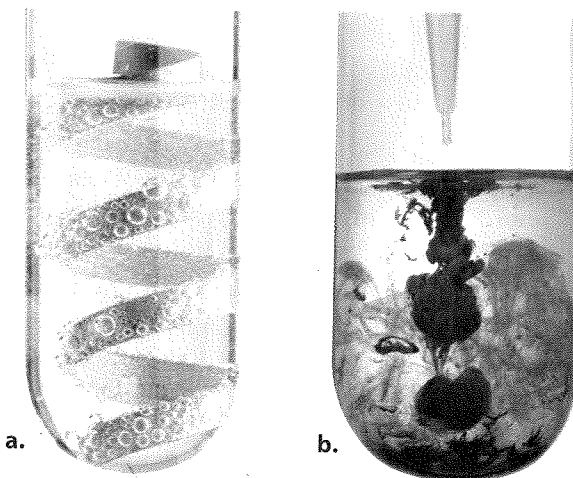
57. Explain why mass cannot be used as a property to identify a sample of matter.
58. Is malleability an extensive property or an intensive property? Explain.
59. The state of a substance can change when the substance is heated or cooled. So what does it mean to say that a certain substance is a solid, liquid, or gas?

Use the data table to answer Questions 60–63.

Substance	Color	Melting point (°C)	Boiling point (°C)
Bromine	red-brown	-7	59
Chlorine	green-yellow	-101	-34
Ethanol	colorless	-117	78
Mercury	silvery-white	-39	357
Neon	colorless	-249	-246
Sulfur	yellow	115	445
Water	colorless	0	100

60. Which colorless substance is a liquid at -30°C ?
61. Which colorless substance is a gas at 60°C ?
62. Which substance is a solid at 7°C ?
63. As the temperature rises, which solid will melt before mercury boils?
64. Use the arrangement of particles in solids and gases to explain why solids are not as easy to compress as gases.
65. Imagine you are standing in a kitchen and then in the middle of a park. When you view your surroundings in each location do you see mostly elements, compounds, or mixtures?
66. Identify each of the following items as a mixture or compound. Classify the mixtures as homogeneous or heterogeneous.
- raw egg
 - ice
 - gasoline
 - blood
67. Classify the following properties of the element silicon as chemical or physical properties.
- blue-gray color
 - brittle
 - doesn't dissolve in water
 - melts at 1410°C
 - reacts vigorously with fluorine

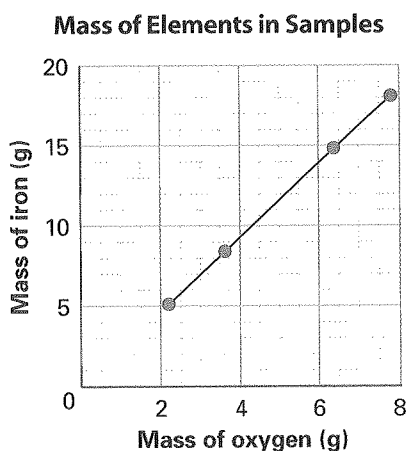
68. How are the items in each of the following pairs similar? How are they different?
- copper and silver
 - distilled water and saltwater
 - table sugar and table salt
69. In photograph A, a coil of zinc metal is in a solution of sulfuric acid. In photograph B, a yellow solution of sodium chromate is being added to a colorless solution of silver nitrate. What clues in the photographs indicate that a chemical change is probably occurring?



70. Describe clues you might observe during the following events that could support the conclusion that a chemical change is occurring.
- An antacid tablet is dropped into water.
 - A ring of scum forms around a bathtub.
 - Iron rusts.
 - A firecracker explodes.
71. Explain why the production of a gas does not always mean that a chemical reaction has occurred.
72. The wax appears to disappear as a candle burns. How can the law of conservation of mass apply to this reaction?

Critical Thinking

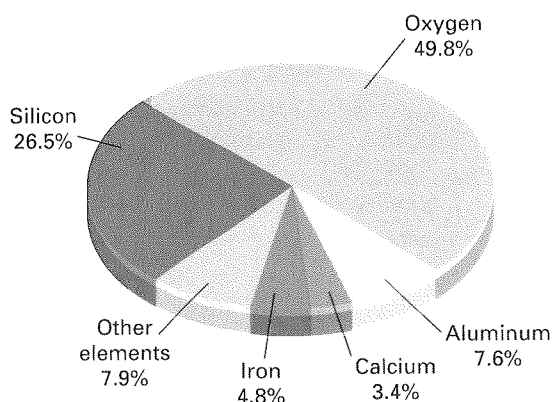
73. Discuss the statement “A gas requires a container but a solid is its own container.”
74. Explain why this statement is false. “Because there is no change in composition during a physical change, the appearance of the substance will not change.”
75. Assume that water, mercury, and gallium are all at 40°C. As the temperature drops, which substance will freeze first? Which will be the last to freeze?
76. Devise a way to separate sand from a mixture of charcoal, sand, sugar, and water.
77. When powdered iron is left exposed to the air, it rusts. Explain why the mass of the rust is greater than the mass of the powdered iron.
78. A change in odor can also be a clue that a chemical change has occurred. Describe at least one situation in which you might be likely to detect such a change in odor in a kitchen.
79. The mass of the elements iron and oxygen in four samples of a rust-colored substance was measured in grams (g). The amount of iron and oxygen in each sample is shown on the graph.



- a. Do you think all four samples are the same compound? Explain.
- b. Another sample of similar material was found to contain 9.9 grams of iron and 3.4 grams of oxygen. Is this sample the same substance as the other four samples? Explain.

Concept Challenge

80. Five elements make up 98% of the mass of the human body. These elements are oxygen (61%), carbon (23%), hydrogen (10.0%), nitrogen (2.6%), and calcium (1.4%). Compare these data with those in the pie graph below, which shows the five most abundant elements by mass in Earth's crust, oceans, and atmosphere.



- a. Which elements are abundant both in the human body and Earth's crust, oceans, and atmosphere?
- b. Which elements are abundant in Earth's crust, oceans, and atmosphere, but not in the human body?
- c. Would you expect the compounds found in the human body to be the same as or different from those found in rocks, seawater, and air? Use the data to explain your answer.
81. Use Table 2.1 on p. 40 to answer this question.
- a. Which substances in the table are in the liquid state at 125°C?
- b. Use the physical properties of one of these substances to explain how you figured out the answer to Question 81a.
- c. The substances in the table are listed in order of increasing melting point. Propose another way that these data could be arranged.
82. Each day you encounter some chemical changes that are helpful and some that are harmful to humans or the environment. Cite three examples of each type. For each example, list the clues that identified the change as a chemical change.

Standardized Test Prep

Test-Taking Tip

Using Models To answer some test questions, you will be asked to use visual models. At first the models may look very similar. Decide which information will help you answer the question. The number of particles, their colors, or their shapes may or may not be important.

Select the choice that best answers each question or completes each statement.

- Which of the following is *not* a chemical change?
 - paper being shredded
 - steel rusting
 - charcoal burning
 - a newspaper yellowing in the sun
- Which phrase best describes an apple?
 - heterogeneous mixture
 - homogeneous compound
 - heterogeneous substance
 - homogeneous mixture
- Which element is paired with the wrong symbol?

a. sulfur, S	b. potassium, P
c. nitrogen, N	d. calcium, Ca
- Which of these properties could *not* be used to distinguish between table salt and table sugar?

a. boiling point	b. melting point
c. density	d. color
- The state of matter characterized by a definite volume and an indefinite shape is a

a. solid.	b. liquid.
c. mixture.	d. gas.

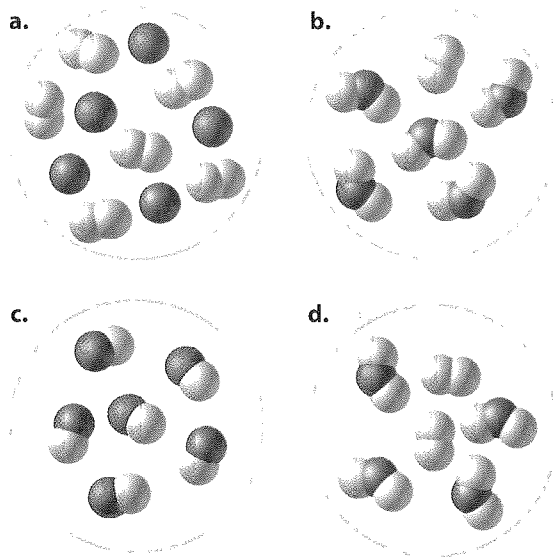
The lettered choices below refer to Questions 6–9. A lettered choice may be used once, more than once, or not at all.

- (A) compound
 (B) heterogeneous mixture
 (C) element
 (D) homogeneous mixture

Which description correctly identifies each of the following materials?

- air
- carbon monoxide
- zinc
- mushroom pizza

Use the atomic windows to answer Question 10.



10. The species in window A react. Use the law of conservation of mass to determine which window best represents the reaction products.

Use the data table to answer Questions 11–14.

Mass of magnesium (g)	Mass of oxygen (g)	Mass of magnesium oxide (g)
5.0	3.3	8.3
6.5	(a)	10.8
13.6	9.0	(b)
(c)	12.5	31.5

- Magnesium metal burns vigorously in oxygen to produce the compound magnesium oxide. Use the law of conservation of mass to identify the masses labeled (a), (b), and (c) in the table.
- Use the data in the completed table to construct a graph with mass of magnesium on the x -axis and mass of magnesium oxide on the y -axis.
- How many grams of magnesium oxide form when 8.0 g of magnesium are burned?
- How many grams of magnesium and oxygen react to form 20.0 g of magnesium oxide?