Composition of Matter

Use the words listed below to correctly complete the concept map.

- atoms (different)
- gold
- oxygen
- solutions
- vinegar
- atoms (same)
- iron
- salt
- substances
- water
- colloids
- mixtures
- smoke
- suspensions
- whipped cream
- fog
- muddy water
- soft drinks
- syrup

**Matter**

- Pure Substances
  - Elements
    - Made up of: Same atoms
    - Examples: O₂, Fe, Au
  - Compounds
    - Made up of: Different atoms
    - Examples: Salt, H₂O

- Mixtures
  - Homogeneous
    - Solutions
    - As in: Vinegar
  - Heterogeneous
    - Colloids
    - As in: Syrup
    - Suspensions
    - As in: Soft drink

MATTER—SUBSTANCES VS. MIXTURES

All matter can be classified as either a substance (element or compound) or a mixture (heterogeneous or homogeneous).

<table>
<thead>
<tr>
<th>Matter</th>
<th>Substance</th>
<th>Mixtures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>can write chemical formula, homogeneous</td>
<td>variable ratio</td>
</tr>
<tr>
<td>Element</td>
<td>one type atom</td>
<td>Homogeneous solutions</td>
</tr>
<tr>
<td>Compound</td>
<td>two or more different atoms chemically bonded</td>
<td>Heterogeneous colloids and suspensions</td>
</tr>
</tbody>
</table>

Classify each of the following as to whether it is a substance or a mixture. If it is a substance, write Element or Compound in the substance column. If it is a mixture, write Heterogeneous or Homogeneous in the mixture column.

<table>
<thead>
<tr>
<th>Type of Matter</th>
<th>Substance</th>
<th>Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. chlorine</td>
<td>element</td>
<td></td>
</tr>
<tr>
<td>2. water</td>
<td>compound</td>
<td></td>
</tr>
<tr>
<td>3. soil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. sugar water</td>
<td>compound</td>
<td>homogeneous</td>
</tr>
<tr>
<td>5. oxygen</td>
<td>element</td>
<td></td>
</tr>
<tr>
<td>6. carbon dioxide</td>
<td>compound</td>
<td></td>
</tr>
<tr>
<td>7. rocky road ice cream</td>
<td></td>
<td>heterogeneous</td>
</tr>
<tr>
<td>8. alcohol</td>
<td>compound</td>
<td>homogeneous</td>
</tr>
<tr>
<td>9. pure air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. iron</td>
<td>element</td>
<td></td>
</tr>
</tbody>
</table>
THE FORMS OF MATTER

8:1 The States of Matter
8:2 The Kinetic Theory of Matter
8:3 Thermal Expansion

There are three ordinary states of matter: solid, liquid, and gas. A fourth state of matter, the plasma state, is matter that exists at extremely high temperatures and consists of electrically charged particles. Matter that has a definite volume and shape is called a solid. If matter has a definite volume, but no definite shape it is called a liquid. When matter does not have a definite shape or volume it is a gas. The state of matter depends on its temperature. At cold enough temperatures, all materials become solids. As they warm, they form liquids. At still higher temperatures, they become gases. At very high temperatures, they may become plasma.

According to the kinetic theory of matter, all matter is made of tiny particles. The particles are in constant motion. The state of matter is determined by the motion and energy of these particles. The particles of a solid are packed very closely together. In solids, particles move back and forth, but do not change positions. In crystals, the particles are arranged in repeating patterns. Materials that appear to be solids, but do not form repeating patterns are sometimes called amorphous solids. Because particles of a liquid are very close to one another, they have about the same volume as solids. Particles in a liquid have enough energy so that the forces between them cannot hold them in fixed positions. Liquids flow because particles are free enough to slip past each other. The particles in a gas have much spacing and they move in straight lines, flying all over the container. A gas is mostly empty space.

When you add heat or do work on matter, its thermal energy increases. The kinetic and potential energy of its particles increase. As a result of the increase in kinetic energy, the particles move faster and collide with other particles more violently. Thus, the particles move farther apart, and the volume of the material increases. The increase in volume of matter as the temperature goes up is called thermal expansion. Materials expand at different rates.
2–5 Review and Reinforcement

Mixtures

Use what you have learned in Section 2–5 to identify each of the following substances as pure substances, heterogeneous mixtures, or homogeneous mixtures. Write “pure,” “heterogeneous,” or “homogeneous” on the line.

hetero 1. alphabet soup
dpure substance 2. salt
hetero 3. concrete
homogen 4. vegetable oil
homogen 5. air
homogen 6. paint
hetero 7. sea water
hetero 8. granite
homogen 9. steel
pure substance sugar

Complete the following sentences by filling in the appropriate word from the list below. Each word can be used once, more than once, or not at all.

filtration
crystallization
chromatography
electrolysis
distillation

11. Heterogeneous mixtures are often separated by filtration
12. Separating sand from water can be done by filtration
13. The sugar in sugar water can be removed by crystallization
14. The separation technique that takes advantage of different boiling points is called distillation
15. Removing chlorophyll pigment from leaves might be done by chromatography
16. The best way to decompose water into oxygen and hydrogen is by electrolysis
17. Crude oil is broken down by heat, vaporized, and allowed to condense into various liquids such as gasoline. This process is called distillation
Classification of Matter

Choose words from the list to fill in the blanks in the paragraphs.

Word List

chemical property
compound
element
extensive property

heterogeneous matter
homogeneous matter
intensive property
mixture

physical property
property
substance

Matter that has uniform characteristics throughout is called (1). Matter that has parts with different characteristics is called (2). A characteristic by which a variety of matter is recognized is called a(n) (3). A characteristic that depends upon the amount of matter in the sample is called a(n) (4). A characteristic that does not depend upon the amount of matter is called a(n) (5). A characteristic that can be observed without producing new kinds of matter is called a(n) (6). A characteristic that depends on how a kind of matter changes its composition (or fails to change its composition) during interactions with other kinds of matter is called a(n) (7).

Matter can also be classified according to the basic types of matter it contains. A simple substance that cannot be broken down into other substances by chemical means is called a(n) (8). A chemical combination of simple substances is called a(n) (9). A physical combination of different substances that retain their individual properties is called a(n) (10). Either an element or a compound may be referred to as a(n) (11).

Classify each of the following as an element, compound, heterogeneous mixture, or homogeneous mixture.

12. Water
13. Carbon
14. Air
15. Table salt
16. Sugar dissolved in water
17. Homogenized milk
18. Granite
19. Oxygen
20. Sand in water

CHEMISTRY
The Study of Matter
Properties

Recall that physical properties can be observed without producing new substances. Chemical properties describe how a substance interacts (or fails to interact) with other substances to produce new substances. Extensive properties depend upon the amount of matter in the sample; intensive properties do not.

Classify each of the properties listed below as extensive physical, intensive physical, or chemical.

1. Color
2. Combustibility
3. Hardness
4. Density
5. Mass
6. Melting point
7. Ductility
8. Volume
9. Failure to react with other substances
10. Odor
11. Weight
12. Malleability
13. Tendency to corrode

Some of the measured properties of a given substance are listed below. Write the general name describing each property. Select the names from the properties listed for Exercises 1–13 above.

14. 15 mL
15. Can easily be hammered into sheets.
16. 2.8 g/mL
17. Burns when heated in the presence of O₂.
18. Stinks when heated.
19. Can be scratched by a diamond.
20. 500°C
21. Can easily be drawn into a wire.

Chemical props are never interrupted.
**PHYSICAL VS. CHEMICAL PROPERTIES**

A physical property is observed with the senses and can be determined without destroying the object. For example, color, shape, mass, length and odor are all examples of physical properties.

A chemical property indicates how a substance reacts with something else. The original substance is fundamentally changed in observing a chemical property. For example, the ability of iron to rust is a chemical property. The iron has reacted with oxygen, and the original iron metal is changed. It now exists as iron oxide, a different substance.

Classify the following properties as either chemical or physical by putting a check in the appropriate column.

<table>
<thead>
<tr>
<th></th>
<th>Physical Property</th>
<th>Chemical Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>blue color</td>
<td>√</td>
</tr>
<tr>
<td>2.</td>
<td>density</td>
<td>√</td>
</tr>
<tr>
<td>3.</td>
<td>flammability</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>solubility</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>reacts with acid to form H₂</td>
<td>√</td>
</tr>
<tr>
<td>6.</td>
<td>supports combustion</td>
<td>√</td>
</tr>
<tr>
<td>7.</td>
<td>sour taste</td>
<td>√</td>
</tr>
<tr>
<td>8.</td>
<td>melting point</td>
<td>√</td>
</tr>
<tr>
<td>9.</td>
<td>reacts with water to form a gas</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>reacts with a base to form water</td>
<td>√</td>
</tr>
<tr>
<td>11.</td>
<td>hardness</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>boiling point</td>
<td>√</td>
</tr>
<tr>
<td>13.</td>
<td>can neutralize a base</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>luster</td>
<td>√</td>
</tr>
<tr>
<td>15.</td>
<td>odor</td>
<td>√</td>
</tr>
</tbody>
</table>
2–3 Review and Reinforcement

Matter

Complete the following sentences by filling in the appropriate word from the list below.

gas — plasma — physical —
liquid — matter — chemical —
solid — energy — evaporation

1. ___________ is anything that has mass and volume.
2. The two states of matter that occupy a definite volume are __________ and __________.
3. __________ and __________ are the other two states of matter.
4. __________ changes alter the identity of a substance, whereas __________ changes do not.

Identify whether each of the following changes is a physical change or a chemical change. Write a "P" on the line for a physical change and a "C" for a chemical change.

5. water boiling
6. iron rusting
7. butter melting
8. alcohol evaporating
9. wood rotting
10. leaves changing color
11. glass breaking
12. mowing the lawn
13. magnetizing a nail
14. baking a cake

Answer each of the following questions in the space provided.

15. What is the relationship between the kinetic energy of molecules and their physical state?

_________
Chemical and Physical Changes

1. A brown gas is released when copper is placed into nitric acid.
2. Leaves decaying
3. Perfume vaporizing
4. Iodine crystals forming (from purple iodine vapor) on the cool surface of an evaporation dish
5. A soft shelled crab turning into a hard shelled crab
6. Shoe soles wearing down
7. Wine turning into vinegar
8. Alcohol freezing
9. Water boiling
10. Salt dissolving
11. Tomatoes turning red
12. The decomposition of water into hydrogen and oxygen
13. Bending steel
14. West Essex High School on fire
15. Eating pistachio nuts
16. Dry ice subliming
17. Glass breaking
18. A cake baking
19. Leaves changing color in the fall
20. Melting chocolate
21. Making French toast
22. Developing film
23. A clock (windup) winding down
PHYSICAL VS. CHEMICAL CHANGES

In a physical change, the original substance still exists, it has only changed in form. In a chemical change, a new substance is produced. Energy changes always accompany chemical changes.

Classify the following as being a physical or chemical change.

1. Sodium hydroxide dissolves in water. _______ Chem _______

2. Hydrochloric acid reacts with potassium hydroxide to produce a salt, water and heat. _______ Chem _______

3. A pellet of sodium is sliced in two. _______ Phys _______

4. Water is heated and changed to steam. _______ Phys _______

5. Potassium chlorate decomposes to potassium chloride and oxygen gas. _______ Chem _______

6. Iron rusts. _______ Chem _______

7. When placed in H₂O, a sodium pellet catches on fire as hydrogen gas is liberated and sodium hydroxide forms. _______ Chem _______

8. Evaporation _______ Phys _______

9. Ice melting _______ Phys _______

10. Milk sours. _______ Chem _______

11. Sugar dissolves in water. _______ Phys _______

12. Wood rotting _______ Chem _______

13. Pancakes cooking on a griddle _______ Chem _______

14. Grass growing in a lawn _______ Chem _______

15. A fire is inflated with air. _______ Phys _______

16. Food is digested in the stomach. _______ Chem _______

17. Water is absorbed by a paper towel. _______ Phys _______