MATTER—SUBSTANCES VS. MIXTURES

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

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Matter
   /\  
  /   \  
Substance | Mixtures
       | variable ratio
Element   | Compound
one type atom | two or more different atoms chemically bonded

Homogeneous solutions         Heterogeneous colloids and suspensions
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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></td>
<td></td>
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<tr>
<td>2. water</td>
<td></td>
<td></td>
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<tr>
<td>3. soil</td>
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<td></td>
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<tr>
<td>4. sugar water</td>
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<td></td>
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<tr>
<td>5. oxygen</td>
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<td></td>
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<tr>
<td>6. carbon dioxide</td>
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<tr>
<td>7. rocky road ice cream</td>
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<td></td>
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<tr>
<td>8. alcohol</td>
<td></td>
<td></td>
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<tr>
<td>9. pure air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. iron</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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. ____________________________

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

3. A pellet of sodium is sliced in two. ____________________________

4. Water is heated and changed to steam. ____________________________

5. Potassium chlorate decomposes to potassium chloride and oxygen gas. ____________________________

6. Iron rusts. ____________________________

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

8. Evaporation ____________________________

9. Ice melting ____________________________

10. Milk sours. ____________________________

11. Sugar dissolves in water. ____________________________

12. Wood rotting ____________________________

13. Pancakes cooking on a griddle ____________________________

14. Grass growing in a lawn ____________________________

15. A tire is inflated with air. ____________________________

16. Food is digested in the stomach. ____________________________

17. Water is absorbed by a paper towel. ____________________________
**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, density, specific heat and odor are all examples of physical properties.

A chemical property indicates how a substance reacts with something else. When a chemical property is observed, the original substance is changed into a different substance. For example, the ability of iron to rust is a chemical property. The iron has reacted with oxygen and the original iron metal is gone. It is now iron oxide, a new substance. All chemical changes include physical changes.

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

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Chemical Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. red color</td>
<td></td>
</tr>
<tr>
<td>2. density</td>
<td></td>
</tr>
<tr>
<td>3. flammability</td>
<td></td>
</tr>
<tr>
<td>4. solubility</td>
<td></td>
</tr>
<tr>
<td>5. reacts with acid to form hydrogen</td>
<td></td>
</tr>
<tr>
<td>6. supports combustion</td>
<td></td>
</tr>
<tr>
<td>7. bitter taste</td>
<td></td>
</tr>
<tr>
<td>8. melting point</td>
<td></td>
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<tr>
<td>9. reacts with water to form a gas</td>
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<tr>
<td>10. reacts with a base to form water</td>
<td></td>
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<tr>
<td>11. hardness</td>
<td></td>
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<tr>
<td>12. boiling point</td>
<td></td>
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<tr>
<td>13. can neutralize a base</td>
<td></td>
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<tr>
<td>14. luster</td>
<td></td>
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<tr>
<td>15. odor</td>
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</tr>
</tbody>
</table>
CHEMICAL vs. PHYSICAL CHANGE

In a physical change, the original substance still exists, it has only changed in form. Energy changes usually do not accompany physical changes, except in phase changes and when substances dissolve.

In a chemical change, a new substance is produced. Energy changes always accompany chemical changes. Physical changes usually accompany chemical changes.

Classify the following as being either a chemical or a physical change.

1. Sodium chloride dissolves in water.

2. Hydrochloric acid reacts with sodium hydroxide to produce a salt, water and heat.

3. A pellet of sodium is sliced in half.

4. Water is heated and changed to steam.

5. Food is digested.

6. Starch molecules are formed from smaller glucose molecules.

7. Ice melts.

8. Plant leaves lose water through evaporation.

9. A red blood cell placed in distilled water will swell and burst.

10. The energy in food molecules is transferred into molecules of ATP.

11. The roots of a plant absorb water.


13. Oxygen is incorporated into hemoglobin to bring it to the cells.


15. Proteins are made from amino acids.

16. A match burns.

17. A toothpick is broken in half.
ELEMENTS, COMPOUNDS AND MIXTURES

An element consists of only one kind of atom. A compound consists of two or more different elements chemically combined in a fixed ratio. The components of a mixture can be in any proportion and are not chemically bound.

Classify each of the following as an element, compound or mixture by writing E, C or M in the space provided.

1. sodium ______
2. water ______
3. soil ______
4. coffee ______
5. oxygen ______
6. alcohol ______
7. carbon dioxide ______
8. cake batter ______
9. air ______
10. soap ______
11. iron ______
12. salt water ______
13. ice cream ______
14. nitrogen ______
15. eggs ______
16. blood ______
17. table salt ______
18. nail polish ______
19. milk ______
20. cola ______

21. orange juice ______
22. helium ______
23. methane ______
BOYLE'S LAW

Boyle's Law states that the volume of a gas varies inversely with its pressure if temperature is held constant. (If one goes up, the other goes down.) We use the formula:

\[ P_1 \times V_1 = P_2 \times V_2 \]

Solve the following problems (assuming constant temperature).

1. A sample of oxygen gas occupies a volume of 250. mL at 740. torr pressure. What volume will it occupy at 800. torr pressure?

2. A sample of carbon dioxide occupies a volume of 3.50 liters at 125 kPa pressure. What pressure would the gas exert if the volume was decreased to 2.00 liters?

3. A 2.0 liter container of nitrogen had a pressure of 3.2 atm. What volume would be necessary to decrease the pressure to 1.0 atm?

4. Ammonia gas occupies a volume of 450. mL at a pressure of 720. mm Hg. What volume will it occupy at standard pressure?

5. A 175 mL sample of neon had its pressure changed from 75 kPa to 150 kPa. What is its new volume?

6. A sample of hydrogen at 1.5 atm had its pressure decreased to 0.50 atm producing a new volume of 750 mL. What was its original volume?

7. Chlorine gas occupies a volume of 1.2 liters at 720 torr pressure. What volume will it occupy at 1 atm pressure?

8. Fluorine gas exerts a pressure of 900. torr. When the pressure is changed to 1.50 atm its volume is 250. mL. What was the original volume?
CHARLES' LAW

Charles' Law states that the volume of a gas varies directly with the Kelvin temperature, assuming that pressure is constant. We use the following formulas:

\[
\frac{V_1}{T_1} = \frac{V_2}{T_2} \quad \text{or} \quad V_1 \times T_2 = V_2 \times T_1
\]

\[K = ^\circ C + 273\]

Solve the following problems assuming a constant pressure.

1. A sample of nitrogen occupies a volume of 250 mL at 25\(^\circ\) C. What volume will it occupy at 95\(^\circ\) C?

2. Oxygen gas is at a temperature of 40\(^\circ\) C when it occupies a volume of 2.3 liters. To what temperature should it be raised to occupy a volume of 6.5 liters?

3. Hydrogen gas was cooled from 150\(^\circ\) C to 50\(^\circ\) C. Its new volume is 75 mL. What was its original volume?

4. Chlorine gas occupies a volume of 25 mL at 300 K. What volume will it occupy at 600 K?

5. A sample of neon gas at 50\(^\circ\) C and a volume of 2.5 liters is cooled to 25\(^\circ\) C. What is the new volume?

6. Fluorine gas at 300 K occupies a volume of 500 mL. To what temperature should it be lowered to bring the volume to 300 mL?

7. Helium occupies a volume of 3.8 liters at -45\(^\circ\) C. What volume will it occupy at 45\(^\circ\) C?

8. A sample of argon gas is cooled and its volume went from 380 mL to 250 mL. If its final temperature was -55\(^\circ\) C, what was its original temperature?
PARTS OF AN ATOM

An atom is made up of protons and neutrons which are in the nucleus, and electrons which are in the electron cloud surrounding the atom.

The atomic number equals the number of protons. The electrons in a neutral atom equal the number of protons. The mass number equals the sum of the protons and neutrons. The charge indicates the number of electrons that have been lost or gained. A positive charge indicates the number of electrons (which are negatively charged) lost. A negative charge indicates the number of electrons gained.

This structure can be written as part of a chemical symbol.

Example:

\[
\begin{array}{c}
\text{mass} \\
\text{number} \\
\downarrow \\
_{6}^{12}\text{C}^{+4} \\
\text{atomic} \\
\text{number}
\end{array}
\]

This carbon ion would have 6 protons, 6 neutrons and 2 electrons.

Complete the following chart.

<table>
<thead>
<tr>
<th>Element/Ion</th>
<th>Atomic Number</th>
<th>Mass Number</th>
<th>Charge</th>
<th>Protons</th>
<th>Neutrons</th>
<th>Electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{24}_{12}\text{Mg}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$^{39}_{19}\text{K}$</td>
<td></td>
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</tr>
<tr>
<td>$^{23}_{11}\text{Na}^{+1}$</td>
<td></td>
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</tr>
<tr>
<td>$^{19}_{9}\text{F}^{-1}$</td>
<td></td>
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</tr>
<tr>
<td>$^{27}_{13}\text{Al}^{+3}$</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$^{1}_{1}\text{H}$</td>
<td></td>
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</tr>
<tr>
<td>$^{24}_{12}\text{Mg}^{2+}$</td>
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<tr>
<td>Ag</td>
<td></td>
<td></td>
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<tr>
<td>S$^{-2}$</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$^{2}_{1}\text{H}$</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$^{35}_{17}\text{Cl}^{-}$</td>
<td></td>
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</tr>
<tr>
<td>Be$^{2+}$</td>
<td></td>
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</tr>
</tbody>
</table>
ELEMENTS AND THEIR SYMBOLS

Write the symbols for the following elements.

1. oxygen
2. hydrogen
3. chlorine
4. sodium
5. fluorine
6. carbon
7. helium
8. nitrogen
9. copper
10. sulfur
11. magnesium
12. manganese
13. neon
14. bromine
15. phosphorus
16. silver
17. lead
18. iron
19. calcium
20. potassium

Write the name of the element that corresponds to each of the following symbols.

21. Cu
22. K
23. C
24. Au
25. Zn
26. Pb
27. Fe
28. Na
29. S
30. Al
31. Ca
32. Ag
33. P
34. O
35. I
36. Sn
37. H
38. F
39. Ni
40. Hg
ACROSS
2. Element on which life is based
4. Its low melting point is useful in automatic sprinkler systems.
6. Its common allotropes are red and white.
11. It is a good conductor.
12. Halogen found in seawater
13. Most abundant halogen
14. Gas used in lighted signs to produce a red color

DOWN
1. Most abundant element in air
3. Fire resistant material no longer used due to its carcinogenicity
5. Light element used for lifting airships
7. Ozone is an allotrope of this element.
8. This element is responsible for the odor of rotten eggs.
9. Poisonous element that is also used in medicines and rat poison
10. Most reactive nonmetal
PERIODIC TABLE PUZZLE

Place the letter of each of the above elements next to its description below. Each answer may be used only once, so choose the best answer in each case.

1. An alkali metal ____
2. An alkaline earth metal ____
3. An inactive gas ____
4. An active nonmetal ____
5. A semimetal ____
6. An inner transition element ____
7. Its most common oxidation state is -2. ____
8. A metal with more than one oxidation state ____
9. Metal with an oxidation number of +3 ____
10. Has oxidation numbers of +1 and -1 ____
PERIODIC TABLE CROSSWORD

Across
2. Group I metals
4. Elements in the middle of the periodic table are the ____ metals.
5. The sum of the protons and neutrons is the ____ number.
6. Inactive gases.
7. The horizontal rows are called ____ .
8. Most of the elements are ____ .
10. Nonmetals tend to form ____ ions.

Down
1. Most active nonmetals
2. Group II metals
3. Atomic number is the number of ____ .
7. Metals tend to form ____ ions.
9. The elements are arranged by atomic ____ .
11. The vertical columns are called families or ____ .