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## Physical and Chemical Changes to Matter

### Learning Objective

Identify the key features of physical and chemical changes

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### Key Points

Physical changes only change the appearance of a substance, not its chemical composition.

Chemical changes cause a substance to change into an entirely substance with a new chemical formula.

Chemical changes are also known as chemical reactions. The "ingredients" of a reaction are called reactants, and the end results are called products.

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### Terms

**chemical change**A process that causes a substance to change into a new substance with a new chemical formula.

**chemical reaction**A process involving the breaking or making of interatomic bonds and the transformation of a substance (or substances) into another.

**physical change**A process that does not cause a substance to become a fundamentally different substance.

There are two types of change in matter: physical change and chemical change. As the names suggest, a physical change affects a substance's physical properties, and a chemical change affects its chemical properties. Many physical changes are reversible (such as heating and cooling), whereas chemical changes are often irreversible or only reversible with an additional chemical change.

**Physical & Chemical Changes - YouTube** This video describes physical and chemical changes in matter.

### Physical Changes

Another way to think about this is that a physical change does not cause a substance to become a fundamentally different substance but a chemical change causes a substance to change into something chemically new. Blending a smoothie, for example, involves two physical changes: the change in shape of each fruit and the mixing together of many different pieces of fruit. Because none of the chemicals in the smoothie components are changed during blending (the water and vitamins from the fruit are unchanged, for example), we know that no chemical changes are involved.



**Physical change** Blending a smoothie involves physical changes but no chemical changes.

Cutting, tearing, shattering, grinding, and mixing are further types of physical changes because they change the form but not the composition of a material. For example, mixing salt and pepper creates a new substance without changing the chemical makeup of either component.

Phase changes are changes that occur when substances are melted, frozen, boiled, condensed, sublimated, or deposited. They are also physical changes because they do not change the nature of the substance.



**Boiling water** Boiling water is an example of a physical change and not a chemical change because the water vapor still has the same molecular structure as liquid water ( $\text{H}_2\text{O}$ ). If the bubbles were caused by the decomposition of a molecule into a gas (such as  $\text{H}_2\text{O} \rightarrow \text{H}_2$  and  $\text{O}_2$ ), then boiling would be a chemical change.

### Chemical Changes

Chemical changes are also known as chemical reactions. The "ingredients" of a reaction are called the reactants, and the end results are called the products. The change from reactants to products is signified by an arrow:

Reactants  $\rightarrow$  Products

The formation of gas bubbles is often the result of a chemical change (except in the case of boiling, which is a physical change). A chemical change might also result in the formation of a precipitate, such as the appearance of a cloudy material when dissolved substances are mixed.

Rotting, burning, cooking, and rusting are all further types of chemical changes because they produce substances that are entirely new chemical compounds. For example, burned wood becomes ash, carbon dioxide, and water. When exposed to water, iron becomes a mixture of several hydrated iron oxides and hydroxides. Yeast carries out fermentation to produce alcohol from sugar.

An unexpected color change or release of odor also often indicates a chemical change. For example, the color of the element chromium is determined by its oxidation state; a single chromium compound will only change color if it undergoes an oxidation or reduction reaction. The heat from cooking an egg changes the interactions and shapes of the proteins in the egg white, thereby changing its molecular structure and