

From Chapter 2 (pp. 40-53) of Prentice Hall *Chemistry* by Wilbraham et al., 2008:

Matter that has a uniform and definite composition is called a substance. Gold and copper are examples of substances, which are also referred to as pure substances. Gold and copper have some properties in common, but there are differences besides their distinctive colors. Pure copper can scratch the surface of pure gold because copper is harder than gold. Copper is better than gold as a conductor of heat or electric current. Both gold and copper are malleable, which means that they can be hammered into sheets without breaking. But gold is more malleable than copper. Hardness, color, conductivity, and malleability are examples of physical properties. A physical property is a quality or condition of a substance that can be observed or measured without changing the substance's composition.

What do gold and copper have in common? _____

What are three property differences between gold and copper? _____

The table below lists physical properties for some substances. The states of the substances are given at room temperature. Physical properties can help chemists identify substances. For example, a colorless substance that was found to boil at 100 °C and melt at 0 °C would likely be water. A colorless substance that boiled at 78 °C and melted at -117 °C would most certainly not be water. Based on the table below, it would likely be ethanol.

Table 2.1: Physical Properties of Some Substances

Substance	State	Color	Melting Point (°C)	Boiling Point (°C)
neon	gas	colorless	-249	-246
chlorine	gas	greenish-yellow	-218	-34
ethanol	liquid	colorless	-117	78
mercury	liquid	silvery-white	-39	357
sulfur	solid	yellow	115	445
copper	solid	reddish	1084	2562

How are physical properties helpful to chemists? _____

According to the table, which of the chemicals has the lowest melting point? _____

According to the table, Which of the chemicals has the highest boiling point? _____

The melting point of gallium metal is 30 °C. Heat from a person's hand can melt a sample of gallium. The shape of the sample changes during melting as the liquid begins to flow, but the composition of the sample does not change. Melting is an example of a physical change. During a physical change, some properties of a material change, but the composition of the material does not change.

Words such as *boil, freeze, melt, and condense* are used to describe physical changes. So are words such as *break, split, grind, cut, and crush*. However, there is a difference between these two sets of words. Each set describes a different type of physical change. Physical changes can be classified as reversible or irreversible. Melting is an example of a reversible physical change. If a sample of liquid gallium is cooled below its melting point, the liquid will become a solid. All physical changes that involve a change from one state to another are reversible. Cutting hair, filing nails, and cracking an egg are examples of irreversible physical changes.

List two reversible physical changes: _____

List two irreversible physical changes: _____

Physical methods that are used to separate mixtures cannot be used to break a compound into simpler substances. Boil liquid water and you get water vapor, not the oxygen and hydrogen that water contains. Dissolve a sugar cube in water and you still have sucrose, not oxygen, carbon, and hydrogen. This result does not mean that sucrose or water cannot be broken down into simpler substances. But the methods must involve a chemical change. A chemical change is a change that produces matter with a different composition than the original matter. Heating is one of the processes used to break down compounds into simpler substances. There is no chemical process that will break down carbon into simpler substances because carbon is an element. Heating will not cause water to break down, but electricity will. When an electric current passes through water, oxygen gas and hydrogen gas are produced.

Why isn't dissolving sugar in water a chemical change? _____

How can water be separated into hydrogen and oxygen? _____

The chemical formed when iron rusts is iron oxide (Fe_2O_3). Words such as *burn, rot, rust, decompose, ferment, explode, and corrode* usually signify a chemical change. The ability of a substance to undergo a specific chemical change is called a chemical property. Iron is able to combine with oxygen to form rust. So the ability to rust is a chemical property of iron. Chemical properties can be used to identify a substance. But chemical properties can be observed only when a substance undergoes a chemical change.

List three examples of chemical changes: _____

When a magnet is used to separate iron from sulfur, the change is a physical change. The substances present before the change are the same substances present after the change, although they are no longer physically blended. Recall that during a physical change, the composition of matter never changes. During a chemical change, the composition of matter always changes. When the mixture of iron and sulfur is heated, a chemical change occurs. The sulfur and iron react and form iron sulfide (FeS).

How is a physical change different from a chemical change? _____

A chemical change is also called a chemical reaction. One or more substances change into one or more new substances during a chemical reaction. A substance present at the start of the reaction is a reactant. A substance produced in the reaction is a product. In the reaction of iron and sulfur, iron and sulfur are reactants and iron sulfide is a product.

What is another name for a chemical change? _____