Physical and Chemical Properties and Changes

Physical Change of Water into Ice

Chemical Change of Hydrogen Peroxide into Water
Essential Standard 2.1

Understand types, properties, and structure of matter.

Objective 2.1.3

Compare physical and chemical properties of various types of matter.
I Can Statements

At the end of this lesson, you should be able to say, with confidence:

• I can distinguish between a physical and chemical property.

• I can provide examples of both physical and chemical properties.

• I can distinguish between a physical and chemical change.

• I can provide examples of both physical and chemical changes.
Identifying Substances

Most familiar substances can be identified easily by their unique set of characteristics, such as appearance, odor, or taste.

Salt of Sugar?

Identifiable characteristics unique to any substance can be either physical or chemical.
Physical Properties

A physical property is any characteristic of a substance that can be observed or measured without changing the composition of the substance.

Appearance, size, color, texture, shape, taste, odor, and density are all physical properties.
Another physical property is a substance’s resistance to flow, called viscosity.

In general, viscosity decreases as temperature increases.
Whether a substance is magnetic or not is also a physical property.

Iron, cobalt, and nickel are the only magnetic elements.

In order for a substance to be magnetic, it must contain iron, cobalt, or nickel.
Physical Properties

Three physical properties common to metals are ductility, malleability and conductivity.

Ductile means a substance can be drawn into wires.

Malleable means a substance can be pounded into sheets.

Conductivity refers to a substance’s ability to conduct heat or electricity.
Melting and boiling points are also physical properties since the substance is still the same substance no matter whether it is a solid, liquid or gas.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Melting Point (°C)</th>
<th>Boiling Point (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>-218</td>
<td>-183</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>-210</td>
<td>-196</td>
</tr>
<tr>
<td>Mercury</td>
<td>-39</td>
<td>357</td>
</tr>
<tr>
<td>Water</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Lead</td>
<td>327</td>
<td>1740</td>
</tr>
</tbody>
</table>
Physical Properties

Solubility is also a physical property.

Solubility in 100 g of Water at 20 °C

<table>
<thead>
<tr>
<th>Compound</th>
<th>Solubility (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table Salt</td>
<td>36.0</td>
</tr>
<tr>
<td>Baking Soda</td>
<td>9.6</td>
</tr>
<tr>
<td>Sugar</td>
<td>203.9</td>
</tr>
</tbody>
</table>

Note that the substance still stays the same substance, regardless of how much of it has dissolved in water.
Separating by Physical Properties

Some physical properties can be used to separate mixtures.

Filtration uses size difference to separate substances.

Magnets are often used to separate metals from non-metals, especially during the recycling process.
Separating by Physical Properties

Distillation uses different boiling points to separate substances.

Oil refineries separate out various petroleum products from crude oil through distillation.
Physical Changes

Physical Changes occur whenever the appearance of the substance changes but the identity of the substance remains the same.

Phase changes are physical changes.
Physical Changes

Cutting, tearing, painting, and breaking things are all just physical changes.

Dissolving is also just a physical change as the two substances retain their chemical composition, they are just mixed together.
Chemical Properties

A chemical property is the ability of a substance to undergo a chemical change.

Chemical properties can only be observed when the substances is undergoing the chemical change.
Chemical Properties

Flammability of the ability to burn in the presence of oxygen is a chemical property.
Whether a substance is corrosive or can burn skin upon contact is also a chemical property.
Sensitivity to light is also a chemical property.
Chemical Properties

A substance’s ability to decompose is also a chemical property. (Biodegradable)
How readily substances combines chemically with other substances is called reactivity and is also a chemical property.

Iodine will react with starch to produce a purplish-black color.

Substances without starch will not turn purplish-black.
Iron in the presence of water and oxygen will rust.

Iron is mixed with chromium to prevent rusting in stainless steel.

Examples of Chemical Properties

Ability to rust is a chemical property.
Chemical Changes

A chemical change occurs when one or more substances react to form one or more new substances.

When logs are burned, in the presence of oxygen, the carbon combines with the oxygen to form carbon dioxide, $\text{CO}_2$, and ash.

Burning is a chemical change.
Chemical Changes

In order for a chemical change to take place, the substances react to each other so they are called reactants. The new substance produced is called a product.

Reactants
- Sulfur (match)
- Potassium Chlorate (match)
- Red Phosphorus (box)

Products
- White Phosphorus
- Potassium Chloride
- Oxygen

Chemical reactions are a chemical change.
Chemical Changes

Cooking actually causes chemical changes to occur.

When we cook or bake, we are combining reactants together to produce a new product.

When you fry an egg, notice how the liquid egg-white part becomes solid and changes to pure white colour. The fried egg’s properties are different from that of the uncooked egg.
Chemical Changes

Digestion and Decomposition are both chemical changes whereby substances are broken down and new substances are produced.

**Cellular Respiration**

- glucose/food
  (Even if we eat meat, all food chains begin with a green plant, which has glucose.)
- oxygen
- water
  (breathe out water vapor; lose water through perspiration)
- CO₂
  (breathe out)
- energy

Cellular Respiration takes place in the cell.

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Rusting is also a chemical change. Iron, Fe, rusts when it reacts with oxygen, $O_2$, to produce iron oxide, $Fe_2O_3$. 

Ground Surface

A Horizon

B Horizon

Iron reacting with oxygen

C Horizon

No oxygen, so no rusting
Chemical Changes

When substances react or change with changes in light exposure, a chemical change takes place.

Photographers use chemicals to stop the light sensitive paper from reacting to light.
Chemical Changes

Why does paper turn yellow?

Paper is made from wood, which is made up of cellulose with a glue-like material, called lignin, that binds the cellulose together.

In the tree, the lignin makes the wood stiff and allows trees to stand upright.

When lignin is exposed to oxygen, it absorbs light and becomes darker.

Selaginella

Xylem cell: with a rigid woody wall and no ends. Many of these cells in a row form a pipe for water conduction.

Xylem: the tissue that conducts water from roots to leaves.

Lignin: about 25% of the material in the plant cell wall. Hard to process and cannot be fermented into alternative fuel.

Cellulose: material that can be degraded into fermentable sugars which can be converted into biofuel.
Detecting Chemical Changes

When a substance undergoes a change in odor, it can signal a chemical change has taken place.

You can always tell if milk has turned sour by the distinct odor of sour milk.

You can also tell when rubber is being burned, by its distinct odor.
Detecting Chemical Changes

Another indication that a chemical change is a change in color.

When copper is exposed to moist air, new copper compounds are produced that form a greenish patina over the copper.
Detecting Chemical Changes

Explosions are also indicators of a chemical change.

In this case, energy is released as light or heat and a sound is produced.
Detecting Chemical Changes

The production of a gas, often seen as bubbles, when certain chemicals react is another indication that a chemical change has taken place.
Detecting Chemical Change

A formation of a precipitate, or a solid, when two liquids are combined, is also an indication of a chemical change.
The End