

1.5: States of Matter



Figure 1.5.1 (Credit: Iceberg: Courtesy of Rear Admiral Harley D. Nygren, NOAA; Beach: User:Wicki/Wikimedia Commons; Volcano: Courtesy of E. Klett, US Fish and Wildlife Service; Source: Iceberg: http://commons.wikimedia.org/wiki/File:Ice_berg.jpg (opens in new window); Beach: http://commons.wikimedia.org/wiki/File:Ocean_Spokojny.JPG (opens in new window); Volcano: http://commons.wikimedia.org/wiki/File:Dds40-097_large.jpeg (opens in new window); License: Public Domain)

Why is the state of water different in each picture?

Water can take many forms. At low temperatures (below 0°C), water is a solid. When at "normal" temperatures (between 0°C and 100°C), it is a liquid. At temperatures above 100°C , water is a gas (steam).

The state of water depends on the temperature. Each state (solid, liquid, and gas) has its own unique set of physical properties.

Matter and its States

Matter typically exists in one of three states: **solid**, **liquid**, or **gas**. There is a fourth state of matter called **plasma**, which rarely exists on earth, but we will omit this from our current discussion. The state a given substance exhibits is also a physical property. Some substances exist as gases at room temperature (oxygen and carbon dioxide), while others, like water and mercury metal, exist as liquids. Most metals exist as solids at room temperature. All substances can exist in any of these three states.

Liquid

Liquids have the following characteristics:

- No definite shape (takes the shape of its container).
- Has definite volume.
- Particles are free to move over each other, but are still attracted to each other.

A familiar liquid is mercury metal. Mercury is an anomaly. It is the only metal we know of that is liquid at room temperature. Mercury also has an ability to stick to itself (surface tension), which is a property that all liquids exhibit. Mercury has a relatively high surface tension, and this makes it very unique. Here you can see mercury in its common liquid form.



Figure 1.5.2: Mercury. (Courtesy of the EPA; Source: <http://commons.wikimedia.org/wiki/File:Mercury-element.jpg> (opens in new window); License: Public Domain)

If we heat liquid mercury to its boiling point of 357°C , and contain it under the right pressure conditions, we would notice all particles in the liquid state go into the gas state.

Gas

Gases have the following characteristics:

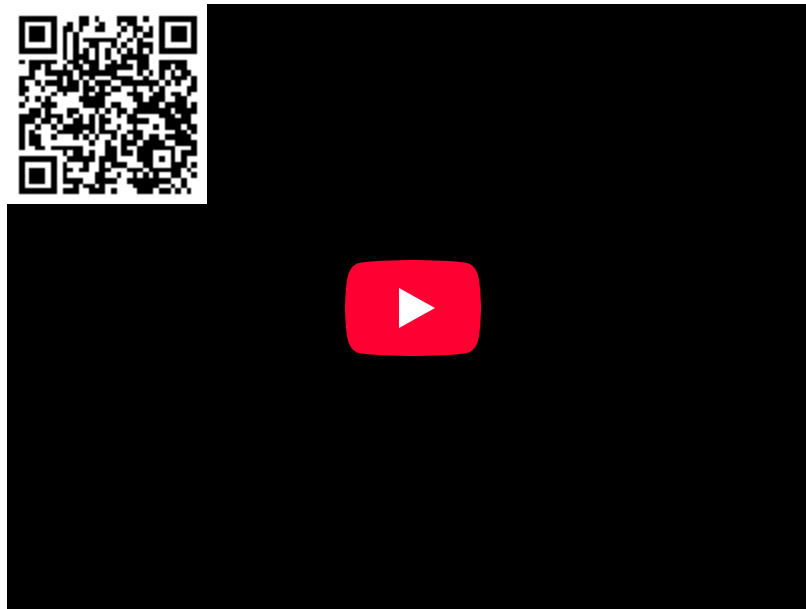
- No definite shape (takes the shape of its container).
- No definite volume.
- Particles move in random motion with little or no attraction to each other.
- Highly compressible.

Solid

Solids are defined by the following characteristics:

- Definite shape (rigid).
- Definite volume.
- Particles vibrate around fixed axes.

If we were to cool a sample of liquid mercury to its freezing point of -39°C , and had it contained under the right pressure conditions, we would notice all of the liquid particles would go into the solid state.



As you can see in the video, mercury can be solidified when its temperature is brought to its freezing point. However, when returned to room temperature conditions, mercury does not exist in solid state for long, and returns back to its more common liquid form.



Plasma

Plasma is a state of matter that resembles a gas but has certain properties that gases do not have. Like a gas, plasma consists of particles of matter that can pull apart and spread out, so it lacks a fixed volume and a fixed shape. Unlike a gas, plasma can conduct

electricity and respond to a magnetic field. That's because plasma consists of electrically charged particles called ions, instead of uncharged particles such as atoms or molecules.

Plasma are defined by the following characteristics:

- particles are charged ions and free electrons
- no definite shape
- no definite volume
- conducts electricity
- responds to magnetic field

Summary

- Three states of matter exist: solid, liquid, and gas.
- Solids have a definite shape and volume.
- Liquids have a definite volume, but take the shape of their container.
- Gases have no definite shape or volume.

Review

1. How many states of matter are there?
2. What is a solid?
3. What is a liquid?
4. What is a gas?

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