

States of Matter Simulation

https://phet.colorado.edu/sims/html/states-of-matter/latest/states-of-matter_en.html

Link-

Comparing Substances

Substance	Number of atoms	Freezing Point	Boiling Point
Neon		-246°C	-248°C
Argon		-189°C	-185°C
Oxygen			
Water			

The boiling point is

The freezing point is

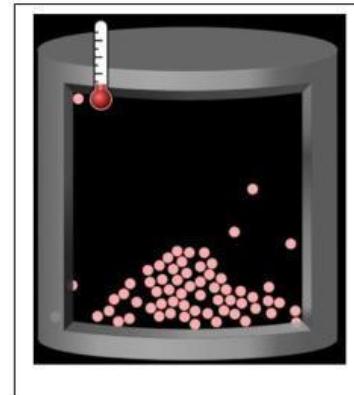
In the simulator, **argon** is a liquid at temperatures above -185°C and -189°C

Click on argon in its liquid form. What temperature is recorded? °C

Lower the temperature is lowered to -190°C? Observe for 60 seconds.

Describe what happens?

- More atoms are released from their bonds.
- Less atoms are released from their bonds
- Less atoms are bonded together
- More atoms become bonded together
- The atoms speed up
- The atoms slow down



What happens when the temperature is lowered by another 10°C

The atoms **slow down** and the force of attraction **increases**. There are **more** atoms separating and floating freely.

What happens when the temperature is lowered by another 10°C

Occasionally an atom will **break free** from its bonds. The force of attraction **decreases**. We can see this because as the atom approaches the solid, it's **distance** increases.

What happens as the temperature is slowly increased to -184°C

When the **liquid** is heated, **kinetic energy** is transferred to its **atoms**. This causes them to move **fast** and as they gain **kinetic energy**. In a liquid state, particles are close together but can **move** past each other, allowing the liquid to flow. However, as more heat is added, some **atoms** gain enough **energy** to **break free** from the **atoms** holding them together.

Theoretically, what should happen over time if the temperature stays at -184°C and the container is not pressurized?

Water is a liquid at temperatures between 0°C and -100°C

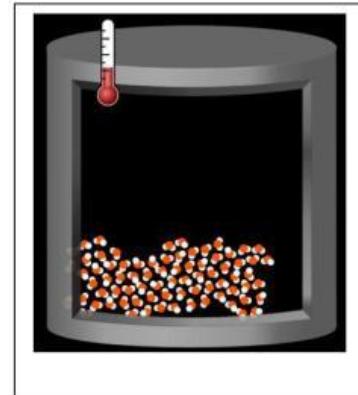
Click on water in its liquid form. What temperature is recorded? °C

Raise the temperature to between 75°C and 80°C

Observe for 60 seconds.

Describe what happens?

- The bonds between the atoms become tighter.
- The bonds between the atoms become looser.
- Less atoms are bonded together
- More atoms become bonded together
- The atoms speed up
- The atoms slow down



What happens as the temperature is increased to 90°C

The molecules vibrate/move . The bonds become , and the molecules . It is easier for the to past each other. More separate from the liquid. Evaporation occurs at temperatures between 0°C and °C. This means that water molecules can separate from a liquid at temperatures between 0°C and 100°C. The the temperature, the faster the rate of evaporation. The the temperature the the rate of evaporation.

At 100°C water boils and rapidly become a gas.

Click on gas phase for water in the simulator.

The gas phase in the simulator shows how water molecules are acting at °C

What happens to the molecules as the temperature is lowered to below 100°C

According to **particle theory**, all matter is made of tiny particles that are in constant . The speed and arrangement of these determine whether a substance exists as a , , or .

When **superheated water vapor** is cooled to 100°C, the following changes occur at the **particle level**:

1. **High-Energy Particles in Superheated Vapor (Above 100°C)**
 - o In the superheated state, **water molecules move** and are with **intermolecular forces**.
 - o The high temperature gives the molecules **excess kinetic** , preventing them from sticking together to form liquid droplets.
2. **Cooling to 100°C – Slowing Down of Particles**
 - o As heat is removed, **particles** **kinetic energy** and begin moving more .
 - o The molecules **move** , increasing the chance of forming intermolecular attractions.
 - o At **100°C**, the water vapor is now in its **saturated state**, meaning it is at the **edge of condensation**.
3. **Phase Change Begins – Condensation Process**
 - o If **any more** is removed, the weakened **intermolecular** (**hydrogen bonds**) start pulling molecules . The water molecules **begin clustering**, forming tiny **liquid droplets** suspended in the remaining vapor.
 - o This stage is known as **saturated steam**—a mix of and particles.
4. **Full Condensation (Below 100°C)**
 - o If the temperature drops **below 100°C**, most particles enough to fully into liquid form. As the water vapor **completely condenses**, it turns into **liquid water** as pack together.

