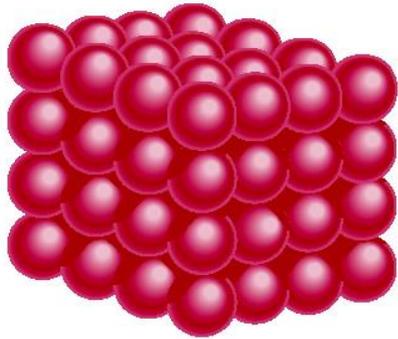
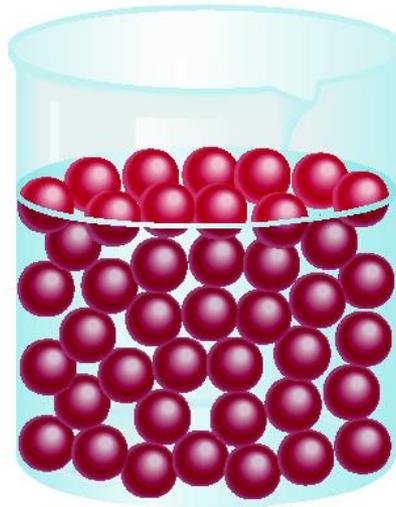


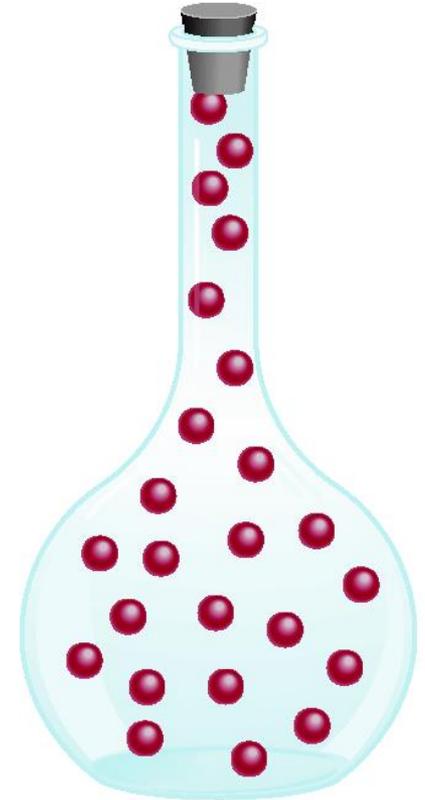
A Comparison: The Three States of Matter



Solid



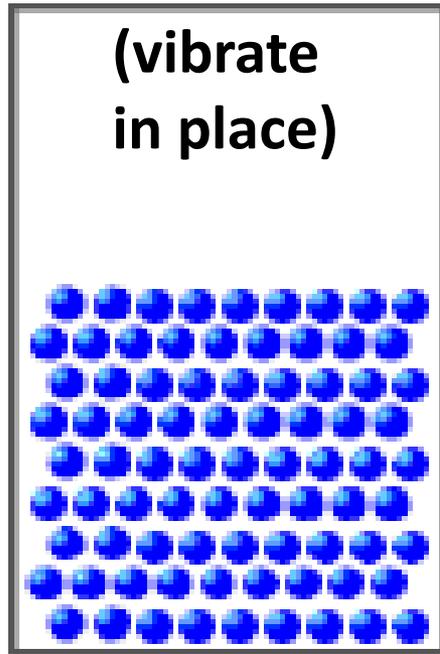
Liquid



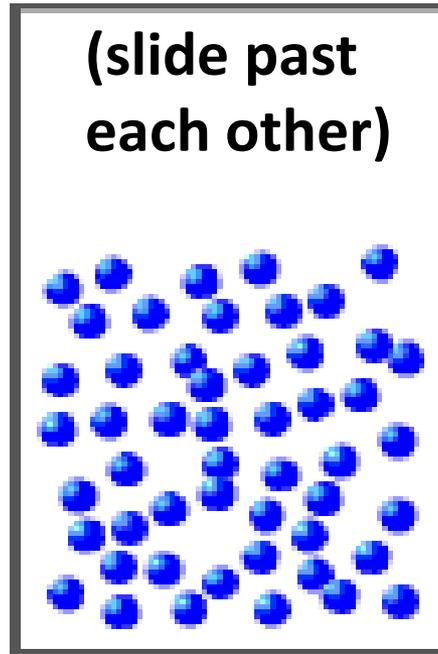
Gas

Example: ICE → WATER → WATER VAPOR

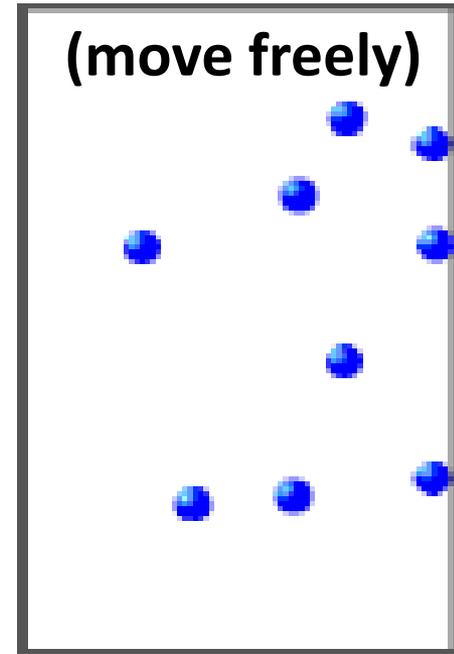
A Comparison: The Three States of Matter



Solid



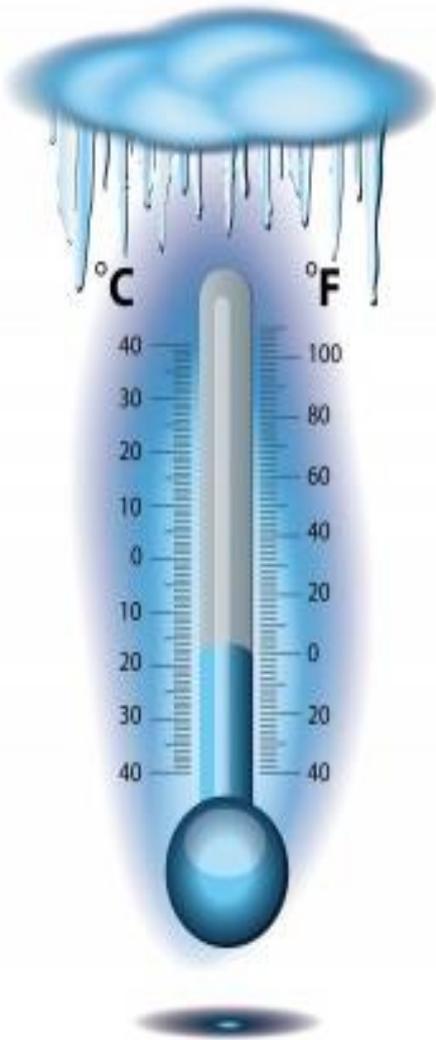
Liquid



Gas

Example: ICE \longrightarrow WATER \longrightarrow WATER VAPOR

What is Temperature?



- **Particles of matter are in constant motion** (*vibrating in place in solids, sliding past each other in liquids, flying around freely in gases*), but they don't all move at the same speed and in the same direction all the time.
- **Temperature is a measure of the average energy associated with random motion of the particles of a substance.**
- The *higher* the temperature of an object, the *faster* on average its particles move.

Flame:
1000-1500°C



How to measure temperature?



Galileo Galilei: water based **thermoscope**, uses “balancing weights” principle, gives very *approximate estimate*

Mercury based thermometers use metals expansion principle:

Daniel Gabriel Fahrenheit scale was designed to cover range of temperatures common in Europe



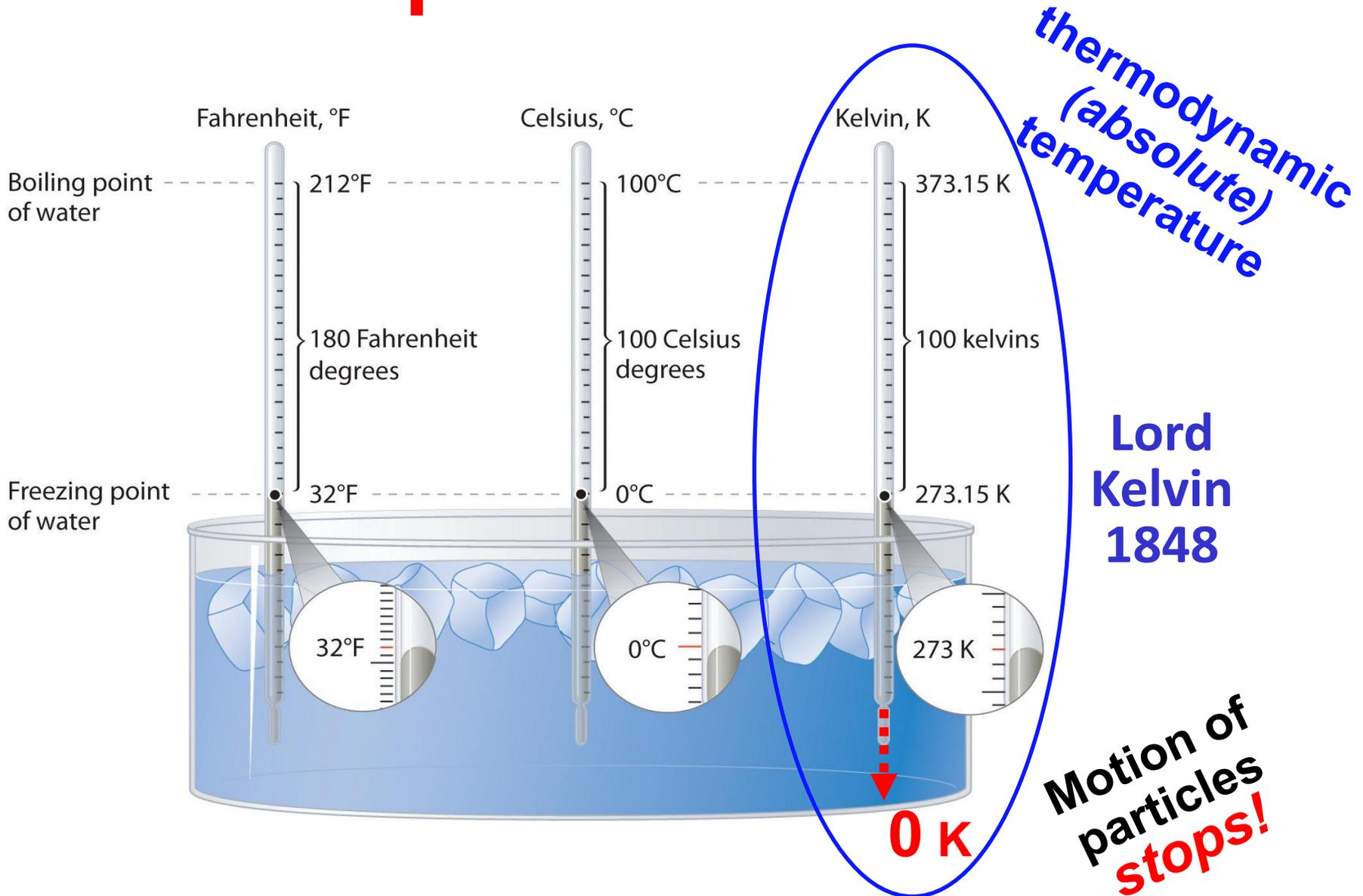
(0F - freezing point of a half-water-half-salt brine, and 96F - human body temperature)

Anders Celsius
“centi-grade”



(scale *originally* based on freezing (100) and boiling (0) points of pure water at sea level)

Temperature Scales

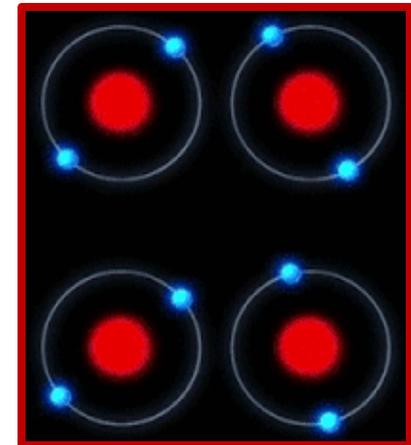
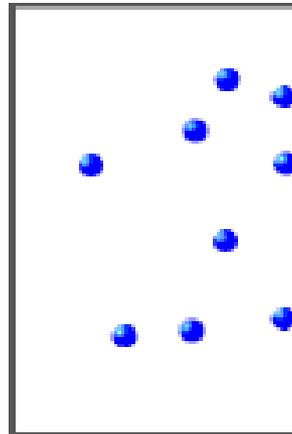
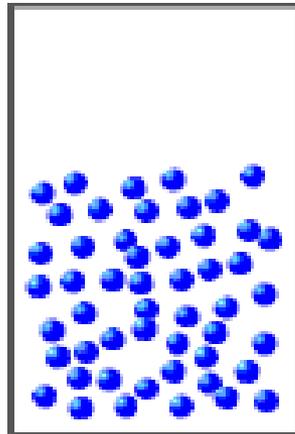
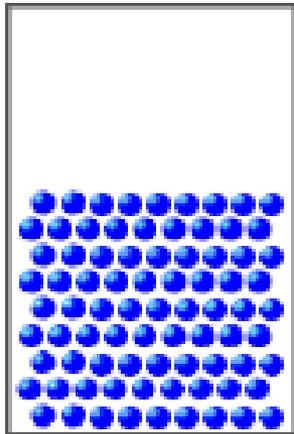
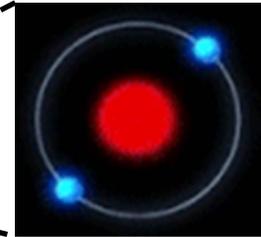
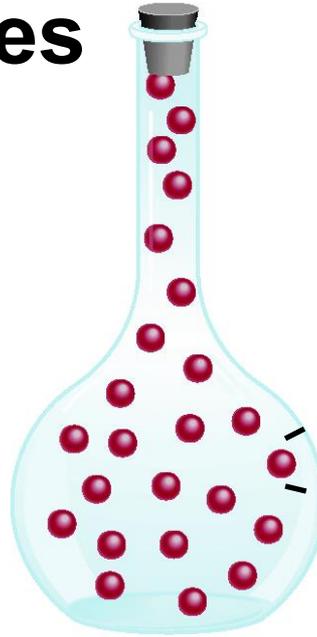
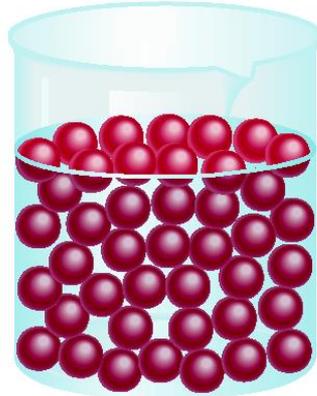
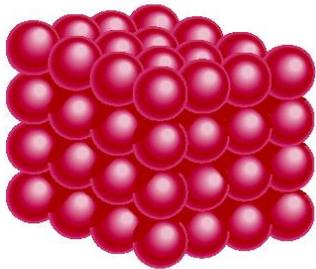


But what happens if you raise the temperature to super-high levels... between 1000°C and 1,000,000,000°C ?

Will everything just be a gas?

As **energy** of particles
increases...

...**electrons**
fly free!



Solid

Liquid

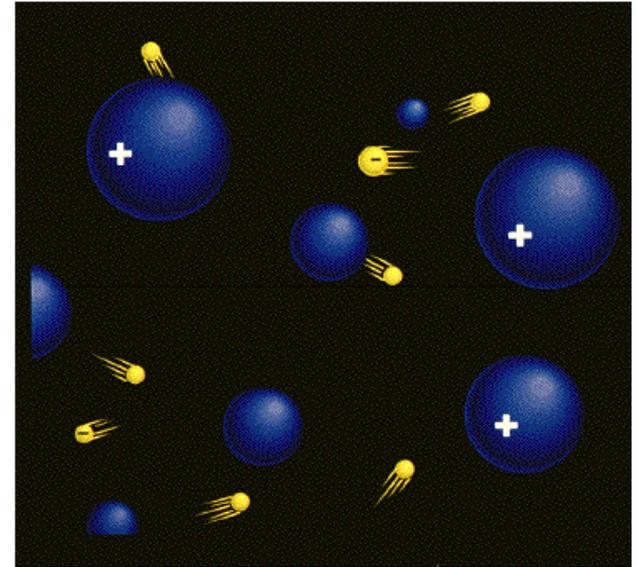
Gas

Plasma



PLASMA

- A plasma is an **ionized gas**: positively charged nuclei swim in a "sea" of freely-moving dissociated electrons.
- A plasma is a very good **conductor of electricity**: it produces and responds to magnetic fields.
- Plasmas, like gases, have an **indefinite shape** and an **indefinite volume**.
- A gas is usually converted to a plasma in one of the following two ways:
 - by exposing gas to **extremely high temperatures** that cause electrons to leave the atoms
 - from a **huge voltage** difference between two points



Plasma is a common state of matter!

Some places where plasmas are found...

