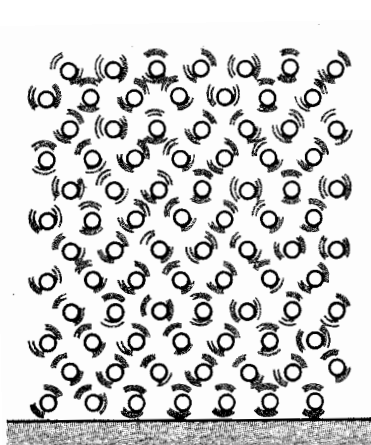


Properties of matter

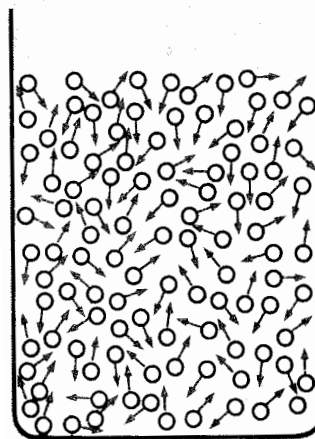
Matter is composed of atoms and molecules to which we refer to as particles. Atoms are incredibly tiny and incredibly numerous. They are too small to be seen under a regular microscope. Atoms and molecules are perpetually moving and jiggling about.

- The faster the movement of the atoms and molecules of an object, the warmer is the object.
- If the movement of an object's particles becomes more intense, the particles need more room for moving about and the object expands.

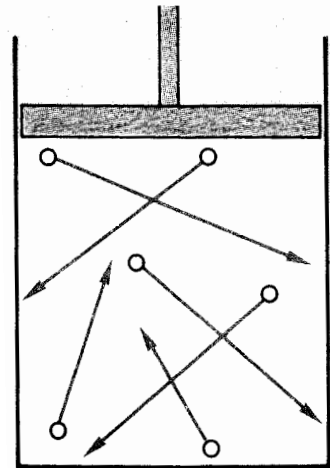
Matter around us exists in different states (phases): The solid, liquid or gaseous phase. The phase depends on the temperature and on the pressure.



In a *solid* material the atoms vibrate about their fixed positions. The atoms or molecules are closer together and the attractive force between them is strong.



In a *liquid* material the particles have no fixed positions. They move about in all directions, constantly changing places. Since the atoms or molecules are slightly further apart the attractive forces are weaker than in the solid state.



In a *gas* the atoms and molecules move about randomly at high speeds. The particles are very far apart and the attractive force between them is negligible. The atoms or molecules spread out, taking up as much room as possible.

Phases of matter

If a material is heated or cooled, it can change its phase (state). This occurs at a certain temperature which is specific to the material (*boiling point* and *melting point*).

As the temperature of a solid object increases, the atoms and molecules vibrate more and more until they are no longer held in their fixed places. The object *melts*.

If a liquid is cooled, the movement of the particles slows down until they vibrate about their fixed places. The object *freezes*.

As the temperature of a liquid increases, the particles move faster until they escape from it. The liquid *evaporates*.

If a gas is cooled, the movement of the molecules slows down until the weak attractive forces take over and the particles are moving about randomly, close to each other. The gas *condenses*.

The discovery of the motion of particles (Brownian motion)



Robert Brown (Scottish botanist, 21 december 1773 – 10 june 1858) observed in 1827 the random motion of tiny particles (grains of pollen) under a microscope.

The atoms and molecules are too small to be observed under a microscope. They are moving constantly, shoving and pushing the grains of pollen around. However, the motion of the grains of pollen can be observed. The motion of those larger observable objects is called *Brownian motion*.

Links

Phase states of matter:

<https://www.middleschoolchemistry.com/multimedia/chapter1/lesson5>

Choose “Comparing Solids, Liquids and Gases”

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

Choose “Phase changes” - a new window opens. Then click on “water” and choose “°C” for temperature. Move the lever under the bucket to “heat” and watch the phase changes.

Brownian motion:

https://www.vascak.cz/data/android/physicsatschool/template.php?s=mf_brownuv_pohyb&l=en

https://www.leifiphysik.de/sites/default/files/images/e78aab6ea61aafbc51b1a4625811bdcc/0brownsche_bewegung_bild_3.gif