

MODULE: *Matter 1*

Activity Sheet 1.11: Bonding and properties of materials

Atoms are indestructible in physical and chemical changes. The atoms that are in a material to start with will still be there at the end of the change, but they may be arranged into different combinations.

Chemistry is about rearranging atoms into new and different combinations. The reason for this is to make better or more useful materials out of the atoms. Materials are useful to us because of their physical and chemical properties.

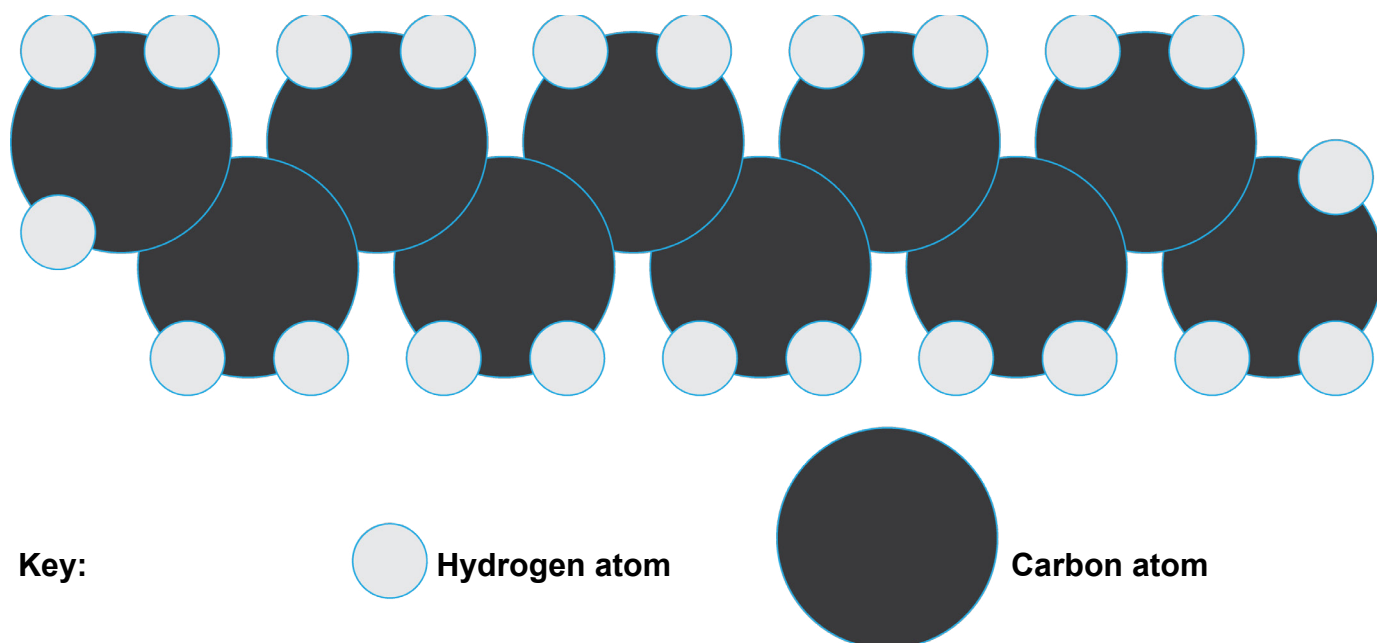
Atoms link to make compounds. The only way atoms can link up is by using their outer shells of electrons. This is called **atomic bonding**.

Atoms can **share** electrons with each other. That holds the atoms together strongly. This is how molecules are made.

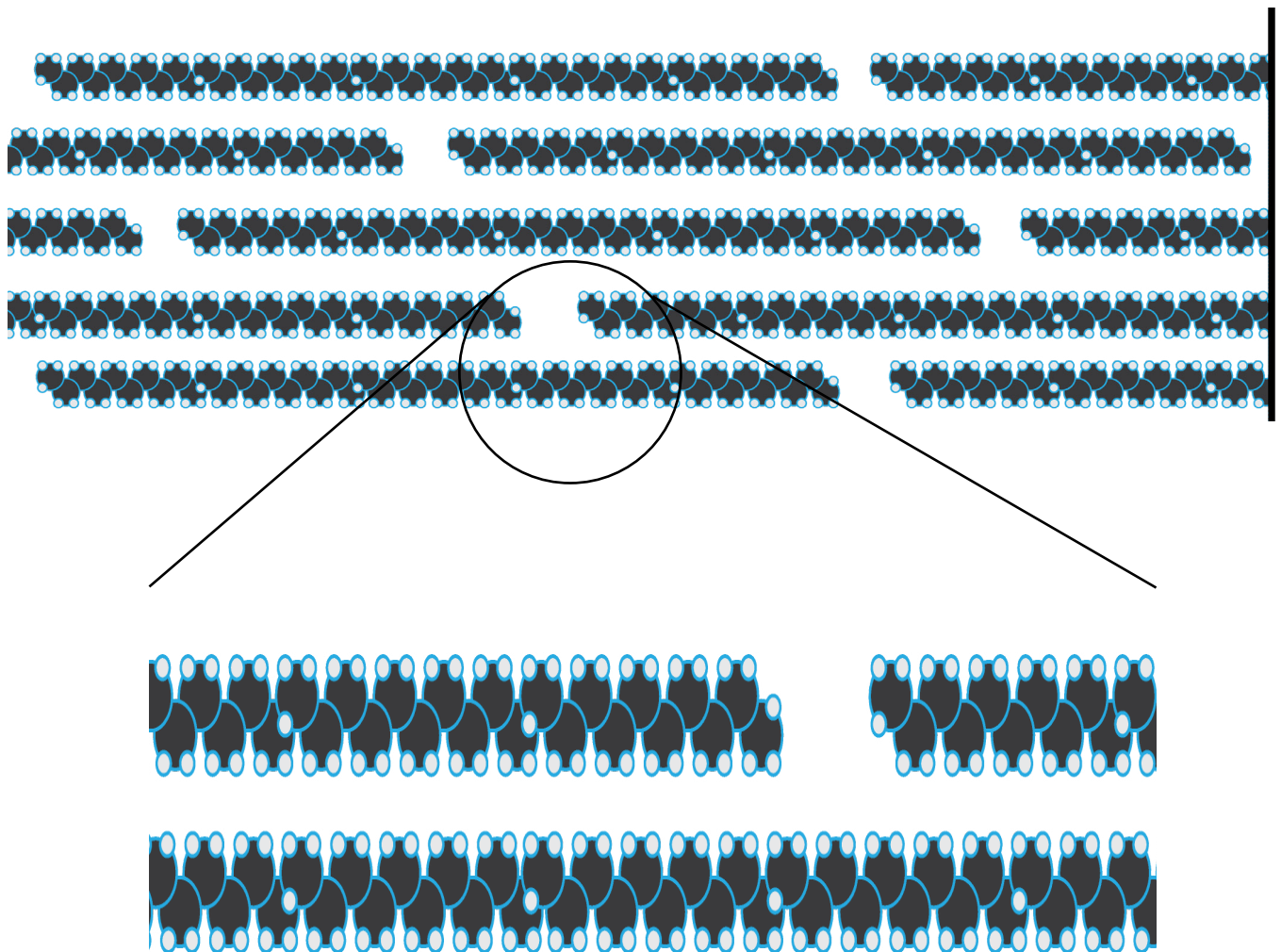
Atoms can also **transfer** electrons to another atom. This turns both atoms into **ions** – particles that have an electric charge. These ions are stable, and they are held together by a strong electrostatic force of attraction.

What makes salt and sand hard, but wax soft?

Wax is made of molecules that look like the diagram below, but about three times as long.



The long wax molecule itself is quite strong and cannot be pulled apart easily. But between the molecules in wax there are only weak forces. As the molecules can be pulled away from each other and moved about in the solid structure, wax is quite soft.



These weak forces between molecules mean it is very easy to break up the arrangement of molecules in solid wax. It is soft. Wax melts at a reasonably low temperature.

Salt



Salt is sodium chloride. Do you know that Sodium (a dangerously reactive metal) combines with chlorine (a poisonous gas) to make sodium chloride (common salt) that we use to flavour food.

Sodium atoms react with chlorine atoms. They both have a combining power of 1, so a sodium atom loses an outer electron and a chlorine atom gains one. The atoms become charged particles, ions.

But the ions in sodium chloride do not team up in pairs to make molecules. Instead they form into big 3-D arrays, with all the ions strongly held onto each other by electrostatic forces.

As a result, salt is hard, and only melts at a very high temperature.



Sand



Sand is silicon dioxide. Silicon atoms make bonds with oxygen atoms. Silicon has a combining power of 4, and so a silicon atom makes bonds with four oxygen atoms around it.

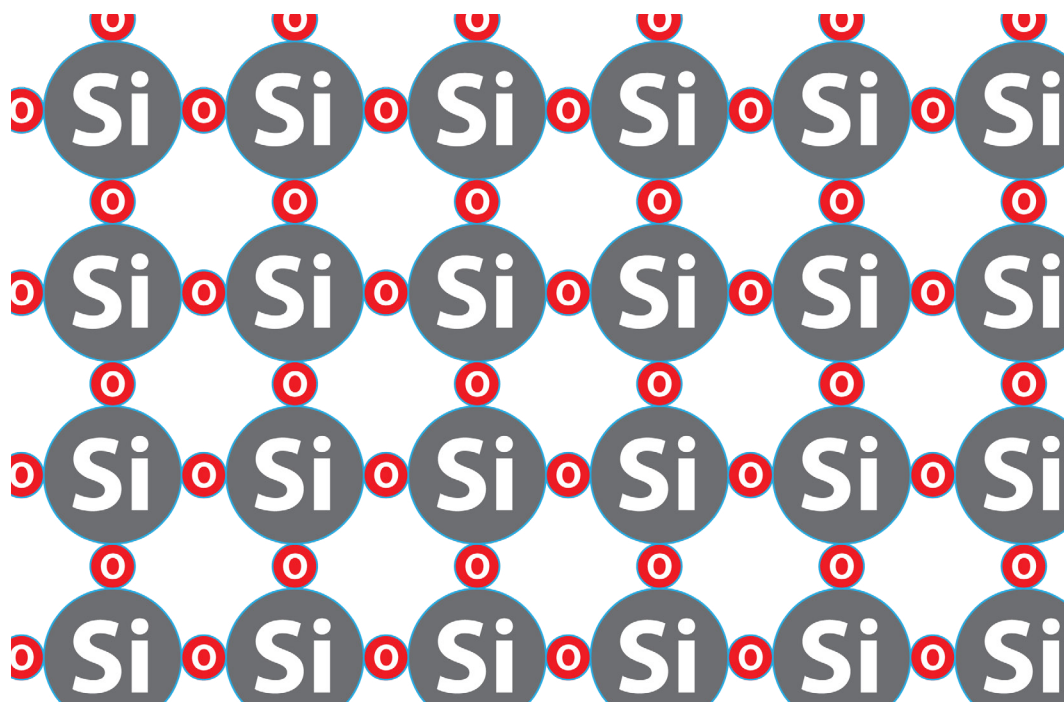
Oxygen has a combining power of 2 and an oxygen atom makes bonds with two silicon atoms.

All the atoms in the array are held together very strongly because they share electrons with their neighbouring atoms.

As in sodium chloride, these do not make molecules but a gigantic 3-D array of atoms.

This means that sand, silicon dioxide, also is very hard with a high melting temperature.

The structure of silicon dioxide looks like this.



Bonding properties

The forces between a material's atoms or molecules determine the properties of that material.

- Wax has only weak forces between the molecules in its solid structure. Because the forces between its molecules are easily broken, wax is soft, with a low melting point.
- Sodium chloride and silicon dioxide form giant structures, and both of these giant structures are held together by strong forces. So salt and sand are hard materials with high melting points.