

Additional Teacher Background

Chapter 2, Lesson 3, p. 98

Exploring evaporation and condensation gives middle school students an opportunity to understand some common phenomena on the molecular level. It can also give you an opportunity to review and better understand some big ideas in chemistry and physical science that are relevant to evaporation and condensation as well as other contexts in chemistry.

Big idea 1:

If two atoms or molecules, like water molecules, are attracted to each other and are “bonded”, it takes energy to pull them apart. If two atoms or molecules are attracted to each other and are not bonded, energy is released when they come together and bond. In chemistry, this concept is often stated as:

It takes energy to break bonds.

Energy is released when bonds are formed.

Note: In the context of evaporation and condensation, the use of the term “bond” refers to the interaction and close association between water molecules. It does not refer to the covalent bond which holds the oxygen atom and the hydrogen atoms together within the water molecule. The bond breaking and bond making involved in evaporation and condensation deals with the attractions and interactions between water molecules.

Big idea 2:

Another big idea is that the energy atoms and molecules have based on their motion is called kinetic energy. The energy they have based on their attraction to each other is called potential energy.

Big idea 3:

This is like a combination of Big ideas 1 and 2. When we say it takes energy to break bonds and energy is released when bonds are formed, it really means energy is converted between kinetic and potential energy. For example, it takes a certain amount of kinetic energy to separate two water molecules. When they are separated, the kinetic energy used to separate them is converted to the potential energy of attraction between them. If they come together again, this potential energy is converted back to kinetic energy. Energy is not created or destroyed; it is converted from one form to another.

These ideas can help explain why evaporation has a cooling effect and condensation has a warming effect.

Think about a single water molecule in a sample of water. Assume that the molecule has average kinetic energy. This molecule gets hit by some fast-moving water molecules and gains some extra kinetic energy. The water molecule now has above-average kinetic energy. This extra kinetic energy is “used” to break its “bonds” to other water molecules causing it to evaporate. This extra kinetic energy is converted to potential energy of attraction between the water molecule as a gas and the other water molecules in the liquid. The extra kinetic energy is not in the water anymore so the temperature of the water decreases.

Now imagine that same water molecule as a molecule of water vapor with average kinetic energy. As this molecule is attracted to other water molecules its potential energy decreases while its kinetic energy increases. The water molecule now has above-average kinetic energy. It hits other water molecules and transfers this extra kinetic energy to them which enables it to bond to other water molecules. The extra kinetic energy is now in the water so the temperature of the water increases.