USING THE KINETIC MODEL TO EXPLAIN THINGS

Theories in science. Scientists use their imaginations to invent theories to help them explain what they observe (see Module 1.7). If a theory explains many observations, and if it helps scientists to make correct *predictions*, then the theory is accepted as true. Later, if new observations are made, which do not agree with the theory, then the theory has to be changed, or replaced by a better theory. The present form of the kinetic theory has existed for more than 100 years. Some of the things it helps to explain are described on the remainder of this page.

Changes of state. An important part of the kinetic theory is that the hotter particles get, the faster they move! When we heat a solid, the particles vibrate faster and faster. If we continue heating, they eventually gain so much energy they start pushing past one another! When this happens, the solid melts. The particles stay together in a crowd but they are all moving, so they can flow into any shape. When a liquid is cooled, the particles slow down. The reverse changes occur and the liquid freezes.

Some properties of solids, liquids and gases

A solid has a fixed volume and a fixed shape. This is because the particles in a solid cannot change their position.

A liquid has a fixed volume, but it takes the shape of any container. The volume is fixed because the particles remain together in a crowd or group, but the shape of the crowd can change because the particles can move.

A gas has no fixed volume or shape. It expands to fill any container. This is because the particles in a gas do not remain together and are completely free to move anywhere.

When we heat a liquid, the particles move faster. A few particles may gain so much energy that they fly away from the crowd! This is what happens when a liquid evaporates. As we continue heating the liquid, more particles evaporate. When all the particles start leaving the crowd, the liquid boils. All the particles are free to fly anywhere! The reverse changes occur when a gas is cooled and condenses into a liquid.

Diffusion in gases. Sometimes your nose tells you there are beautiful flowers nearby, or what is for dinner before you see it! The smell *diffuses* (spreads out) through the air, from the flower or your dinner to your nose. The kinetic model makes diffusion easy to explain. Molecules evaporate from anything that smells and fly about between the particles of air. Some of the molecules from the flower or the food reach your nose. An example of diffusion that you can see is smoke diffusing through the air.

Dissolving and diffusion in liquids. The kinetic model helps to explain what happens when a solid dissolves in a liquid. When a little sugar is added to water, the molecules of water bump against the sugar crystals. Some of the sugar molecules are knocked off the crystals (they *dissolve*) and are carried away in the jostling crowd of water molecules (they *diffuse*). After some time, all the sugar molecules dissolve and diffuse throughout the water. Heat speeds up dissolving and diffusion because heat makes the water molecules move faster.

The shapes of crystals can be explained by the stacking of particles in solids. The models below are made from fruits. Silver crystals are diamond shaped and salt crystals are cubic.

Particles of silver in a silver crystal

Sodium and chlorine particles in a salt crystal

Thermal expansion. When a solid is heated, the particles vibrate more and take up just a tiny bit more room. That is why solids expand, but not very much. Liquids and gases expand more because the particles are free to move faster. In gasses, a little heat speeds them up a lot so they take up much more room.

- 1. Copy the diagram in Module 9.2 that shows the kinetic model for a liquid. Label any particles that are evaporating.
- 2. Use the kinetic theory to explain a solid dissolving in a liquid using the words *solute*, *solvent, solution*.
- 3. Use the kinetic theory to explain why air and other gases are compressible, but not liquids and solids.
- 4. Imagine you are a water molecule. Describe what happens to you when you are (i) put in a freezer, (ii) boiled in a kettle.