

## CAREERS in Chemistry

### Environmental Chemist

What happens to all of our chemical waste, such as household cleaners and shampoos that we rinse down the drain, industrial smoke, and materials that have not been removed in water treatment plants? Environmental chemists investigate the sources and effects of chemicals in all parts of the environment. Then, chemists also devise acceptable ways to dispose of chemicals. This may involve conducting tests to determine whether the air, water, or soil is contaminated; developing programs to help remove contamination; designing new production processes to reduce the amounts of waste produced; handling regulation and compliance issues; and advising on safety and emergency responses. Environmental chemists must understand and use many other disciplines, including biology, geology and ecology.

and bring fresh solvent into contact with the solute surface. Thus, the effect of stirring is similar to that of crushing a solid—contact between the solvent and the solute surface is increased.

### Heating a Solvent

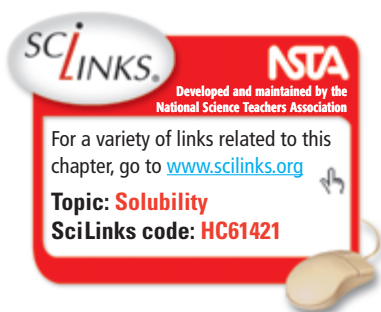
You have probably noticed that sugar and many other materials dissolve more quickly in warm water than in cold water. As the temperature of the solvent increases, solvent molecules move faster, and their average kinetic energy increases. Therefore, at higher temperatures, collisions between the solvent molecules and the solute are more frequent and are of higher energy than at lower temperatures. This helps to separate solute molecules from one another and to disperse them among the solvent molecules.

## Solubility

If you add spoonful after spoonful of sugar to tea, eventually no more sugar will dissolve. For every combination of solvent with a solid solute at a given temperature, there is a limit to the amount of solute that can be dissolved. The point at which this limit is reached for any solute-solvent combination is difficult to predict precisely and depends on the nature of the solute, the nature of the solvent, and the temperature.

The following model describes why there is a limit. When solid sugar is first added to water, sugar molecules leave the solid surface and move about at random in the solvent. Some of these dissolved molecules may collide with the crystal and remain there (recrystallize). As more solid dissolves and the concentration of dissolved molecules increases, these collisions become more frequent. Eventually, molecules are returning to the crystal at the same rate at which they are going into solution, and a dynamic equilibrium is established between dissolution and crystallization. Ionic solids behave similarly, as shown in **Figure 7**.

**Solution equilibrium** is the physical state in which the opposing processes of dissolution and crystallization of a solute occur at equal rates.



**FIGURE 7** A saturated solution in a closed system is at equilibrium. The solute is recrystallizing at the same rate that it is dissolving, even though it appears that there is no activity in the system.

