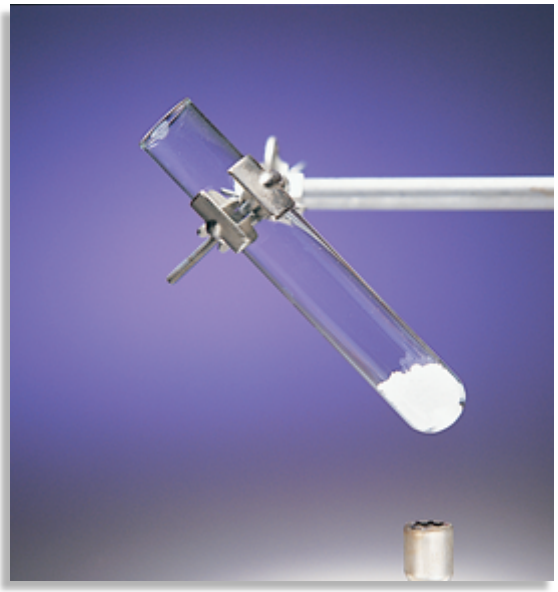
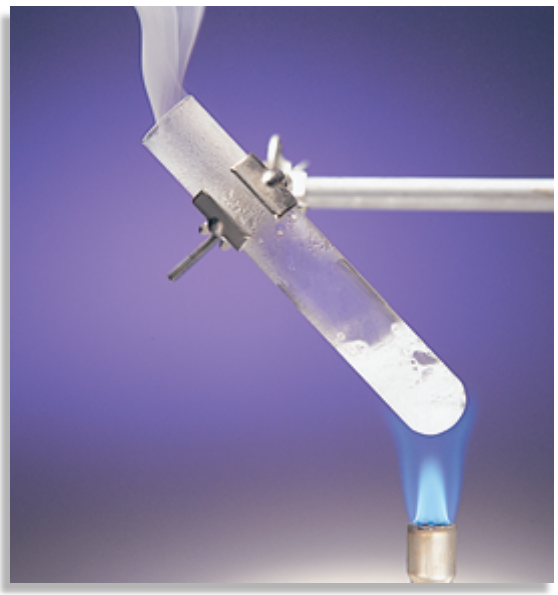
On the left side are 2 mol of solid ammonium nitrate. The right-hand side of the equation shows 3 mol of gaseous molecules plus 4 mol of a liquid. The arrangement of particles on the right-hand side of the equation is more random than the arrangement on the left side of the equation and hence is less ordered. **Figures 6a** and **6b** show the reactant and products of this decomposition reaction.

These examples illustrate that there is a tendency in nature to proceed in a direction that increases the randomness of a system. A random system is one that lacks a regular arrangement of its parts. This tendency toward randomness is called entropy. **Entropy,** *S,* can be defined in a simple qualitative way as *a measure of the degree of randomness of the particles, such as molecules, in a system*. To understand the concept of entropy, consider solids, liquids, and gases. In a solid, the particles are fixed in position in their small regions of space, but they are vibrating back and forth. Even so, we can determine with fair precision the location of the particles. The degree of randomness is low, so the entropy is low. When the solid melts, the particles are still very close together, but they can move about somewhat. The system is more random, and it is more difficult to describe the location of the particles. The entropy is higher. When the liquid evaporates, the particles are moving rapidly and are also much farther apart. Locating an individual particle is much more difficult, and the system is much more random. The entropy of the gas is still higher than that of the liquid. A general but not absolute rule is that the entropy of liquids is larger than that of solids and the entropy of gases is larger than that of liquids. But this rule must be used with caution. For example, the entropy of liquid mercury is much less than that of some solids.



(a)



(b)

FIGURE 6 When ammonium nitrate, NH_4NO_3, decomposes, the entropy of the reaction system increases as (a) one solid reactant becomes (b) two gaseous products and one liquid product.

The entropy of a pure crystalline solid is zero at absolute zero. As energy is added, the randomness of the molecular motion increases. Measurements of energy absorbed and calculations are used to determine the absolute entropy or standard molar entropy, and values are then recorded in tables. These molar values are reported as kJ/(mol•K). Entropy change, which can also be measured, is defined as the difference between the entropy of the products and the reactants. Therefore, an increase in entropy is represented by a positive value for ΔS, and a decrease in entropy is represented by a negative value for ΔS.

The process of forming a solution almost always involves an increase in entropy because there is an increase in randomness. This is true for mixing gases, dissolving a liquid in another liquid, and dissolving a solid in a liquid.