



FIGURE 7 When a solid dissolves in a liquid, the entropy of the system increases.

CHEMISTRY



Module 9: Thermochemistry

extension

CROSS-DISCIPLINARY

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Keyword: HC6NRGX

Free Energy

Processes in nature are driven in two directions: toward least enthalpy and toward largest entropy. When these two oppose each other, the dominant factor determines the direction of change. As a way to predict which factor will dominate for a given system, a function has been defined to relate the enthalpy and entropy factors at a given temperature and constant pressure. *This combined enthalpy-entropy function is called the **free energy**, G , of the system;* it is also called *Gibbs free energy*. This function simultaneously assesses the tendencies for enthalpy and entropy to change. Natural processes proceed in the direction that lowers the free energy of a system.

Only the *change* in free energy can be measured. It can be defined in terms of changes in enthalpy and entropy. *At a constant pressure and temperature, the **free-energy change**, ΔG , of a system is defined as the difference between the change in enthalpy, ΔH , and the product of the Kelvin temperature and the entropy change, which is defined as $T\Delta S$.*

$$\Delta G^0 = \Delta H^0 - T\Delta S^0$$

Note that this expression is for substances in their standard states. The product $T\Delta S$ and the quantities ΔG and ΔH have the same units, usually kJ. The units of ΔS for use in this equation are usually kJ/K. If $\Delta G < 0$, the reaction is spontaneous.

ΔH and ΔS in the free-energy equation can have positive or negative values. This leads to four possible combinations of terms.

Table 2 on the next page shows that if ΔH is negative and ΔS is positive, then both terms on the right in the free energy equation are