1.10.5.3: The Effect of Temperature Changes on Equilibrium

Learning Objectives

- Explain how temperature changes affect a system at equilibrium.

When temperature is the stress that affects a system at equilibrium, there are two important consequences:

- an increase in temperature will favor that reaction direction that ***absorbs*** heat (i.e. the endothermic reaction)
- the value of K_{eq} will change

Consider the following equilibrium system:

$$\mathrm{N_2O_4(g) \leftrightarrow 2\,NO_2(g)}$$

$$\text{with } \Delta H^\circ = 58 \cdot 0 \text{ kJ}$$

We see by the sign of ΔH° that the forward reaction is endothermic. Heat is absorbed (required as a reactant) when the reaction proceeds as

$$\mathrm{N_2O_4(g) \rightarrow 2\,NO_2(g)}$$

By adding more heat, equilibrium will shift to use up the additional heat, thus favoring this forward direction.

Why will K_{eq} change, when it did not change when concentration, pressure, and volume were the applied stresses?

When temperature changes cause an equilibrium to shift, one entire side of the reaction equation is favored over the other side. Mathematically, this will alter the value of K_{eq} as follows:

$$K_{eq} = \frac{[\text{products}]}{[\text{reactants}]}$$

\ce{K_{eq}}

forward and reverse reactions

if the forward reaction is favored	more products are produced; fewer reactants	K_{eq} will increase
if the reverse reaction is favored	fewer products; more reactants	K_{eq} will decrease

So in our example given above, increasing the temperature will favor the forward direction. The value of K_{eq} will increase. **Removing heat (making the system colder) will favor the exothermic reaction**—the exothermic reaction ***releases heat*** to the surroundings, thus "replacing" the heat that has been removed.
