Equilibrium

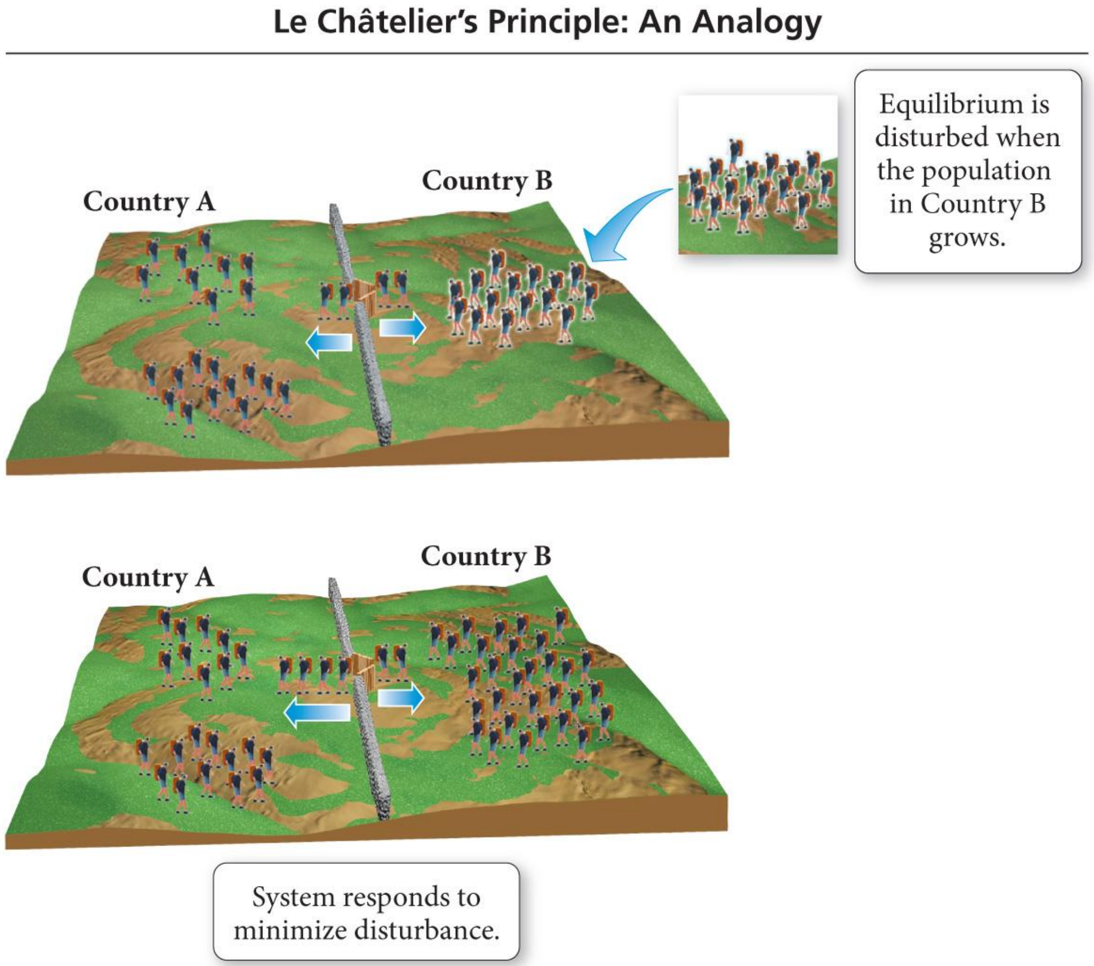
Le Châtelier’s Principle

Le Châtelier’s Principle

Le Châtelier's principle- guides us in predicting the effect various changes in conditions have on the position of equilibrium.

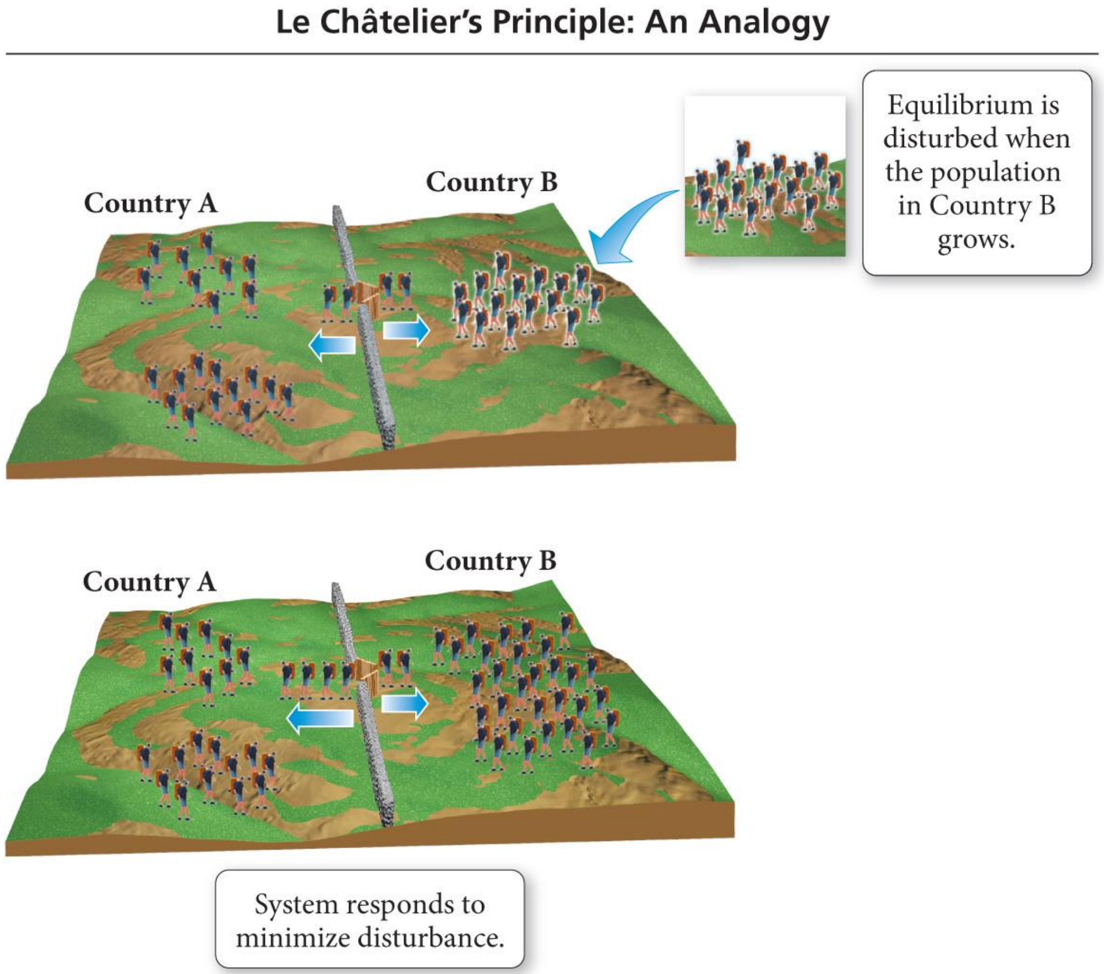
If a system at equilibrium is disturbed, the position of equilibrium will shift to minimize the disturbance.

An Analogy: Population Changes



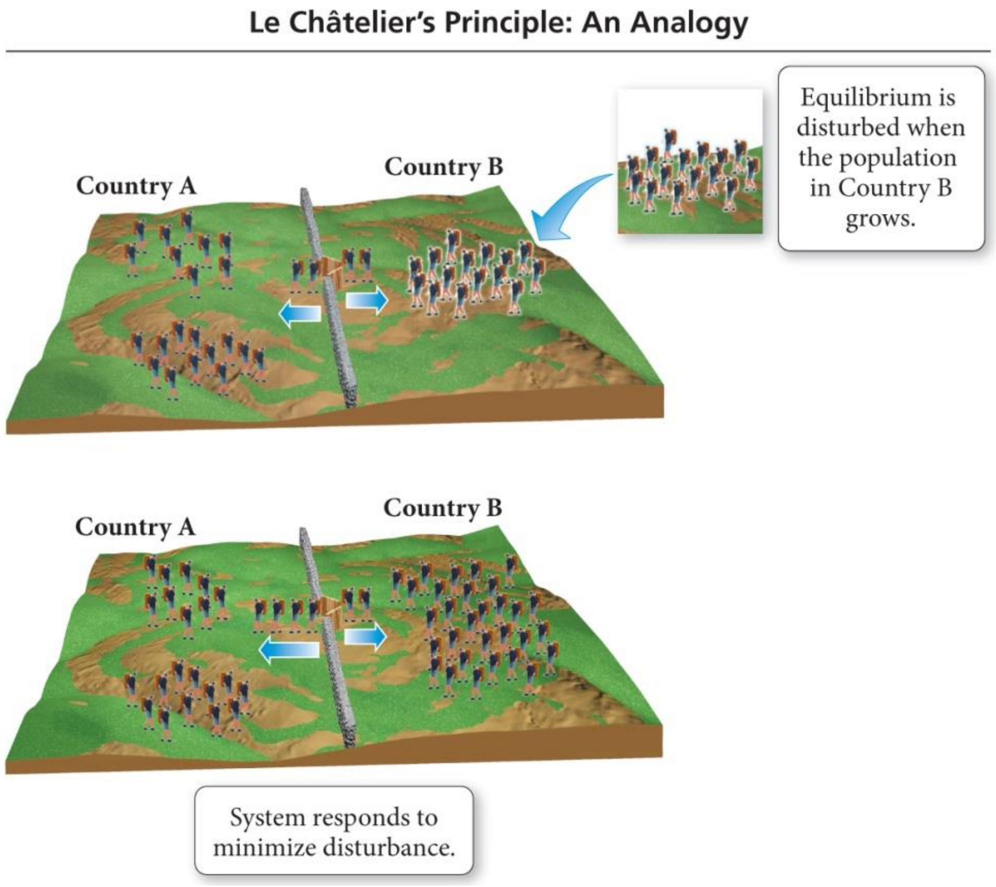
When the populations of Country A and Country B are in equilibrium, the emigration rates between the two countries are equal so the populations stay constant.

An Analogy: Population Changes



When an influx of population enters Country B from somewhere outside Country A, it disturbs the equilibrium established between Country A and Country B.

An Analogy: Population Changes



The result will be people moving from Country B into Country A faster than people moving from Country A into Country B.

This will continue until a new equilibrium between the populations is established; the new populations will have different numbers of people than the old ones.

Le Chatelier Example #1

A closed container of ice and water is at equilibrium. Then, the temperature is raised.

Ice + Energy ⇆ Water

The system temporarily shifts to the **right** to restore equilibrium.

Le Chatelier Example #2

A closed container of N_2O_4 and NO_2 is at equilibrium. NO_2 is added to the container.

$$N_2O_4\,(g) + \text{Energy} \leftrightarrows 2\,NO_2\,(g)$$

The system temporarily shifts to the ___left___ to restore equilibrium.

Le Chatelier Example #3

A closed container of water and its vapor is at equilibrium. Vapor is removed from the system.

water + Energy ⇆ vapor

The system temporarily shifts to the ___**right**___ to restore equilibrium.

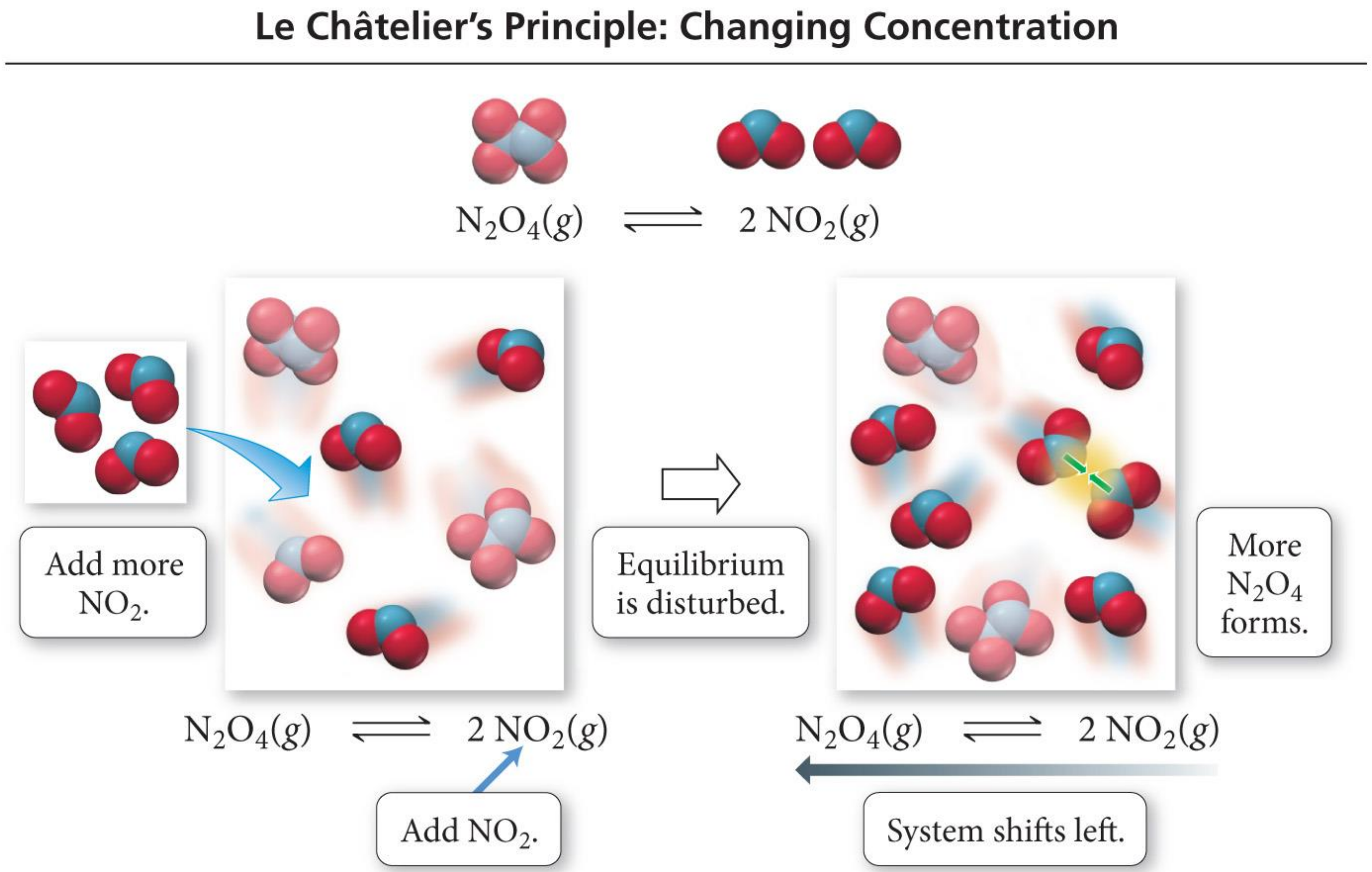
Le Chatelier Example #4

A closed container of N_2O_4 and NO_2 is at equilibrium. The pressure is increased.

$$\mathbf{N_2O_4}\ (g) + \mathbf{Energy} \leftrightarrows \mathbf{2\ NO_2}\ (g)$$

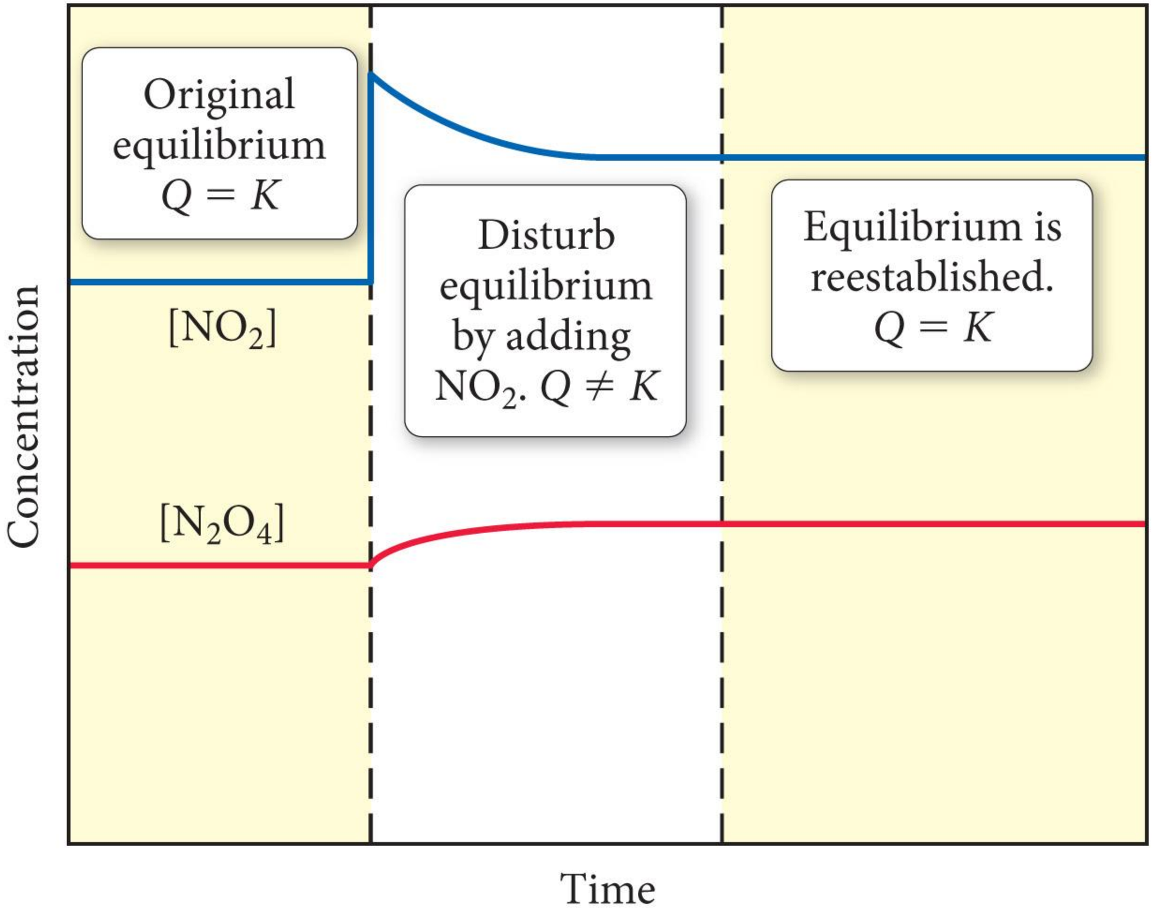
The system temporarily shifts to the __left__ to restore equilibrium, because there are ***fewer moles of gas*** on that side of the equation.

The Effect of [ ] Changes on Equilibrium



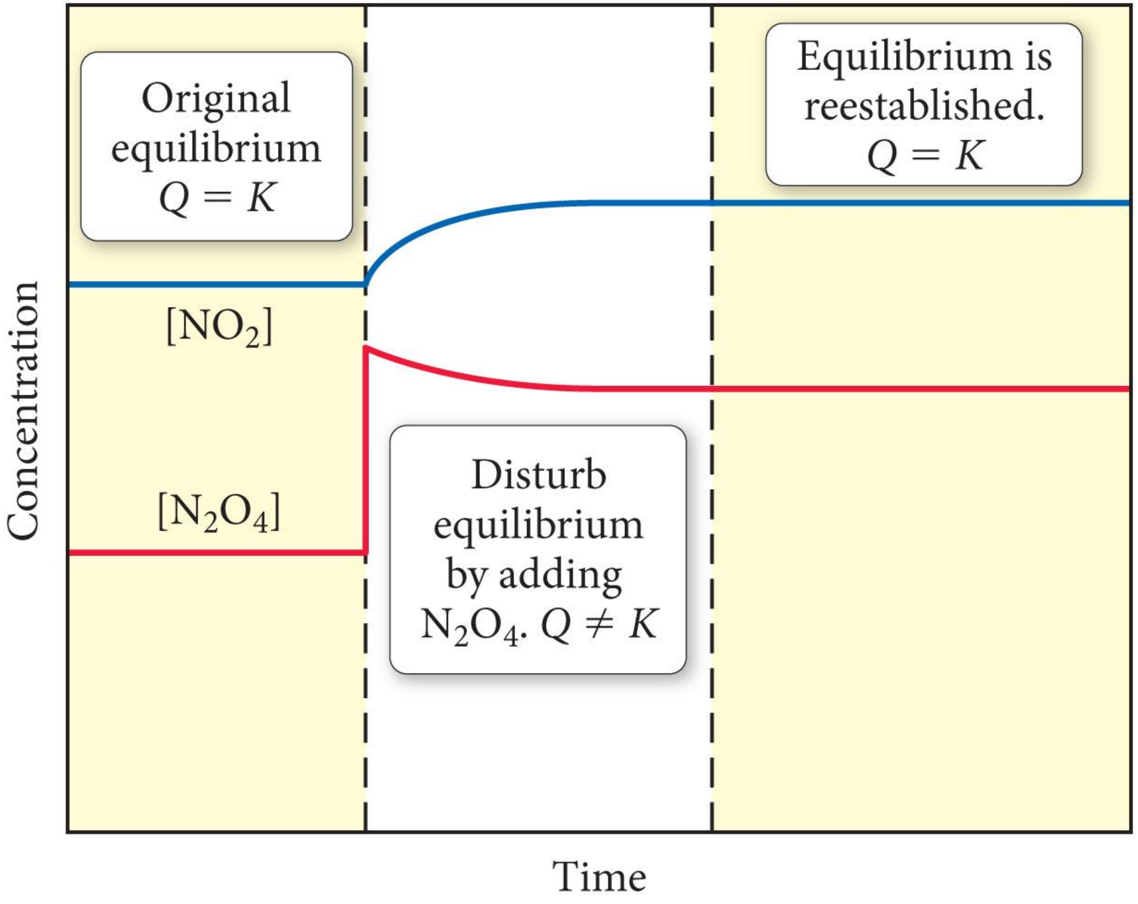
When NO_2 is added, some of it combines to make more N_2O_4.

The Effect of [ ] Changes on Equilibrium



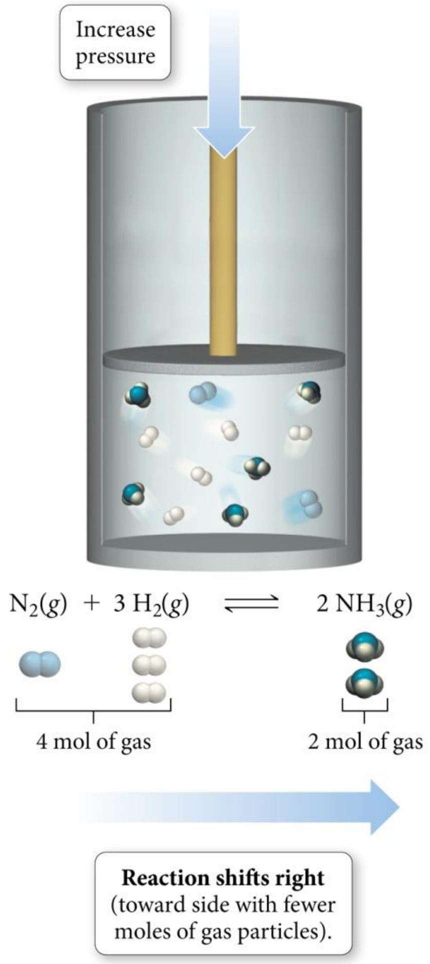
When N_2O_4 is added, some of it decomposes to make more NO_2.

The Effect of [   ] Changes on Equilibrium

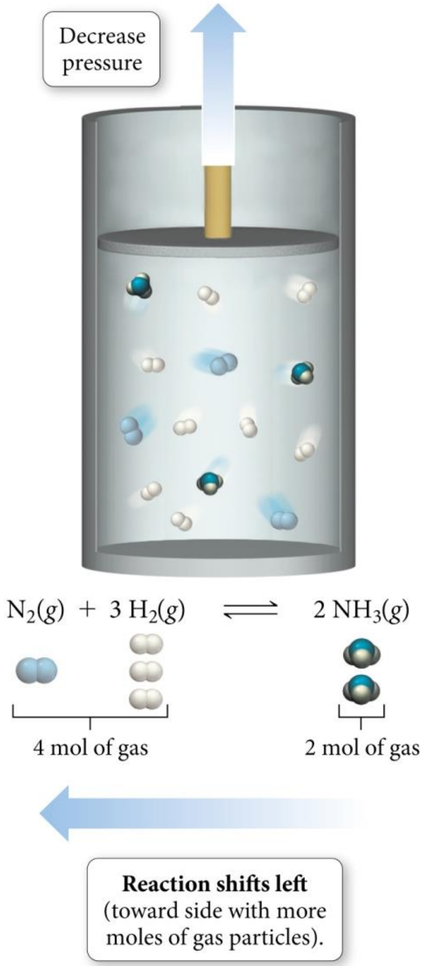


When N_2O_4 is added, some of it decomposes to make more NO_2.

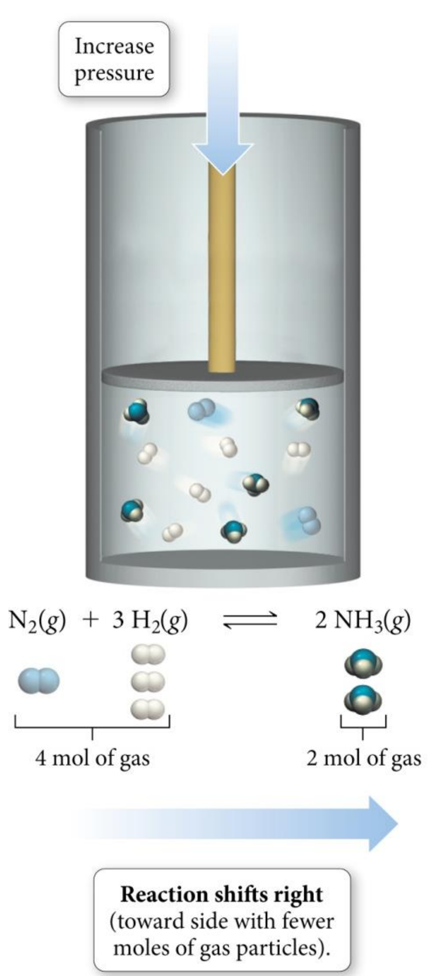
The Effect of Volume Changes on Equilibrium



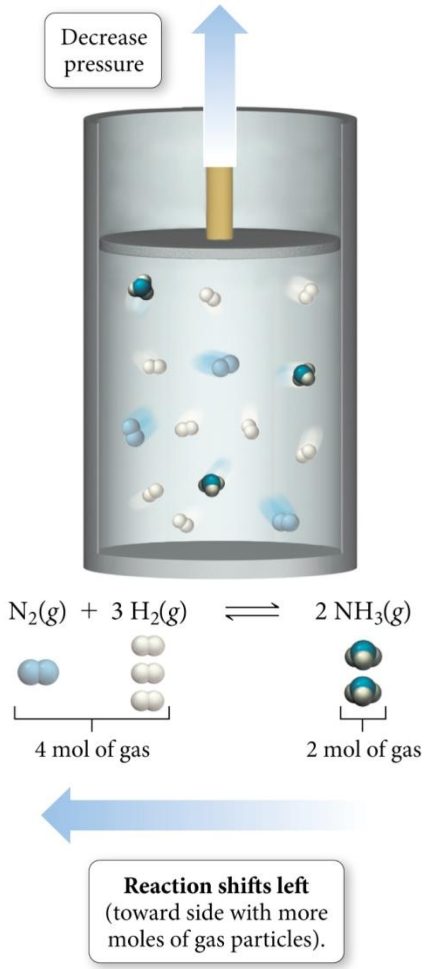
Because there are more gas molecules on the reactants side of the reaction, when the pressure is increased, the position of equilibrium shifts toward the side with fewer molecules to decrease the pressure.



The Effect of Volume Changes on Equilibrium



When the pressure is decreased by increasing the volume, the position of equilibrium shifts toward the side with the greater number of molecules—the reactant side.



The Effects of Catalysts

- Provide an alternative, more efficient mechanism.
- Work for both forward and reverse reactions.
- Affect the rate of the forward and reverse reactions by the same factor.
- Therefore, catalysts do not affect the position of equilibrium.

They do not change the position of equilibrium…

You just get to equilibrium faster!