# Equilibrium

**Unit 13D:** Le Châtelier’s Principle

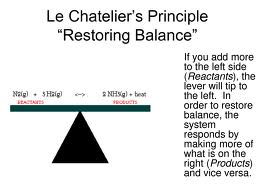
### Skills:

* predict a shift in equilibrium using Le Châtelier’s Principle

### Notes:

If a reaction is at equilibrium, the reaction will resist any change with a corresponding change that shifts the reaction back to its equilibrium. Because *Keq* is a constant, after the equilibrium shifts, the value of *Keq* will be the same as it was before the change.

In plain English, if you change something, the equilibrium will shift to partly undo the change.



For example, consider the reaction:

N2 (g) + 3 H2 (g)  2 NH3 (g)  ΔH = -91.9 kJ

For this reaction,  at 500°C.

Suppose we started at equilibrium with:

, , and .

(This works out to the correct value for *Kp*.)

If we add enough hydrogen gas to make  = 10 atm at equilibrium, the new partial pressures of the other gases would be:

= 2.93 atm, and = 0.21 atm.

(You could prove this by solving for “x” from the Kp equation)

As you can see, adding more H2 caused the reaction to use up more N2 and make more NH3.

Le Châtelier tells us that we don’t have to do the equilibrium calculation to predict what will happen. We can just look at the equation:

N2 (g) + 3 H2 (g)  2 NH3 (g) + 91.9 kJ

if we add more H2, the reaction will try to use some of it up. This means the equilibrium will shift to the right, using up more N2 and making more NH3.

On the other hand, if we added NH3, the equilibrium would instead shift to the left to use up some of the NH3, and make more N2 and H2.

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| **Action** | **Equilibrium shift** |
| Add N2 or H2 | to the right |
| Remove N2 or H2 | to the left |
| Add NH3 | to the left |
| Remove NH3 | to the right |
| Increase the temperature (add heat) | to the left |

Note that the value of *K* is different at different temperatures. Adding reactants or products doesn’t change the value of *K*, but changing the temperature does. The fact that adding heat shifts the equilibrium to the *left* means that increasing the temperature would result in a lower value of *K* for this particular equation.