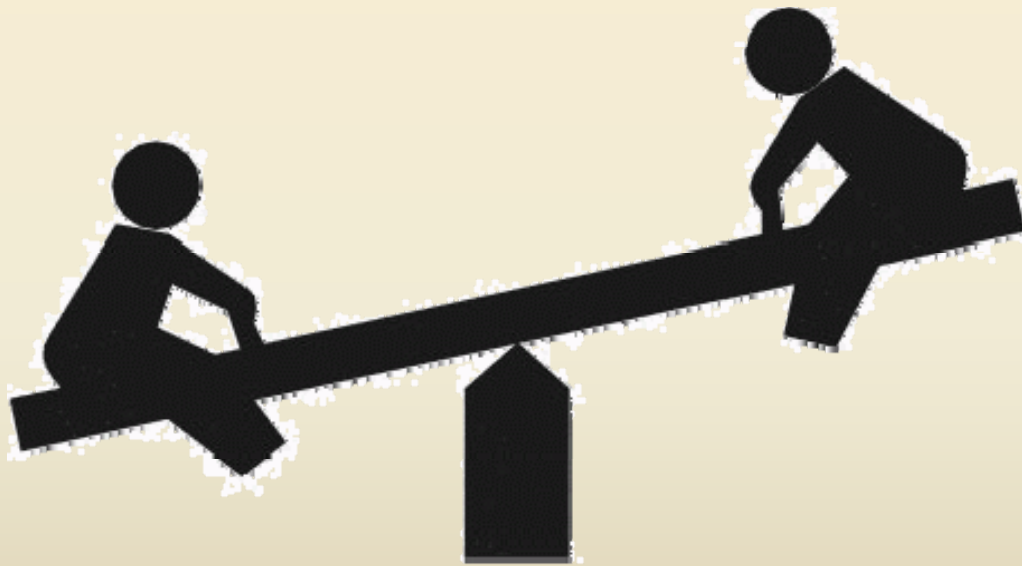# Equilibrium
and
Le Chatelier's Principle

CA Standards

Students know how to use LeChatelier's principle to predict the effect of changes in concentration, temperature, and pressure.

*Students know* equilibrium is established when forward and reverse reaction rates are equal.

Chemical Equilibrium

Reversible Reactions:

A chemical reaction in which the products can react to re-form the reactants

Chemical Equilibrium:

When the rate of the forward reaction equals the rate of the reverse reaction and the concentration of products and reactants remains unchanged

$$2HgO(s) \rightleftharpoons 2Hg(l) + O_2(g)$$
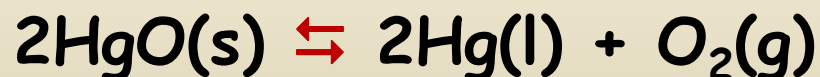
Arrows going both directions ($\rightleftharpoons$) indicates equilibrium in a chemical equation

LeChatelier's Principle

When a system at equilibrium is placed under stress, the system will undergo a change in such a way as to relieve that stress.
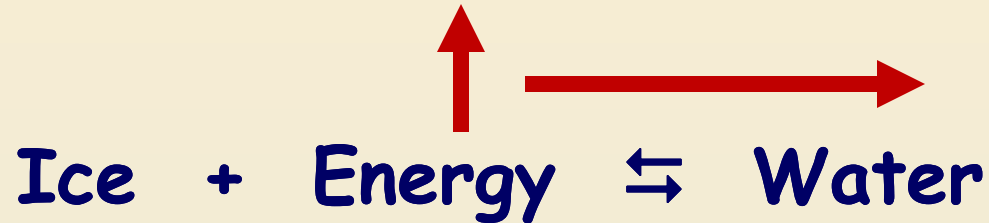
Henry Le Chatelier

Le Chatelier Translated:

When you take something away from a system at equilibrium, the system **shifts** in such a way as to **replace what you've taken away.**

When you add something to a system at equilibrium, the system **shifts** in such a way as to **use up what you've added.**
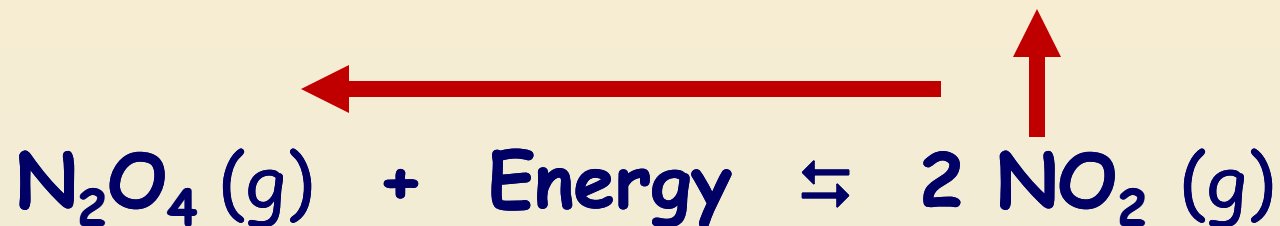
LeChatelier Example #1

A closed container of ice and water at equilibrium. The **temperature is raised.**

Ice + Energy ⇆ Water

The equilibrium of the system shifts to the __right__ to use up the added energy.

LeChatelier Example #2

A closed container of N_2O_4 and NO_2 at equilibrium. **NO$_2$ is added** to the container.

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

The equilibrium of the system shifts to the __left__ to use up the added NO_2.

LeChatelier Example #3

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

water + Energy ⇆ vapor
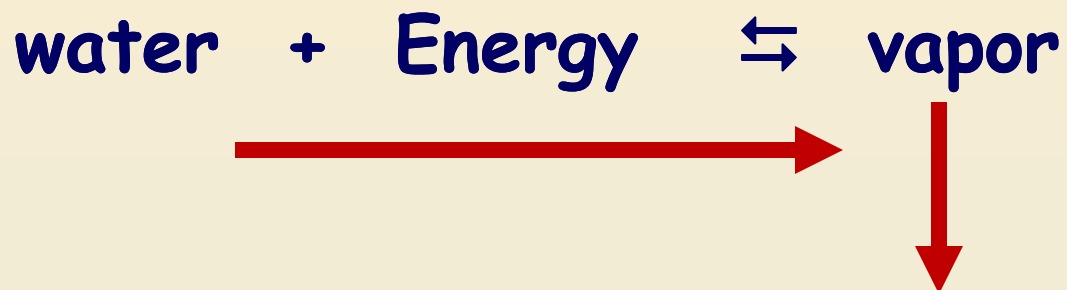
The equilibrium of the system shifts to the ___right___ to replace the vapor.

LeChatelier Example #4

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

$\longleftarrow$

$$N_2O_4\ (g)\ +\ \text{Energy}\ \leftrightharpoons\ 2\ NO_2\ (g)$$
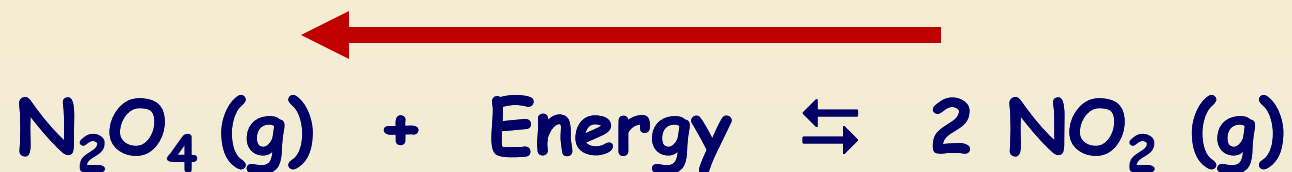
The equilibrium of the system shifts to the __left__ to lower the pressure, because there are fewer moles of gas on that side of the equation.