Le Chatelier's Principle

Stress and Equilibrium

Collision Theory Analysis

- The reaction

  $SO_2(g) + NO_2(g) = SO_3(g) + NO(g)$

  is at equilibrium. What effect will addition of $SO_3(g)$have? Why?
  - Addition of $SO_3(g)$ will cause more $SO_2(g)$ and $NO_2(g)$ to form, while the amount of $NO(g)$ decreases.
  - This is because addition of $SO_3(g)$ increases the number of collisions among product molecules.
- This example as well as many others can be analyzed more simply by Le Chatelier's Principle.

Stress Relief

- Imagine you squeeze a balloon on one side.
- Air moves toward the other side of the balloon causing the it to bulge.

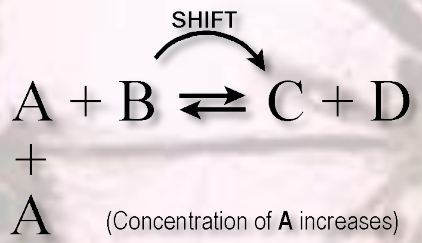
- As a result, the pressure is reduced on the side where you are squeezing.
- The air moves in a way that relieves the stress caused by increased pressure.

Definitions

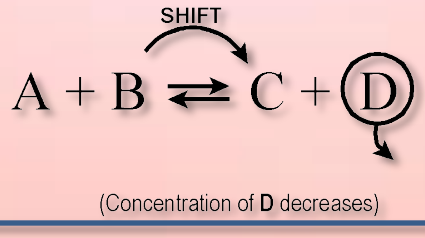
- **Le Chatelier's principle** = when stress is applied to a system in equilibrium, the reaction will shift in a direction that relieves the stress, and a new equilibrium will be established.
- **Applied stresses**
  - changes in concentration,
  - changes in pressure, or
  - changes in temperature.

Change in Concentration

- Shift due to increase in concentration of a reactant.
  - If the concentration of a reactant is increased, the reaction will shift in a way that reduces it's concentration.



- Shift due to decrease in concentration of a product.
  - If the concentration of a product is decreased, the reaction will shift in a way that increases it's concentration.



Change in Temperature

- Shift due to an increase in temperature.
  - If the temperature increases, the reaction will shift in a way that uses heat.

$$A + B \underset{\text{endothermic}}{\overset{\text{exothermic}}{\rightleftharpoons}} C + D$$

SHIFT

(Temperature increases)

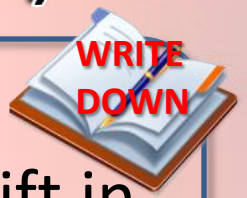
- Shift due to a decrease in temperature.
  - If the temperature decreases, the reaction will shift in a way that releases heat.

SHIFT

$$A + B \underset{\text{endothermic}}{\overset{\text{exothermic}}{\rightleftharpoons}} C + D$$

(Temperature decreases)

Change in Pressure (gas only!)



- Shift due to an increase in pressure.
  - If the pressure increases, the reaction will shift in a way that reduces pressure by decreasing the number of particles.

SHIFT

$$aA_{(g)} + bB_{(g)} \rightleftharpoons cC_{(g)} + dD_{(g)}$$

$$(a + b > c + d)$$

(Pressure increases)

- Shift due to a decrease in pressure.
  - If the pressure decreases, the reaction will shift in a way that increases pressure by increasing the number of particles.

$$aA_{(g)} + bB_{(g)} \rightleftharpoons cC_{(g)} + dD_{(g)}$$

SHIFT

$$(a + b > c + d)$$

(Pressure decreases)