Part 3 - LeChateliers Principle - pgs 690-695

- Controlling the extent of equilibrium by manipulating properties is very desirable because it leads to more efficient and economic processes

- According to Le Châtelier's principle, when a chemical system at equilibrium is disturbed by a change in a property of the system, the system always appears to react in the direction that opposes the change, until a new equilibrium is reached

- Using this simple and completely empirical approach, chemical engineers could produce more of the desired products, making technological processes more efficient and more economical

Le Châtelier's Principle and Concentration Changes

- an increase in the [ ] of the products or reactants favors the other side of the equation

  eg) $N_{2(g)} + 3\ H_{2(g)} \rightarrow 2\ NH_{3(g)}$

  ↑ $[N_{2(g)}]$ or $[H_{2(g)}]$ will shift the equilibrium to produce $NH_{3(g)}$

  ↑ $[NH_{3(g)}]$ will shift the equilibrium to produce the reactants

- A decrease in the [ ] of the products or reactants favors that side of the equation

  If you take away products more products will form

  If you take away reactants more reactants will form

Read **Collision–Reaction Theory and Concentration Changes on pg 692**

Thymol Blue Demo

Le Châtelier's Principle and Temperature Changes

- energy is treated like a reactant or product

  eg) reactants + energy --> products (endothermic) $\Delta_r H = +$

  reactants --> products + energy (exothermic) $\Delta_r H = -$

- Heating or cooling a system adds or removes thermal energy from the system.
- In either situation, the equilibrium shifts to minimize the change
- if cooled, the equilibrium shifts so more heat (energy) is produced
- if heated, the equilibrium shifts away from the heat so it cools down

Read **Collision–Reaction Theory and Energy Changes on pg 693**

http://www.tutorvista.com/content/chemistry/chemistry-ii/chemical-equilibrium/chemical-equilibrium-animation.php

N_2O_4-NO_2 Demo

http://www.youtube.com/watch?v=0XQVXFL4uoo

Le Châtelier's Principle and ***Gas*** Volume Changes

$C = \frac{n}{V}$

With **gases**, volume, pressure and concentration are related

- an increase in pressure caused by a drop in volume causes a shift towards the side of the equation with fewer moles

eg) $N_{2(g)} + 3\ H_{2(g)} \rightarrow 2\ NH_{3(g)}$ will shift to $NH_{3(g)}$
4 moles 2 moles

Increased pressure causes a shift to the right, which decreases the total number of gas molecules (4 moles to 2 moles) and, thus, reduces the pressure

- if the number of moles are the same on both sides of the reaction, a change in volume (pressure) has no effect

Read Collision-Reaction Theory and Gas Volume Changes on pg 694

N_2O_4-NO_2 Demo

http://www.youtube.com/watch?v=YMqyG9QG6oc

Examples

Add F- ions to: $HF_{(aq)} \rightarrow H^+_{(aq)} + F^-_{(aq)}$

Shifts to:	products	or	reactants
$[HF_{(aq)}]$	↓	or	↑

Remove H+ ions from: $H_2CO_{3(aq)} \rightarrow H^+_{(aq)} + HCO_3^-{}_{(aq)}$

Shifts to:	products	or	reactants
$[H_2CO_{3(aq)}]$	↓	or	↑

Add heat to: $SO_{2(g)} + ½\ O_{2(g)} \rightarrow SO_{3(g)} + 98.9kJ$

Shifts to:	products	or	reactants
$[SO_{2(g)}]$	↓	or	↑
$[SO_{3(g)}]$	↓	or	↑

Add heat to: $178.3kJ + CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$

Shifts to:	products	or	reactants
$[CO_{2(g)}]$	↓	or	↑

Increase pressure to: $PCl_{5(g)} \rightarrow PCl_{3(g)} + Cl_{2(g)}$

Shifts to:	products	or	reactants
[PCl3(g)]	↓	or	↑
[PCl5(g)]	↓	or	↑