7.3 Qualitative Changes in Equilibrium Systems aka: Le Châtelier's Principle

- If a system in equilibrium is disturbed, the system will tend to react so as to establish a new equilibrium.
- Le Châtelier's Principle states that when a stress is applied to a system at equilibrium, the system readjusts so as to relieve or offset the stress.
- An external stress to an equilibrium could be any one or more of the following:
    a) Change in [reactant]
    b) Change in [product]
    c) Change in temperature
    d) Change in pressure
    e) Change in volume

    } only for gases

Effect of a Change in Conc. of an Equilibrium System

- E.g. $H_{2(g)} + I_{2(g)} \leftrightarrow 2HI_{(g)}$

Change (Stress)	Response	Result
↑ $[H_2]$	shift → to decrease $[H_2]$	↑ [HI]
↑ $[I_2]$	shift → to decrease $[I_2]$	↑ [HI]
↓$[H_2]$ or ↓$[I_2]$	shift ← to decrease [HI]	↑ $[H_2]$ + ↑ $[I_2]$
↑ [HI]	shift ← to decrease [HI]	↑ $[H_2]$ + ↑ $[I_2]$
↓ [HI]	shift → to decrease $[H_2]$ & $[I_2]$	↑ [HI]

Effect of a Change in Volume or Pressure

- When the volume of a gaseous reaction that has an unequal number of gases on each side of the equation is decreased, the equilibrium will shift so as to reduce the number of gas molecules.

- E.g. $N_{2(g)} + 3H_{2(g)} \leftrightarrow 2NH_{3(g)}$ $\Delta H = -92$ kJ

Change (Stress)	Response	Result
↑ pressure = ↓ volume	shift → to decrease # of gas molecules	↑ $[NH_3]$
↓ pressure = ↑volume	shift ← to increase # of gas molecules	↑ $[N_2]$ + ↑ $[H_2]$

- E.g. $H_{2(g)} + I_{2(g)} \leftrightarrow 2HI_{(g)}$
  Changing the pressure in this reaction will not change equilibrium since there is an equal number of reactant and product molecules.

Effect of a Change in Temperature

- Increasing the temperature shifts the reaction in the direction that produces an endothermic change, while decreasing the temperature shifts the reaction in a direction that produces an exothermic change.

- E.g. $N_{2(g)} + 3H_{2(g)} \leftrightarrow 2NH_{3(g)}$ $\Delta H = -92$ kJ

Change (Stress)	Response	Result
↑ temperature	shift ← decomposition of NH_3 to absorb heat to compensate (favours endothermic reaction)	↑ $[N_2]$ + ↑ $[H_2]$
↓ temperature	shift → formation of NH_3 to generate heat to compensate (favours exothermic reaction)	↑ $[NH_3]$

Effect of Catalysts

- Catalysts cause reactions to reach equilibrium faster, but they do not alter the amounts of components at equilibrium.
- A catalyst speeds up the forward and reverse reaction to the same degree. It only allows the system to reach equilibrium faster.

Homework:

- Practice 1,2,3,4,5,6
- Questions 1,2,3,4,5,6