Le Chatelier's Principle

- Regaining Equilibrium

Le Chatelier’s Principle

- Le Chatelier's Principle states:
  If something is changed in a system at equilibrium, the system shifts in equilibrium composition in order to counteract (or oppose) this change.

Le Chatelier's Principle

- A change imposed on an equilibrium system is called a stress.
- There are 3 types of stress:

1) Changing concentration
2) Changing temperature
3) Changing pressure (for gases)

- The equilibrium always responds in such a way so as to counteract the stress.

Concentration Changes

- If concentration is increased
  - shifts to consume some of the added reactant or product
- If concentration is decreased
  - shifts to replace some of the removed reactant or product

e.g. $2A_{(g)} \leftrightarrow 2B_{(g)} + C_{(g)} + 100\ kJ$

- If A is added, shifts right
- If B is added, shifts left
- If A is removed, shifts left

Temperature Changes

- If temperature is increased
  - shifts to consume some of the added thermal energy
- If temperature is decreased
  - shifts to replace some of the removed thermal energy
- Energy is treated as a reactant (endothermic) or product (exothermic)

e.g. $2A_{(g)} \leftrightarrow 2B_{(g)} + C_{(g)} + 100\ kJ$

- If temperature is reduced, shifts right
- If temperature is increased, shifts left

e.g. $X_{(g)} + 100\ kJ \leftrightarrow Y_{(g)}$

- If temperature is increased, shifts right

Gas Volume Changes

- To predict whether a change in pressure will affect equilibrium, consider total moles of gas reactants and total moles of gas products.

e.g. $2A_{(g)} \leftrightarrow 2B_{(g)} + C_{(g)} + 100\ kJ$

(2 moles) *(3 moles)*

- If volume is increased (pressure is decreased)

  - shifts toward the side with the **larger** number of moles of gaseous entities i.e. shifts right

- If volume is decreased (pressure is increased)

  - shifts toward in the direction that has the **smaller** number of moles i.e. shifts left

Note – In some cases there is no shift because

$n_{reactants} = n_{products}$

Other Effects?

Adding catalyst

- affects only how fast reaction reaches equilibrium

- no overall effect on equilibrium

Nature of Reactants

- Only affect how fast reaction reaches equilibrium
- no effect overall

Adding inert gases (keeping volume constant)

- no effect on equilibrium

- See Summary Table p 456