Le Chatelier's Principle

When stress is applied to a system at equilibrium, the system will react to relieve the stress and restore an equilibrium. What are examples of these stresses?

1. Change in any Concentration

The equilibrium will:

Shift toward the substance that decreases
Shift away from the substance that increases

Ex:
$$A + B \leq C + D$$

If [A] is increased: reaction shifts right

If [C] is increased: reaction shifts left

If [B] is decreased: reaction shifts left

2. Change Pressure or Volume

(Only affects gas systems)

Increase pressure - system shifts to side with the least number of gas particles

Decrease pressure - system shifts to side with more gas particles

Ex:
$$A_{(g)} + 3B_{(g)} \lesssim 2C_{(g)}$$

Pressure increases: shifts right Pressure decreases: shifts left



Ex:
$$CO_{(g)} + H_2O_{(g)} = CO_{2(g)} + H_{2(g)}$$

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This reaction is not affected by a change in pressure

3. Change Temperature

Is reaction exothermic or endothermic?

For Endothermic reactions: (picture heat as a reactant)

- Increase temp shift right
- Decrease temp shift left

For Exothermic reactions: (picture heat as a product)

- Increase temp shift left
- Decrease temp shift right

Note: This is the **only** factor that will change the value of the Keq

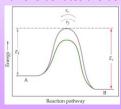


Catalysts

No effect the equilibrium concentrations

Gets to equilibrium faster

Forward and reverse rates are both increased



Haber Process:

 $N_{2(g)}$ + $3H_{2(g)} \leftrightarrows 2$ $NH_{3(g)}$ exothermic What conditions would increase production of ammonia?

 $\begin{array}{ccc} [\mathrm{N_2}] & \uparrow \\ [\mathrm{H_2}] & \uparrow \\ [\mathrm{NH_3}] & \downarrow \\ \mathrm{pressure} & \uparrow \\ \mathrm{temperature} & \downarrow \\ \end{array}$

