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3. Le Chatelier's Principle

This principle explains how equilibrium works in a nutshell!

If a reaction in equilibrium is subjected to a change, the equilibrium will take steps to counteract that change.

Le Chatelier's principle is a tool we can use to predict what will happen to the equilibrium when a change (like increasing the temperature!) occurs.

4. Minor Factors that Affect Equilibrium

- these following factors apply to reactions in equilibrium.
- we can use Le Chatelier's principle to help us predict what will happen.

a) Temperature Changes

i) temperature changes affect all equilibrium (solids, solutions, liquids, gases).

ii) if we ***add heat*** to the reaction equilibrium, according to Le Chatelier's principle, the reaction will *shift* to ***remove heat***.

iii) Example: $N_2O_{4\,(g)}$ + heat energy $\rightleftharpoons$ $2NO_{2\,(g)}$

1. Add heat.
2. The equilibrium will "shift" to the right to remove the extra heat.

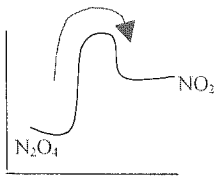
iv) if we ***remove heat*** to the reaction equilibrium, according to Le Chatelier's principle, the reaction will *shift* to ***add heat***.

v) Example: $N_2O_{4\,(g)}$ + heat energy $\rightleftharpoons$ $2NO_{2\,(g)}$

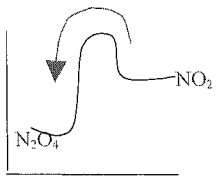
1. Remove heat.
2. The equilibrium will "shift" to the left to replace the heat lost.

vi) Another way to look at it:

Increase in temperature favors the endothermic path →



Decrease in temperature favors the exothermic path: →



b) Pressure Changes

i) pressure changes affect **only gases**, and has no affect on solids, liquids or solutions.

ii) If we increase pressure we decrease volume.

iii) According to Le Chatelier's principle, the reaction will shift to decrease the pressure....or increase the volume!

iv) The equilibrium will shift to the side of reaction having the least moles of gas present.

v) Example: $\underbrace{N_2O_{4\,(g)}}_{1\text{ mol}} + \text{heat energy} \rightleftharpoons \underbrace{2NO_{2\,(g)}}_{2\text{ moles}}$

1. Increase pressure and equilibrium will shift to the left.
2. Decrease pressure and equilibrium will shift to the right.

vi) Example: $\underbrace{2HI_{\,(g)}}_{2\text{ moles}} \rightleftharpoons \underbrace{H_{2\,(g)} + I_{2\,(g)}}_{2\text{ moles}}$

1. Increase **or** decrease in pressure results in no change in equilibrium!

c) Concentration Changes

i) the changes described below are for gases only! (concentration changes for solids, liquids and solutions will be discussed another day)

ii) according to Le Chatelier's principle, if we **increase** the [reactant(s)], the equilibrium will *shift* to the product side of the reaction. This occurs to "use up" the added reactant.

iii) Example: $2HI_{(g)} \rightleftharpoons H_{2(g)} + I_{2(g)}$

1. If we increase the [HI], the equilibrium will shift to the right to use up the added HI.

2. If we increase the $[I_2]$ or $[H_2]$, the equilibrium will shift to the left!

iv) if we **decrease** the [reactant(s)], the equilibrium will shift to the reactant side to replace "lost" reactant.

v) Example: $2HI_{(g)} \rightleftharpoons H_{2(g)} + I_{2(g)}$

1. If we decrease the [HI], the equilibrium will shift to the left to replace the lost HI.

2. If we decrease the $[I_2]$ or $[H_2]$, the equilibrium will shift to the right!

d) Catalyst Effects

i) adding a catalyst will **NOT** cause a shift in equilibrium to right or left.

ii) recall, a catalyst will only lower the E_a. This helps both forward and reverse directions of the reaction equally!

iii) adding a catalyst **WILL** increase the overall rate of reaction and cause the system to reach equilibrium faster.

Do questions: ~~#2, page 37-38~~ and #17 – ~~28~~ 23 page ~~54-55~~ 50-55

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