Equilibrium: Trying to Find a Balance - Chapter 18

I. Equilibrium: Trying to find a balance!

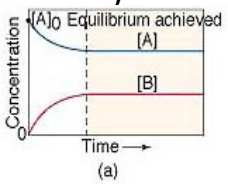
A. Most reactions that we have talked about have gone in ( )

B. In reality, most reactions go ( ).

C. Equilibrium: state at which a chemical reaction ( )

1. Two criteria for a reaction to be at equilibrium

a. **(a.k.a.)**

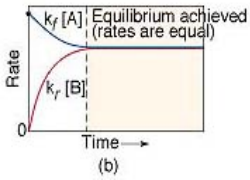


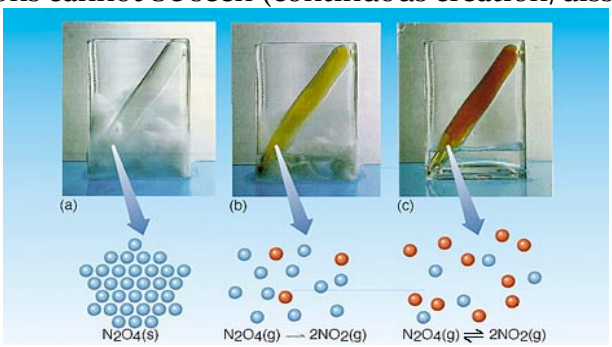
2. Think about a closed bottle of water.

a.

b.

3. Sometimes, these reactions cannot be seen (continuous creation/dissolving of a solid)





II. Le Chatelier's Principle: Trying to KEEP the balance!

A. Le Châtelier's Principle

1. You can add to an equilibrium reaction.

2. The system will brought on to the system.

3. The system will react by depending on the stress.

4. See Saw Model

EQUILIBRIUM

Stress: increase concentration of A

Reaction:

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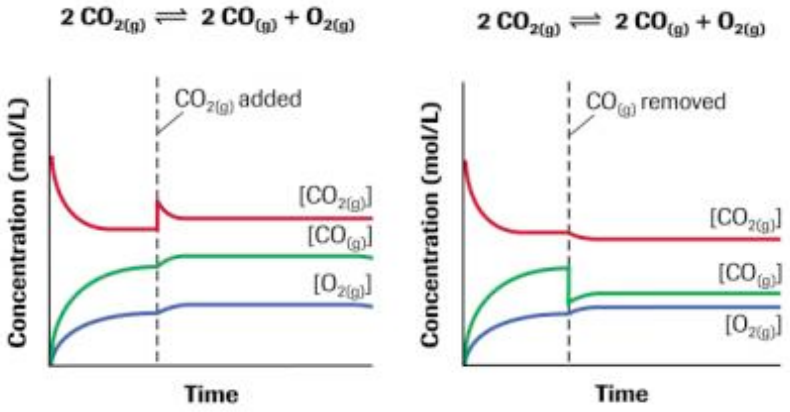
Example: $2\ NO_{2\,(g)} \leftrightarrow N_2O_{4\,(g)} + 57.2\ kJ$

B. Changes in
1. If NO_2 were added to the system, it will…
   a.
2. If NO_2 were removed from the system, it will…
   a.
3. Bottom line: the reaction shifts



Example: $2\ NO_{2\,(g)} \leftrightarrow N_2O_{4\,(g)} + 57.2\ kJ$

C. Changes in
1. Increasing temperature
2. in the reaction and shift as you would with
3. If you increase temperature of the system, it will…
   a.
4. If you decrease temperature of the system, it will…
   a.

Example: $2\ NO_{2\,(g)} \leftrightarrow N_2O_{4\,(g)} + 57.2\ kJ$

D. Changes in Pressure
1. Again, this
2. If you inc. pressure, the system will…
   a. go of gas to take up
   b. Thus, the system will
3. If you dec. pressure, the system will…
   a. go because there's
   b. Thus, the system will
4.

E. Steps to determine shifting
1. What is the **stress** and how will it tilt?
2. Which way does it **shift** to regain equilibrium? (react)

F. Final notes:
1. only make reactions reach equilibrium faster.
2.

G. Examples:

1. N_2 (g) + 3 H_2 (g) ↔ 2 NH_3(g) + heat

Predict the shift (left or right) when these changes occur. [N_2] [NH_3]

Temp. is decreased.
Pressure is decreased.
[H_2] is increased.
[NH_3] is increased.

2. 2NO $_{(g)}$ + $Br_{2\,(g)}$ + 48kJ ↔ 2NOBr $_{(g)}$

Predict the shift (left or right) when these changes occur. [NO] [NOBr]

Temp. is decreased.
Pressure is decreased.
[NOBr] is decreased.
[Br_2] is increased.

3. 3 Fe $_{(s)}$ + 4 H_2O $_{(g)}$ ↔ $Fe_3O_{4\,(s)}$ + 4 $H_{2\,(g)}$ (exothermic)

Predict the shift (left or right) when these changes occur.

Temperature is decreased.
Pressure is decreased.
[H_2] is increased.
[Fe_3O_4] is increased.

III. Equilibrium "**K**"onstant

A. Definitions:

1. Equilibrium concentration [ ]:
2. Equilibrium constant
3. Equilibrium Constant Expression
   a. For the rxn: aA + bB ↔ cC + dD

   b.
4. Write expression for the following reaction: 2 $HI_{(g)}$ ↔ $H_{2\,(g)}$+ $I_{2\,(g)}$

B. Solving for Equilibrium Constant

1. Write equilibrium expression for the reaction.
2. Plug in all the equilibrium concentrations and solve!
3. Example: 2 $HI_{(g)}$ ↔ $H_{2\,(g)}$+ $I_{2\,(g)}$

What is the K_{eq} when: [HI] = 0.0175 M [H_2] = 0.0045 M [I_2] = 0.00125 M?

4. Equilibrium Involving
   a. in the equilibrium constant expression.
   b. and, thus,

C. Solving for equilibrium concentrations.

1. Write equilibrium expression.
2. Plug and solve for unknown.
3. Example: $CaCO_{3\,(s)}$ ↔ $Ca^{2+}{}_{(aq)}$ + $CO_3^{2-}{}_{(aq)}$

If enough $CaCO_3$ is added so that the equilibrium [CO_3^{2-}] is 0.10M. What is the resulting [Ca^{2+}] if K_{eq} is 3.9 x 10^{-9}?