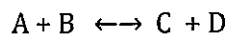


Chapter 8 - Chemistry in Industry

8.1-Equilibrium

What is a reversible reaction?

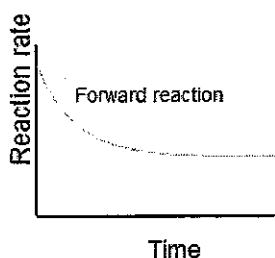
How are they represented?



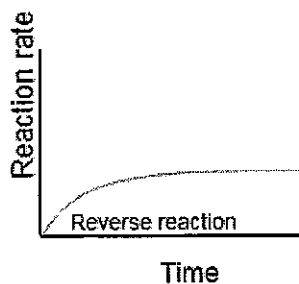
What does collision theory say?

The more molecules, the more collisions, the faster the rate of the reaction!!

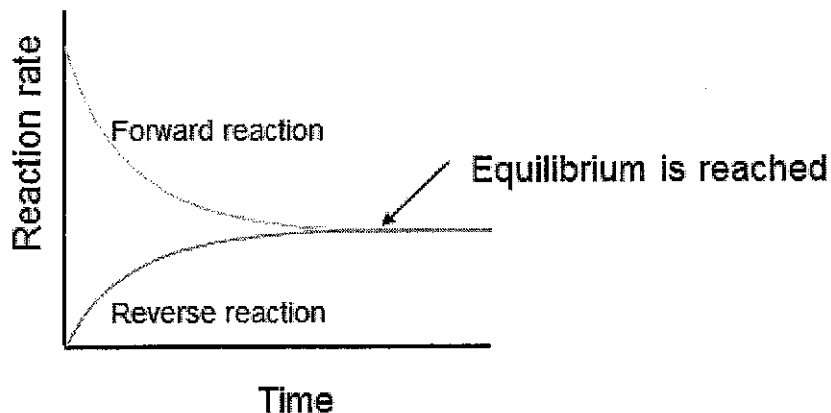
At first, the reaction rate is fast because there are lots of reactants. As time passes, the rate slows and LEVELS out because reactants are being consumed and now it is more difficult for them to collide and reactant.



In the reverse direction, once product forms, the products can react and start to form reactants but this too will eventually level out.



Eventually, system reaches a point where it reaches equilibrium.



What is the meaning of **Chemical Equilibrium**?

When equilibrium is established, the number of products and reactants doesn't change...but the reaction keeps going.

So, what exactly is equal at equilibrium??

What is Dynamic Equilibrium?

8.2 The Equilibrium Constant

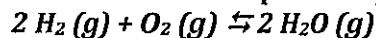
What is an Equilibrium Constant Expression:

How do we represent the word concentration?

Writing the Equilibrium Constant Expression –

- 1) Write the product of the product concentrations on the top—take each one to a power of the coefficient from the balanced equation.
- 2) Write the product of the reactant concentrations on the bottom—also take each to the power of the balanced equation coefficient.

Example: Write the equilibrium constant expression for the following:



Homogeneous Equilibrium –

Ex.

Heterogeneous Equilibrium –

Ex.

For the Equilibrium Constant Expression we leave out solids and liquids!
Only Gases and Aqueous particles go in!

Example: Write the expression for: $2 \text{H}_2 (\text{g}) + \text{O}_2 (\text{g}) \rightleftharpoons 2 \text{H}_2\text{O} (\text{l})$

Example: Write the equilibrium constant expression for $\text{Fe}_2\text{O}_3 (\text{s}) + 3 \text{H}_2 (\text{g}) \rightleftharpoons 2 \text{Fe} (\text{s}) + 3 \text{H}_2\text{O} (\text{g})$

Equilibrium Constant (K) –

What does K tell us?

In general if K is very large (OR Greater than one) -

If K is very small (OR Less than one) -

Let's Practice One: Write the equilibrium constant expression for



Let's Practice Two: If the equilibrium constant for $\text{N}_2 (\text{g}) + \text{O}_2 (\text{g}) \rightleftharpoons 2 \text{NO} (\text{g})$ is 1.24×10^{-4} , what can be said in general about this reaction at equilibrium?

8.4 Stresses on an Equilibrium System – Le Chatelier's Principle - Q

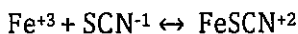
Define Le Chatelier's Principle -

What are three ways to apply a stress?

- 1) Adding or removing a _____ or _____
- 2) Increasing or decreasing the _____
- 3) Adding or removing _____

What is Q? What's the difference between K and Q?

Let's look at Increasing or decreasing concentrations first! Same as adding or removing substances



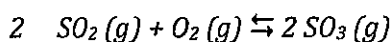
Predict what direction the reaction will shift if:

- | | |
|-----------------------------------|--------------------------------------|
| a) We add some Fe^{+3} : | b) We remove FeSCN^{+2} : |
| b) We remove SCN^{-1} : | d) We add some FeSCN^{+2} : |

Notice - When we add - it runs in the opposite direction and when we remove it goes to that substance.

Let's look at Pressure changes next! **THESE CHANGES ONLY MATTER IF YOU HAVE GASES IN THE REACTION!**

Predict what direction the reaction below will shift if:



Increase volume

Decrease pressure

Decrease volume

Increase Pressure

1. We decrease the volume: Decreasing the volume actually increases the pressure so:

2. We increase the volume: Increasing the volume actually decreases the pressure so:

Finally - Let's look at changes in temperature that are caused by adding and removing heat!

Review: In an *endothermic* reaction the energy is listed as a _____
In an *exothermic* reaction the energy is listed as a _____

Endothermic Reaction: $181\text{kJ} + 2\text{HgO} \leftrightarrow 2\text{Hg} + \text{O}_2$

Predict what will happen to the reaction above if we:

- 1) Increase the temperature (add heat): HINT - IT IS LIKE THEY ARE SAYING, "Add more reactant!"
- 2) Decrease the temperature (remove heat):

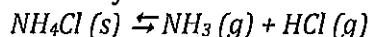
Exothermic Reactions: Where HEAT is a PRODUCT

- 1) Increase the temperature -
- 2) Decrease the temperature -

Some Changes have no effect! So the equilibrium will not shift to relieve these nonstressors!

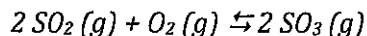
- 1) Adding more of a solid or liquid
- 2) Increasing pressure by adding an inert gas (nonreactive gases like Ne, He etc)
- 3) Changing the volume when there isn't a gas or when there are equal moles of gas on each side
- 4) Adding a catalyst

Example Questions : Which way will the reaction shift for each of the following changes:



Removing some NH_4Cl
Adding HCl
Adding Ne (g)
Decreasing volume

Which way will the exothermic reaction shift for each of the following changes:



Increasing volume
Raising temperature
Adding O_2
Removing SO_2