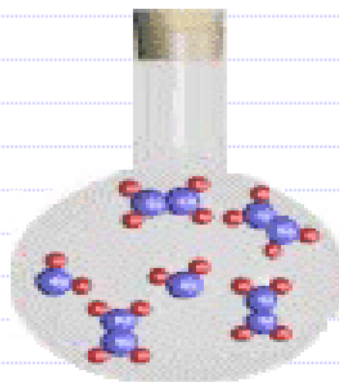


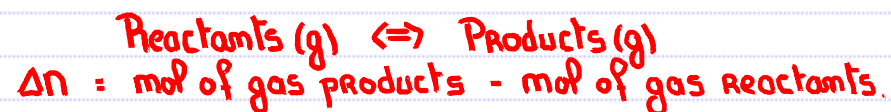
15.4 Disturbing a Chemical Equilibrium: Le Chatelier's Principle Change in the Volume of the System

Chemistry Interactive: Effect of Changing Volume on the $\text{NO}_2/\text{N}_2\text{O}_4$ Equilibrium



See Cross Web Site.

15.4 Disturbing a Chemical Equilibrium: Le Chatelier's Principle Change in the Volume of the System



$$\Delta n : = 0, > 0, \text{ or } < 0$$

ACTION:

EQUILIBRIUM SHIFT

a) Volume \uparrow , ie Pressure \downarrow

Toward the side with the greater number of gas molecules ... trying to increase the pressure ... if it can.*

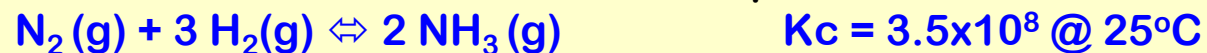
b) Volume \downarrow , ie Pressure \uparrow

Toward the side with the fewest number of gas molecules ... trying to decrease the pressure ... if it can.*

* $\Delta n = 0$: Nothing the equilibrium can do to counter any pressure changes.

15.4 Disturbing a Chemical Equilibrium: Le Chatelier's Principle Change in the Volume of the System.

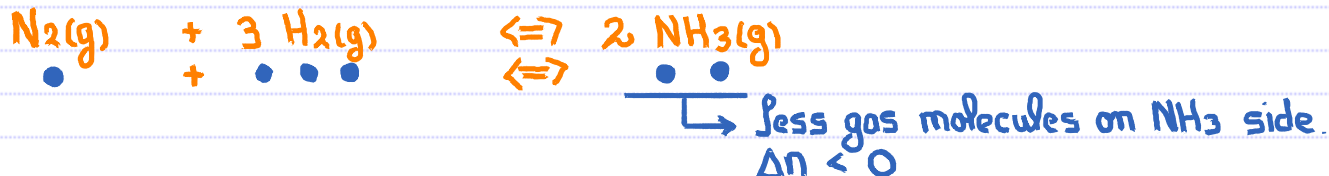
The production of ammonia is an exothermic process –



To maximize the $[\text{NH}_3]$ at equilibrium it is best to



- a) Increase the volume
- b) Decrease the volume ✓ ... increases the pressure
- c) Leave it as is



15.4 Disturbing a Chemical Equilibrium: Le Chatelier's Principle

Production of ammonia – an equilibrium dilemma!

The production of ammonia is an exothermic process –



How can we maximize the production of $[\text{NH}_3]$.

- a) At room temperature, K_c is product favored
However at room temperature this reaction is extremely slow. Very high activation energy.
To speed it up ... heat it ... and/or use a catalyst to lower the activation energy
- b) However the reaction is exothermic ... thus heating it will result in K_c decreasing
As we calculated previously ... even with a catalyst the process is done at $\sim 450^\circ\text{C}$...
at 450°C , $K_c = 1.19 \times 10^{-3}$. Thus while reaching equilibrium in a reasonable time, the equilibrium is now very reactant favored.
- c) Not daunted as this gaseous reaction has $\Delta n < 0$
Therefore if P is increased, then Q becomes $> K_c$, thereby causing a shift towards products ... increasing the $[\text{NH}_3]$.

16.1 Introduction to Acids and Bases

Acid and Base Definitions

ARRHENIUS:

Acid :- A substance containing hydrogen that, when dissolved in water, increases the concentration of H^+ ions.

Base :- A substance containing the hydroxide group that, when dissolved in water, increases the concentration of OH^- ions.

BRONSTED-LOWRY:

Acid :- A substance that can donate a proton (H^+ ion).

Base :- A substance that can accept a proton.

As the Bronsted-Lowry definition is more inclusive, this is the definition that we will focus on. For example NH_3 is a base, which would not be obvious under the Arrhenius definition.

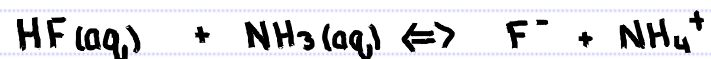


↓
Proton acceptor.
Base

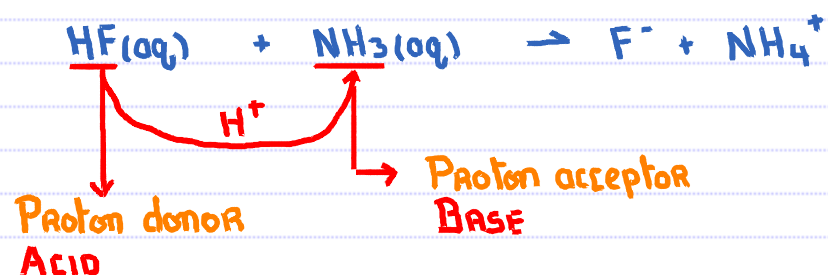
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 OH^- ion concentration increase, thus it now obviously fits the Arrhenius definition

16.1 Introduction to Acids and Bases

Simple Bronsted-Lowry Acids and Bases



FORWARD REACTION :-



REVERSE REACTION :-

