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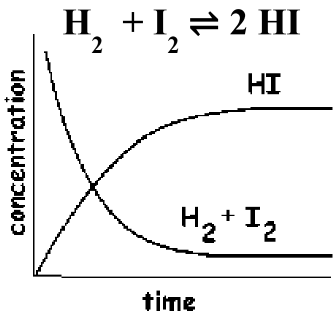
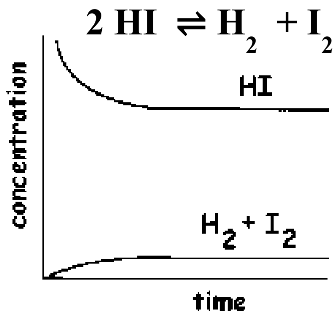
Reversible Reactions : LeChâtelier's Principle





Equilibrium:

- The point when____
  ____
- ________________________ of Reactant & Products ________________________
- **On the graph**: equilibrium occurs when the graph flattens out (draw in the lines)
- Depends on ___________________, _____________________, &
  _______________________ (gases only)

The reaction has NOT STOPPED, but it appears to have stopped!

Equilibrium Position:

Guldberg & Waage- Law of Mass Action: $aA + bB \rightleftharpoons cC + dD$

$$K_c = \frac{[\_\_\_\_\_\_\_\_\_\_\_\_]}{[\_\_\_\_\_\_\_\_\_\_\_\_]} = \frac{[C]^c\,[D]^d}{[A]^a\,[B]^b}$$

K is the ___________________ of _______________________________________ at equilibrium

Magnitude of the Value of K:

K >> : more _____________ present: ____________ favored: Equilibrium Lies to the __________

K << 1: more _____________ present: ____________ favored: Equilibrium Lies to the __________

1. What gets included in the equilibrium expression? WHY??
   ***Leave** ____________ **out** completely. * Include ______________________
   ***Leave** ____________ **out** completely.

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Le Châtlier's Principle

if a stress is imposed on a system at equilibrium,____

____

What are stresses (3) on a chemical reaction?

1. .
2. .
3.

*_______________ and ___________________ changes have ________________ on equilibrium position, because…..

- **Concentration :** add or remove species.
  - **ADD or Increase concentration**: Reaction will shift to ______________________ & consume the additional species.
  - Ex: $2NO_{(g)} + Br_{2(g)} \rightleftharpoons 2NOBr_{(g)}$

    Add NO: shift_________

  - **Remove or Decrease concentration** Reaction will shift to ___________________ & replace species removed.

  Ex: $2NO_{(g)} + Br_{2(g)} \rightleftharpoons 2NOBr_{(g)}$

  Remove Br_2: shift: _________

Example: $\mathbf{FeSCN^{2+}_{(aq)} \leftrightarrow Fe^{3+}_{(aq)} + SCN^{-}_{(aq)}}$

ADD SCN^- : What happens?

- .
- .

At the new equilibrium is there more, less or the same amount of each chemical that was initially present.

Stress	Shift	$FeSCN^{+2}$	Fe^{+3}	SCN^-
Add SCN^-				

Why is the color darker?

Example: $\mathbf{FeSCN^{2+}_{(aq)} \leftrightarrow Fe^{3+}_{(aq)} + SCN^{-}_{(aq)}}$

Remove Fe^{+3} : What happens?

- .
- .

At the new equilibrium is there more, less or the same amount of each chemical that was initially present.

Stress	Shift	$FeSCN^{+2}$	Fe^{+3}	SCN^-
Remove Fe^{+3}				

Why is the color lighter?

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- **<u>Changes in Pressure</u>** : Gases only
  - Increase pressure by ____________ the volume of the container will cause the Reaction to shift to the side with ____________ moles of gas.

    $2NO_{(g)} + Br_{2(g)} \rightleftharpoons 2NOBr_{(g)}$ ↑pressure: shift_________

WHY?

  - Decrease pressure by ____________ the volume of the container will cause the Reaction to shift to the side with ____________ moles of gas.

    $2NO_{(g)} + Br_{2(g)} \rightleftharpoons 2NOBr_{(g)}$ ↓pressure: shift: ________

WHY?

Example: $H_2O_{(g)} + Cl_2O_{(g)} \rightleftharpoons 2HOCl_{(g)}$ ↓pressure: shift: ________

  - Increasing pressure by adding an inert gas: What happens?

    What are Inert Gases?

Example: $\mathbf{I_{2\,(g)} \leftrightarrow 2\,I_{(g)}}$

At the new equilibrium is there more, less or the same amount of each chemical that was initially present.

Stress	**Pressure change**	**Mole comparison**	**Shift**	**I_2**	**I**
Decrease Volume					
Increase Volume					

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- **<u>Stress: Temperature:</u>**
  - What side is ΔH on?
    - + ΔH: __________________ : ______________ side
    - - ΔH: __________________ : ______________ side
  - Like concentration:
    - Increase Temp : Shift: ______________Decrease Temp: Shift: _____________

Changing temperature will change the value of the equilibrium constant, K.

EX: <u>Endothermic</u> $2NO_{(g)} + Br_{2(g)} \rightleftharpoons 2NOBr_{(g)}$ **ΔH= +125kJ**

<u>Increase temperature</u>:

Shift:_____________

$K_c = \frac{[\_products]}{[\_reactants]}$ therfore K _________

$2NO_{(g)} + Br_{2(g)} \rightleftharpoons 2NOBr_{(g)}$ **ΔH= +125kJ**

<u>Decrease temperature</u>:

Shift:_____________

$K_c = \frac{[\_products]}{[\_reactants]}$ therfore K _________

EX: <u>Exothermic</u> $H_2O_{(g)} + Cl_2O_{(g)} \rightleftharpoons 2HOCl_{(g)}$ **ΔH= -125kJ**

<u>Increase temperature:</u>

Shift:_____________

$K_c = \frac{[\_products]}{[\_reactants]}$ therfore K _________

$H_2O_{(g)} + Cl_2O_{(g)} \rightleftharpoons 2HOCl_{(g)}$ **ΔH= -125kJ**

<u>Decrease temperature:</u>

Shift:_____________

$K_c = \frac{[\_products]}{[\_reactants]}$ therfore K _________

What____

Example: **$N_2O_{4(g)} \leftrightarrow 2NO_{2(g)}$** **ΔH= +350 kJ**

Write the **ΔH** on the correct side of the reaction.
At the new equilibrium is there more, less or the same amount of each chemical that was initially present.

Stress	Shift	$N_2O_{4(g)}$	$2NO_{2(g)}$	Evaluate K	Change to K
Decrease Temperature				$K_c = \frac{[\_products]}{[\_reactants]}$	
Increase Temperature				$K_c = \frac{[\_products]}{[\_reactants]}$	