Announcements – Lecture XV – Tuesday, Oct 29th

1. **Lab 4 – Saturday, November 2nd, 1:00-4:00 pm – ISB 155/160 A-E**
   Lab Owl III – Deadline – Saturday, November 2nd, 11:59 pm

2. **Exam II – Tuesday, November 5th – In Class – 12:45-2:15 pm**
   Sunday, November 3rd – Review , 3:00-5:00pm – ISB 135

3. 

   iClicker:
   Choose any letter: A-E

7.6 What is an Equilibrium Constant and How Do We Use It?

The Significance of the Magnitude of K

a) $K \gg 1$: At equilibrium the reaction favors products

b) $K \ll 1$: At equilibrium the reactions favors Reactants

c) $K \sim 1$: At equilibrium significant quantities of products and Reactants present.

a) $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$

$K = 3.5 \times 10^8$ @ 25°C

$K \gg 1$

Product favored at equilibrium.

b) $HF(aq) + H_2O(l) \Leftrightarrow H_3O^+ + F^-$

$K = 7.6 \times 10^{-5}$ @ 25°C

$K \ll 1$

Reactant favored at equilibrium

c) $H_2 + O_2 \Leftrightarrow H_2O_2$

$K \approx 12$ @ 25°C

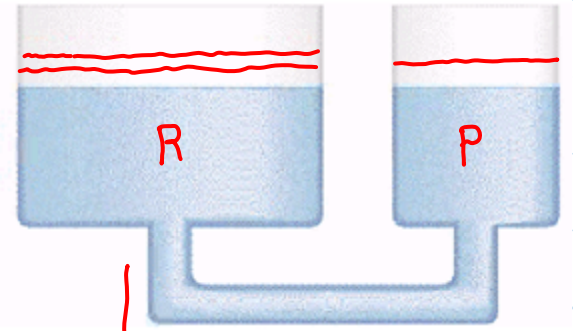
$K \sim 1$

Significant quantities of Reactants and products present at equilibrium.

7.7 What Is Le Chatelier's Principle

Adding/Removing Reactants .

Add Reactant



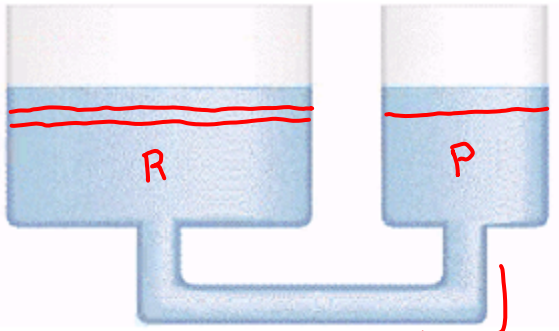
Reaction flows towards P (products)

Add R ... shift towards P ...

more P produced.

Adding R changes the value of [P]/[R] ...
Reaction wants to return to the original value of [P]/[R] ... K

Remove Reactant



Reaction flows towards R (reactants)

Remove R .... shift towards R ....

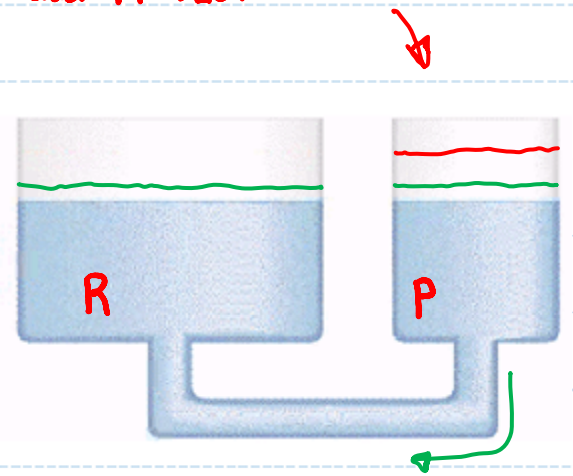
more R produced

Remove R changes the value of [P]/[R] ...
Reaction wants to return to the original value of [P]/[R] ... K

7.7 What Is Le Chatelier's Principle

Adding/Removing Products .

Add Product

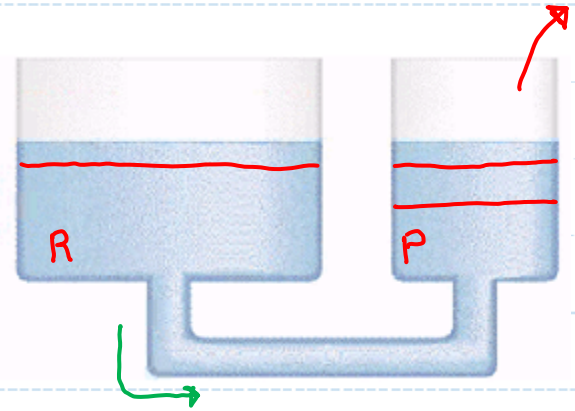


Reaction flows towards R

Add P ... shift towards R ... more R produced.

Adding more P changes the value of [P]/[R] ...
Reaction wants to return to the original [P]/[R]
... K

Remove Product.



Reaction flows towards P

Remove P ... shift towards P ... more P produced.

Removing P changes the value of [P]/[R] ...
Reaction wants to return to the original
[P]/[R] ... K

7.7 What Is Le Chatelier's Principle
Adding/Removing Reactant and Products

HCN is a weak acid –

$HCN(aq) + H_2O(l) \Leftrightarrow H_3O^+ + CN^-$

Removal of H_3O^+ from this equilibrium will cause the $[CN^-]$ to

a) Increase
b) Decrease
c) Remain unchanged
d) Impossible to determine

$HCN(aq) + H_2O(l) \Leftrightarrow H_3O^+ + CN^-$

↳ Remove H_3O^+ ... removing P

⟶ shift towards P ... $[CN^-]\uparrow$

7.7 What Is Le Chatelier's Principle
Adding/Removing Reactant and Products

HCN is a weak acid –

$HCN(aq) + H_2O(l) \Leftrightarrow H_3O^+ + CN^-$

Addition of OH^- to this equilibrium will cause the $[CN^-]$ to

a) Increase
b) Decrease
c) Remain unchanged
d) Impossible to determine

At first glance you might think c), since OH^- is neither a P or an R ... but!

$HCN(aq) + H_2O(l) \Leftrightarrow H_3O^+ + CN^-$

$OH^- = 2\,H_2O(l)$

Adding OH^- removes H_3O^+ (a P)

→ shift towards P ... $[CN^-]\uparrow$

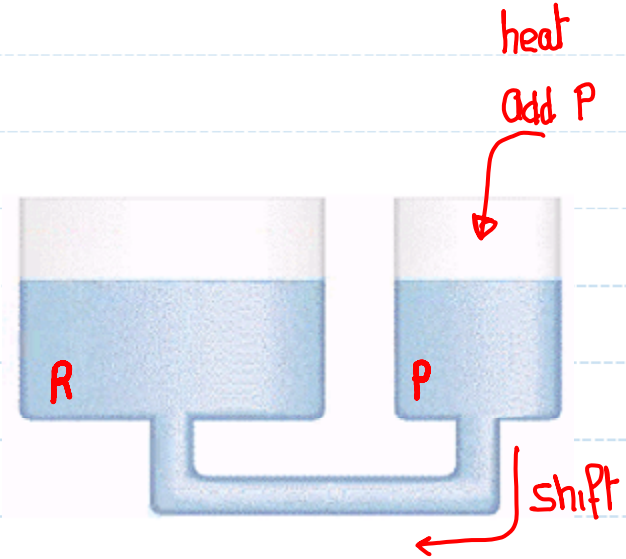
7.7 What Is Le Chatelier's Principle

Changing the Temperature – Exothermic

↳ Reaction that gives off heat

'Heat is a product'

$R \Leftrightarrow P + heat$



If we heat this reaction ... the equivalent of adding a product ... the equilibrium will shift towards Reactants.

Why does this happen ? $K = \frac{[P]}{[R]}$ ... heat is not part of the expression.

But when ↑ heat reaction, $[R]\uparrow$, $[P]\downarrow$ and thus $[P]/[R]\downarrow$ ... ie $K\downarrow$

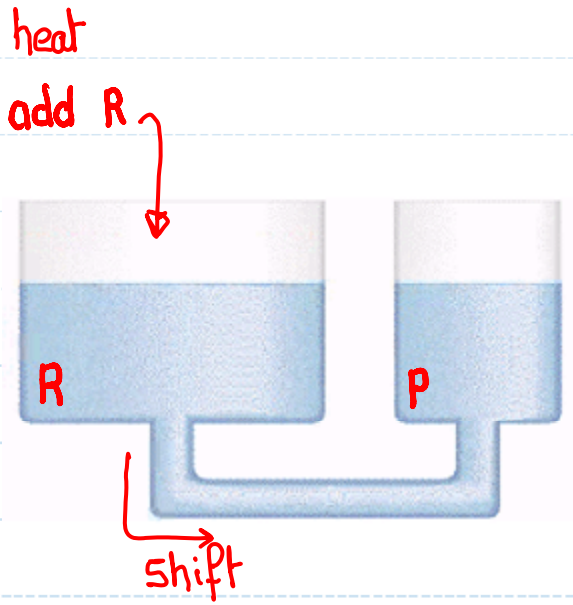
K is dependant on T ... exothermic reaction, as $T\uparrow$: $[R]\uparrow$, $[P]\downarrow$ and $K\downarrow$

7.7 What Is Le Chatelier's Principle

Changing the Temperature – Endothermic

↳ Reaction that requires heat

'Heat is a reactant'



$R + heat \Leftrightarrow P$

If we heat this reaction ... the equivalent of adding more reactant ... the equilibrium will shift towards products.

Why does this happen ... $K = [P]/[R]$ ... heat is not part of the expression!

But when I heat the reaction $[P]\uparrow$, $[R]\downarrow$ and thus $[P]/[R]\uparrow$, ie $K\uparrow$.

K is dependant on T ... endothermic reaction, as $T\uparrow$: $[P]\uparrow$, $[R]\downarrow$ and $K\uparrow$