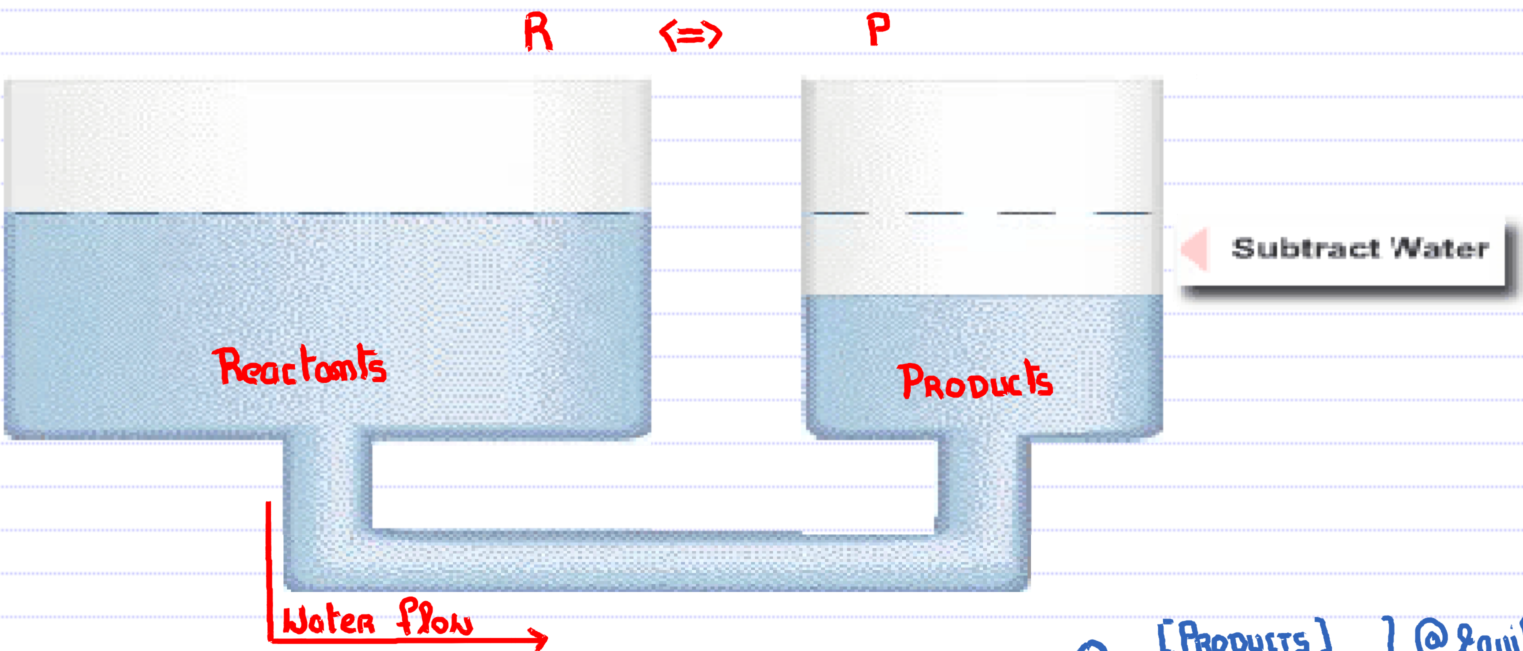
15.4 Disturbing a Chemical Equilibrium: Le Chatelier's Principle

Removing a Product.

Chemistry Interactive: LeChatelier's Principle - The Water Tank Analogy



The water tank cartoon correctly predicts that the removal of a Product at Equilibrium causes a shift towards Products ... chemically why is this prediction correct ?

$Q = \frac{[\text{Products}]}{[\text{Reactants}]}$ } @ Equilibrium, Q = K

Removing a Product causes Q↓

Q < K

↳ Shift towards Products until Q = K again.

15.4 Disturbing a Chemical Equilibrium: Le Chatelier's Principle

Addition or Removal of a Reactant or Product

HCN is a weak acid –

$HCN(aq) + H_2O(l) \Leftrightarrow H_3O^+ + CN^-$ $K_c = 4.0\times10^{-10}$ @ 25°C

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

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

$$Q = \frac{[\text{Products}]}{[\text{Reactants}]}$$

Removal of a Product (H_3O^+), causes Q↓, Q < K

↳ Shift towards Products (which produces more $[N^-]$) until Q = K again.

15.4 Disturbing a Chemical Equilibrium: Le Chatelier's Principle

Addition or Removal of a Reactant or Product

HCN is a weak acid –

$HCN(aq) + H_2O(l) \Leftrightarrow H_3O^+ + CN^-$ Kc = 4.0×10^{-10} @ 25°C

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 it looks like c) : as OH^- is neither a product or a reactant!

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

↳ $+ OH^- = 2\,H_2O(l)$

Net result is the removal of a products ... Q becomes < K, thus a shift towards products (producing more CN^-) until Q once more equals K.

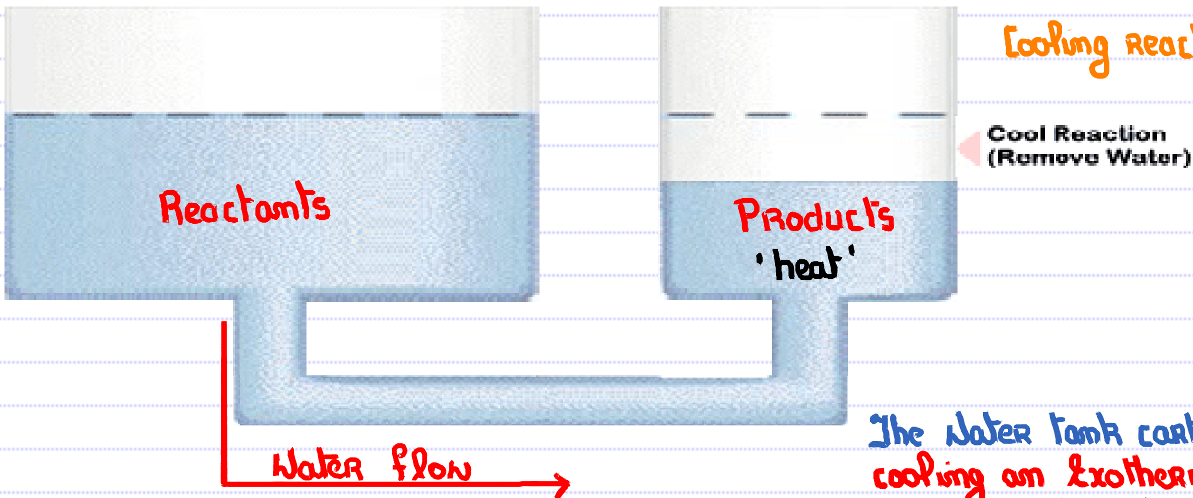
Beware of secondary reaction that can affect an equilibrium by indirectly removing a reactant or product.

15.4 Disturbing a Chemical Equilibrium: Le Chatelier's Principle

Change in Temperature – Exothermic Reactions

Chemistry Interactive: LeChatelier's Principle - The Water Tank Analogy

R <=> P + 'heat'



Cooling Reaction = Removing a product

The water tank cartoon correctly predicts that cooling an exothermic reaction at equilibrium causes a shift towards products.. Chemically why is this prediction correct ?

$$K = \frac{[\text{Products}]}{[\text{Reactants}]}$$

} No 'heat' in the equation.

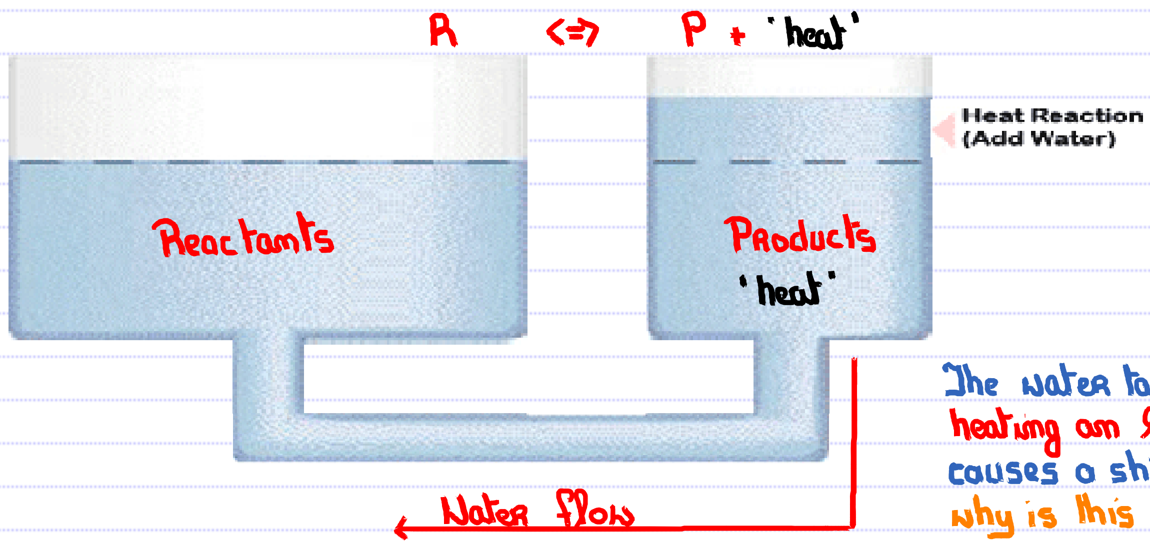
K must be T dependant.

Cooling an exothermic equilibrium reaction Results in K↑

15.4 Disturbing a Chemical Equilibrium: Le Chatelier's Principle

Change in Temperature – Exothermic Reactions

Chemistry Interactive: LeChatelier's Principle - The Water Tank Analogy



The water tank cartoon correctly predicts that heating an exothermic reaction at equilibrium causes a shift towards reactants ... Chemically why is this prediction correct?

$$K = \frac{[\text{Products}]}{[\text{Reactants}]}$$ No 'heat' in the equation.

K must be T dependent.

Heating an exothermic equilibrium reaction results in K ↓

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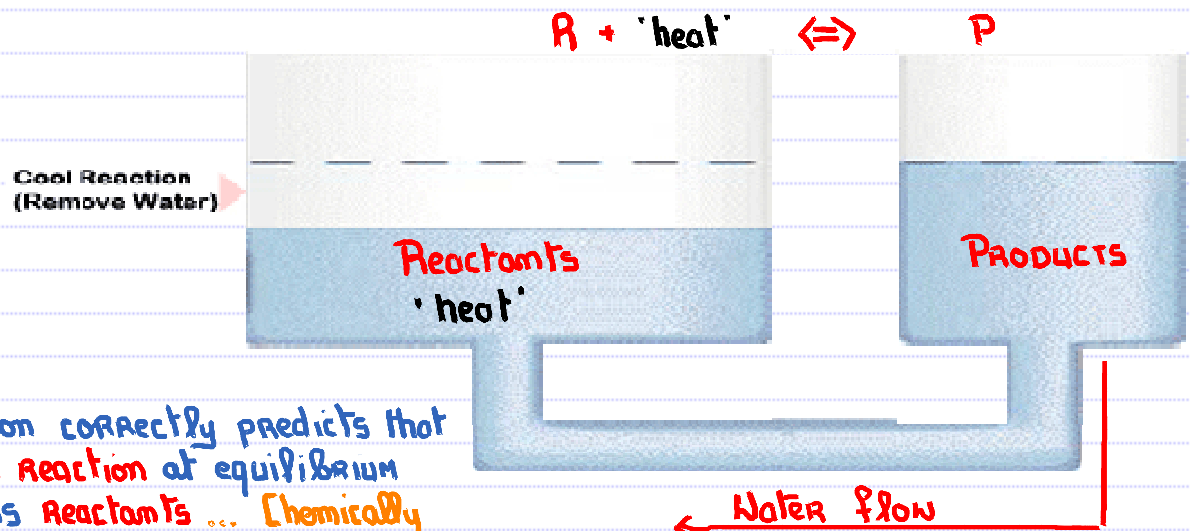
Change in Temperature – Endothermic Reactions

Chemistry Interactive: LeChatelier's Principle - The Water Tank Analogy



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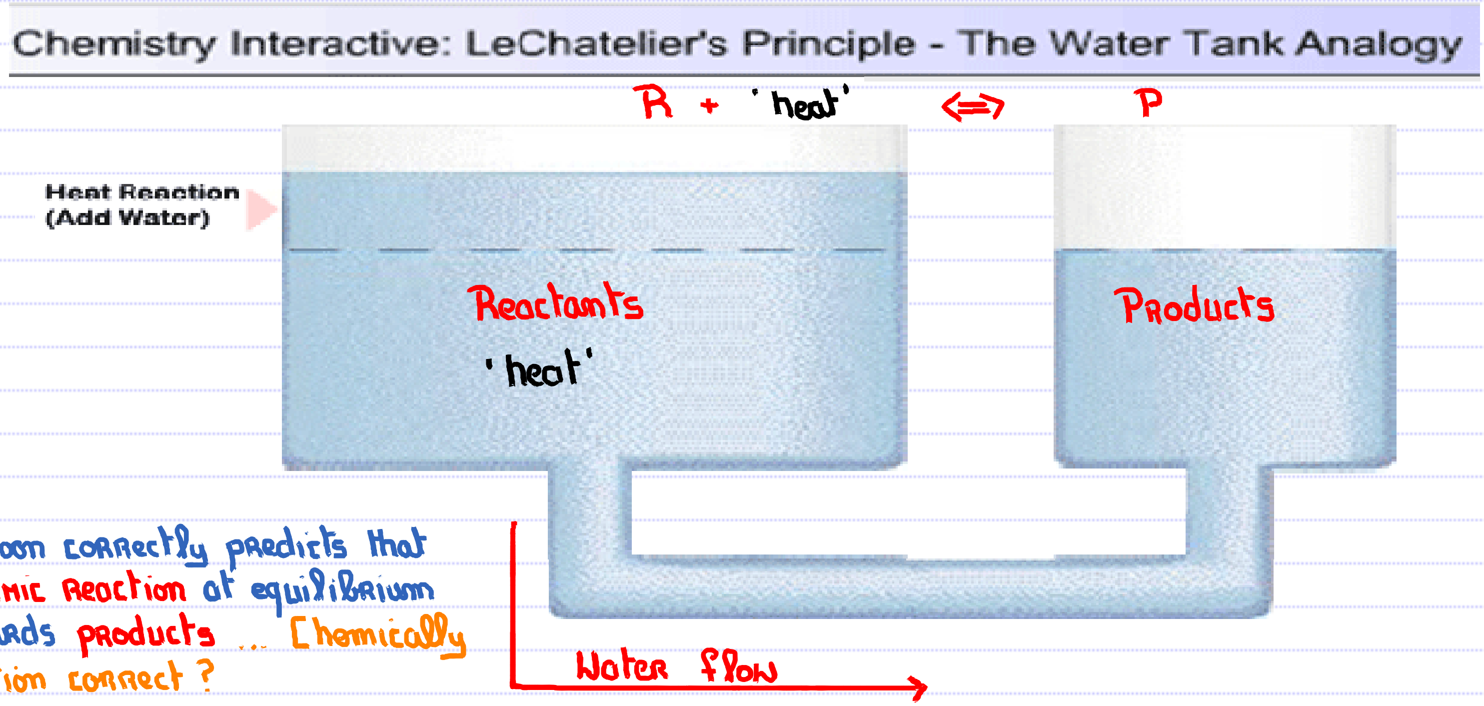
Change in Temperature – Endothermic Reactions



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