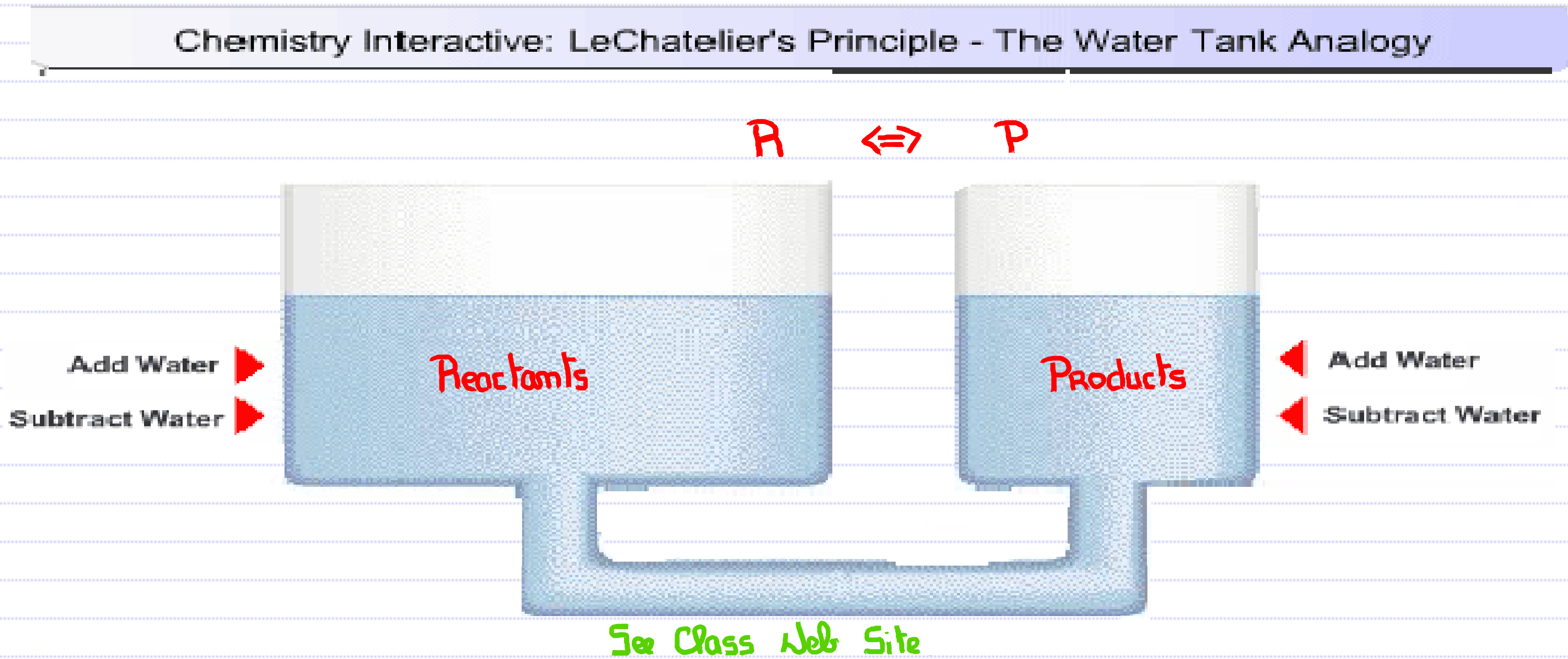
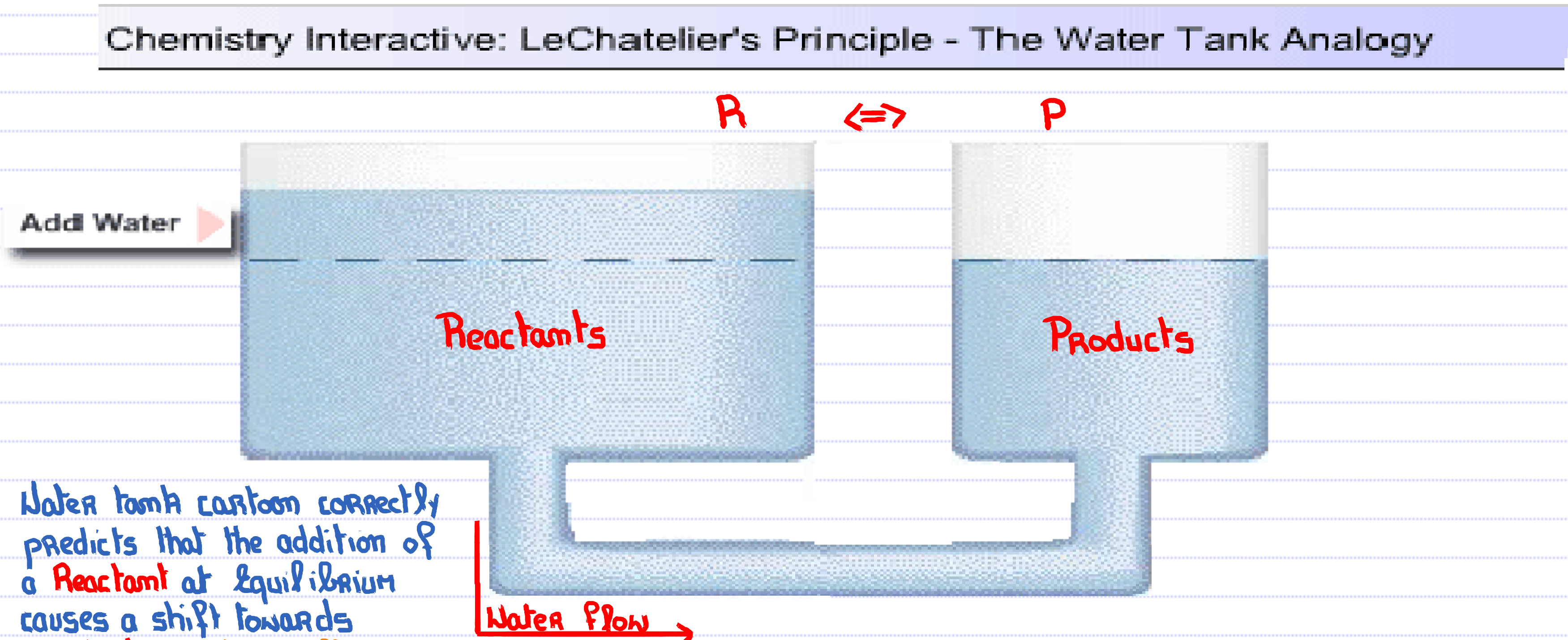
15.4 Disturbing a Chemical Equilibrium: Le Chatelier's Principle

Addition or Removal of a Reactant or Product



15.4 Disturbing a Chemical Equilibrium: Le Chatelier's Principle

Addition of a Reactant.



Water tank cartoon correctly predicts that the addition of a Reactant at Equilibrium causes a shift towards Products ... chemically why is this prediction correct ?

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

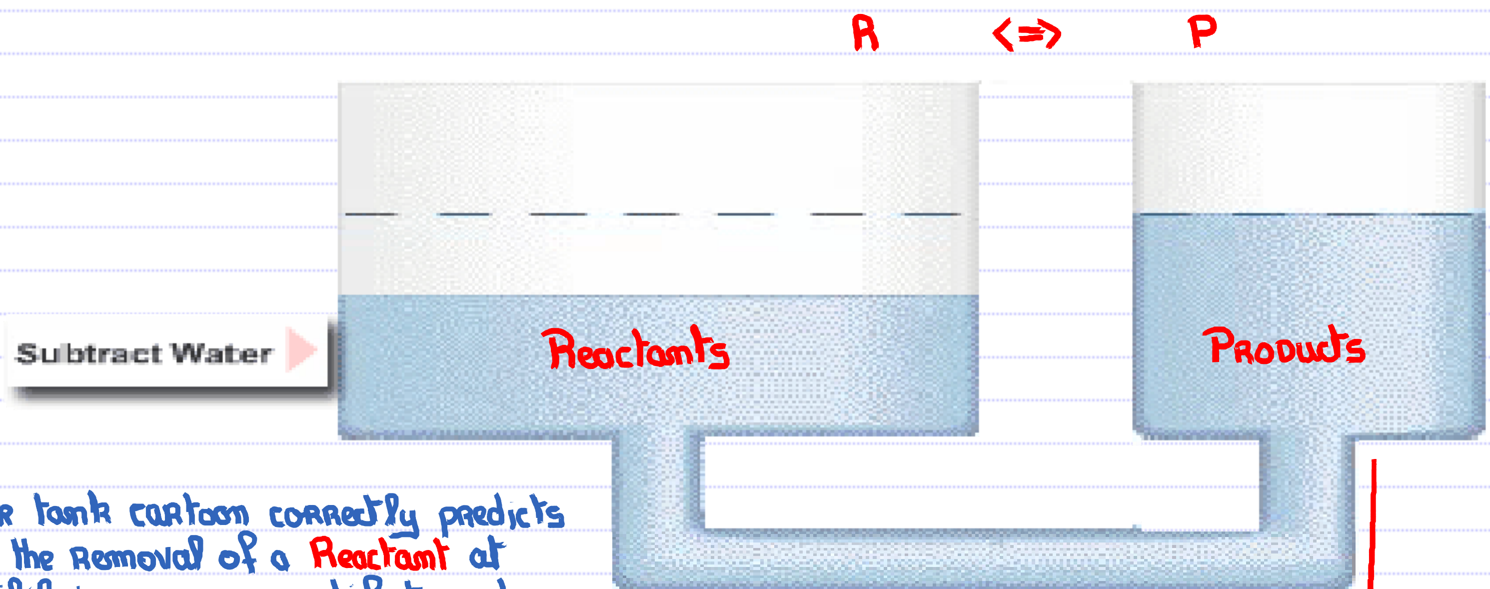
Addition of a Reactant causes $Q\downarrow$, thus now $Q < K$

→ Shift towards Products until again $Q = K$

15.4 Disturbing a Chemical Equilibrium: Le Chatelier's Principle

Removing an Reactant.

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



Water flow

Water tank cartoon correctly predicts that the removal of a Reactant at Equilibrium causes a shif towards Reactants ... chemically why is this prediction correct.

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

Removal of a Reactant causes $Q\uparrow$, thus now $Q > K$

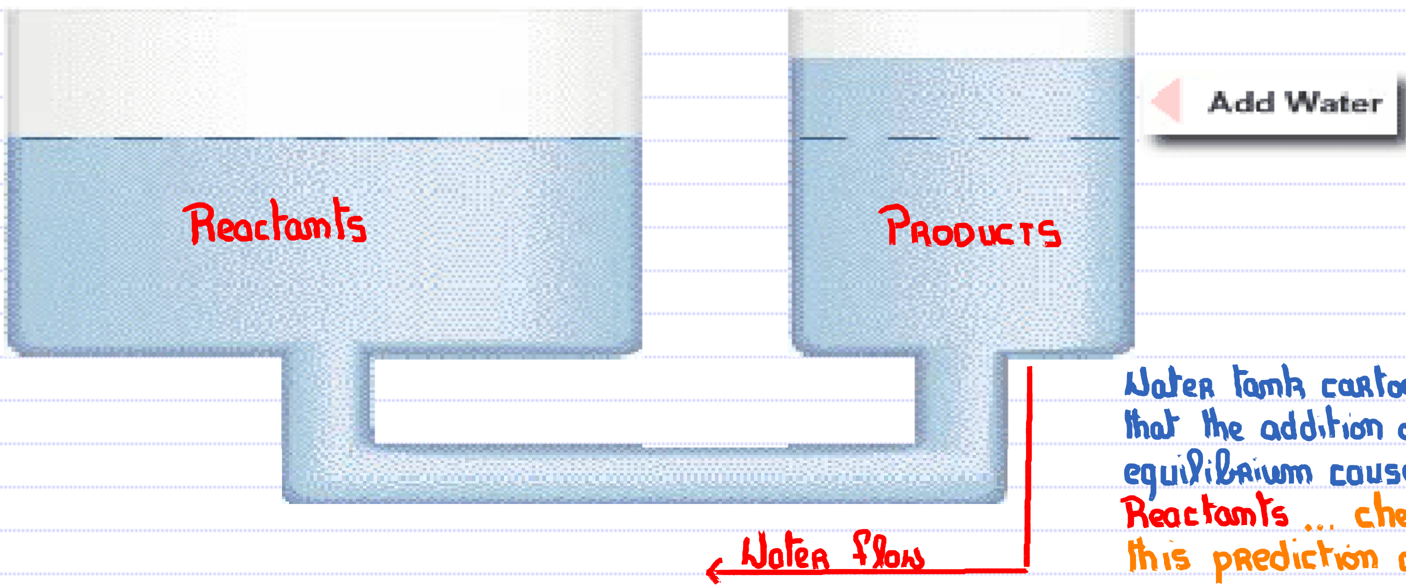
↳ Shift towards Reactants until $Q = K$ again.

15.4 Disturbing a Chemical Equilibrium: Le Chatelier's Principle

Adding a Product.

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

R ⟺ P



Water tank cartoon correctly predicts that the addition of a Product at equilibrium causes a shift towards Reactants ... chemically why is this prediction correct?

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

Addition of Product causes Q ↑

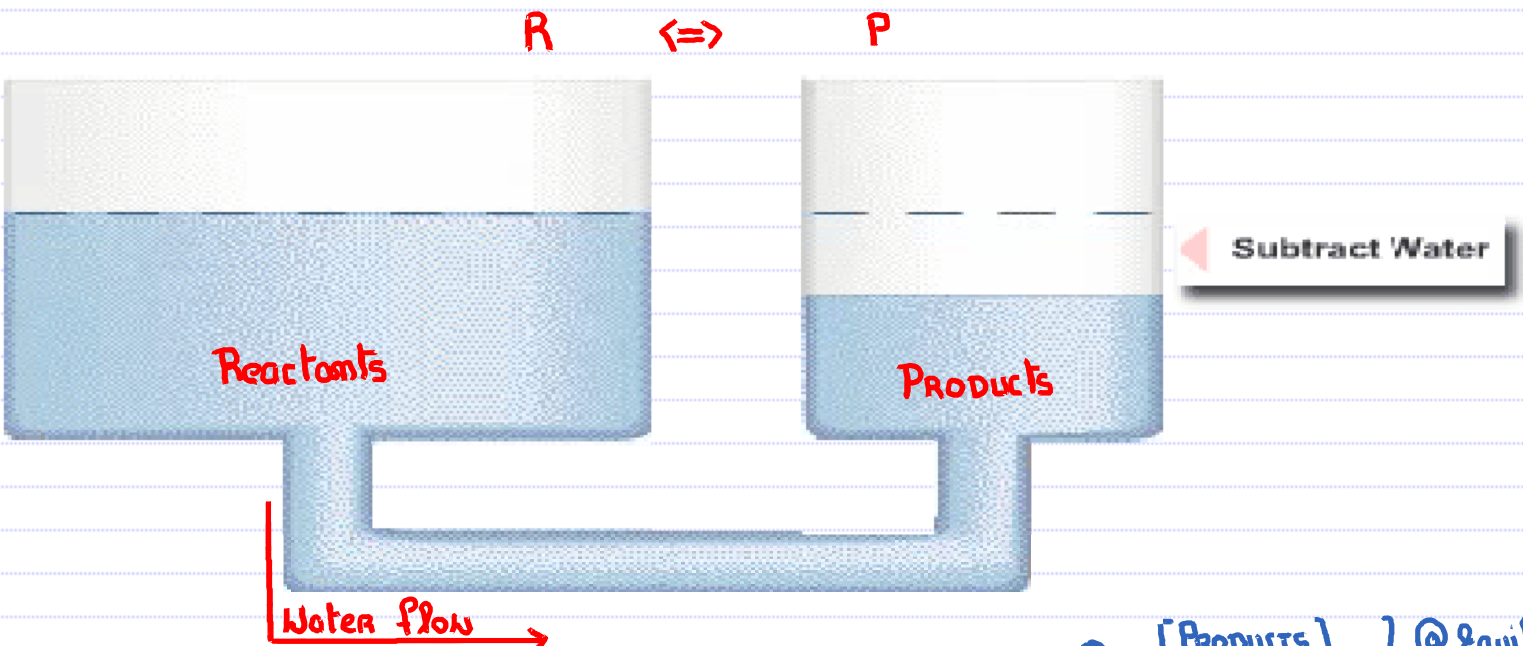
Q > K

→ Shift towards Reactants until Q = K again

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 –

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

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

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

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

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 –

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

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!

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

H_3O^+ ↳ $+ OH^- = 2\,H_2O(l)$

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.