

[TP] The reaction 3 A(aq) ⇌ 2 B(aq) is at equilibrium, with
$[A]_e = 0.10$ M and $[B]_e = 2.0$ M and so $K = 4000$.
Then 0.05 M of A is added.
At the moment of this change, the value of [A] will be …

33% 1. 0.05 M
33% 2. 0.10 M
33% 3. 0.15 M

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Response Counter

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Lecture 14 CH102 A2 (MWF 11:15 am)

Friday, February 22, 2019

- Review: Knowing K does not fix individual concentrations.
- Disturbing equilibrium (Le Chatelier)

Being ch14: Acid-base equilibria in aqueous solutions
- The pH of water

Next: Composition of water. Weak acids and strong acids. Getting weak acid K_a values; $pK_a = -\log(K_a)$; Using K_a to get $[H_3O^+]$. Titration: What happens when some OH^- is added to an acid

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Knowing K does not fix individual concentrations

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Practice question

At 25 °C the equilibrium constant for the reaction 3 A + B ⇌ 2 C is 0.145. In one experiment, a student measured at equilibrium that the concentrations of A and B are each 2.45 M. In a second experiment, the student measured at equilibrium that $[A]_e = 2.45$ M but $[B]_e = 1.94$ M. Must there be errors in one or both of the measurements?

If errors, show why.

If no errors, show why.

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Disturbing equilibrium

Essential idea: A system at equilibrium responds to a disturbance by ...

partially offsetting the disturbance.

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At the moment of this change, the value of [A] will be ...

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33% 2. 0.10 M
33% 3. 0.15 M

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[TP] The reaction 3 A(aq) ⇌ 2 B(aq) is at equilibrium, with
$[A]_e = 0.10$ M and $[B]_e = 2.0$ M and so $K = 4000$.
Then 0.05 M of A is added.
At the moment of this change, the value of Q will be ...

33% 1. > 4000
33% 2. $= 4000$
33% 3. < 4000

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[TP] The reaction 3 A(aq) ⇌ 2 B(aq) is at equilibrium, with
$[A]_e = 0.10$ M and $[B]_e = 2.0$ M and so $K = 4000$.
Then 0.05 M of A is added.
At the moment of this change, the system will ...

33% 1. have too much reactant
33% 2. still be at equilibrium
33% 3. have too much product

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[TP] The reaction 3 A(aq) ⇌ 2 B(aq) is at equilibrium, with
$[A]_e = 0.10$ M and $[B]_e = 2.0$ M and so $K = 4000$.
Then 0.05 M of A is added.
After the system is once again at equilibrium, $[A]_e$ must be …

33% 1. < 0.10 M
33% 2. = 0.10 M
33% 3. > 0.10 M

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[Quiz] The reaction 3 A(aq) ⇌ 2 B(aq) is at equilibrium, with
$[A]_e = 0.10$ M and $[B]_e = 2.0$ M and so $K = 4000$.
Then 0.05 M of A is added.
After the system is once again at equilibrium, $[B]_e$ must be …

33% 1. < 2.0 M
33% 2. = 2.0 M
33% 3. > 2.0 M

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Disturbing equilibrium

Essential idea: A system at equilibrium responds to a disturbance by partially offsetting the disturbance.

This behavior is called Le Chatelier's principle.

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Begin ch14:
Acid-base equilibria in aqueous solutions

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The pH of water

Write down the chemical equilibrium that accounts for the pH of water.

$H_2O(l) + H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$

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The pH of water

Write down the reaction quotient for the water autoionization equilibrium,

$H_2O(l) + H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$

$Q_w = [H_3O^+]\,[OH^-]$

$K_w = [H_3O^+]_e\,[OH^-]_e$

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The pH of water

Pure water at 50 °C is measured to have a pH of 6.63.

Write down the value of $[H_3O^+]_e$ at 50 °C.

$[H_3O^+]_e = 10^{-6.63} = 2.34 \times 10^{-7}$

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The pH of water

Pure water at 50 °C is measured to have a pH of 6.63.

Write down the value of $[OH^-]_e$ at 50 °C.

$[OH^-]_e = [H_3O^+]_e = 10^{-6.63} = 2.34 \times 10^{-7}$

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The pH of water

Pure water at 50 °C is measured to have a pH of 6.63.

Write down the value of the reaction quotient of the water autoionization at equilibrium at 50 °C.

$$Q_{w,e} = K_w = [H_3O^+]_e\,[OH^-]_e = (10^{-6.63})^2 = 5.48 \times 10^{-14}$$

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[TP] Pure water at 50 °C is measured to have a pH of 6.63.
This means that pure water at 50 °C is ...

0% 1. acidic
0% 2. neutral
0% 3. basic

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[TP] Pure water at 10 °C has $[H_3O^+] = 5.39 \times 10^{-8}$.
This means that pure water at 10 °C is ...

0% 1. acidic
0% 2. neutral
0% 3. basic

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[Quiz] The pH of pure water is different at different temperatures.
This means that as temperature changes ...

0% 1. the proportions of $H_3O^+(aq)$ and $OH^-(aq)$ to one another in pure water change
0% 2. the acidity of pure water changes
0% 3. the value of the equilibrium constant changes
0% 4. All of the above
0% 5. None of the above

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Equilibrium constants change with temperature

The pH of pure water at 50 °C is 6.63.

The pH of pure water at 25 °C is 7.00.

The pH of pure water at 10 °C is 7.27.

Sketch K_w versus temperature for $H_2O(l) + H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$.

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Equilibrium constants change with temperature

If A ⇌ B is endothermic (gains energy from it surroundings), its K increases with temperature.

If A ⇌ B is exothermic (loses energy to its surroundings), its K decreases with temperature.

Later, we'll learn why K is related to $\Delta_r H$ in this way.

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[TP] The pH of pure water at 50 °C is 6.63.
The pH of pure water at 25 °C is 7.00.
This means the autoionization of water,
$H_2O(l) + H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$
is ...

0% 1. Exothermic
0% 2. Endothermic
0% 3. More information needed to know

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