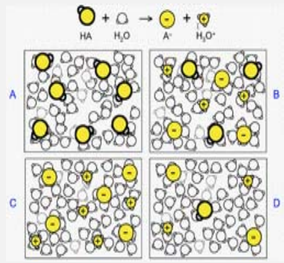
[TP] Which solution in the diagram contains the most dilute acid?

25% 1. A
25% 2. B
25% 3. C
25% 4. D



Lecture 15 CH102 A2 (MWF 11:15 am)

Friday, February 23, 2018

- Review: K_w versus T
- Composition of liquid water
- Weak acids and strong acids.

Next: 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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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

Composition of liquid water

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Liquid water

Using chevrons (/\) to represent water molecules, make a sketch of liquid water. Show about 50 water molecules in your sketch. Remember to represent liquid water rather than solid water (ice).

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[Quiz] Based on your sketch (rather than on what you anticipate to be the correct answer), calculate to one significant figure the pH of the water.

0% 1. –1
0% 2. 1
0% 3. 7
0% 4. 10
0% 5. 14
0% 6. ∞
0% 7. Something else

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Liquid water

Using chevrons (/\) to represent water molecules, make a sketch of liquid water. Show about 50 water molecules in your sketch. Remember to represent liquid water rather than solid water (ice).

If there are no hydronium ions, then $[H_3O^+] = 0$, and so …

$$pH = -\log([H_3O^+]) = -\log(0) = -\log(10^{-\infty}) = -(-\infty) = +\infty$$

since we can represent 0 as $\frac{1}{10^{+\infty}} = 10^{-\infty}$

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log(x) is power 10 is raised to equal x

$\log(1) = \log(10^0) = 0$

$\log(10) = \log(10^1) = 1$

$\log(100) = \log(10^2) = 2$

$\log(\infty) = \log(10^\infty) = \infty$

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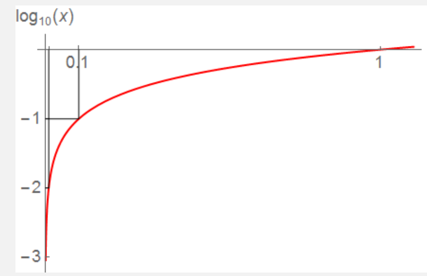
log(x) is power 10 is raised to equal x

$\log(0.1) = \log(10^{-1}) = -1$

$\log(0.01) = \log(10^{-2}) = -2$

$\log(0.001) = \log(10^{-3}) = -3$

$\log(0) = \log(10^{-\infty}) = -\infty$



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Liquid water

Modify your sketch of liquid water to add 5 hydronium ions (represented as a circled "+") and 5 hydroxide ions (represented as a circled "–").

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[TP] Modify your sketch of liquid water to add 5 hydronium ions (represented as a circled "+") and 5 hydroxide ions (represented as a circled "–"). Based on your modified sketch (rather than on what you anticipate to be the correct answer), calculate to one significant figure the pH of the water.

1. –1
2. 1
3. 7
4. 10
5. 14
6. ∞

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Liquid water

Further modify your sketch of liquid water so that it corresponds to pH = 7.

$$\frac{10^{-7}\text{mol ions}}{1\text{L}} \times \frac{10^7}{10^7} \times \frac{1\text{L}}{55\text{ mol water}} \approx \frac{1\text{ ion}}{55 \times 10^7\text{ waters}}$$

This means neutral water contains only about 1 hydronium ion for every half (0.55) billion water molecules. Nonetheless, this tiny, tiny amount has dramatic consequences.

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Weak acids and strong acids in aqueous solution

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What is an acid in aqueous solution?

An acid makes $[H_3O^+] > [OH^-]$

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Is an acid strong or weak?

A c_a M aqueous solution of an acid HA has $\text{pH} = x$ and so $[H_3O^+] = 10^{-x}$.

From this, how can we know whether HA is a strong acid or a weak acid?

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Is an acid strong or weak?

A c_a M aqueous solution of an acid HA has pH = x and so $[H_3O^+] = 10^{-x}$.

From this, how can we know whether HA is a strong acid or a weak acid?

Key idea:

Strong acids react nearly 100%:
$$HA(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + A^-(aq)$$

The closer $[H_3O^+]$ is to c_a M, the stronger the acid.

The larger $K_a = \frac{[H_3O^+]\,[A^-]}{[HA]}$, the stronger the acid.

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Is an acid strong or weak?

A c_a M aqueous solution of an acid HA has pH = x and so $[H_3O^+] = 10^{-x}$.

From this, how can we know whether HA is a strong acid or a weak acid?

Key idea:

Weak acids react much less than 100%:
$$HA(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + A^-(aq)$$

The closer [HA] is to c_a M, the weaker the acid.

The smaller $K_a = \frac{[H_3O^+]\,[A^-]}{[HA]}$, the weaker the acid.

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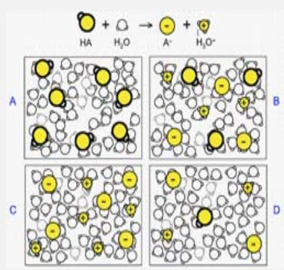
Lecture 15 CH102 A2 (MWF 11:15 am) Spring 2018

[TP] Which solution in the diagram contains the most dilute acid?

1. A
2. B
3. C
4. D



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34

