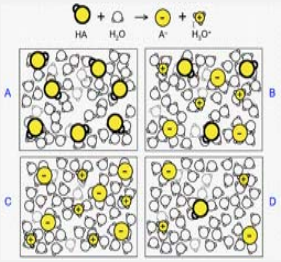
[TP] Which solution in the diagram contains the strongest acid?

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



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Lecture 17 CH102 A1 (MWF 9:05 am)

Wednesday, March 1, 2017

- Complete and review: Weak acids and strong acids
- Getting weak acid K_a values
- pK_a

Next lecture: Using K_a to get $[H_3O^+]$. Practice: $[H_3O^+]$ of a weak acid.
Titration: What happens when some OH^- is added to an acid?

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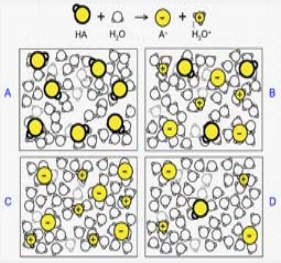
[TP] Which solution in the diagram contains the strongest acid?

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



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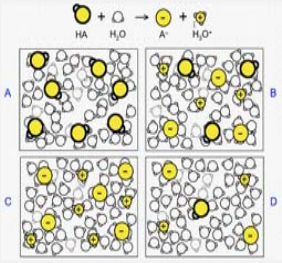
[TP] The reason for your choice in the previous question was that the solution showed the ...

14% 1. highest proportion of A^-
14% 2. lowest proportion of A^-
14% 3. highest $[H_3O^+]$
14% 4. lowest $[H_3O^+]$
14% 5. highest $[HA] + [A^-]$
14% 6. lowest $[HA] + [A^-]$
14% 7. equal $[HA]$ and $[A^-]$



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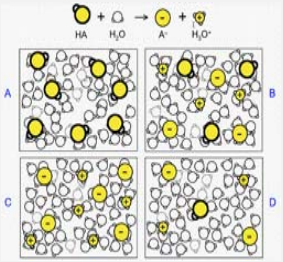
[TP] Which solution in the diagram contains the weakest acid?

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



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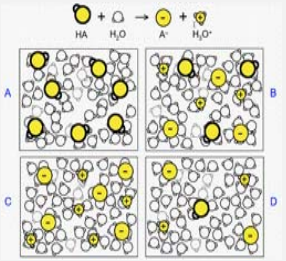
[Quiz] The reason for your choice in the previous question was that the solution showed the ...

14% 1. highest proportion of A^-
14% 2. lowest proportion of A^-
14% 3. highest $[H_3O^+]$
14% 4. lowest $[H_3O^+]$
14% 5. highest $[HA] + [A^-]$
14% 6. lowest $[HA] + [A^-]$
14% 7. equal $[HA]$ and $[A^-]$



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Getting weak acid K_a values

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Weak acid K_a values

Dissolve c_a moles of acid in 1 liter of water, and then measure pH

If $[H_3O^+] = 10^{-pH} \ll c_a$, the acid reacts with water ...

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

$$K_a = [H_3O^+]\,[A^-] \,/\, [HA]$$

much less than 100%.

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[TP] A $c_a = 0.10$ M acid solution has pH = 4.0. The % yield of the reaction $HA(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + A^-(aq)$ is ...

17% 1. 100%
17% 2. 10%
17% 3. 1%
17% 4. 0.1%
17% 5. 0.01%
17% 6. Something else

Weak acid K_a values

If $c_a = 0.10$ and pH = 4.0, what is the percent yield of reaction?

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

actual $[H_3O^+] = 10^{-4.0} = 1 \times 10^{-4}$

maximum possible $[H_3O^+] = 0.10$

% reaction = 100% × actual / maximum

$= 100\% \times (1 \times 10^{-4}) / 0.10 = 0.1\%$

Weak acid K_a values

We can get the numerical value of K_a by analyzing the acid equilibrium.

	$HA(aq)$	$H_3O^+(aq)$	$A^-(aq)$	Q
Initial	c_a	?	?	?

[TP] Before the reaction $HA(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + A^-(aq)$ takes place, $[A^-]$ = ...

25% 1. 0
25% 2. c_a
25% 3. 10^{-7}
25% 4. Further information needed

[TP] Before the reaction $HA(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + A^-(aq)$ takes place, $[H_3O^+] = \ldots$

25% 1. 0
25% 2. c_a
25% 3. 10^{-7}
25% 4. Further information needed

[TP] Before the reaction $HA(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + A^-(aq)$ takes place, at 25 °C, $[H_3O^+] = \ldots$

25% 1. 0
25% 2. c_a
25% 3. 10^{-7}
25% 4. Further information needed

Weak acid K_a values

We can get the numerical value of K_a by analyzing the acid equilibrium.

	$HA(aq)$	$H_3O^+(aq)$	$A^-(aq)$	Q
Initial	c_a	10^{-7}	0	0

If we assume 25 °C.

Weak acid K_a values

We can get the numerical value of K_a by analyzing the acid equilibrium.

	$HA(aq)$	$H_3O^+(aq)$	$A^-(aq)$	Q
Initial	c_a	10^{-7}	0	0
Change	?	?	?	

What change is needed to achieve equilibrium?

Weak acid K_a values

We can get the numerical value of K_a by analyzing the acid equilibrium.

	HA(*aq*)	$H_3O^+(aq)$	$A^-(aq)$	*Q*
Initial	c_a	10^{-7}	0	0
Change	$-x$	$+x$	$+x$	

Since $Q = 0$ is less that K_a, more product must form.

Weak acid K_a values

We can get the numerical value of K_a by analyzing the acid equilibrium.

	HA(*aq*)	$H_3O^+(aq)$	$A^-(aq)$	*Q*
Initial	c_a	10^{-7}	0	0
Change	$-x$	$+x$	$+x$	
Equilibrium	$c_a - x$	$10^{-7} + x$	x	?

What is the value of Q?

Weak acid K_a values

We can get the numerical value of K_a by analyzing the acid equilibrium.

	HA(*aq*)	$H_3O^+(aq)$	$A^-(aq)$	*Q*
Initial	c_a	10^{-7}	0	0
Change	$-x$	$+x$	$+x$	
Equilibrium	$c_a - x$	$10^{-7} + x$	x	K_a

The value of x is determined by requiring that $Q = K_a$.

Weak acid K_a values

We can get the numerical value of K_a by analyzing the acid equilibrium.

	HA(*aq*)	$H_3O^+(aq)$	$A^-(aq)$	*Q*
Initial	c_a	10^{-7}	0	0
Change	$-x$	$+x$	$+x$	
Equilibrium	$c_a - x$	$10^{-7} + x$	x	K_a

The result is a quadratic equation in x,

$K_a = (10^{-7} + x)\,(x) \,/\, (c_a - x)$