

[TP] Which of the following is true about the a weak base?

13% 1. $K_b \ll 1$
13% 2. $K_b \approx 1$
13% 3. $K_b \gg 1$
13% 4. $K_b \gg K_w$
13% 5. $K_b \ll K_w$
13% 6. 1 and 4
13% 7. 1 and 5
13% 8. 1, 4, and 5

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Lecture 20 CH102 A1 (MWF 9:05 am)

Wednesday, March 15, 2017

See Overview of acid-base calculations, https://goo.gl/GEPDqo

- Complete: $[H_3O^+]$ when "too little" base added
- $[H_3O^+]$ when "just enough" base added
- $[H_3O^+]$ when "too much" base added

Next lecture: Continue 14: Practice; $[H_3O^+]$ when different amounts of "not enough" base added

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$[H_3O^+]$ when "too little" base added

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Step 2: $[H_3O^+]$ when "too little" base added

V_b = 100. mL of c_b = 0.20 M of OH^- is combined with V_a = 100. mL of c_a = 0.40 M of HA, $K_a = 1.0 \times 10^{-5}$. Step 1 results:

$[HA] = c_a' = (c_a V_a - c_b V_b) / (V_a + V_b) = 0.020 \text{ mol} / (0.200 \text{ L}) = 0.10 \text{ M}$

$[A^-] = c_b' = (c_b V_b) / (V_a + V_b) = (0.020) \text{ mol} / (0.200 \text{ L}) = 0.10 \text{ M}$

$[OH^-] = 0$

$K_b = K_w / K_a = 10^{-14}/(1.0 \times 10^{-5}) = 1.0 \times 10^{-9} \ll K_a$, so in this case ...

when "too little" base has been added, we find $[H_3O^+]$ using the ICE table for

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

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Step 2: $[H_3O^+]$ when "too little" base added

$V_b = 100.$ mL of $c_b = 0.20$ M of OH^- is combined with $V_a = 100.$ mL of $c_a = 0.40$ M of HA, $K_a = 1.0 \times 10^{-5}$

	HA(aq)	H_3O^+(aq)	A^-(aq)	Q
Initial				
Change				
Equilibrium				
Approximate				

$[H_3O^+] = ?$

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Step 2: $[H_3O^+]$ when "too little" base added

$V_b = 100.$ mL of $c_b = 0.20$ M of OH^- is combined with $V_a = 100.$ mL of $c_a = 0.40$ M of HA, $K_a = 1.0 \times 10^{-5}$

	HA(aq)	H_3O^+(aq)	A^-(aq)	Q
Initial	0.10	10^{-7}	0.10	$10^{-7} < K_a$
Change	$-x$	$+x$	$+x$	
Equilibrium	$0.10 - x$	$10^{-7} + x$	$0.10 + x$	1.0×10^{-5}
Approximate	≈ 0.10	$\approx x$	≈ 0.10	1.0×10^{-5}

$[H_3O^+] = x = K_a \times [HA] / [A^-] = (1.0 \times 10^{-5} \times 0.10) / 0.10 = 1.0 \times 10^{-5}$

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$[H_3O^+]$ when "just enough" base added

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Step 2: $[H_3O^+]$ when "just enough" base added

$V_b = 100.$ mL of $c_b = 0.40$ M of OH^- is combined with $V_a = 100.$ mL of $c_a = 0.40$ M of HA, $K_a = 1.0 \text{ x } 10^{-5}$.

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Step 2: $[H_3O^+]$ when "just enough" base added

$V_b = 100.$ mL of $c_b = 0.40$ M of OH^- is combined with $V_a = 100.$ mL of $c_a = 0.40$ M of HA, $K_a = 1.0 \times 10^{-5}$. Step 1 results:

Ignoring acid-base equilibrium, after the limiting reagent reaction is complete, the resulting concentrations of HA, A^-, and OH^- are ...

$[HA] = (c_a V_a - c_b V_b) / (V_a + V_b) = (0.040 - 0.040)$ mol / (0.200 L) $= 0$

$[A^-] = (c_b V_b) / (V_a + V_b) = (0.040)$ mol / (0.200 L) $= 0.20$ M

$[OH^-] = 0$

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Step 2: $[H_3O^+]$ when "just enough" base added

We can get $[H_3O^+]$ by equilibrating the limiting reagent reaction outcome.

When "just enough" base is added, only the conjugate base will be present after the limiting reagent reaction.

But what equilibrium do we work with?

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Step 2: $[H_3O^+]$ when "just enough" base added

We can get $[H_3O^+]$ by equilibrating the limiting reagent reaction outcome.

When "just enough" base is added, only the conjugate base will be present after the limiting reagent reaction.

But what equilibrium do we work with?

If only conjugate base is present, then work with

$H_2O(l) + A^-(aq) \rightleftarrows HA(aq) + OH^-(aq)$, $K_b = K_w / K_a$

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[TP] Which of the following is true about the a weak base?

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13% 4. $K_b \gg K_w$
13% 5. $K_b \ll K_w$
13% 6. 1 and 4
13% 7. 1 and 5
13% 8. 1, 4, and 5

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[Quiz] Which of the following is true about the conjugate base A^- of the weak acid HA?

25% 1. A^- is a strong base
25% 2. A^- is a weak base
25% 3. Not a base, since $K_b \ll K_w$
25% 4. Further information needed

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Step 2: $[H_3O^+]$ when "just enough" base added

$V_b = 100.$ mL of $c_b = 0.40$ M of OH^- is combined with $V_a = 100.$ mL of $c_a = 0.40$ M of HA, $K_a = 1.0 \times 10^{-6}$ and $K_b = K_w / K_a = 1.0 \times 10^{-8}$

	$A^-(aq)$	HA(aq)	$OH^-(aq)$	Q
Initial				
Change				
Equilibrium				
Approximate				

$[OH^-] = ?$

$[H_3O^+] = ?$

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Step 2: $[H_3O^+]$ when "just enough" base added

$V_b = 100.$ mL of $c_b = 0.40$ M of OH^- is combined with $V_a = 100.$ mL of $c_a = 0.40$ M of HA, $K_a = 1.0 \times 10^{-6}$ and $K_b = K_w / K_a = 1.0 \times 10^{-8}$

	$A^-(aq)$	$HA(aq)$	$OH^-(aq)$	Q
Initial	0.20	0	10^{-7}	0
Change	$-x$	$+x$	$+x$	
Equilibrium	$0.20 - x$	x	$10^{-7} + x$	1.0×10^{-8}
Approximate	≈ 0.20	x	$\approx x$	1.0×10^{-8}

$[OH^-] = x = (K_b \times [A^-])^{1/2} = (1.0 \times 10^{-8} \times 0.20)^{1/2} = 4.5 \times 10^{-5}$

$[H_3O^+] = K_w / [OH^-] = (1.0 \times 10^{-14}) / (4.5 \times 10^{-5}) = 2.2 \times 10^{-10}$

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