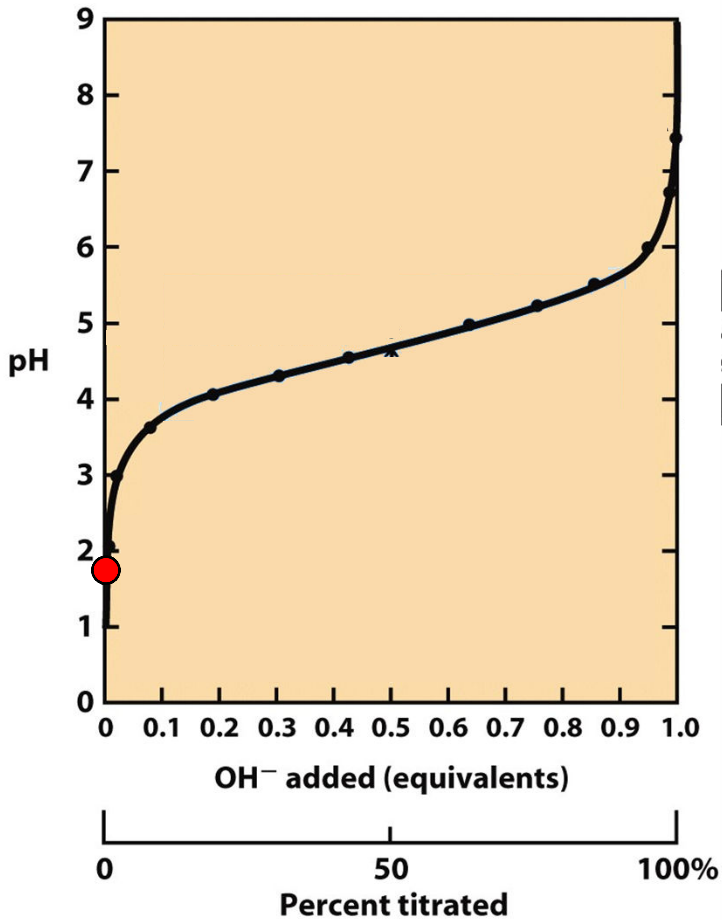
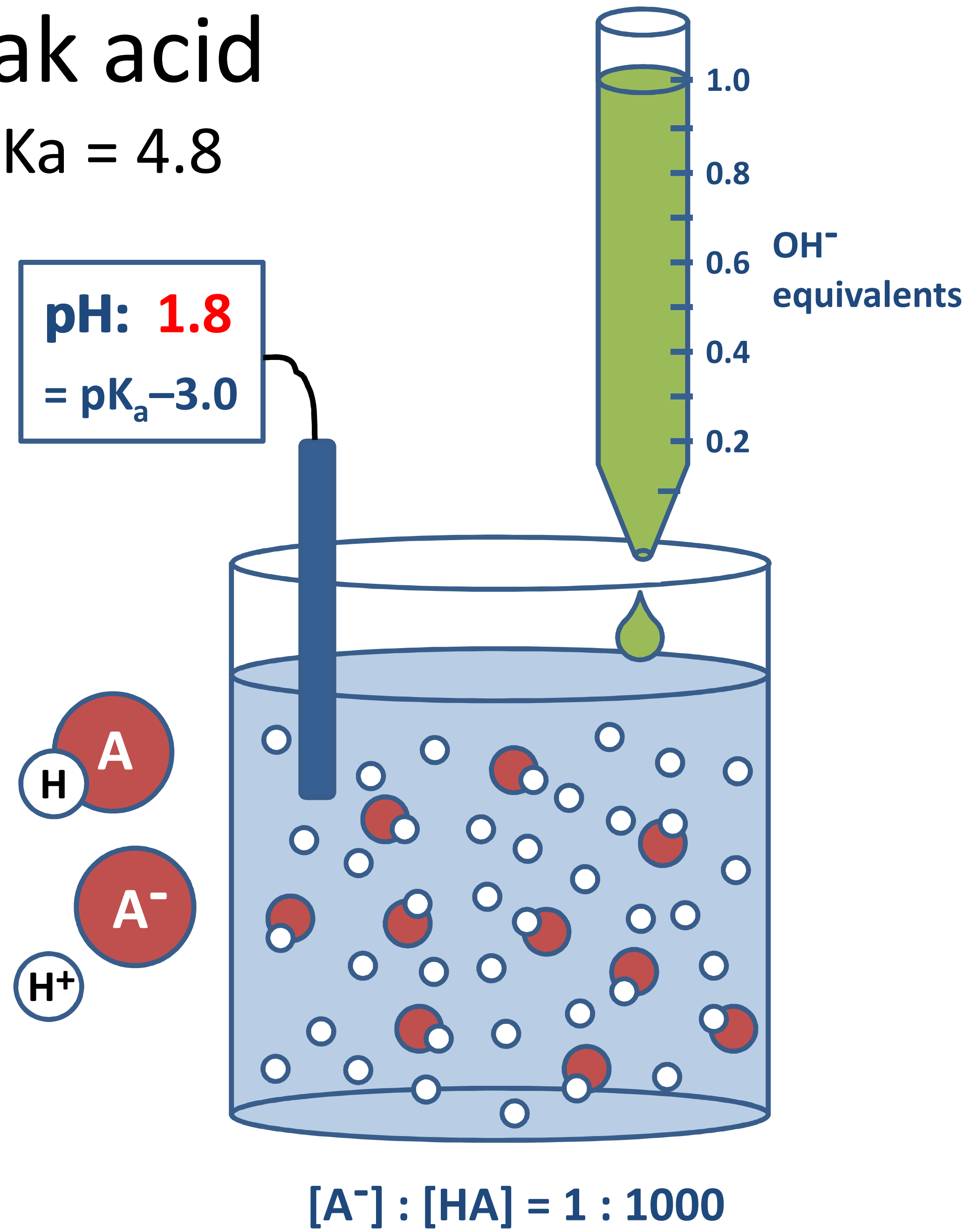
Titration of a weak acid

acetic acid, CH_3COOH, pKa = 4.8





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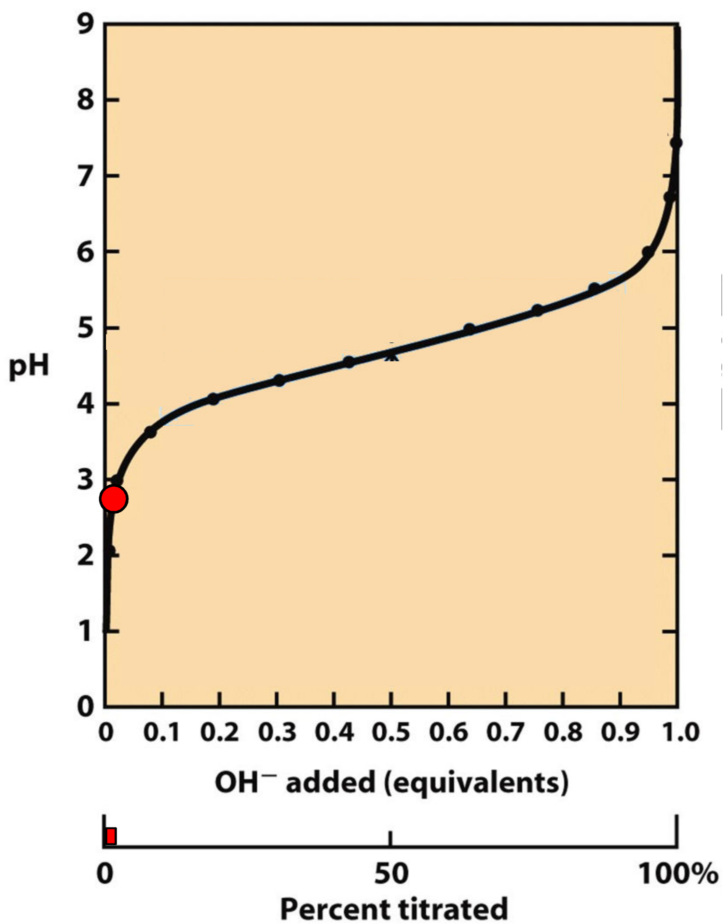
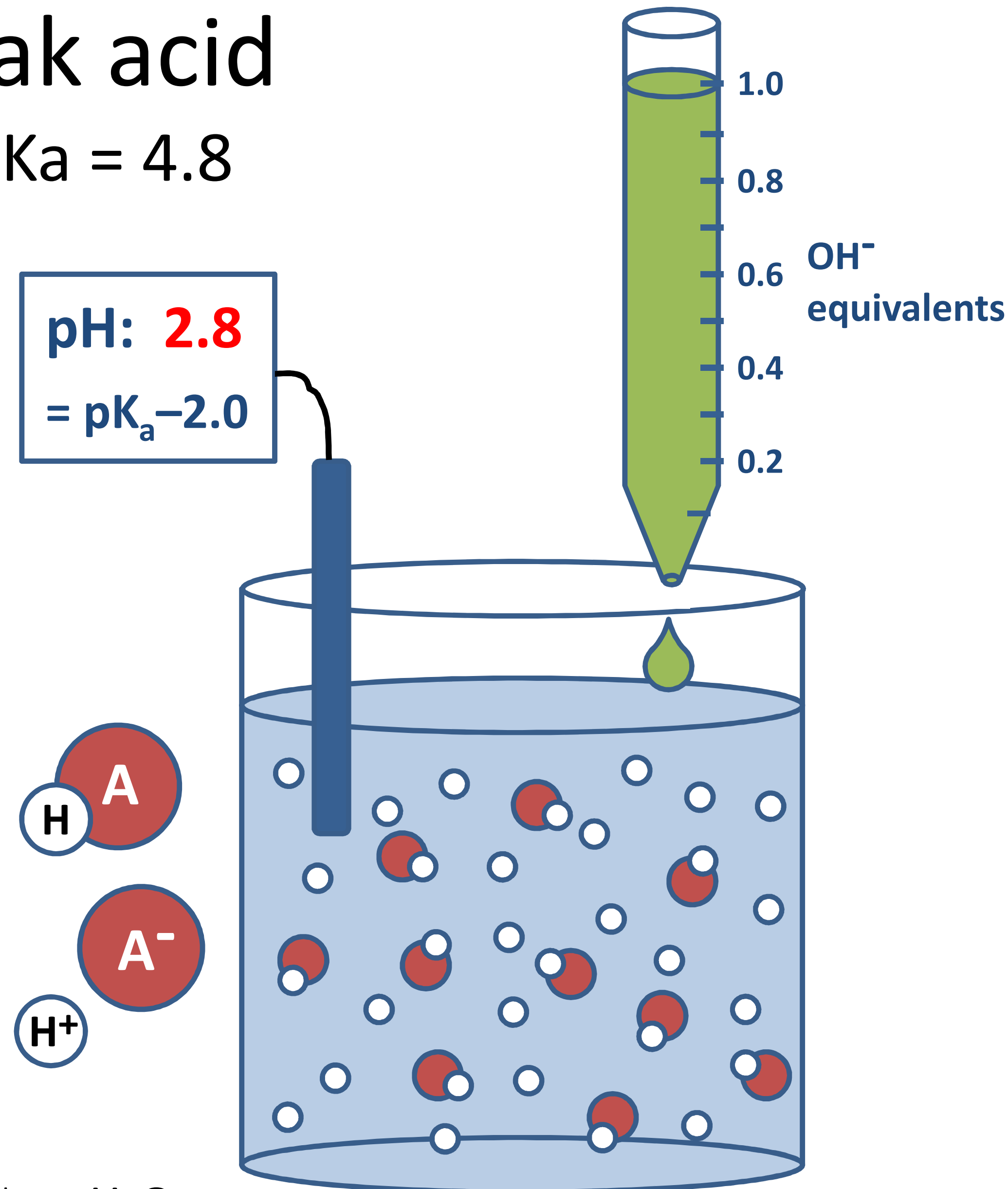




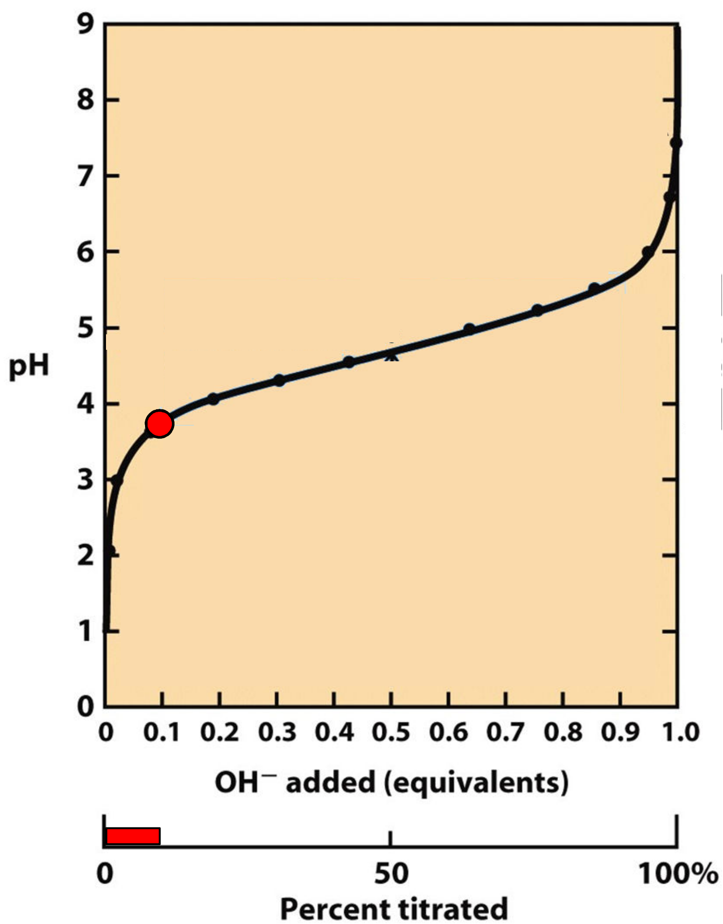
$OH^- + H^+ \rightarrow H_2O$

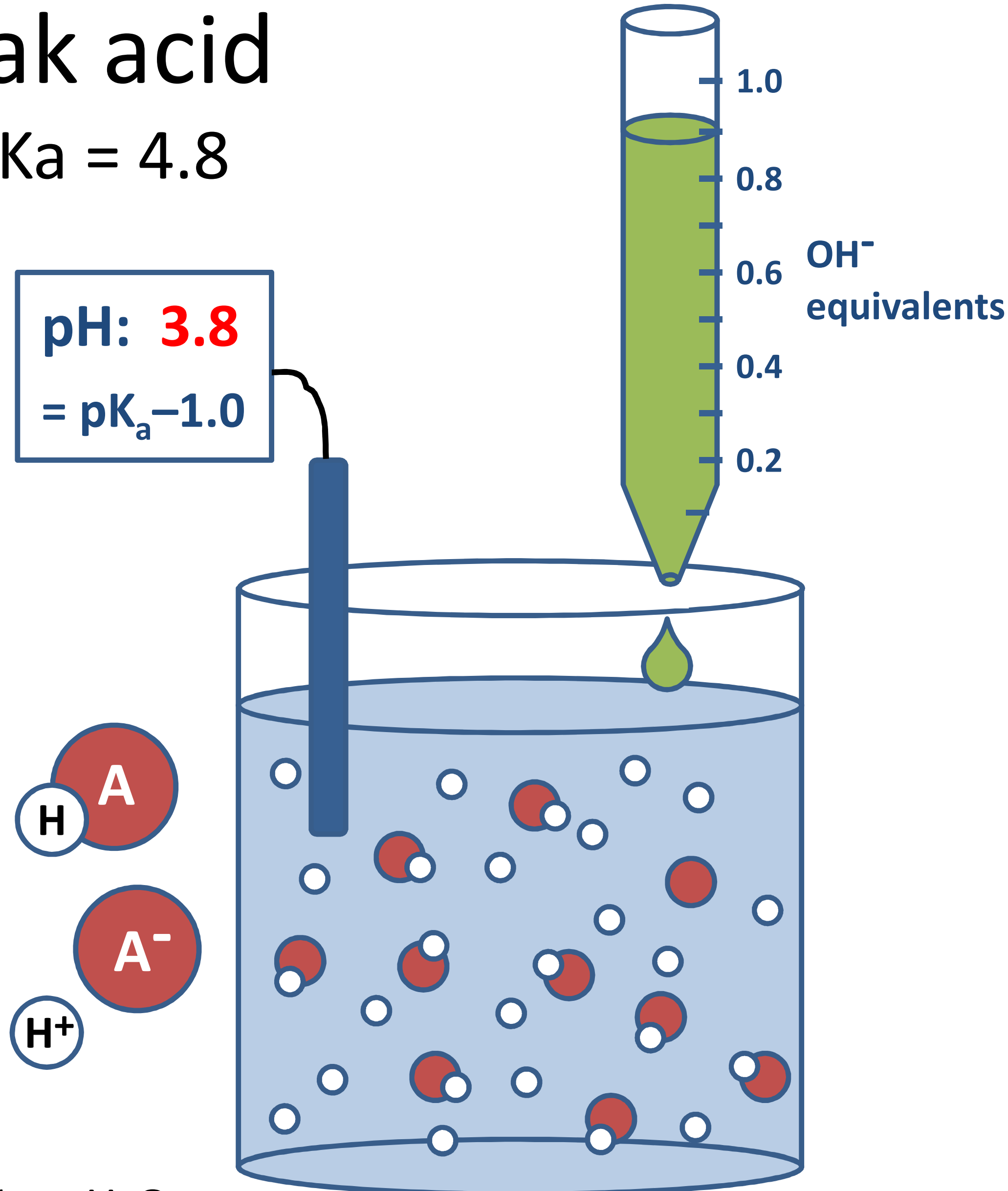
$OH^- + HA \rightarrow H_2O + A^-$

$[A^-] : [HA] = 1 : 100$

Titration of a weak acid

acetic acid, CH_3COOH, pKa = 4.8





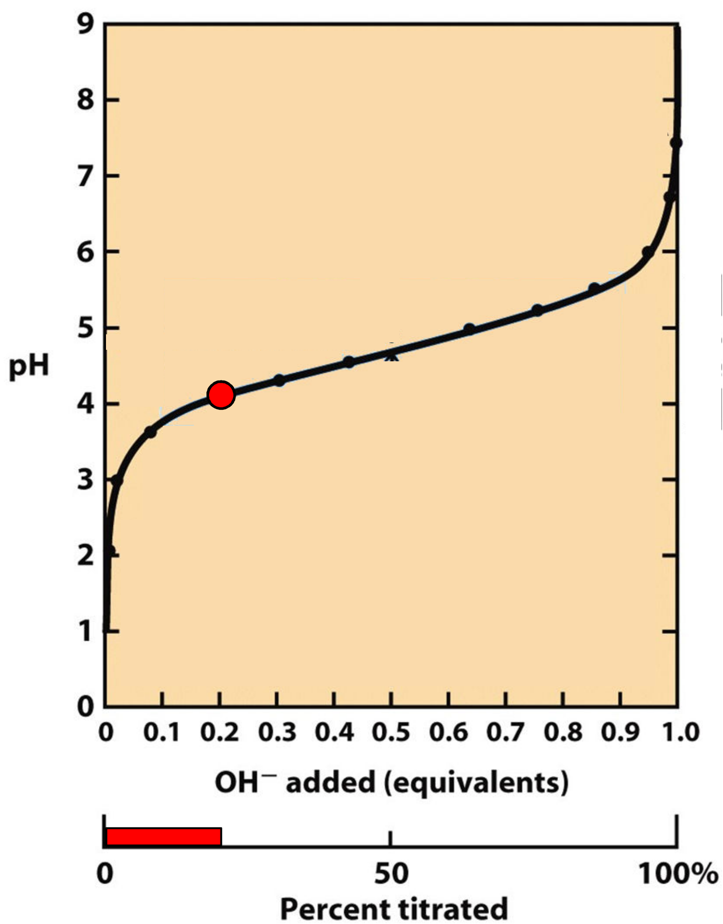
$OH^- + H^+ \rightarrow H_2O$

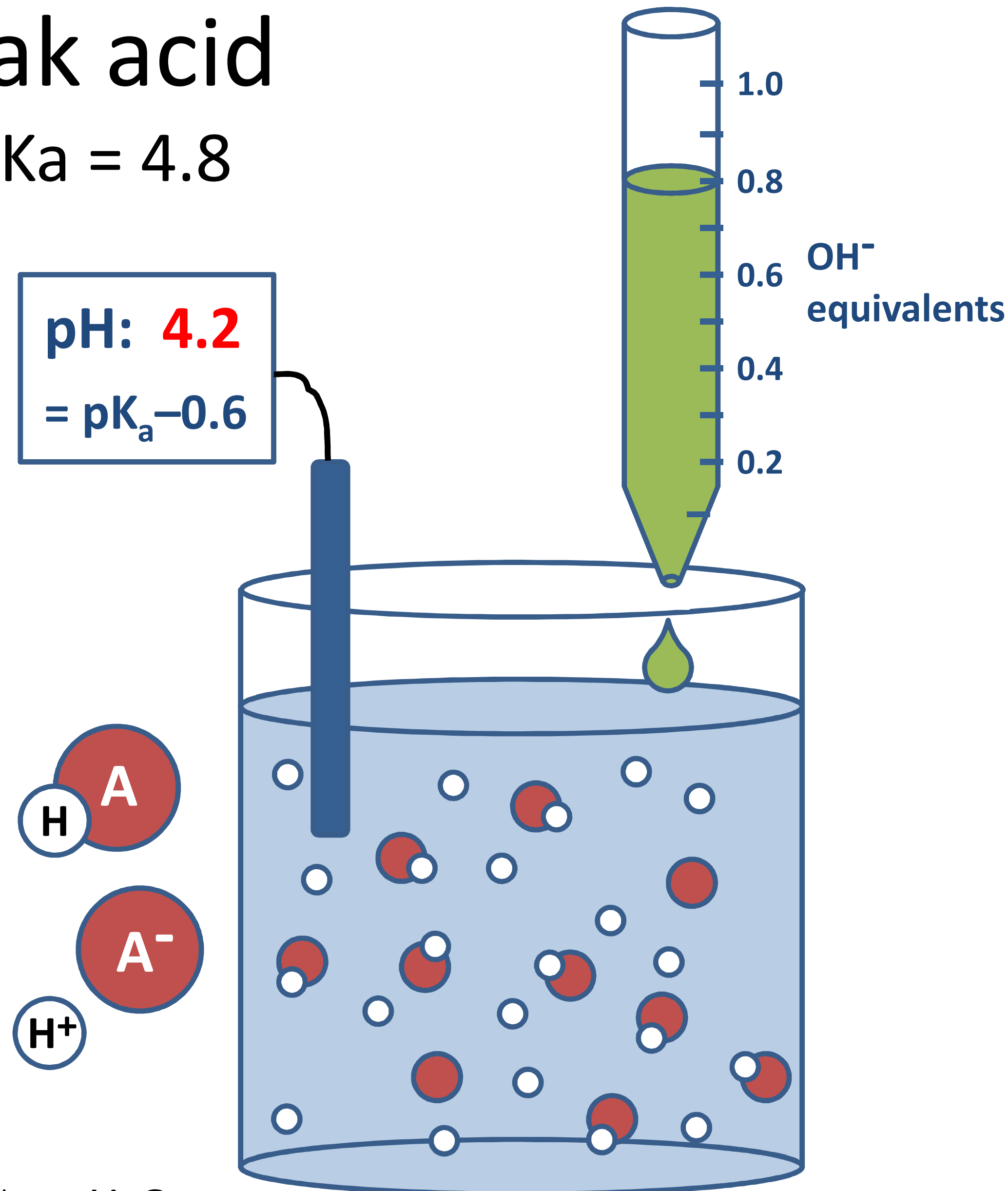
$OH^- + HA \rightarrow H_2O + A^-$

$[A^-] : [HA] = 1 : 10$

Titration of a weak acid

acetic acid, CH_3COOH, pKa = 4.8





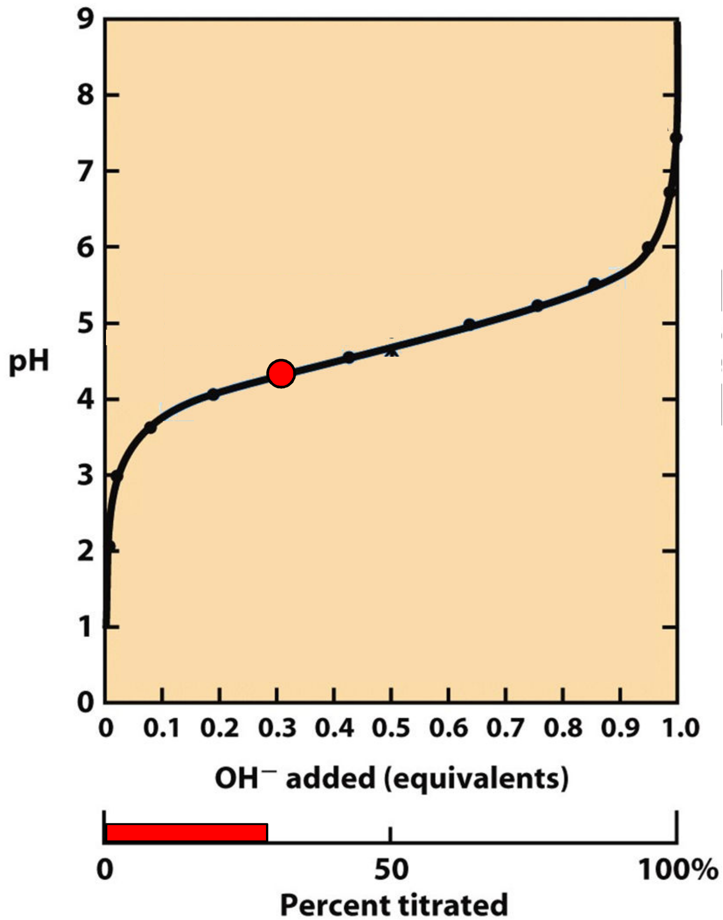
$OH^- + H^+ \rightarrow H_2O$

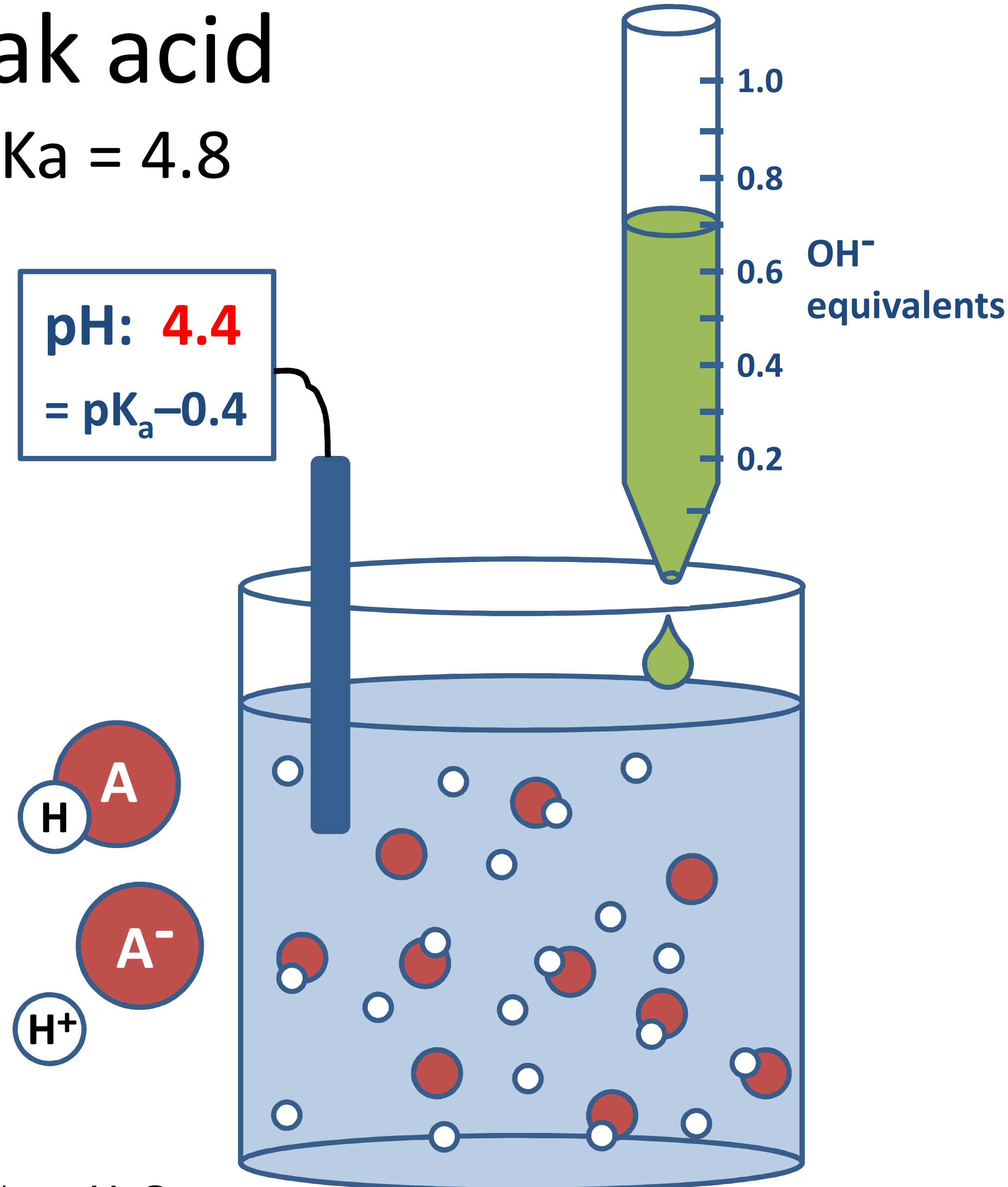
$OH^- + HA \rightarrow H_2O + A^-$

$[A^-] : [HA] = 1 : 4$

Titration of a weak acid

acetic acid, CH_3COOH, pKa = 4.8





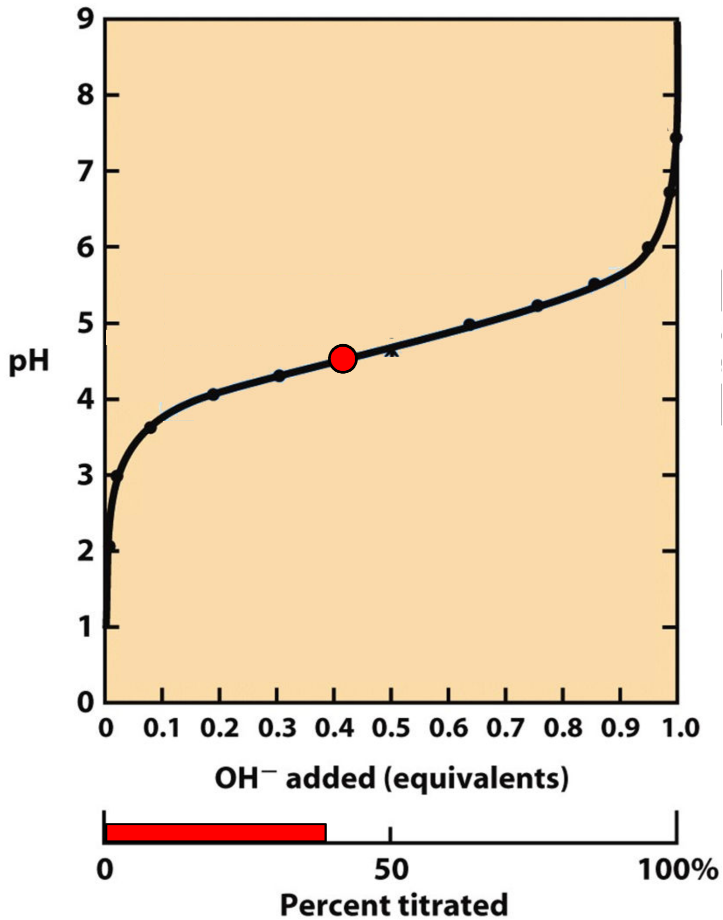
$OH^- + H^+ \rightarrow H_2O$

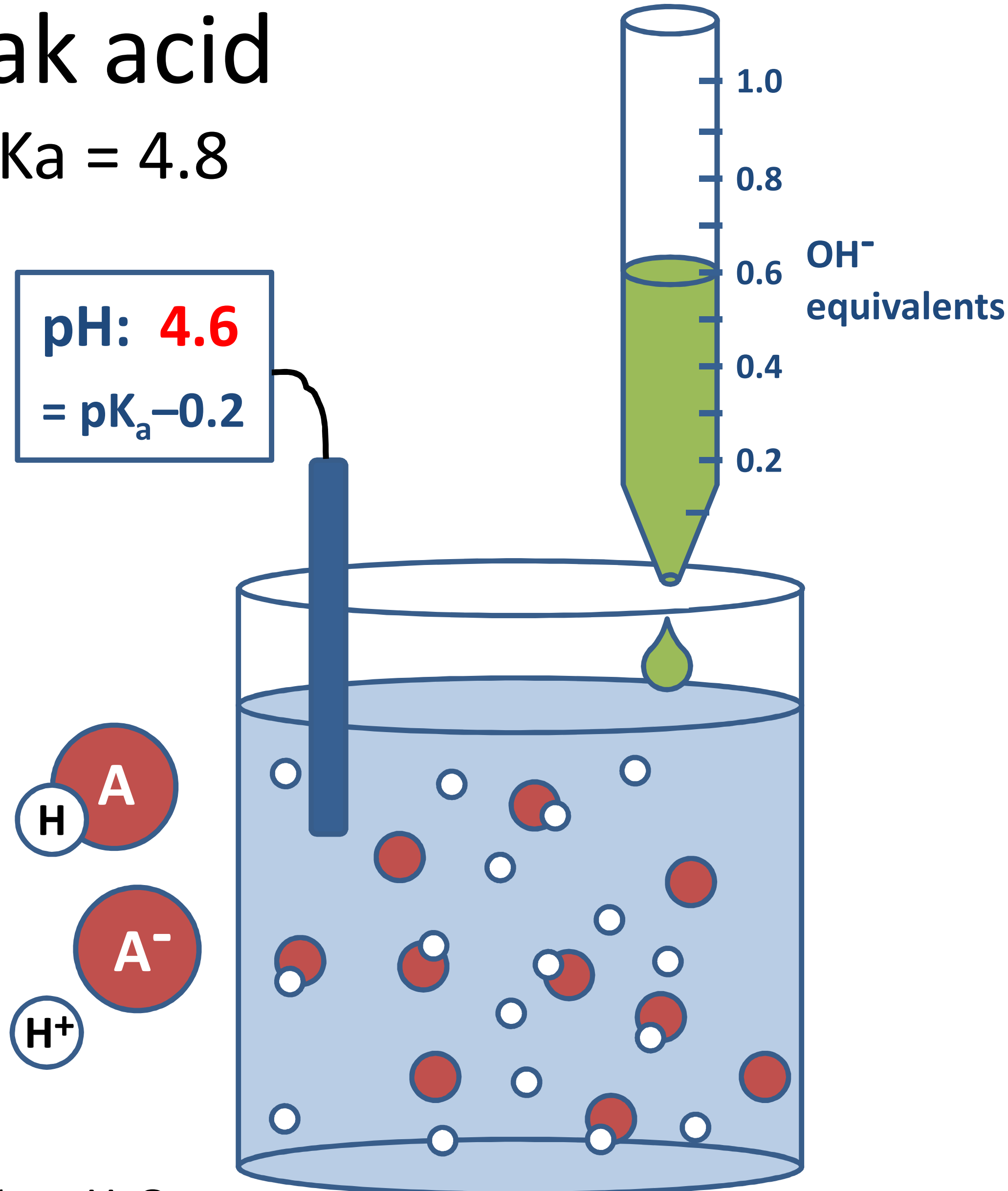
$OH^- + HA \rightarrow H_2O + A^-$

$[A^-] : [HA] = 1 : 2.3$

Titration of a weak acid

acetic acid, CH_3COOH, pKa = 4.8





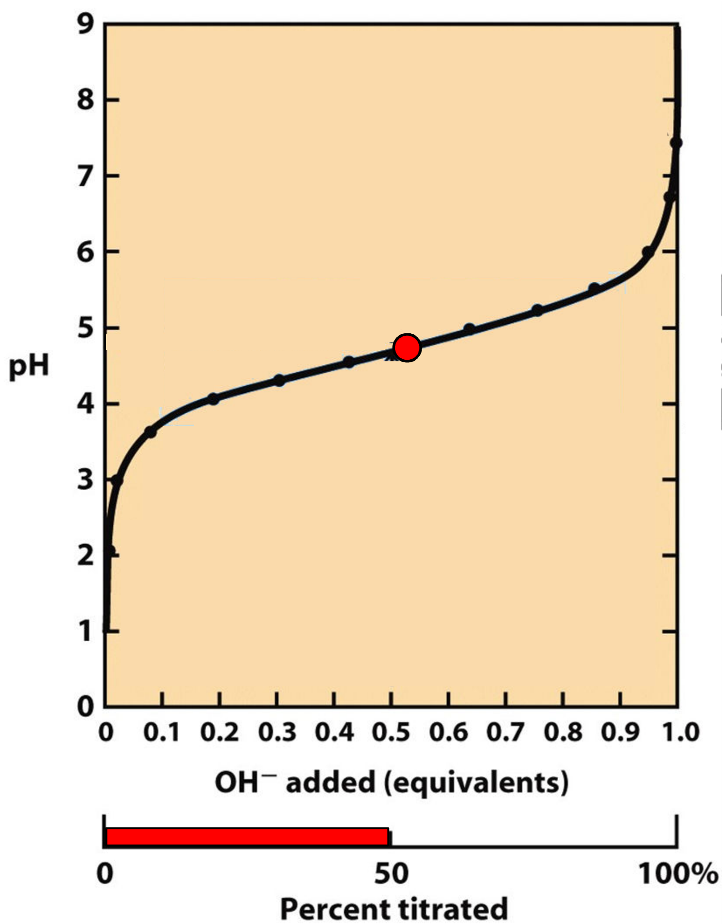
$OH^- + H^+ \rightarrow H_2O$

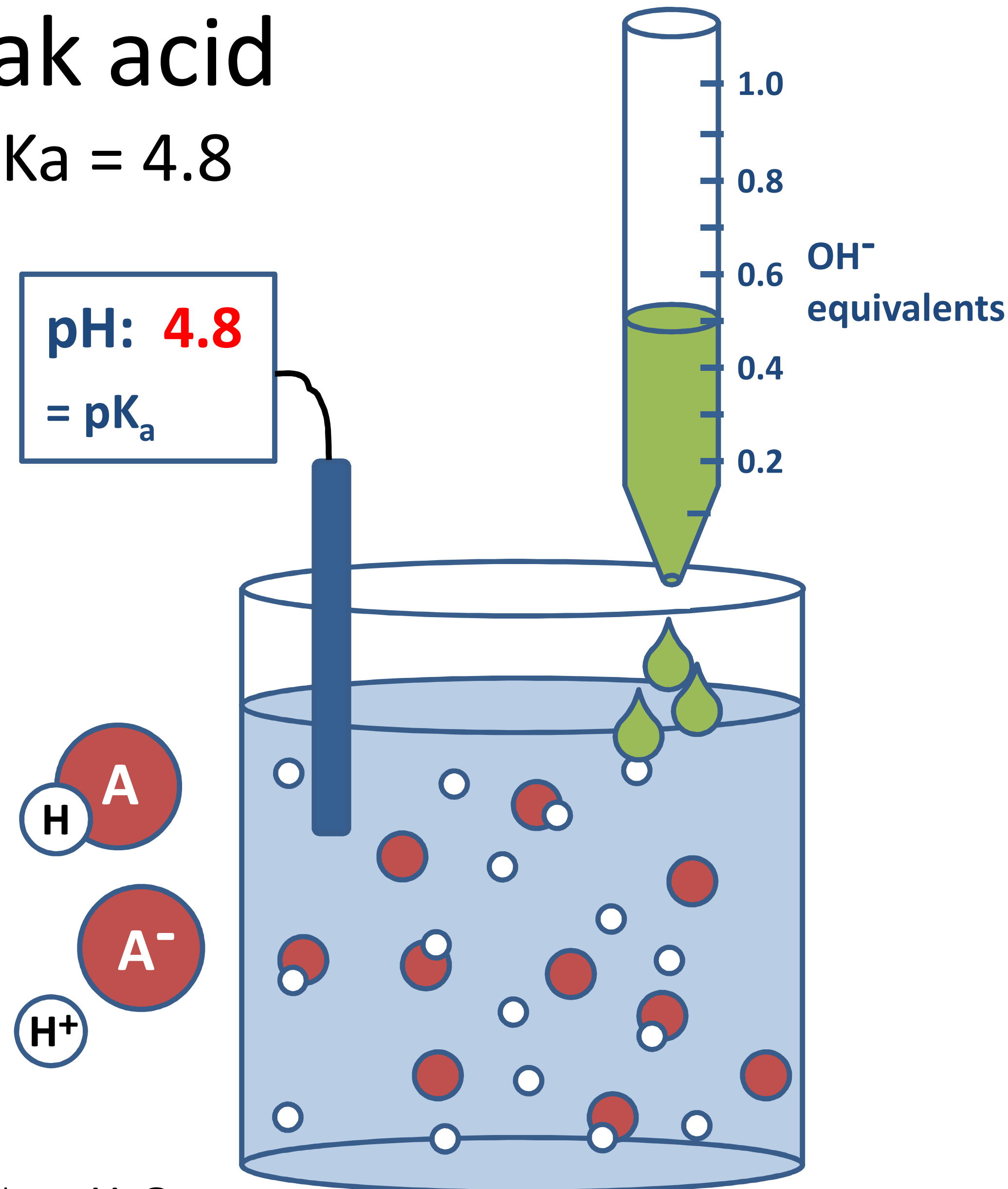
$OH^- + HA \rightarrow H_2O + A^-$

$[A^-] : [HA] = 1 : 1.5$

Titration of a weak acid

acetic acid, CH_3COOH, pKa = 4.8





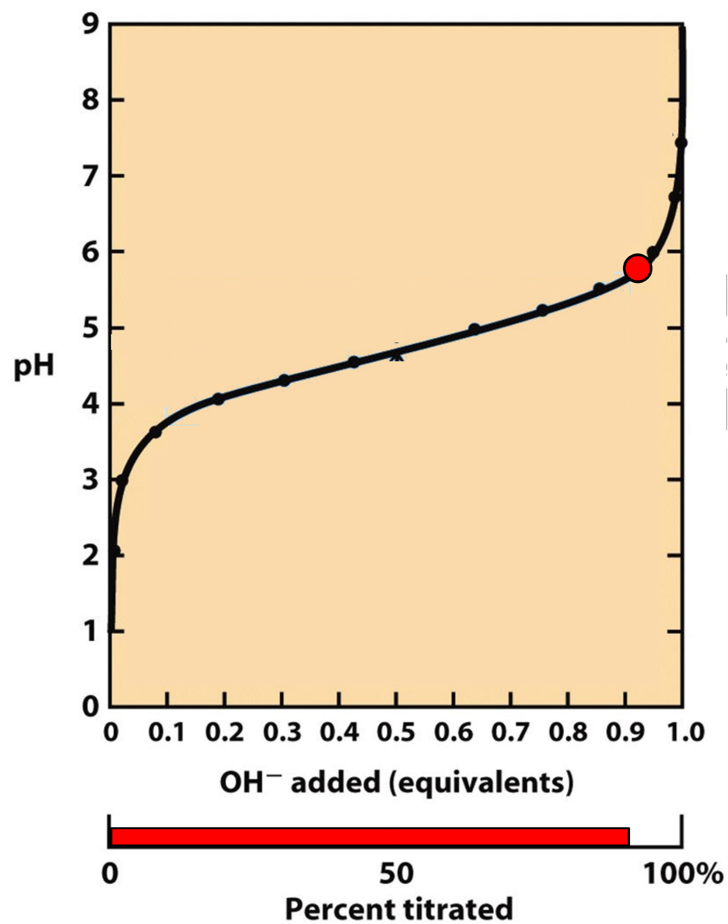
$OH^- + H^+ \rightarrow H_2O$

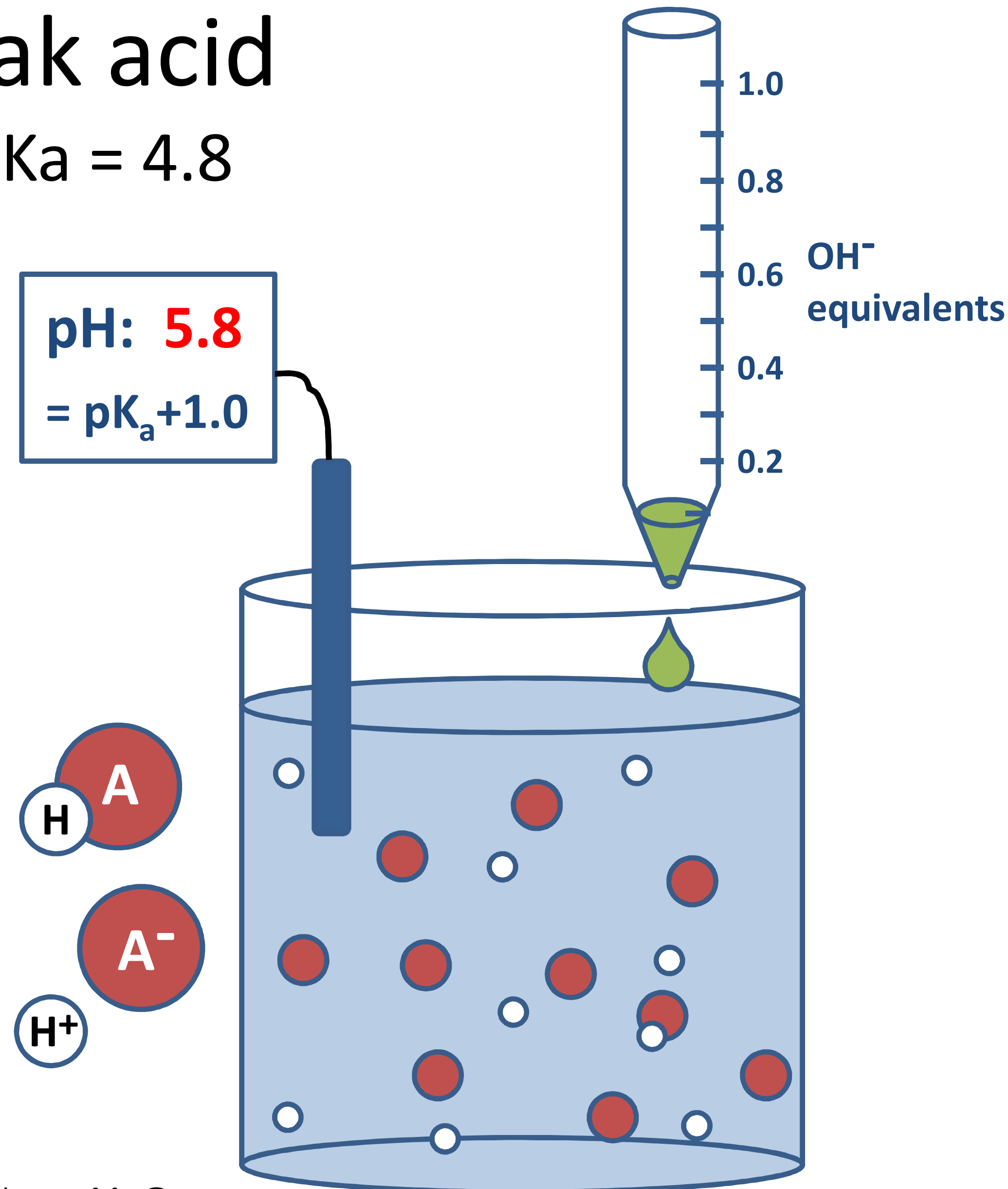
$OH^- + HA \rightarrow H_2O + A^-$

$[A^-] : [HA] = 1 : 1$

Titration of a weak acid

acetic acid, CH_3COOH, pKa = 4.8





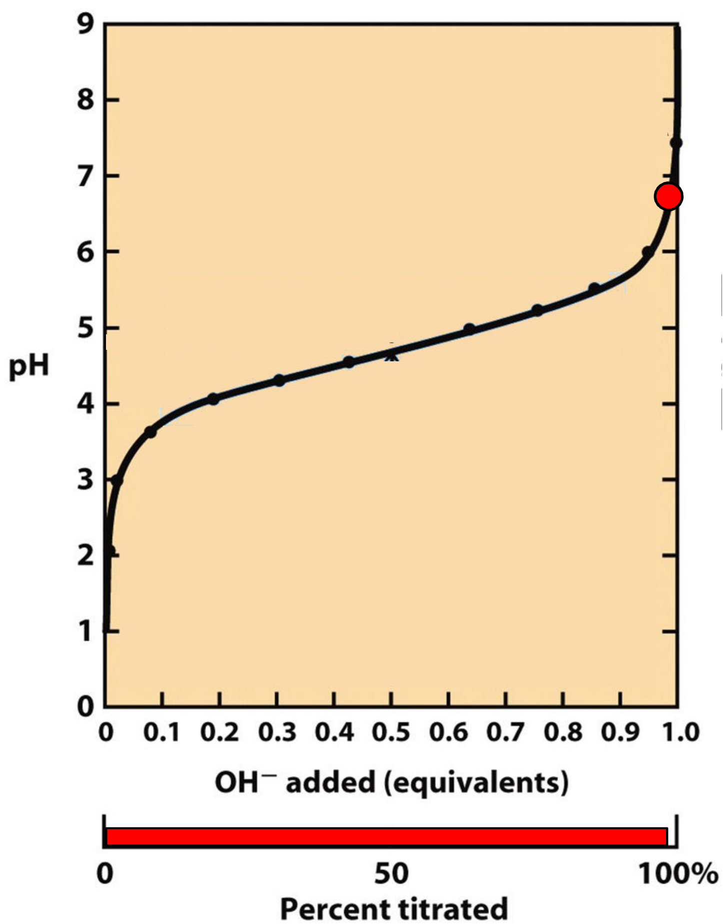
$OH^- + H^+ \rightarrow H_2O$

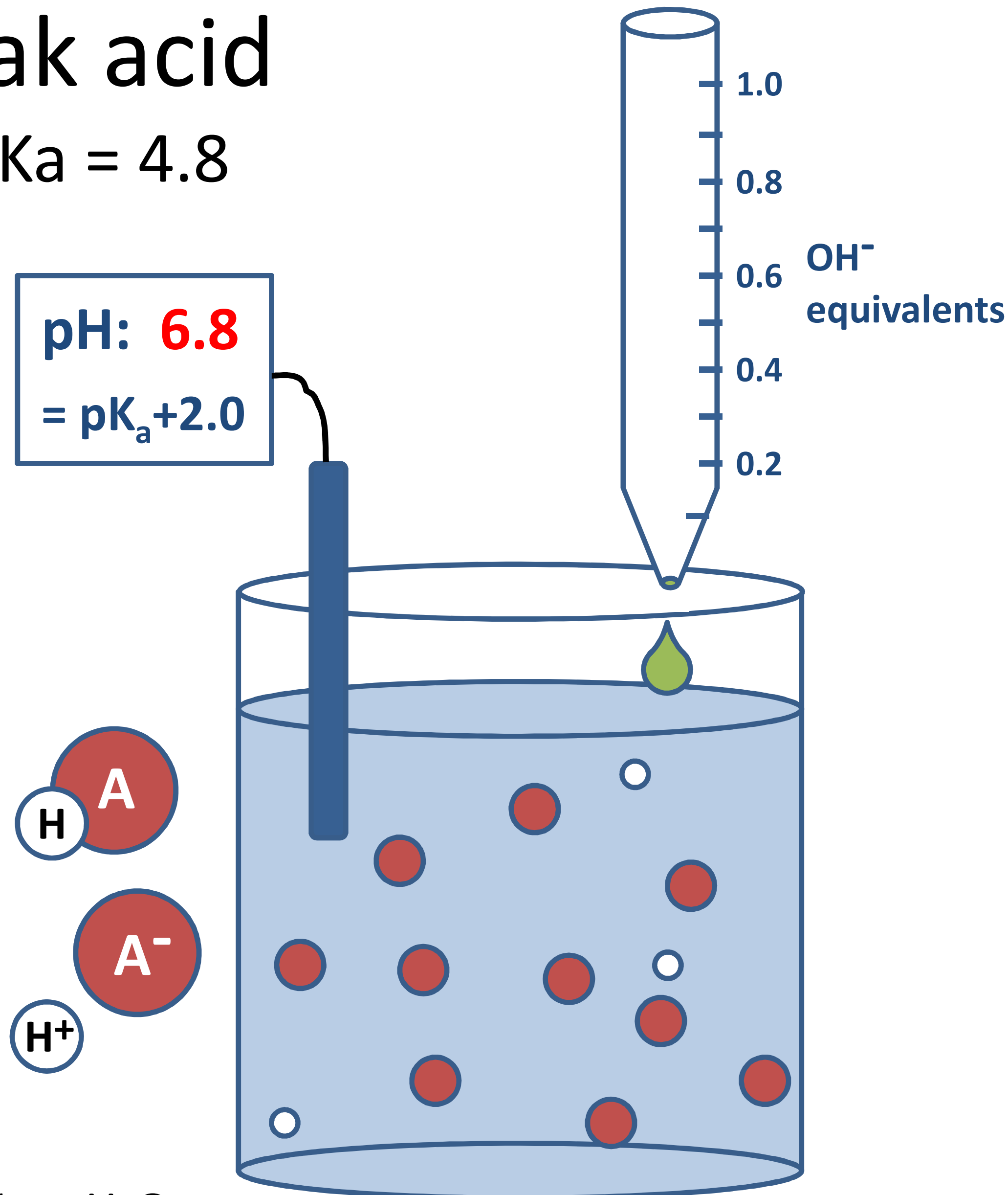
$OH^- + HA \rightarrow H_2O + A^-$

$[A^-] : [HA] = 10: 1$

Titration of a weak acid

acetic acid, CH_3COOH, pKa = 4.8





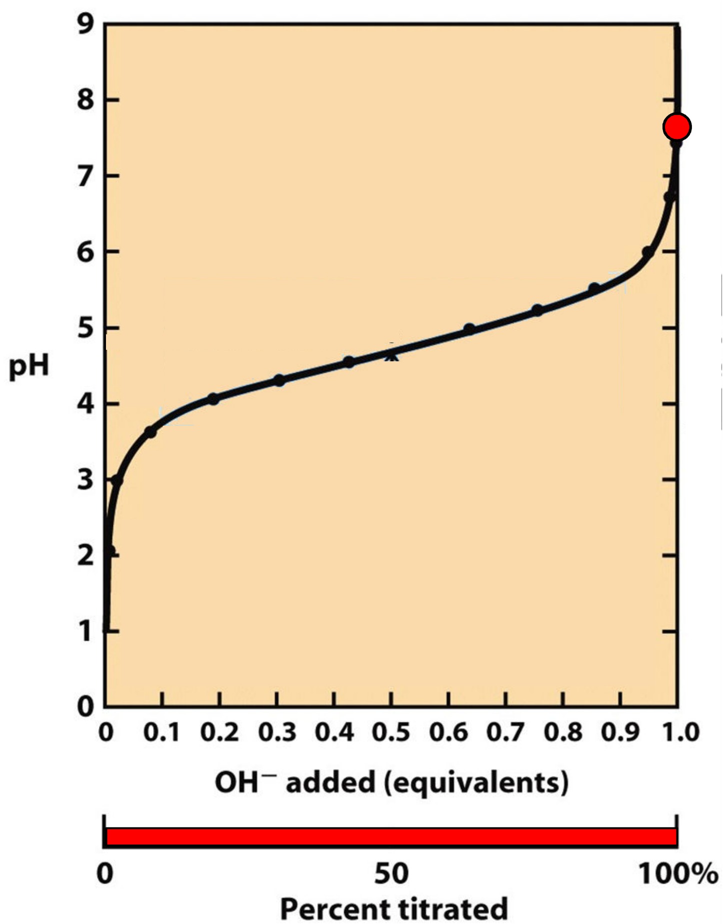
$OH^- + H^+ \rightarrow H_2O$

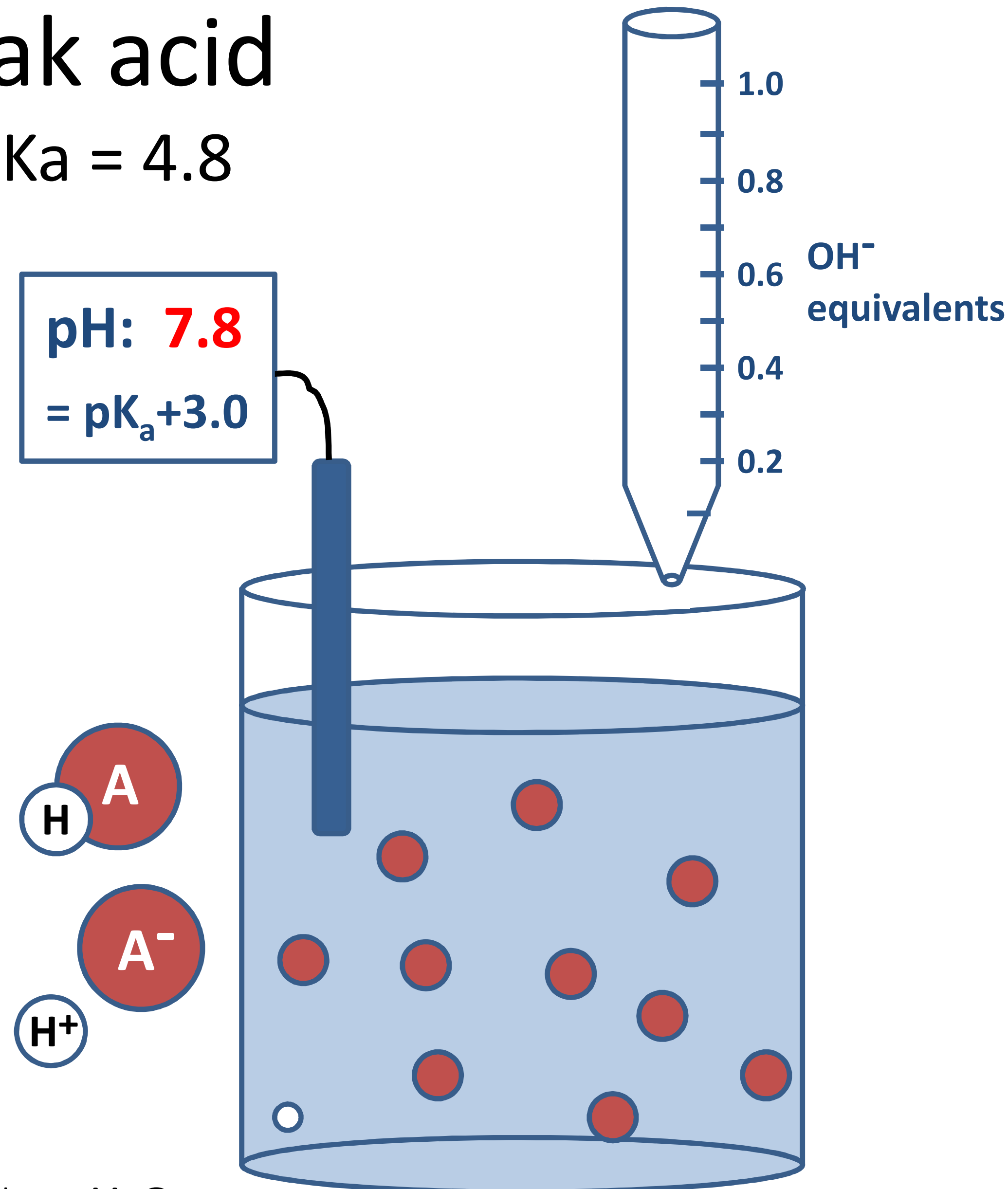
$OH^- + HA \rightarrow H_2O + A^-$

$[A^-] : [HA] = 100: 1$

Titration of a weak acid

acetic acid, CH_3COOH, pKa = 4.8





$OH^- + H^+ \rightarrow H_2O$

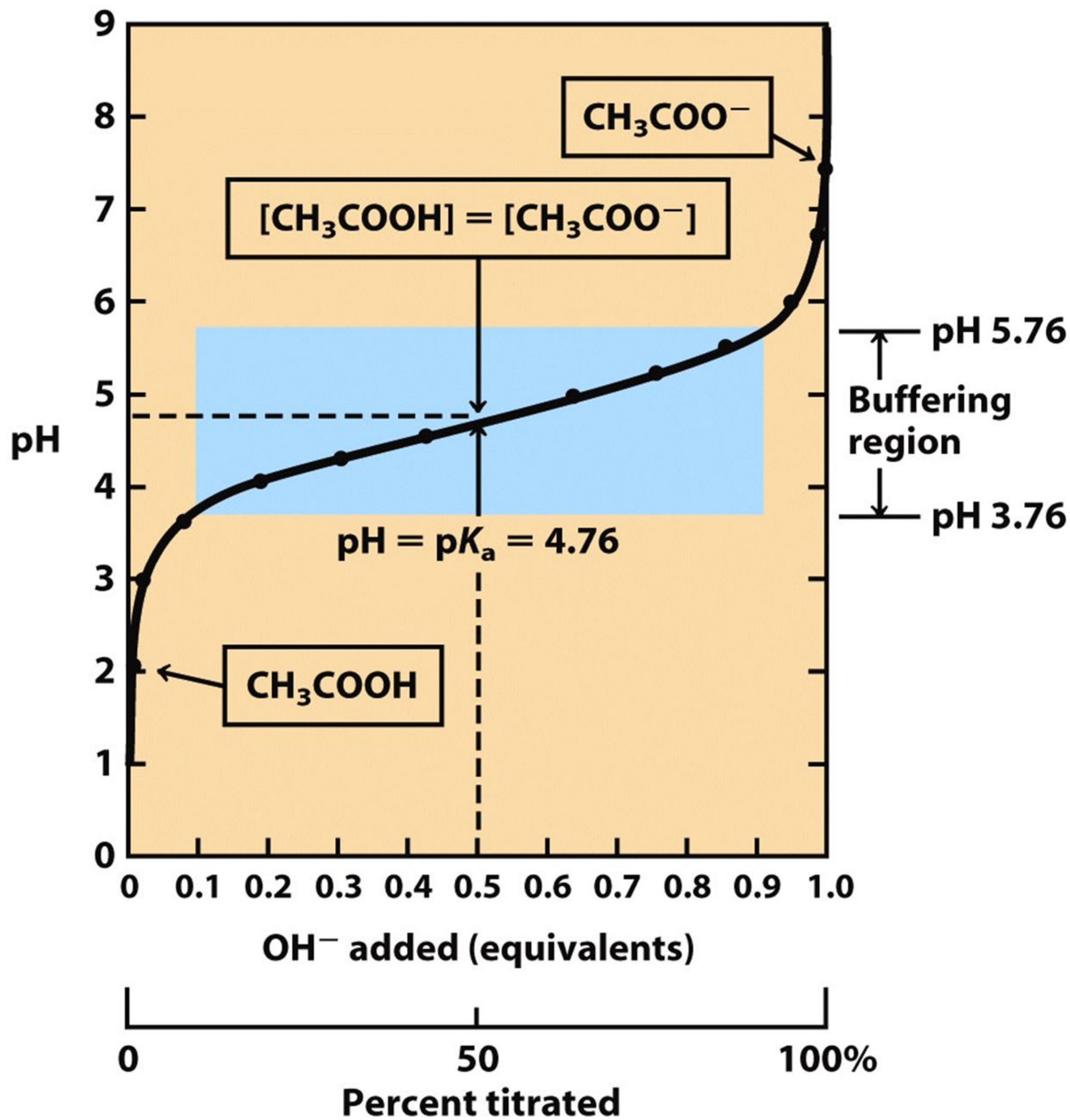
$OH^- + HA \rightarrow H_2O + A^-$

$[A^-] : [HA] = 1000 : 1$

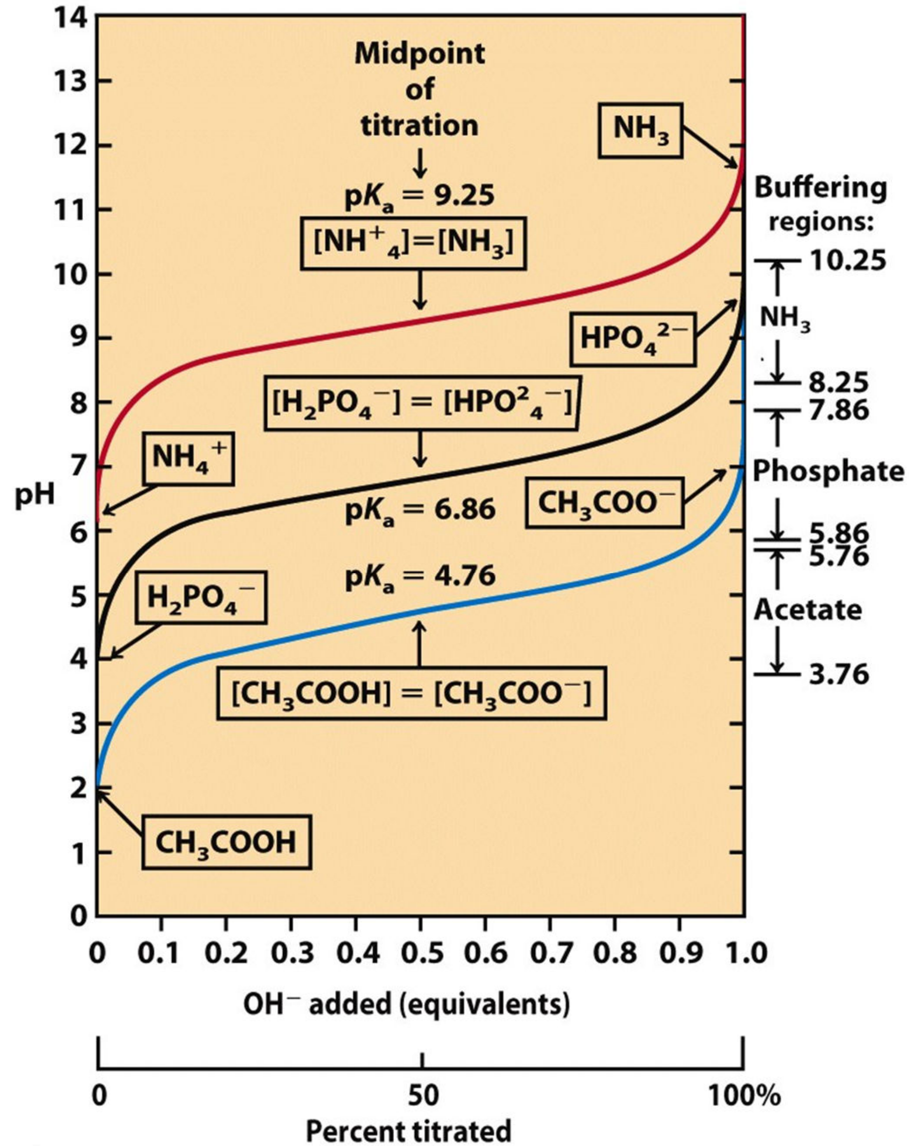
~80% of acid dissociation occurs within 1 pH unit of pKa

OH- eq. added	pH	= pKa + ___	[A-] : [HA]
0.0	1.8	-3.0	1:1000
~0.01	2.8	-2.0	1:100
0.1	3.8	-1.0	1:10
0.2	4.2	-0.6	1:4
0.3	4.4	-0.4	1:2.3
0.4	4.6	-0.2	1:1.5
0.5	4.8	0.0	1:1
0.6	5.0	0.2	1.5:1
0.7	5.2	0.4	2.3:1
0.8	5.4	0.6	4:1
0.9	5.8	1.0	10:1
~0.99	6.8	2.0	100:1
1.0	7.8	3.0	1000:1

In this buffering region (±1 pH unit of pKa), dissociation of the weak acid slows the rise in pH

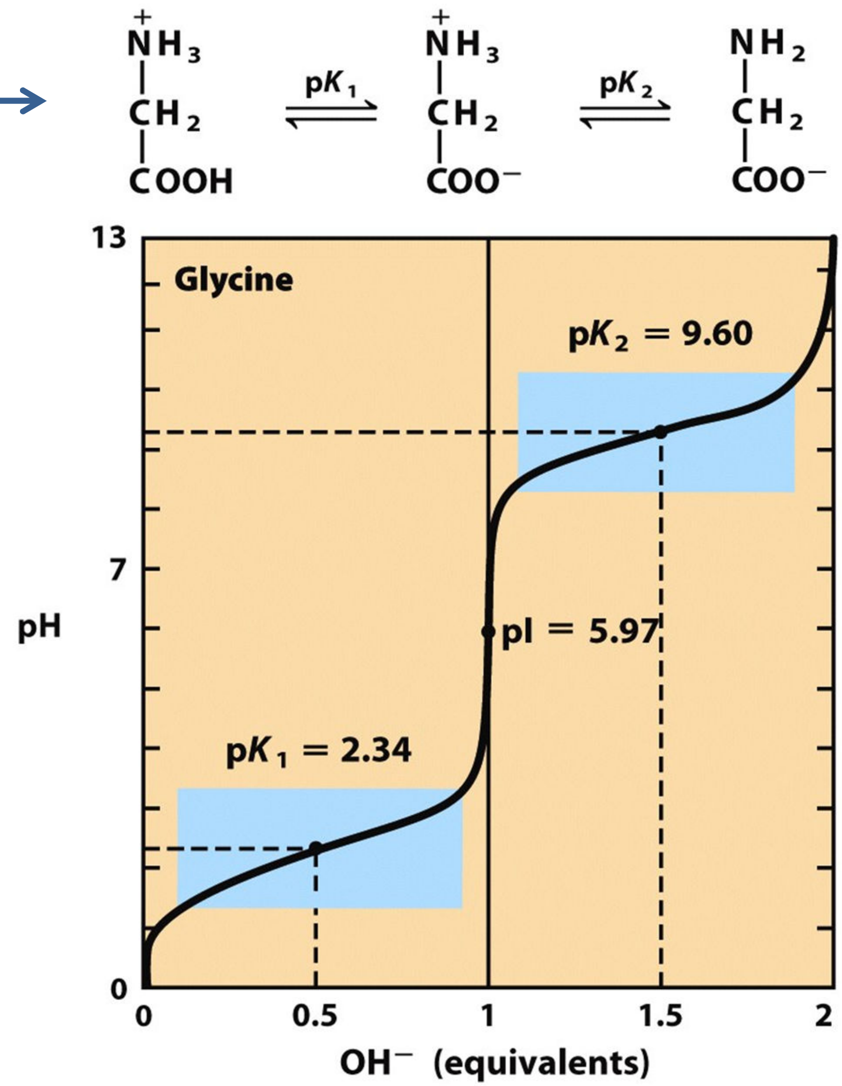


Titration of other acids gives the same curve, just shifted along the pH axis (based on pKa)



Some weak acids (like amino acids) are polyprotic and can buffer over multiple pH ranges

With 2 acidic groups, there are 3 charge states

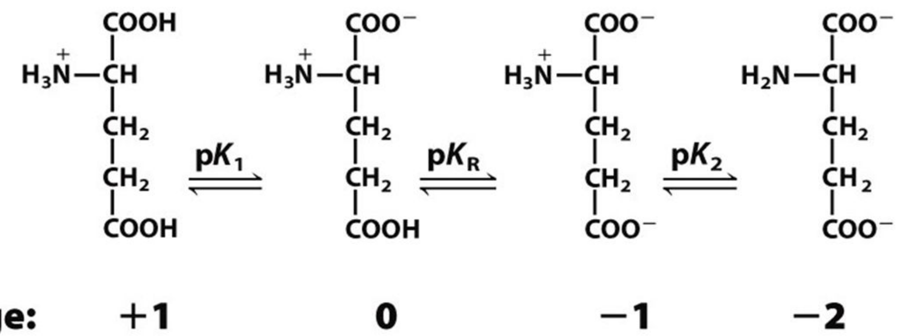


Isoelectric point (pI):
pH of highest occurrence of zero charge state
and
pH at which average charge on molecules is zero

For simple cases,
$pI = (pKa_i + pKa_j)/2$

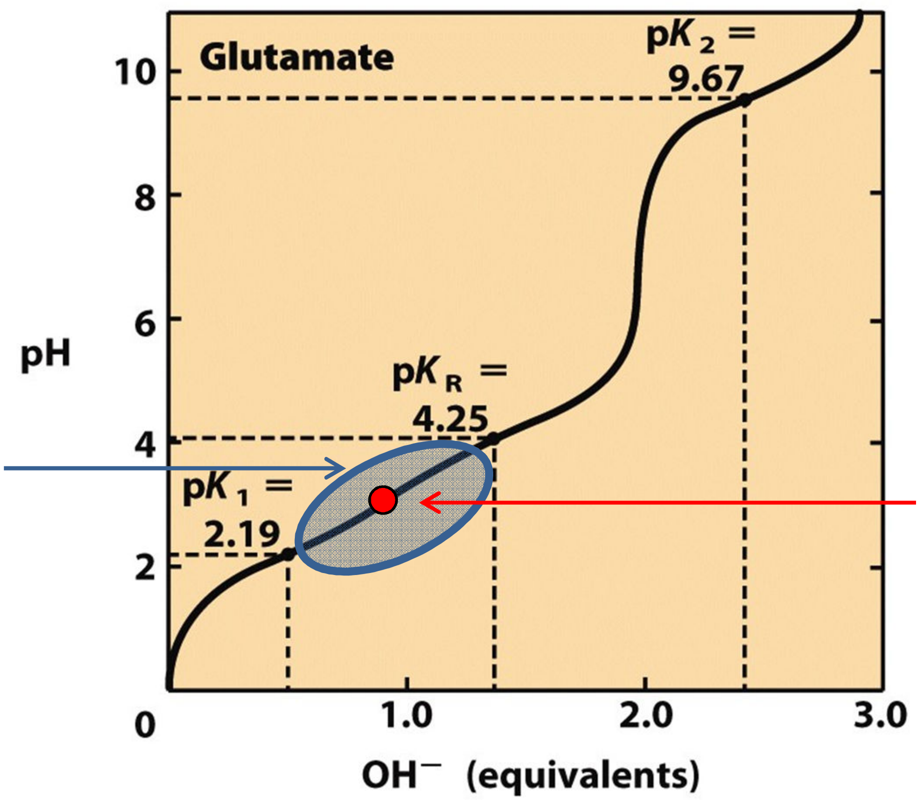
The amino acid glutamate has an acidic R group

With 3 acidic groups, there are 4 charge states



To calculate pI, use pKa's that relate to neutral charge state

Neutral charge state predominates in this region of titration



pI

$= (pK_1 + pK_R)/2$

$= 3.22$