

Weak Acid Titrated with Strong Base: HA + OH⁻ ⇌ H₂O + A⁻

Example: CH₃CO₂H + OH⁻ ⇌ H₂O + CH₃CO₂⁻

Region	Section	mol HA (weak acid)	mol OH ⁻ (strong base)	mol A ⁻ (conjugate base)	Notes
Initial Region	<i>initial</i>	1.0	0	0	
	<i>change</i>	0	0	0	
	<i>equilibrium</i>	1.0	0	0	[H ₃ O ⁺] depends only on HA
Pre-Equivalence	<i>initial</i>	1.0	0.1	0	
	<i>change</i>	-0.1	-0.1	+0.1	
	<i>equilibrium</i>	0.9	0	0.1	[H ₃ O ⁺] depends on HA and A ⁻
Half-Equivalence	<i>initial</i>	1.0	0.5	0	
	<i>change</i>	-0.5	-0.5	+0.5	
	<i>equilibrium</i>	0.5	0	0.5	[H ₃ O ⁺] depends only on K _a
Equivalence	<i>initial</i>	1.0	1.0	0	
	<i>change</i>	-1.0	-1.0	+1.0	
	<i>equilibrium</i>	0	0	1.0	[OH ⁻] depends only on A ⁻
Post-Equivalence	<i>initial</i>	1.0	2.0	0	
	<i>change</i>	-1.0	-1.0	+1.0	
	<i>equilibrium</i>	0	1.0	1.0	[OH ⁻] depends only on strong base - conjugate base A ⁻ too weak to contribute to pH

Weak Base Titrated with Strong Acid: $A^- + H_3O^+ \rightleftharpoons H_2O + HA$

Example: $NH_3 + H_3O^+ \rightleftharpoons H_2O + NH_4^+$

Region	Section	mol A^- (weak base)	mol H_3O^+ (strong acid)	mol HA (conjugate acid)	Notes
Initial Region	<i>initial</i>	1.0	0	0	
	<i>change</i>	0	0	0	
	<i>equilibrium</i>	1.0	0	0	[OH ⁻] depends only on A ⁻
Pre-Equivalence	<i>initial</i>	1.0	0.1	0	
	<i>change</i>	-0.1	-0.1	+0.1	
	<i>equilibrium</i>	0.9	0	0.1	[OH ⁻] depends on HA and A ⁻
Half-Equivalence	<i>initial</i>	1.0	0.5	0	
	<i>change</i>	-0.5	-0.5	+0.5	
	<i>equilibrium</i>	0.5	0	0.5	[OH ⁻] depends only K _b
Equivalence	<i>initial</i>	1.0	1.0	0	
	<i>change</i>	-1.0	-1.0	+1.0	
	<i>equilibrium</i>	0	0	1.0	[H ₃ O ⁺] depends only on HA
Post-Equivalence	<i>initial</i>	1.0	2.0	0	
	<i>change</i>	-1.0	-1.0	+1.0	
	<i>equilibrium</i>	0	1.0	1.0	[H ₃ O ⁺] depends only on strong acid - conjugate acid HA too weak to contribute to pH

Strong Base Titrated with Strong Acid: $\text{OH}^- + \text{H}_3\text{O}^+ \rightleftharpoons 2 \text{H}_2\text{O}$

Example: $\text{NaOH} + \text{H}_3\text{O}^+ + \text{Cl}^- \rightleftharpoons 2 \text{H}_2\text{O} + \text{NaCl}$

Region	Section	mol OH^- (strong base)	mol H_3O^+ (strong acid)	Notes
Initial Region	initial	1.0	0	
	change	0	0	
	equilibrium	1.0	0	$[\text{OH}^-]$ depends only on strong base
Pre-Equivalence	initial	1.0	0.1	
	change	-0.1	-0.1	
	equilibrium	0.9	0	$[\text{OH}^-]$ depends only on strong base
Equivalence	initial	1.0	1.0	
	change	-1.0	-1.0	No acid or base present - pH equals seven
	equilibrium	0	0	
Post-Equivalence	initial	1.0	2.0	
	change	-1.0	-1.0	
	equilibrium	0	1.0	$[\text{H}_3\text{O}^+]$ depends only on strong acid

Strong Acid Titrated with Strong Base: $\text{H}_3\text{O}^+ + \text{OH}^- \rightleftharpoons 2 \text{H}_2\text{O}$

Example: $\text{H}_3\text{O}^+ + \text{Cl}^- + \text{NaOH} \rightleftharpoons 2 \text{H}_2\text{O} + \text{NaCl}$

Region	Section	mol H_3O^+ (strong acid)	mol OH^- (strong base)	Notes
Initial Region	initial	1.0	0	
	change	0	0	
	equilibrium	1.0	0	$[\text{H}_3\text{O}^+]$ depends only on strong acid
Pre-Equivalence	initial	1.0	0.1	
	change	-0.1	-0.1	
	equilibrium	0.9	0	$[\text{H}_3\text{O}^+]$ depends only on strong acid
Equivalence	initial	1.0	1.0	
	change	-1.0	-1.0	No acid or base present - pH equals seven
	equilibrium	0	0	
Post-Equivalence	initial	1.0	2.0	
	change	-1.0	-1.0	
	equilibrium	0	1.0	$[\text{OH}^-]$ depends only on strong base

