Titration of WEAK BASE with STRONG ACID

Think first of major species in solution
→ decide which rxn runs to completion → do stoichiometry
Decide which equilibrium is dominant → calculate pH

Ex: **100.0 ml of 0.050 M NH_3 was titrated with 0.10 M HCl**

a) Determine the pH at the half-way point of the titration.
b) Calculate the pH at the equivalence point.

100.0 ml 0.050 M NH_3 $\quad (100.0\text{ ml})(0.050\text{ M}) = 5.0\text{ mmol}$

0.10 M HCl

$NH_3 + H^+ \rightarrow NH_4^+$

1/2 way = 2.5 mmol

	NH_3	H^+	NH_4^+
I	5.0 mmol	2.5 mmol	0
C	−2.5 mmol	−2.5 mmol	+2.5 mmol
F	2.5 mmol / 125.0 ml = 0.020 M	0	2.5 mmol / 125.1 ml = 0.020 M

$(\text{Vol HCl})(0.10\text{ M HCl}) = 2.5\text{ mmol}$

Vol HCl = 25.0 ml

Vol soln = 125.0 ml

½ way → $pOH = pK_b = 1.8\times10^{-5}$

$pOH = 4.74 \quad \therefore pH = 9.26$

b) All eq. px!

$(\text{V.I HCl})(0.10\text{ M HCl}) = 5.0\text{ mmol}$
$= 50.0\text{ ml}$

$NH_3 + H^+ \rightarrow NH_4^+$

	NH_3	H^+	NH_4^+
I	5.0 mmol	5.0 mmol	0
C	−5.0	−5.0	+5.0
F	0	0	$\frac{5.0\text{ mmol}}{150\text{ ml}} = 0.033\text{ M } NH_4^+$

$NH_4^+ + H_2O \rightleftharpoons H^+ + NH_3$

	NH_4^+	H^+	NH_3
I	0.033 M	0	0
C	−x	−x	−x
E	0.033 M − x	x	x

$K_a = \frac{K_w}{K_b} = \frac{1\times10^{-14}}{1.8\times10^{-5}} = 5.6\times10^{-10} = \frac{x^2}{(0.033 - x)}$

$4.3\times10^{-6} = x = [H^+]$

$pH = 5.37$

c) pH with addition of 55.0 ml 0.10 M HCl

Will be acidic!

Titration of WEAK BASE with STRONG ACID

Think first of major species in solution
→ decide which rxn runs to completion → do stoichiometry
Decide which equilibrium is dominant → calculate pH

Ex: **100.0 ml of 0.050 M NH_3 was titrated with 0.10 M HCl**

a) Determine the pH at the half-way point of the titration.
b) Calculate the pH at the equivalence point.

A summary of the important curves

The way you normally carry out a titration involves adding the acid to the alkali. Here are reduced versions of the graphs described above so that you can see them all together.