(STRONG ACID $\bar{w}$ STRONG BASE)

Calc. pH when a) 40.0 mL and b) 49.0 mL and c) 49.95 mL of 0.100 M NaOH have been added to 50 mL of 0.100 M HCl soln

$$\text{Initial pH} = -\log(0.100) \boxed{= 1.00}$$

a) 40 mL of NaOH

$(0.050\,L)(0.100) = 0.0050$ moles H^+

$(0.04\,L)(0.100) = 0.0040$ mol OH^-

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

	H^+	OH^-
I	0.0050	0.0040
C	-0.0040	-0.0040
E	0.0010 mol	0

$$pH = -\log[H^+]$$

$$= -\log\left(\frac{0.0010\ \text{mol}}{(0.05 + 0.04)}\right) \boxed{= 1.95}$$

b) 49.0 mL of NaOH

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

	H^+	OH^-
	0.0050	0.0049
	−0.0049	−0.0049
	0.0001 mol	0

$(0.049\ L)(0.100\ M) = 0.0049$ mol OH^-

$$[H^+] = \frac{0.0001 \text{ mol } H^+}{0.099\ L}$$

$$pH = -\log(\ ) \boxed{= 3.0}$$

c) 49.9 mL OH^-

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

H^+	OH^-
0.0050	+ 0.00499
− 0.00499	− 0.00499
0.00001	0

$(0.0499 L)(0.100 M) = 0.00499$ mol OH^-

$$[H^+] = \frac{0.00001 \text{ mol } H^+}{0.0999 L} = 1.0\times10^{-4}$$

$$pH = -\log(\underbrace{\quad}) \boxed{= 4.0}$$

mL OH	pH
0	1.00
40	1.95
49	3.0
49.9	4.0

+40

+9

+0.9

pH getting more sensitive to [OH⁻]

@ equivalence point, mol H^+ = mol OH^-

What about pH when you've passed equivalence point?

Continuing w̄ our HCl and NaOH example above:

d) 51 mL NaOH

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

H^+	OH^-
0.0050	0.0051
− 0.0050	− 0.0050
0	0.0001 mol

Note that OH^- is no longer the limiting reactant. Now H^+ is limiting becuz there is less of it

$$[OH^-] = \frac{0.0001 \text{ mol}}{0.101 \text{ L}} = 0.0010 \text{ M}$$

$$pOH = -\log(0.0010 \text{ M}) = 3.0$$

$$pH = 14 - 3.0 \boxed{= 11}$$

BEFORE EQUIVALENCE POINT

$$[H^+] = \frac{\text{mol } H^+ - \text{mol } OH^-}{\text{total volume}}$$

AFTER EQUIVALENCE POINT

$$[H^+] = \frac{\text{mol } OH^- - \text{mol } H^+}{\text{total volume}}$$

What about titration of Weak Acid + Strong Base

($K_a = 1.8\times10^{-5}$)

50mL of 0.100M acetic acid titrated $\bar{w}$ 0.100M NaOH

Calc. pH @ initial, 20mL, 50mL, after 50mL

<u>Initial</u>

$$HCH_3COO \rightleftharpoons H^+ + CH_3COO^-$$

HCH_3COO	H^+	CH_3COO^-
0.100	0	0
$-x$	$+x$	$+x$
$0.100-x$	x	x

$$1.8\times10^{-5} = K_a = \frac{[H^+][CH_3COO^-]}{[HCH_3COO]} = \frac{x^2}{0.100-x} = \frac{x^2}{0.100}$$

$$x^2 = 1.8\times10^{-6}$$

$$x = 0.00134M = [H^+]$$

$$pH = -\log([H^+]) \boxed{= 2.87}$$

20 mL of NaOH

$$HCH_3COO + OH^- \rightleftharpoons CH_3COO^- + H_2O$$

	HCH_3COO	OH^-	CH_3COO^-
	0.0050	0.0020	
	−0.0020	−0.0020	+0.0020
	0.0030 mol	0	0.0020 mol

} Note that this is a **BUFFER SOLN**

HCH_3COO:

$(0.050\,L)(0.100\,M) = 0.0050\,mol$

NaOH:

$(0.020\,L)(0.100\,M) = 0.0020\,ml$

Henderson Hasselbalch Equation (being it's a buffer!) →

$$pH = pK_a + \log\frac{[A^-]}{[HA]}$$

$$= \left(-\log(1.8\times10^{-5})\right) + \log\frac{(0.0020)}{(0.0030)}$$

$$\boxed{pH = 4.92}$$