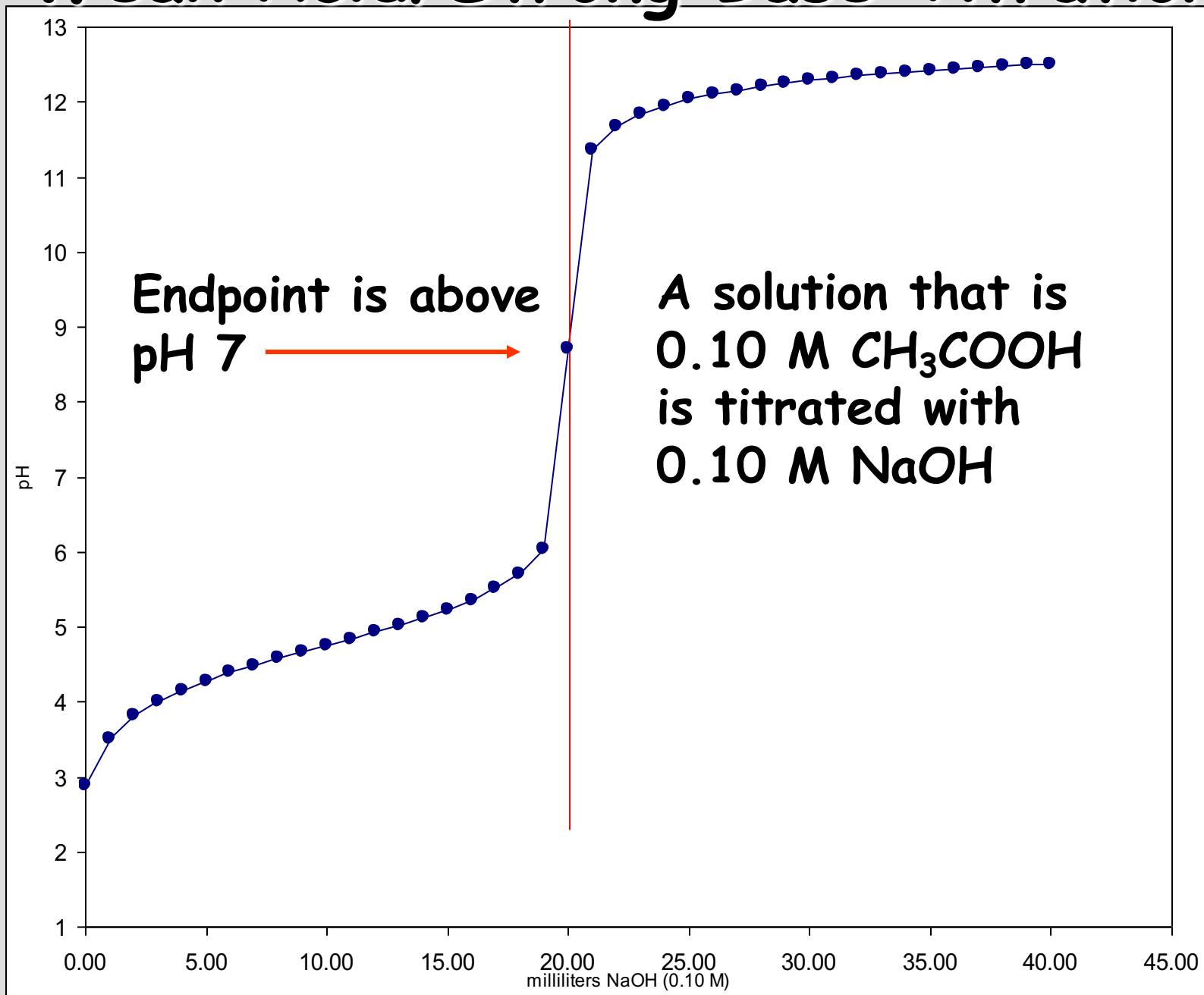


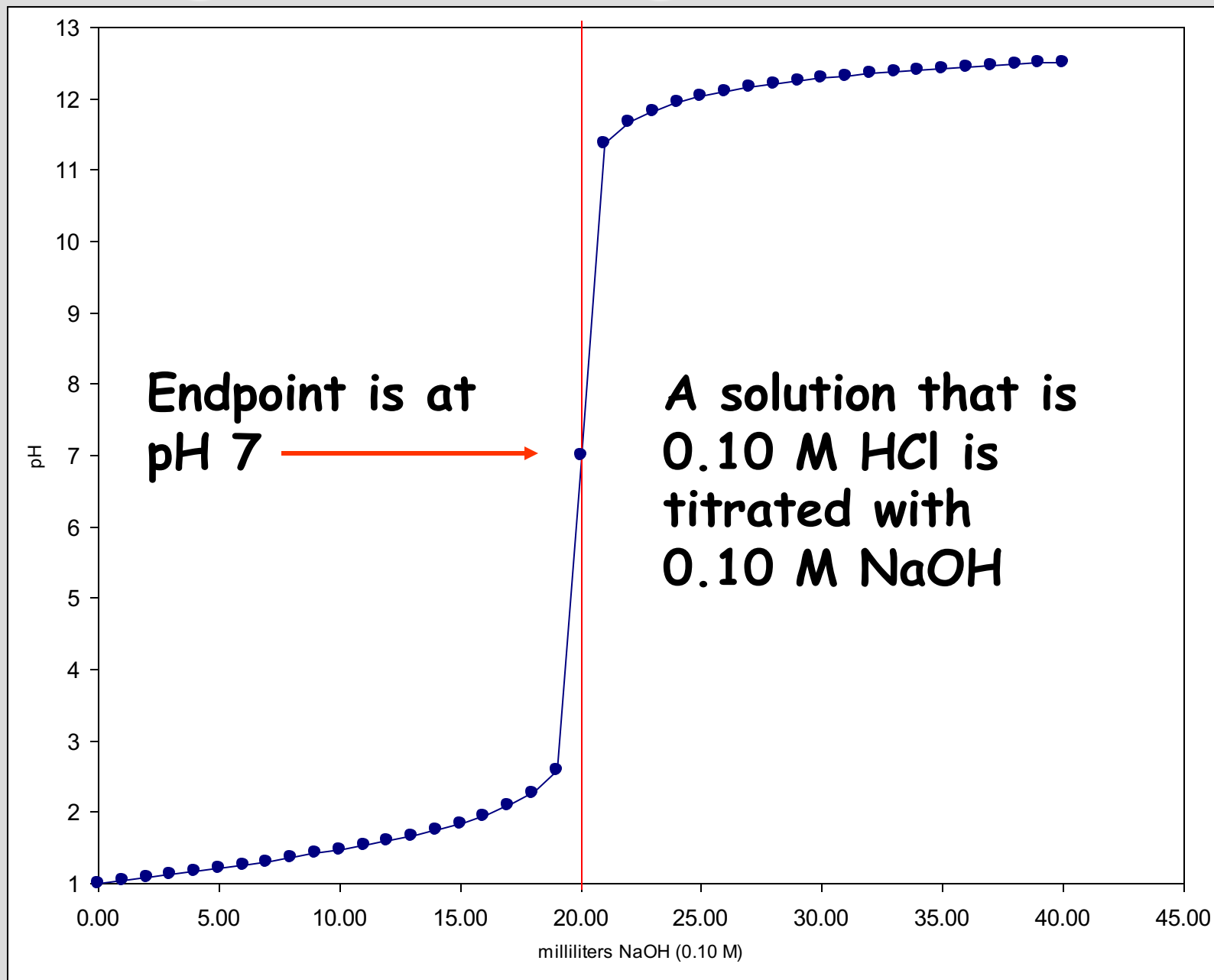
Applications of Aqueous Equilibria

*****Titration*****

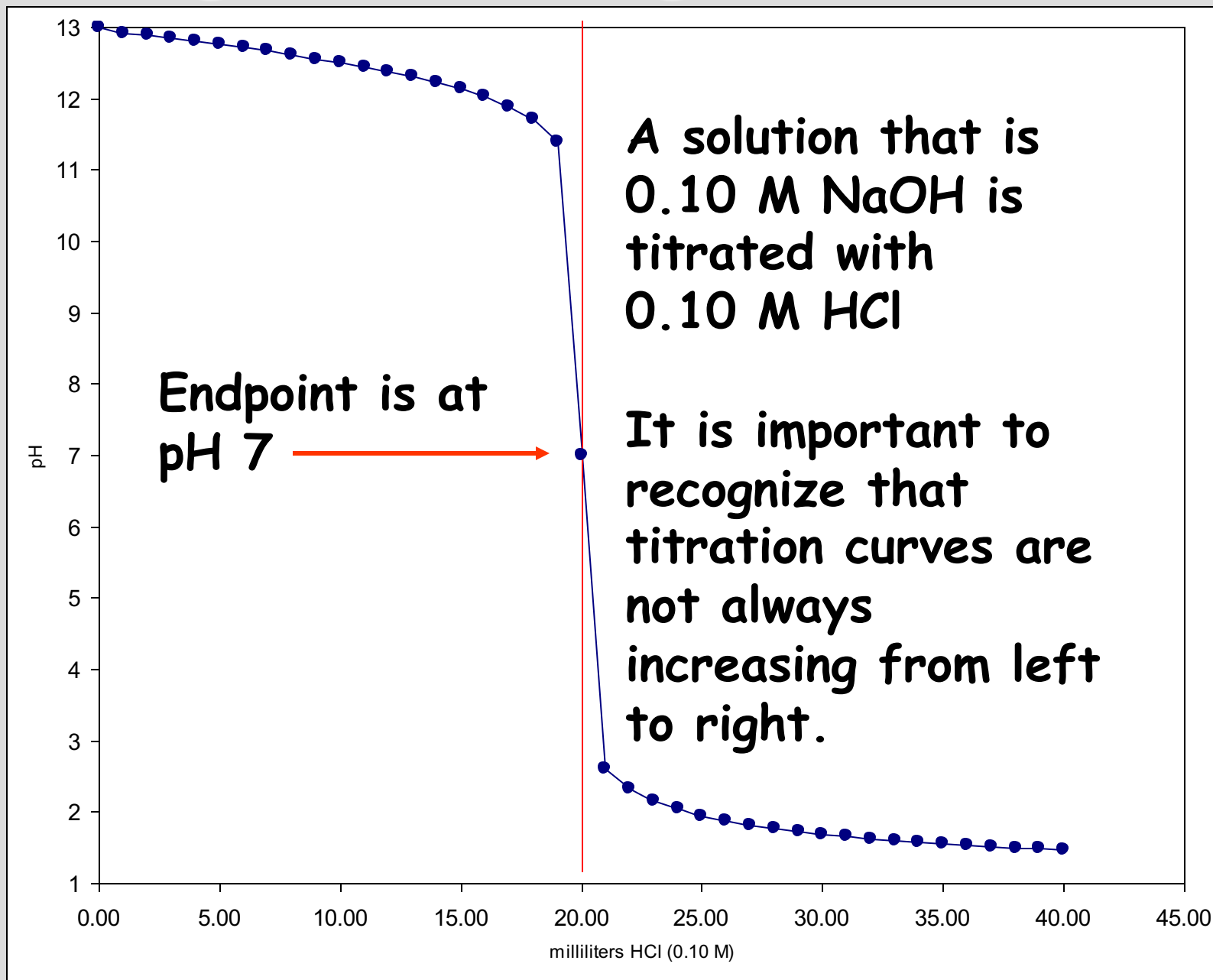
Weak Acid/Strong Base Titration



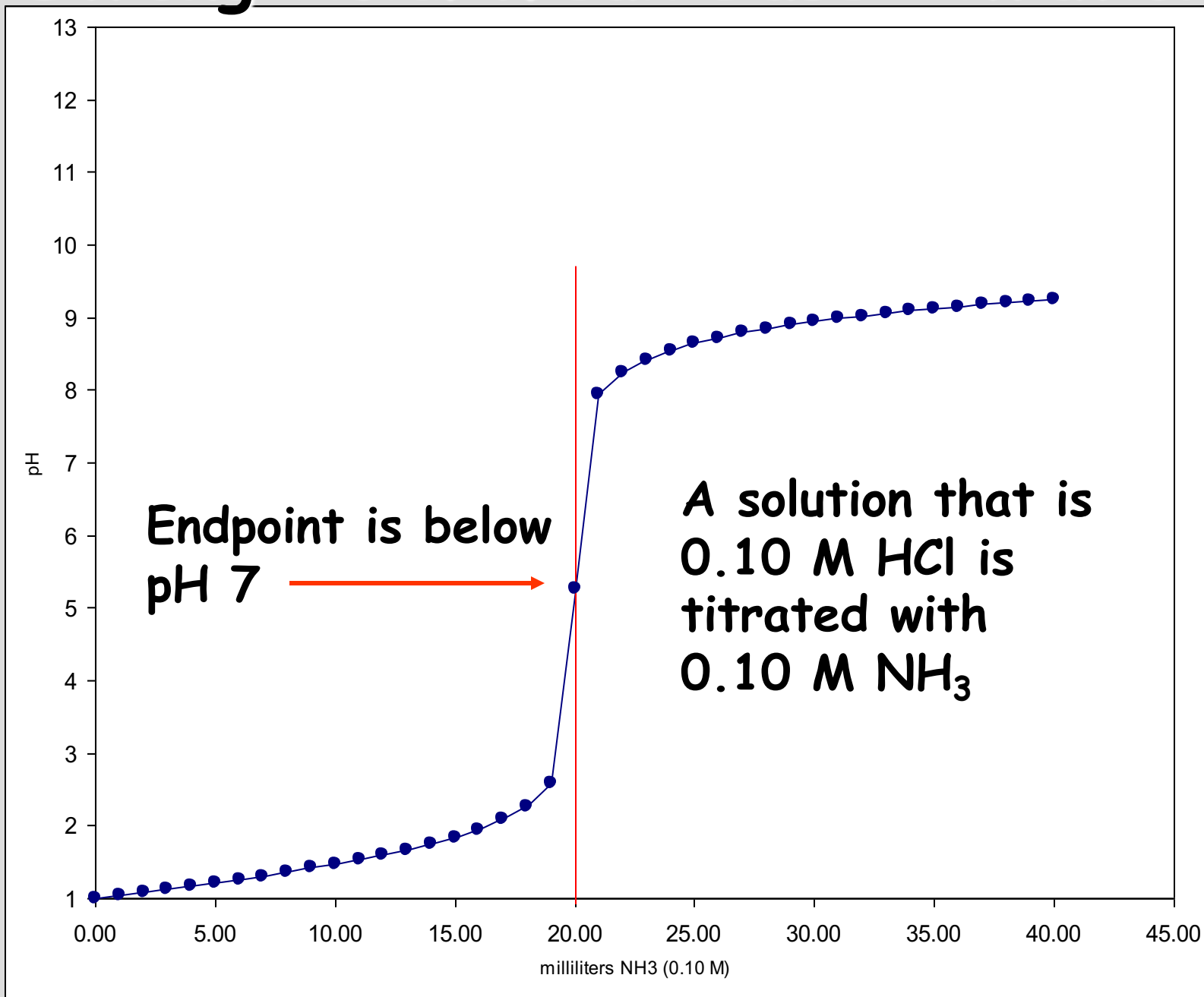
Strong Acid/Strong Base Titration



Strong Acid/Strong Base Titration



Strong Acid/Weak Base Titration



Titration Calcs...

- Lets look at the titration of acetic acid w/ NaOH

- Starting point:

- 25 ml of 0.15M Acetic Acid ($K_a = 1.8E^{-5}$)

- Calculate pH before any titrant is added

- 2.78

- Add 10ml of .1M NaOH

- Determine stoichiometry

- Notice! You have a buffer now. Use HH equ.

C ₂ H ₃ OH	OH ⁻ ↔ H ₂ O	C ₂ H ₃ O ⁻
3.75 mmol	1 mmol	0
2.75 mmol	0 mmol	1 mmol

$$pH = -\log(1.8E-5) + \log\left(\frac{0.0286M}{0.0786M}\right) = 4.31$$

Titration continued...

- Add 25ml of 0.1M NaOH
 - Still a buffer...use HH

$\text{C}_2\text{H}_3\text{OH}$	$\text{OH}^- \leftrightarrow \text{H}_2\text{O}$	$\text{C}_2\text{H}_3\text{O}^-$
3.75 mmol	2.5 mmol	0
1.25 mmol	0 mmol	2.5 mmol

$$\text{pH} = -\log(1.8 \times 10^{-5}) + \log\left(\frac{0.05\text{M}}{0.025\text{M}}\right) = 5.05$$

- Add 37.5ml of 0.1M NaOH
 - Problem! No more buffer
 - Equivalent pt!!
 - What Next? Reverse the Rx. Solve

$\text{C}_2\text{H}_3\text{OH}$	$\text{OH}^- \leftrightarrow \text{H}_2\text{O}$	$\text{C}_2\text{H}_3\text{O}^-$
3.75 mmol	3.75 mmol	0
0 mmol	0 mmol	3.75 mmol

- H_2O source of H^+
- What is Reacting?
- Must use K_b , solve for

$\text{C}_2\text{H}_3\text{O}^-$	$\text{H}_2\text{O} \leftrightarrow \text{C}_2\text{H}_3\text{OH}$	OH^-
3.75 mmol	3.75	0

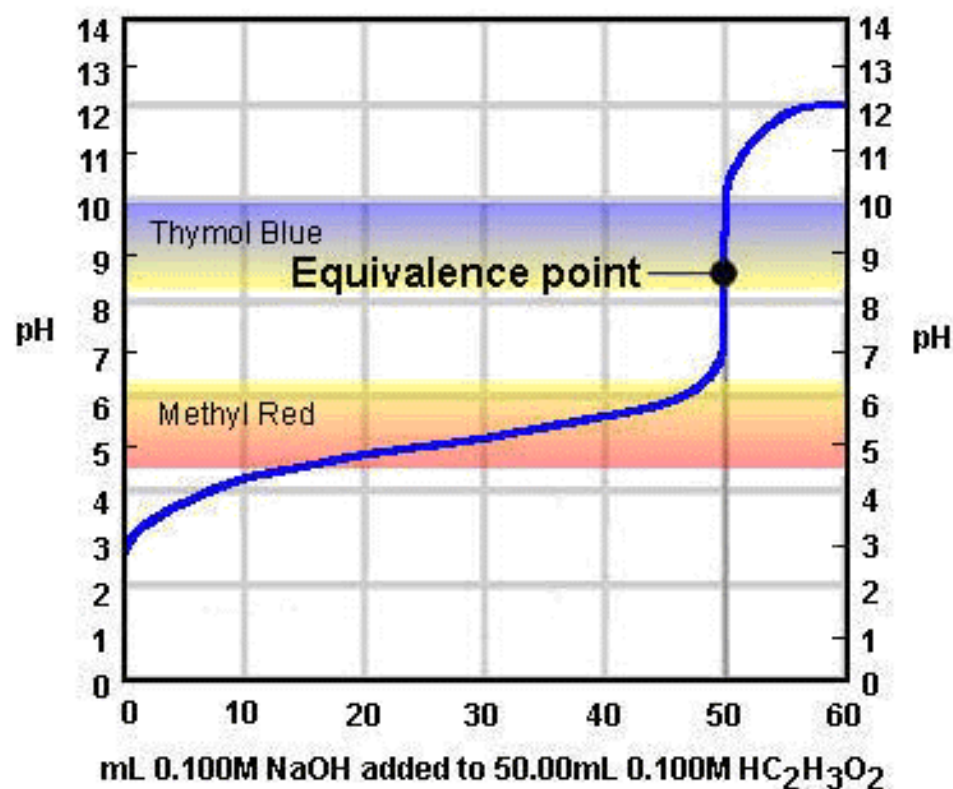
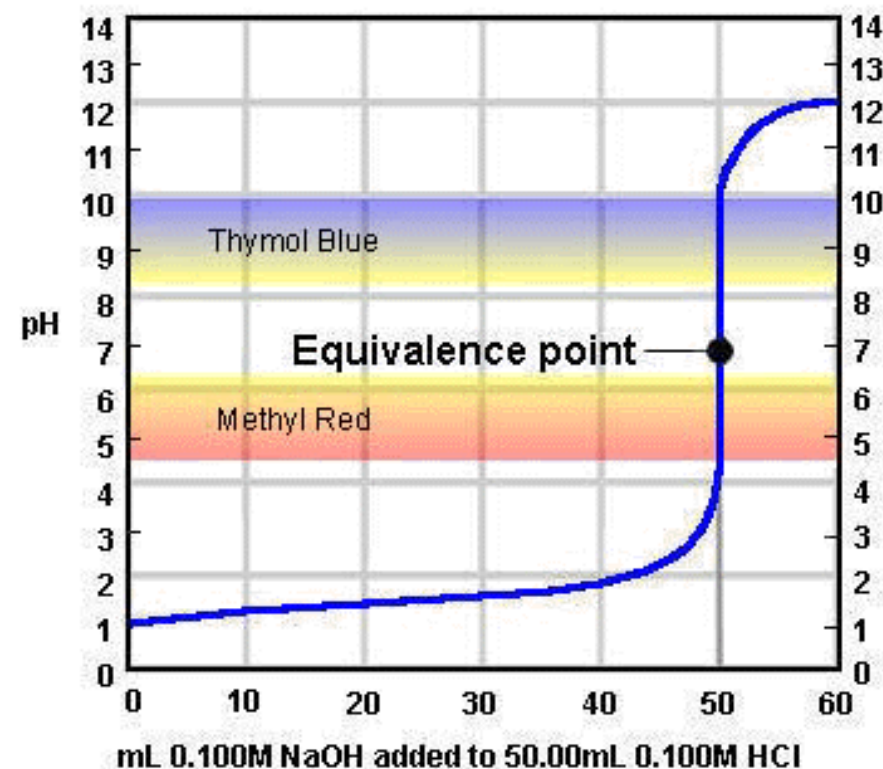
Titration continued...

- Add 50ml of 0.1M NaOH
 - Still no buffer...but...
 - Excess OH⁻

C ₂ H ₃ OH	OH ⁻ ↔ H ₂ O	C ₂ H ₃ O ⁻
3.75 mmol	5 mmol	0
0 mmol	1.25 mmol	3.75 mmol

$$pOH = -\log\left(\frac{1.25\text{mmolOH}^-}{75\text{ml}}\right) = 1.78; pH = 12.22$$

Selection of Indicators



Some Acid-Base Indicators

Indicator	pH Range in which Color Change Occurs	Color Change as pH Increases
Crystal violet	0.0 - 1.6	yellow to blue
Thymol blue	1.2 - 2.8	red to yellow
Orange IV	1.4 - 2.8	red to yellow
Methyl orange	3.2 - 4.4	red to yellow
Bromcresol green	3.8 - 5.4	yellow to blue
Methyl red	4.8 - 6.2	red to yellow
Chlorophenol red	5.2 - 6.8	yellow to red
Bromthymol blue	6.0 - 7.6	yellow to blue
Phenol red	6.6 - 8.0	yellow to red
Neutral red	6.8 - 8.0	red to amber
Thymol blue	8.0 - 9.6	yellow to blue
Phenolphthalein	8.2 - 10.0	colourless to pink
Thymolphthalein	9.4 - 10.6	colourless to blue
Alizarin yellow	10.1 - 12.0	yellow to blue
Indigo carmine	11.4 - 13.0	blue to yellow

pH Range	Color	Name
0.1-1.8		Crystal Violet
1.0-2.0		Cresol Red
1.2-2.8		Thymol Blue
2.7-4.0		2,4-Dinitrophenol
3.0-4.6		Bromophenol Blue
3.1-4.4		Methyl Orange
3.8-5.4		Bromocresol Green
4.2-6.3		Methyl Red
5.0-6.4		Eriochrome Black T
5.2-6.8		Bromocresol Purple
6.2-7.6		Bromothymol Blue
6.8-8.4		Phenol Red
6.8-8.6		m-Nitrophenol
8.3-10.0		Phenolphthalein
9.3-10.5		Thymolphthalein

pH Indicators and their ranges