Write an acid/base reaction and label its parts.

Write the dissociation for HF and label the acid, base, conjugate acid, and conjugate base.

Convert between molarity, pH, and pOH

Find the pH of a 0.045 M solution of $Al(OH)_3$

Find the molarity of a solution of KOH with a pH of 12.3

Find the pOH of a 0.02 M solution of HNO_3

Use Ka or Kb to find equilibrium concentrations

What is the original molarity of a solution of formic acid (HCOOH) whose pH is 3.26 at equilibrium?

Find pH given Ka or Kb

Find the pH of a 0.20 M solution of benzoic acid, C_6H_5COOH, $Ka=6.46 \times 10^{-5}$

Aspirin is a weak organic acid whose molecular formula is $HC_9H_7O_4$. A water solution of aspirin is prepared by dissolving 3.60 g in one liter. The pH of this solution is 2.60. Calculate Ka for aspirin.

Calculate the pH of a 0.10 M NaF solution ($KbF=1.4 \times 10^{-11}$)

Identify the parts of a buffer

Can NH_4Cl and NH_3 form a buffer?

Use Henderson-Hasselbalch to find pH of a buffer

Find the pH of a buffer system that is 0.15 M NH_3/0.35 M NH_4Cl. Kb for NH_3 is 1.8×10^{-8}

Chang #20

Calculate the pH change when acid or base is added to a buffer

#12 in supplemental

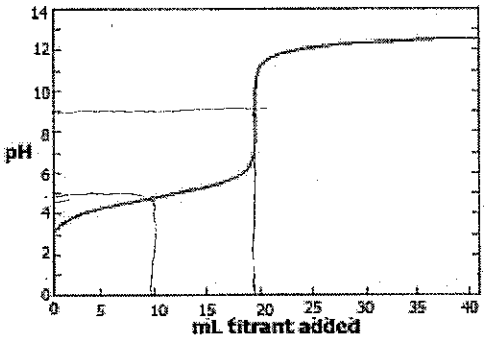
Chang #17

Select an appropriate indicator for a titration

Chang #39

Find the equivalence point of a titration curve

Determine pKa, Ka, and identify an acid from a list given a titration curve



What is the equivalence point for the titration on the left?

What is the pKa of the acid in the titration?

What is the Ka of the acid in the titration?

How would you select an indicator to signal the end of this titration?

A 0.2688 g sample of a monoprotic acid neutralizes 16.4 mL of 0.08133 M KOH. Calculate the molar mass of the acid.

A 10.0 mL solution of 0.300 M NH_3 is titrated with a 0.100 M HCl solution. Calculate the pH after the following additions of the HCl solution: a) 0.0 mL, b)10.0 mL, c)20.0 mL, d)30.0 mL, e)40.0 mL.

Calculate the pH at the equivalence point for the following titration: 0.10 M HCOOH vs 0.10 M NaOH.

1) equivalence point = 9

2) pKa = pH at 1/2 eq.p. = 4.7

3) $pKa = -\log(Ka)$

$4.7 = -\log Ka$

$Ka = 2.0 \times 10^{-5}$

4) Select an indicator that changes color between pH=8 and pH=10

5) moles of base neutralized = moles of acid

$.0164 \times .08133 = 0.0013$

$\text{molar mass} = \frac{g}{mol} = \frac{0.2688}{.0013} = 206.8\ g/mol$

6) see Chang 33 that we did in class.

7) neutralization: $HCOOH + OH^- \rightarrow COOH^- + H_2O$

Assume 1 L

	HCOOH	OH^-	$COOH^-$
I	.1	.1	0
C	-.1	-.1	+.1
E	0	0	+.1

Now calculate the pH resulting from $COOH^-$ reacting with water

$\frac{.1\ mol}{2\ L} = .05\ M$

	$COOH^-$	$+ H_2O \rightleftharpoons$	OH^-	$+ HCOOH$
I	.05		0	0
C	-x		+x	+x
E	.05-x		x	x

look up

$K_b = 5.9 \times 10^{-11} = \frac{x^2}{.05}$

$x = 1.72E-6$

$pOH = -\log(1.72E-6)$

$pOH = 5.77$

$pH = 14 - 5.77$

$\boxed{pH = 8.23}$

Chang #17

- For the 1st part, use K_a for NH_4^+

$$pH = -\log(5.6\times10^{-10}) + \log\left(\frac{.2}{.2}\right) = \boxed{9.25}$$

- For the second part, the neutralization rxn is

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

moles HCl added: $10\,mL \times \frac{0.1\,mol}{1000\,mL} = 0.001\,mol\,HCl$

moles NH_3 & NH_4^+ present:

$$65\,mL \times \frac{.2\,mol}{1000\,mL} = 0.013\,mol\,NH_3\ \&\ NH_4^+$$

Neutralize the acid:

	NH_3	+ H^+	$\rightarrow$ NH_4^+
I	0.013	0.001	.013
C	-.001	-.001	+.001
E	0.012	0	0.014

*all the acid has been neutralized and a buffer w/ new concentration remains.

$$pH = 9.25 + \log\left(\frac{0.012}{0.014}\right) = \boxed{9.18}$$

Chang #39

pKa of the buffer should be close to the pH at the end point

a) cresol red & phenolphthalien (end point will be basic)

b) All except thymol blue, bromophenol blue, and methyl orange (end point will be pH=7)

c) bromophenol blue, methyl orange, methyl red, and chlorophenol blue (endpoint will be acidic)

Chang #20 - In an ideal buffer, $[HA] \approx [A^-]$

$$pH = pK_a + \log\left(\frac{A^-}{A}\right) \rightarrow 0$$

so choose the buffer system where the pH is closest to the pK_a

$HA \rightarrow pK_a = 2.57$

$HB \rightarrow pK_a = 5.36$

$HC \rightarrow pK_a = 8.59$

choose HC because pKa is closest to pH=8.6.

Supplemental 12 - strong acid / strong base

a) $M_A V_A = M_B V_B$

$.05(1) = (.7450)(V)$

$V_{NaOH} = 67.11\ mL$

b) 0.04998 mol acid neutralized

$$\frac{0.00002 \text{ mol HA left}}{0.05 + 0.06709 \text{ total volume}} = 1.71 \times 10^{-4}$$

$pH = -\log(1.71 \times 10^{-4})$

$pH = 3.77$

c) $$0.00002\ L \times \frac{.7450\ mol}{L} = \frac{1.49 \times 10^{-5} \text{ mol base leftover}}{.050 + 0.06713 \text{ total volume}}$$

$= 1.272 \times 10^{-4}\ M$

$pOH = -\log(1.272 \times 10^{-4})$

$= 3.90$

$pH = 14 - 3.90$

$pH = 10.10$

8) $F^- + H_2O \rightleftharpoons OH^- + HF$

	F^-	OH^-	HF
I	.1	0	0
C	-x	+x	+x
E	.1-x	x	x

$$K_b = \frac{x^2}{.1-x}$$

assume x is small

$$1.4 \times 10^{-11} = \frac{x^2}{.1}$$

$$x = 1.18E-6$$

assumption valid

$$[OH^-] = 1.18E-6$$

$$pOH = -\log(1.18E-6)$$

$$pOH = 5.93$$

$$pH = 14 - 5.93$$

$$pH = 8.07$$

9) NH_4Cl and NH_3 can form a buffer because it is a weak base (NH_3) and the salt of its conjugate acid (NH_4Cl)

10) $$K_a = \frac{K_w}{K_b}$$

$$K_a = \frac{1.E-14}{1.8E-8} = 5.56E-7$$

$$pH = pKa + \log \frac{NH_3}{NH_4^+}$$

$$pH = -\log(5.56E-7) + \log\left(\frac{.15}{.35}\right)$$

$$pH = 5.89$$

6) $C_6H_5COOH + H_2O \rightleftharpoons C_6H_5COO^- + H_3O^+$

I	0.2	0	0
C	$-x$	$+x$	$+x$
E	$0.2-x$	x	x

$$K_a = 6.46\times10^{-5} = \frac{x^2}{0.2-x}$$

assume x is small

$$6.46\times10^{-5} = \frac{x^2}{0.2}$$

$$x = 0.0036$$

check assumption

$$\frac{0.0036}{.2} = 1.8\%$$

assumption valid

$$[H_3O^+] = .0036$$

$$pH = -\log(.0036)$$

$$pH = 2.44$$

7) Find molarity: $3.6g \times \frac{1mol}{180g} = \frac{0.02\ mol}{1L}$

$HC_4H_7O_4 + H_2O \rightleftharpoons C_4H_7O_4^- + H_3O^+$

	.02	0	0
	$-x$	x	x
	$.02-x$	x	x
	-0.0025	0.0025	0.0025
	0.0175		

$$pH = 2.6$$

$$10^{2.6} = 10^{-\log(x)}$$

$$x = 0.0025$$

$$K_a = \frac{(.0025)^2}{0.0175}$$

$$K_a = 3.57\times10^{-4}$$

1) $HF + H_2O \rightleftharpoons H_3O^+ + F^-$

2) $[OH^-] = 3 \times .045$

$pOH = -\log(.1350)$

$pOH = 0.8697$

$pH = 14 - 0.8697$

$pH = 13.13$

3) $pOH = 14 - 12.3$

$pOH = 1.7$

$pOH = -\log[OH^-]$

$-1.7 = \log[OH^-]$

$10 \qquad 10$

$[OH^-] = 0.020\ M$

4) $pH = -\log(.02)$

$pH = 1.7$

$pOH = 14 - 1.7$

$pOH = 12.3$

5) $HCOOH + H_2O \rightleftharpoons HCOO^- + H_3O^+$

I	X		0	0
C	-5.4954E-4		+	+
E	X-small		5.4954E-4	5.4954E-4

$K_a = 1.7E-4 = \frac{(5.4954E-4)^2}{X}$

look up

$X = \frac{(5.4954 \times 10^{-4})^2}{1.7E-4}$

$X = 0.0018\ M$