Strong acid-base titrations

If it takes 54.0 mL of 0.1 M NaOH to neutralize 125.0 mL of an HCl solution. What is the concentration of the HCl?

Strong acid-base titrations

What is the pH of the final solution where 30.0 mL of 0.1 M NaOH is mixed with 18.0 mL of 0.5 M HCl?

What is a buffer?

- A buffer is an aqueous solution which resists pH changes
- A buffer composed of a weak acid and its conjugate base OR a weak base and its conjugate acid

KEY QUESTIONS!

1) Why do conjugate acid base pairs matter in buffers?
2) Why are buffers made of ONLY weak acid/bases, and NOT strong?

- Let's review conjugate acid-base pairs!

Find the conjugate pairs

$CH_3COOH_{(aq)} + H_2O_{(l)} \leftrightarrow CH_3COO^-_{(aq)} + H_3O^+_{(aq)}$

acid conjugate base

Write the eq'm expression:

$CH_3COO^-_{(aq)} + H_2O_{(l)} \leftrightarrow CH_3COOH_{(aq)} + OH^-_{(aq)}$

base conjugate acid

Write the eq'm expression:

Try $\mathbf{K_a}$ **x** $\mathbf{K_b}$**,**

if it equals K_w then we have a buffer!

Is it a buffer?

$H_2CO_3 + H_2O_{(l)} \leftrightarrow HCO_3^-{}_{(aq)} + H_3O^+{}_{(aq)}$

acid conjugate base

How do buffers resist changes in pH?

Let's use our acetic acid–acetate example:

$$CH_3COOH_{(aq)} + H_2O_{(l)} \leftrightarrow CH_3COO^-_{(aq)} + H_3O^+_{(aq)}$$

What happens if we add a base (OH^-)?

Normally, the pH would increase.

$$CH_3COOH_{(aq)} + OH^-_{(aq)} \leftrightarrow CH_3COO^-_{(aq)} + H_2O_{(l)}$$

But with a buffer, we have water being formed! So very little change in pH!

BUFFERING REGION

Le Châtelier's Principle!

$CH_3COOH_{(aq)} + OH^-_{(aq)} \leftrightarrow CH_3COO^-_{(aq)} + H_2O_{(l)}$

What happens as we increase $[OH^-_{(aq)}]$?

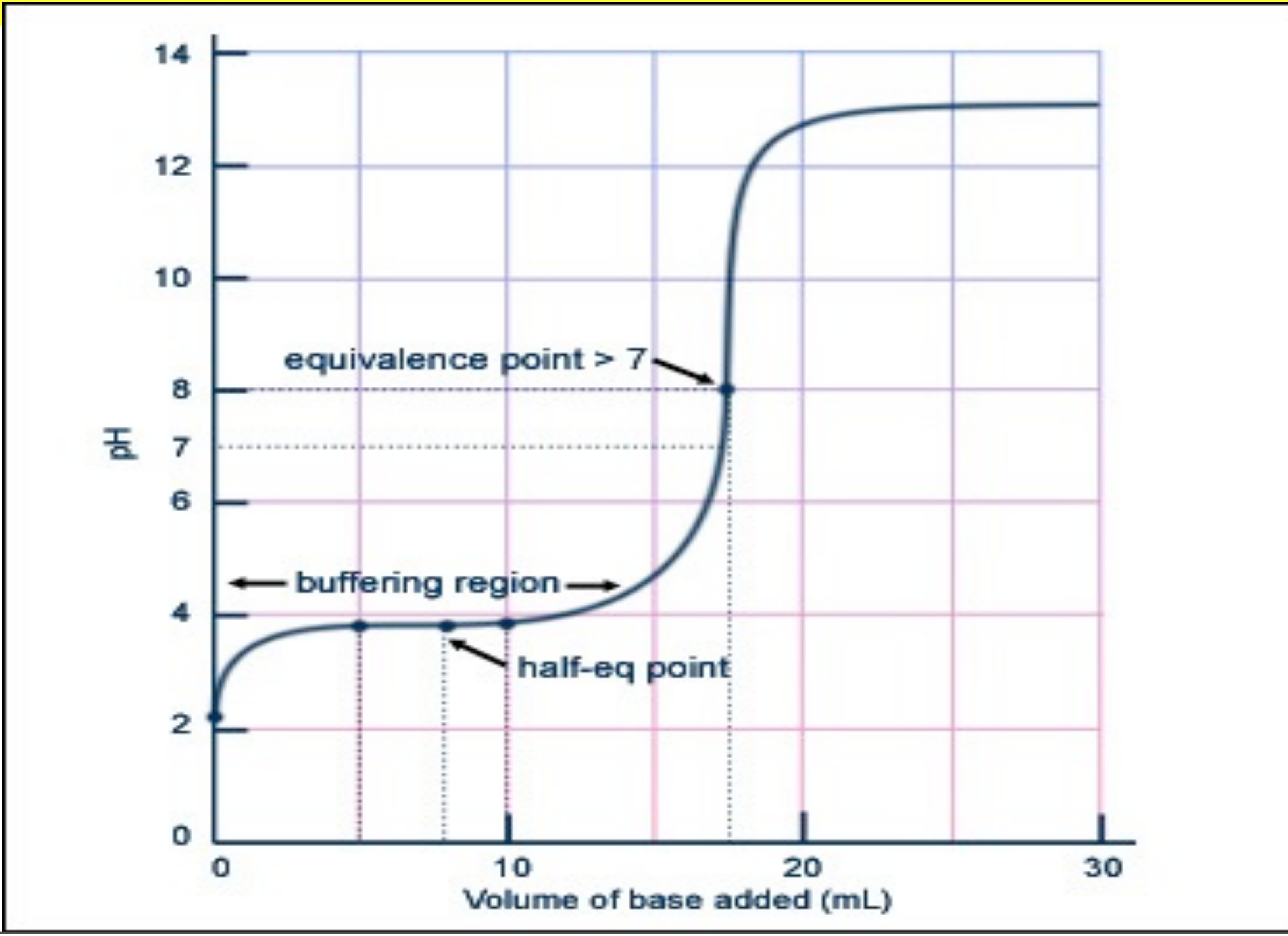
Equilibrium shifts to the right, increasing $[CH_3COO^-_{(aq)}]$ & $H_2O_{(l)}$

If you keep adding base, eventually this reaction will dominate:

$CH_3COO^-_{(aq)} + H_2O_{(l)} \leftrightarrow CH_3COOH_{(aq)} + OH^-_{(aq)}$

At this point, the pH will increase dramatically

Titration Graph



Weak acid–Strong Base

A chemist titrated 25.00mL of 0.1000 mol/L solution of acetic acid, CH_3COOH, with NaOH. Calculate the pH of the solution after the addition of 10.00mL of NaOH.

Weak acid–Strong Base

$NaOH \quad + CH_3COOH <--> H_2O + NaCH_3COO$

Weak acid–Strong Base

$CH_3COOH + H_2O <--> CH_3COO^- + H_3O^+$

I

C

E

Weak acid-Strong Base

Weak base–Strong Acid

100 mL of 0.300M NH_3 is mixed with 180 mL of 0.100M HCl. Find the pH of the solution. $K_b = 1.8 \times 10^{-5}$

$$NH_3 + HCl \longleftrightarrow NH_4^+ + Cl^-$$

Weak acid–Strong Base

$NH_3 + HCl$ <--> $NH_4^+ + Cl^-$

Weak acid–Strong Base

$NH_3 + H_2O \leftarrow\rightarrow NH_4^+ + OH^-$

Strong Weak Titrations

2.0×10^1 mL of 0.20 mol/L $NH_{3(aq)}$ is titrated against 0.20 mol/L $HCl_{(aq)}$. Calculate the pH at equivalence.