EXPERIMENT 8 (DAY 1)
Acids, Bases, & Buffers

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FALL 2018

ACIDS
PROTON
DONORS

$$HA\,(aq) + H_2O\,(\ell) \rightleftharpoons H_3O^+\,(aq) + A^-\,(aq)$$

If $K_a > 1$, the acid is strong
examples: HCl, HNO_3, ...

If $K_a < 1$, the acid is weak

If $K_a \ll 1$, the acid is very weak
examples: CH_3COOH, HCOOH, ...

BASES

PROTON ACCEPTORS

$$NH_3\ (aq) + H_2O\ (\ell) \rightleftharpoons NH_4^+\ (aq) + OH^-\ (aq)$$

If $K_b > 1$, the base is strong

examples: NaOH, KOH, $Ca(OH)_2$ ...

If $K_b < 1$, the base is weak

If $K_b \ll 1$, the base is very weak

examples: CH_3COO^-, any conjugate base

AUTOIONIZATION OF WATER

When an ACID or BASE or BOTH are added to water…

↓

Three simultaneous equilibria will automatically establish.

↓

In many situations, only one of the three equilibria will dominate over the other two.

CONJUGATE ACID-BASE PAIR

$$K_a \times K_b = K_w = 1 \times 10^{-14}$$

If HA is strong, then A^- is very weak.

If HA is (medium) weak, then A^- is (medium) weak.

If HA is very weak, then A^- is strong.

ACID-BASE TITRATIONS

pH = $-\log [H^+]$ vs. volume NaOH added

Steep rise around the EQUIVALENCE POINT — the point where the moles of NaOH added equals the initial moles of (a monoprotic) acid.

Indicator chosen must change color within this steep rise.

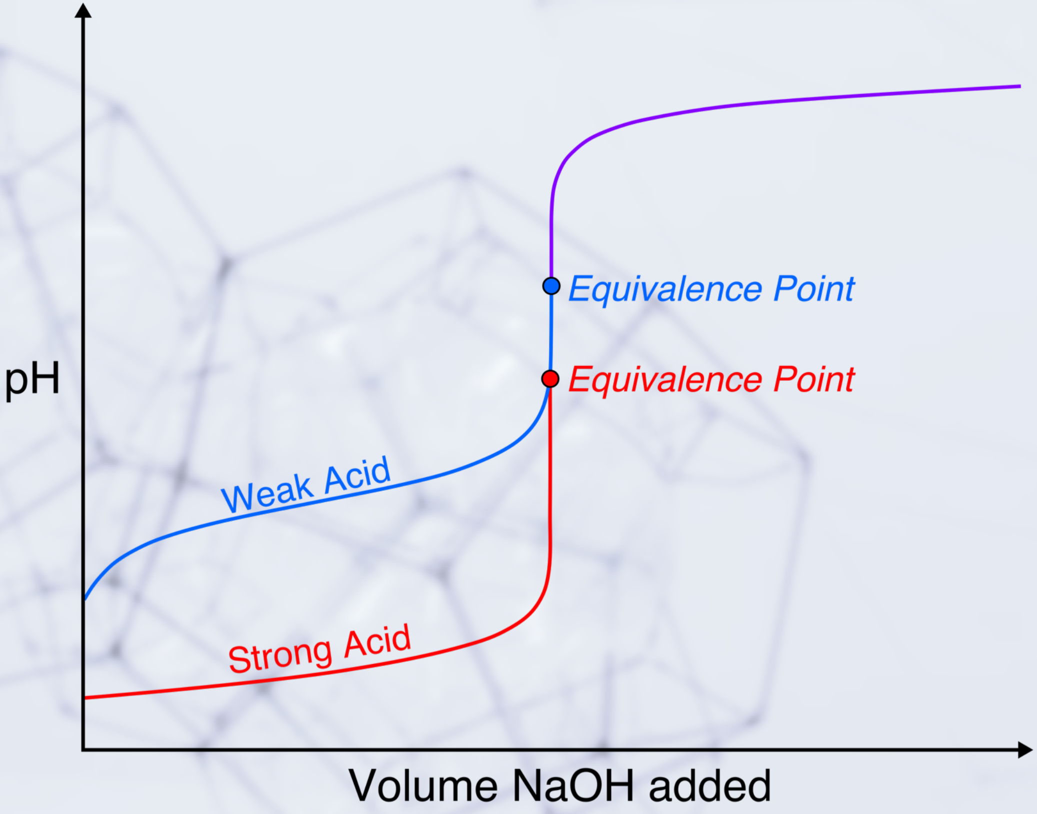
END POINT is the point where there is a distinct visual change in color.

What would the pH be at the EQUIVALENCE POINT in a strong ACID-strong BASE titration?

pH = 7

What would the pH be at the EQUIVALENCE POINT in a weak ACID-strong BASE titration?

pH > 7



BUFFERS

Consists of a weak ACID-conjugate BASE pair.
They are essential in all biochemical processes.

Buffers have the ability to *resist* change in pH when a small amount of a strong ACID or BASE is added.

CALCULATING THE pH OF A BUFFER

$$[\mathrm{H^+}]_{\mathrm{buffer}} = K_{\mathrm{a}} \times \frac{[\mathrm{HA}]_{\mathrm{eq}}}{[\mathrm{A^-}]_{\mathrm{eq}}} \approx K_{\mathrm{a}} \times \frac{[\mathrm{HA}]_{\mathrm{initial}}}{[\mathrm{A^-}]_{\mathrm{initial}}}$$

NOTES

1. The pH electrode is a delicate item, so handle it with care.
   To work well, it needs to be well-immersed in the solution.

2. Plot both pH and its first derivative ($\partial pH/\partial V$).
   → Use the latter to judiciously choose NaOH increments.

3. In the vicinity of the EQUIVALENCE POINT, you must use very small increments of base (one drop at a time).
   If not, you will not be able to determine the EQUIVALENCE POINT accurately.

4. Part 3: Either do it today or next week.

5. No lab report due next week.