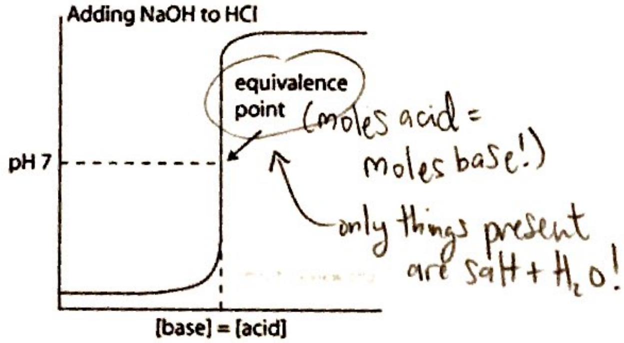
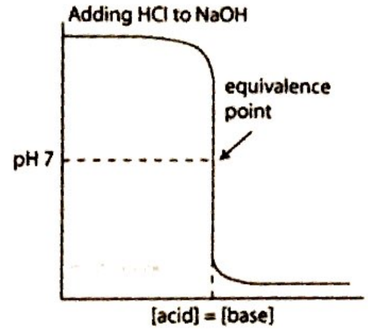
Titration Curves: Quick Summary

Strong Acid Titrated with Strong Base



Strong Base Titrated with Strong Acid



How to Choose the Best Indicator: An indicator is a weak acid where HA and A^- are different colors!

- If pH ≤ pK_a mostly HA (one color), if pH > pK_a mostly A^- (different color)

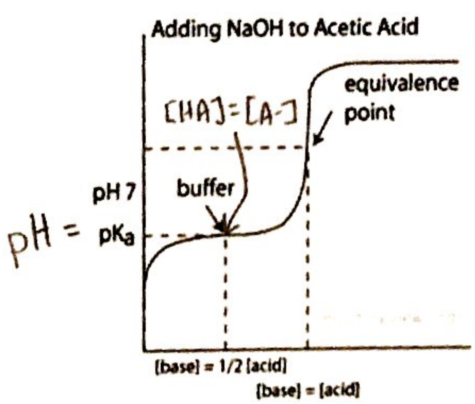
Choose an indicator that:

- ➢ pK_a ≈ pH **equivalence point** of titration (moles acid = moles base).
- ➢ Has K_a ≈ 1×10^{-pH} (that is, the pH of the solution at equivalence point)

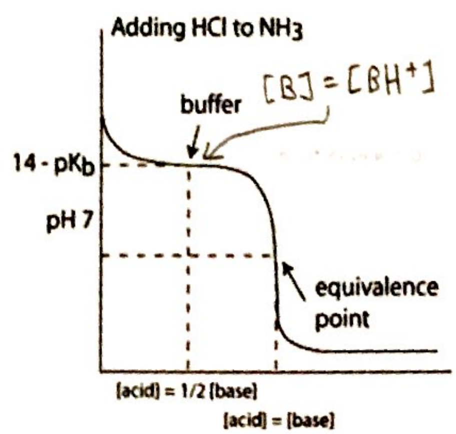
Buffer Influence on Titration Curves: Weak/Strong Titration

- Buffers make the titration curve flat at the region where buffering occurs. On a titration curve, this is the point of inflection (buffer arrow). ⇒ midpoint / $\frac{1}{2}$-equivalence pt
- At point of inflection, solution has maxiumum buffering capacity, and:
  - ➢ [acid] = [conjugate base] or [base] = [conjugate acid]
  - ➢ pH = pK_a (or pH = 14 – pK_b)
  - ➢ [titrant] = ½ [weak acid] or [titrant] = ½ [weak base]

Weak Acid Titrated with Strong Base



Weak Base Titrated with Strong Acid



For any monoprotic titration (weak or strong): use $M_A V_A = M_B V_B$ to find location of equivalence pt!

Let's Practice!

1. Consider the titration of a 20.0 mL sample of 0.105 M HCN ($K_a = 4.9 \times 10^{-10}$) with 0.125 M NaOH. *(added base)*
   a. What is the initial pH? *Weak acid only!*

$$K_a = \frac{[H_3O^+][CN^-]}{[HCN]} = \frac{x^2}{[HCN]_i - x} = \frac{x^2}{0.105 - x} = 4.9E-10 \approx \frac{x^2}{0.105}$$

Assume $x \ll 0.105$

$$x = \sqrt{(4.9E-10)(0.105)} = 7.2E-6\ M = [H_3O^+]$$

$$pH = -\log(7.2E-6) = \boxed{5.14}$$

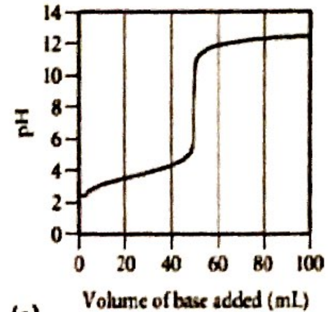
   b. What volume of base (in mL) must be added to reach equivalence point?

$$M_A V_A = M_B V_B$$

$$(0.105\ M)(20.0\ mL) = (0.125\ M)V_B$$

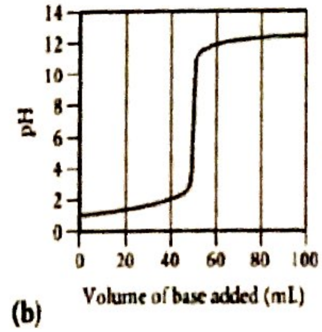
$$V_B = \frac{0.105 \times 20.0}{0.125} = \boxed{16.8\ mL}$$

2. For the following graphs, answer these questions:
   a. What type of titration was performed? (That is, what vs what?)
   b. What is the approximate pH at the equivalence points?
   c. For relevant graphs, what is the pK_a or pK_b of the analyte?



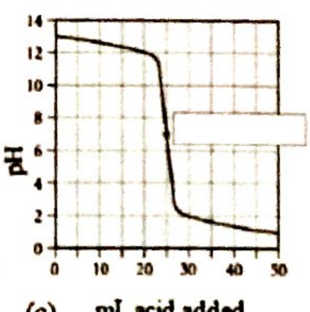
(a)

a) WA + SB
b) ~8
c) $pK_a \approx 3.9$



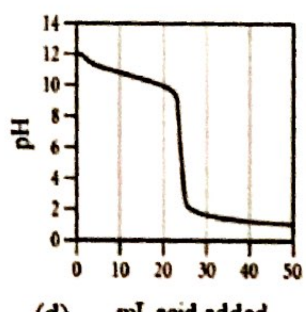
(b)

a) SA + SB
b) 7
c) n/a



(c)

a) SB + SA
b) 7
c) n/a



(d)

a) WB + SA
b) ~6
c) $pK_b \approx 3.5$ (since $pK_a \approx 10.5$)