Next Week Glance

EXAM 3 INFO:

Tues. March 28th
6:15 pm – 7:30 pm

MON	TUE	WED	THU	FRI
3/27	3/28	3/29	3/30	3/31
Quiz 10	EXAM 3	PLQ 28 8 am	PLQ 29 R11 GQ	

Review INFO:

3/25 (Saturday) 1-3 pm, 101 Thomas, Practice Exam 3S

3/26 (Sunday) 1-2:30 pm, 304 Boucke, GSG

3/26 (Sunday) 3-5 pm, 102 Thomas, Practice Exam 3R

3/26 (Sunday) 6:30-8:30 pm, 105 Forum, TPE

3/27 (Monday) 3-5 pm, 117 Thomas, Practice Exam 3Q

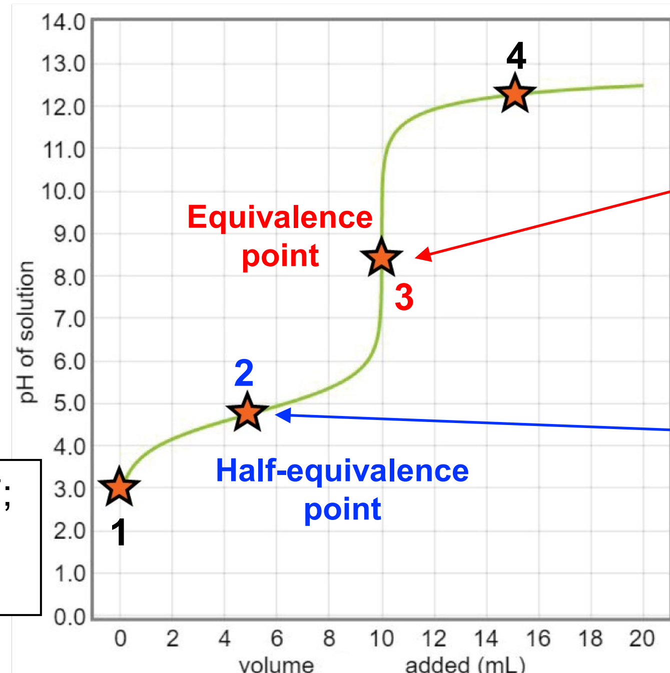
Lesson 22-2 Weak Acid-Base Titrations

Lesson goals:

- Graphically describe the following titration curves; weak acid titrated with strong base, and weak base titrated with strong acid.
- If present, identify the equivalence point, half-equivalence point, and buffer region on a titration graph.
- Using tabulated K_a or K_b values and initial concentrations, calculate the pH at any point in any of the above titrations.
- Qualitatively predict the pH at the equivalence point of any of the above titrations. Describe the species present in solution in significant amounts at any point of the above titrations.
- Given information about the half-equivalence point, calculate the K_a or pK_a of the weak acid, or the K_b or pK_b of the weak base in a titration.
- Identify the titration curve of a polyprotic acid, and calculate the pH at any of the equivalence points.

Titration Curve for Weak Acid with a Strong Base

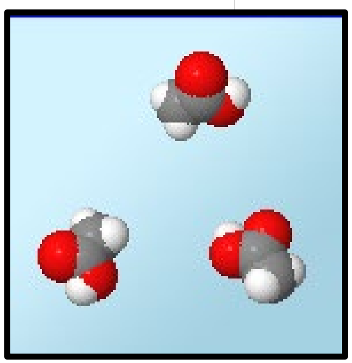
$CH_3COOH + OH^- \rightarrow H_2O + CH_3COO^-$



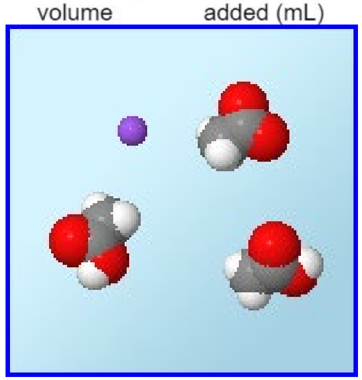
Equivalence Point;
pH > 7
only conjugate base present

Half Equivalence Point;
[HX] = [X⁻]
pH = pK_a

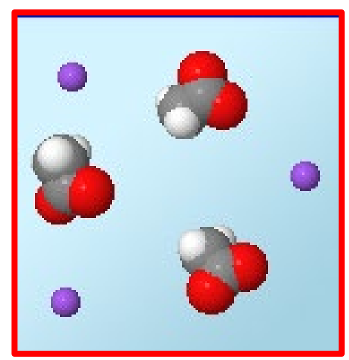
initial pH = 2.87; higher than strong acid



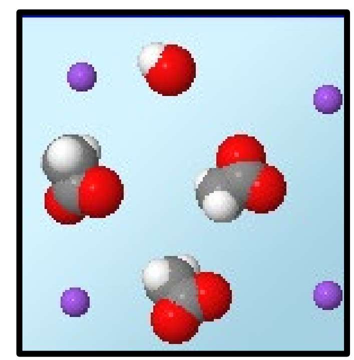
1. Weak Acid ONLY before OH^- addition (pH; acid dissoc.)



2. BUFFER! Half Equivalence Point (pH; H-H)



3. Weak Base ONLY Equivalence Point (pH; base hydrolysis)

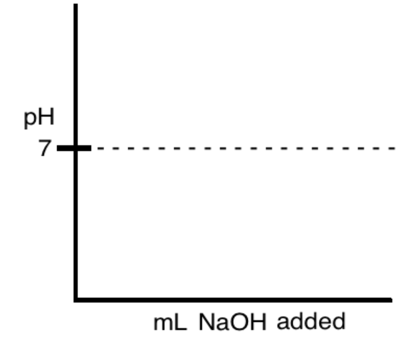


4. Excess Strong Base Past Equivalence Point (pH; based on xs OH^-)

1000 mmol = 1 mole

Lecture 29 Activity 1 – *Weak Acid-Base Titrations*

We will titrate 50 mL of 0.1 M CH_3COOH with varying amounts of 0.2 M NaOH.



1. Sketch the titration curve for this system on the axes to the right. At what pH range do you expect the equivalence point to be?
2. Write the **complete neutralization reaction** and the **net ionic** reaction under the graph. What are the spectator ions?
3. Calculate the pH before any NaOH is added. (For acetic acid, $K_a = 1.8 \times 10^{-5}$)

4. **Before doing titration calculations, ALWAYS CALCULATE THE MOLES OF REACTANT THAT WILL BE TITRATED.** How many total moles of H^+ will be titrated here when the endpoint is reached?

1000 mmol = 1 mole

Lecture 29 Activity 3 – *pH at Equivalence Point*

We will titrate 50 mL of 0.1 M CH_3COOH with varying amounts of 0.2 M NaOH.

The equivalence point (or endpoint) is where:
Total Moles of base present = Total moles of H^+ present

1. We will add 25 mL of 0.2 M NaOH solution to the same CH_3COOH solution. How many moles of base are being added?

2. There are still the same number of initial moles of acid. Fill in the ICF table (Use moles or mmols!)

3. What is the limiting reactant?

4. What non-spectator species is left in solution after reaction? Classify it.

5. What is the total volume?
6. What is the concentration of this species?

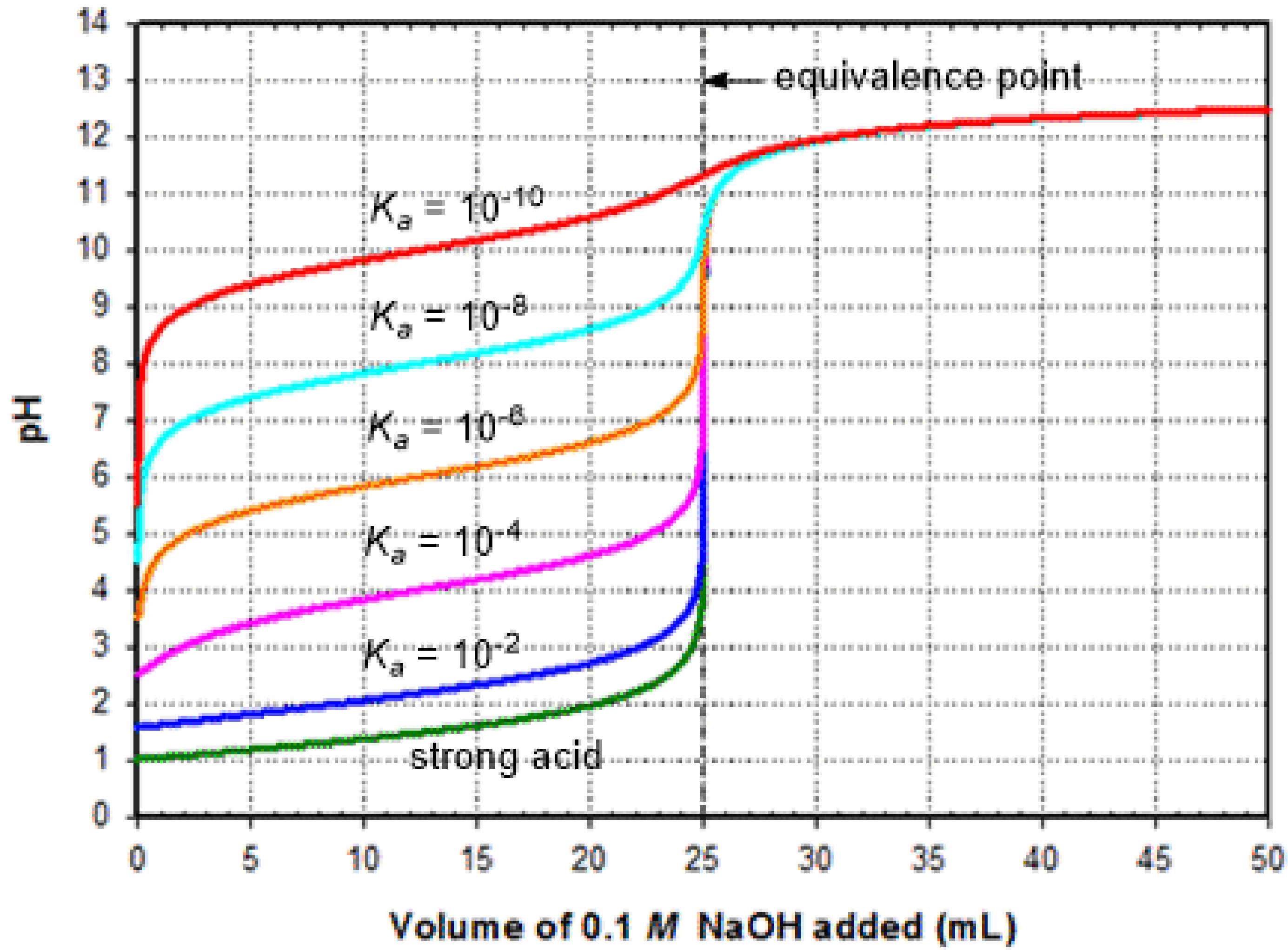
7. What is the pH of the solution at this point? ($K_a = 1.8 \times 10^{-5}$ for acetic acid.)

	CH_3COOH	+ OH^- →	CH_3COO^-	+ H_2O
I				
C				
F				

I			
C			
E			

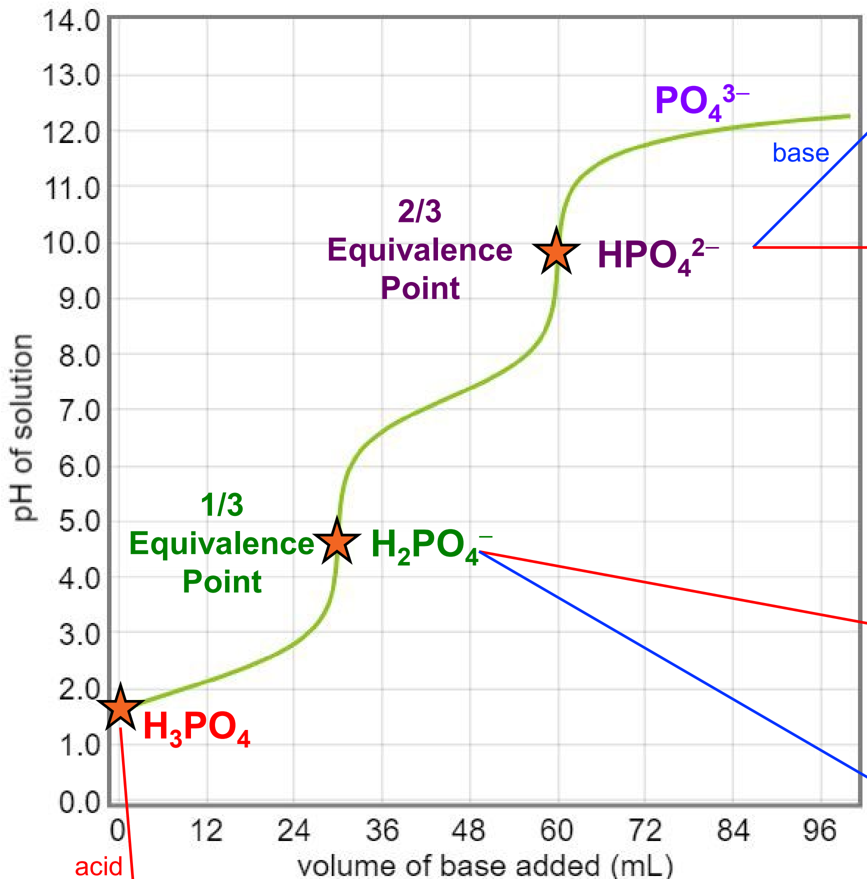
Acid Strength Affects Titration Curve Shape

For weaker acid, higher initial pH, flatter curve, smaller ΔpH



Titration Curve of a Di- or Tri-protic Acid

Titrate 30 mL of 0.1 M H_3PO_4 solution with 0.1 M NaOH solution. $K_{a1} >> K_{a2} >> K_{a3}$



base

$HPO_4^{2-} + H_2O \rightleftharpoons OH^- + H_2PO_4^-$

$K_b = K_w/K_{a2} = 1.6 \times 10^{-7}$

acid

$HPO_4^{2-} \rightleftharpoons H^+ + PO_4^{3-}$

$K_{a3} = 4.2 \times 10^{-13}$

acid

$H_2PO_4^- \rightleftharpoons H^+ + HPO_4^{2-}$

$K_{a2} = 6.2 \times 10^{-8}$

base

$H_2PO_4^- + H_2O \rightleftharpoons OH^- + H_3PO_4$

$K_b = K_w/K_{a1} = 1.3 \times 10^{-12}$

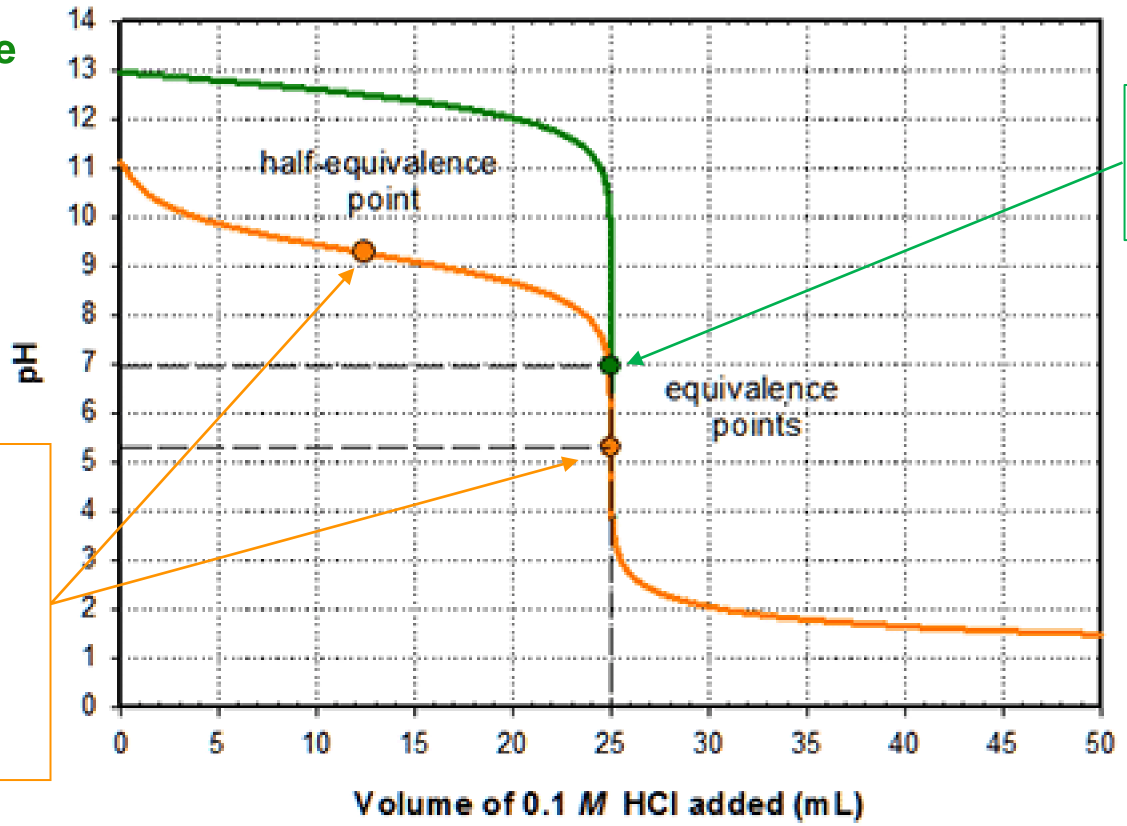
$H_3PO_4 \rightleftharpoons H^+ + H_2PO_4^-$

$K_{a1} = 7.5 \times 10^{-3}$

Titration of Bases Mirror Acid Titrations

Strong Base

Weak Base



Strong Base has equivalence point at **pH = 7**

Weak Base has:

- a half-equivalence point! pH = pK_a
- lower initial pH
- less ΔpH
- pH < 7 at equivalence point

Be able to predict pH at the Equivalence Point

1) Titrating a **strong acid** with a **strong base** (OR vice versa)

pH at equivalence = 7

2) Titrating a **weak acid** with a **strong base**

pH at equivalence > 7

* ***the weaker the acid, the smaller the pH change at equivalence***

3) Titrating a **weak base** with a **strong acid**

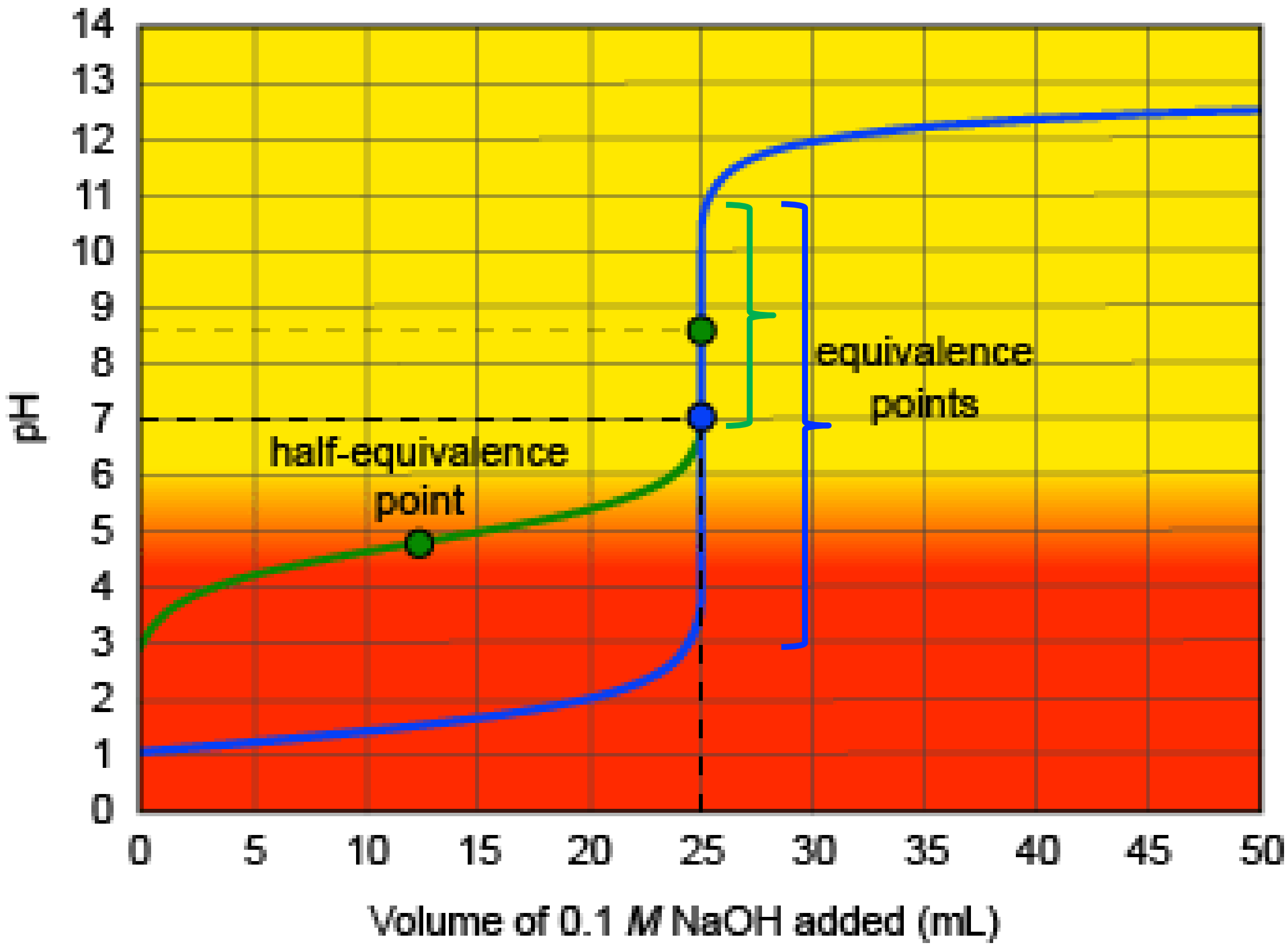
pH at equivalence < 7

The Indicator Must Change Color Within The pH Range at the Equivalence Point

Weak Acid: indicator must change color between pH = 7 to 10.8

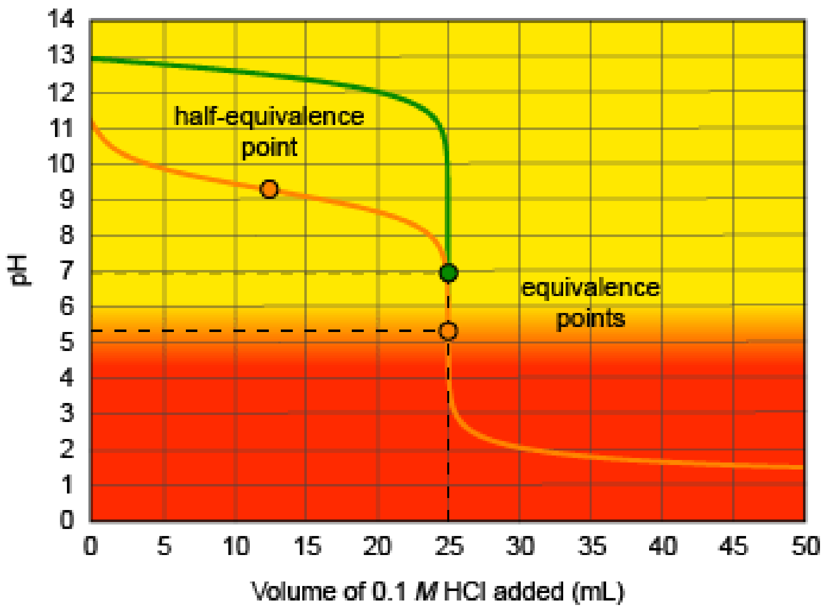
Strong Acid: indicator must change color between pH = 2.8 to 10.8

methyl red (color change at pH 4.4 – 6.2)

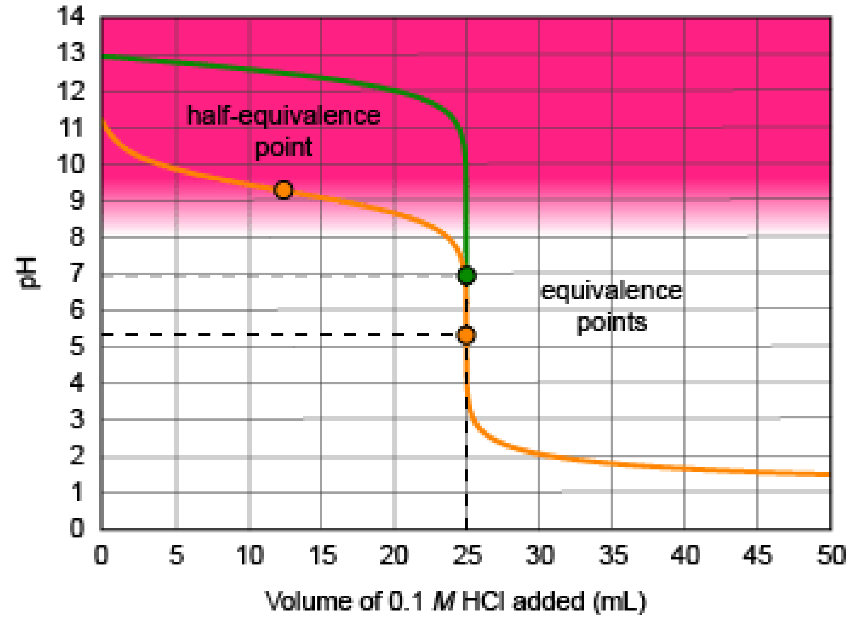


Titrations of NH_3 and NaOH are shown.
Which indicator is appropriate for the titration of of NH_3 with HCl?

methyl red (pH 4.4 – 6.2)



phenolphthalein (pH 8.0 – 9.8)



Indicator must change color between pH = 3 to 11 for strong base titration.
Indicator must change color between pH = 3 to 7 for weak base titration.

A. methyl red only
B. phenolphthalein only
C. both methyl red and phenolphthalein are appropriate