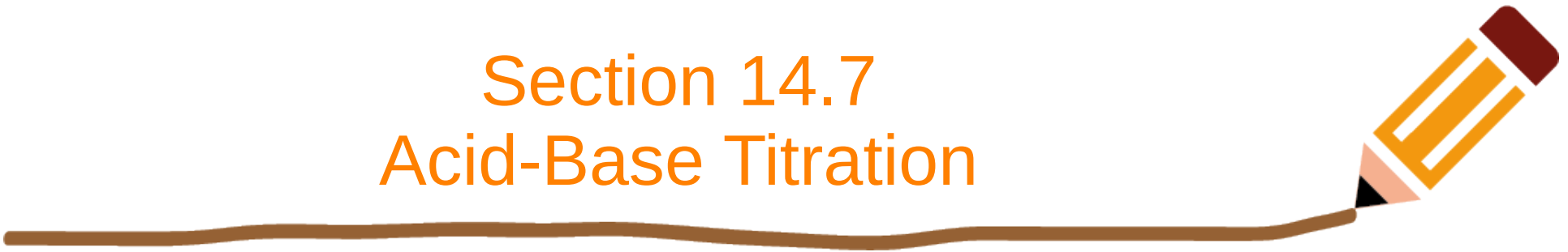
Section 14.7
Acid-Base Titration



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Learning Objectives

- Interpret titration curves for strong and weak acid-base systems
- Compute sample pH at important stages of a titration
- Explain the function of acid-base indicators

Titration Curves

- A titration curve is a plot of some solution property versus the amount of added titrant.
- For acid-base titrations, solution pH is a useful property to monitor because it varies predictably with the solution composition
- The shape of a titration curve is effected by the strength of the **titrand** (analyte) and **titrant**.

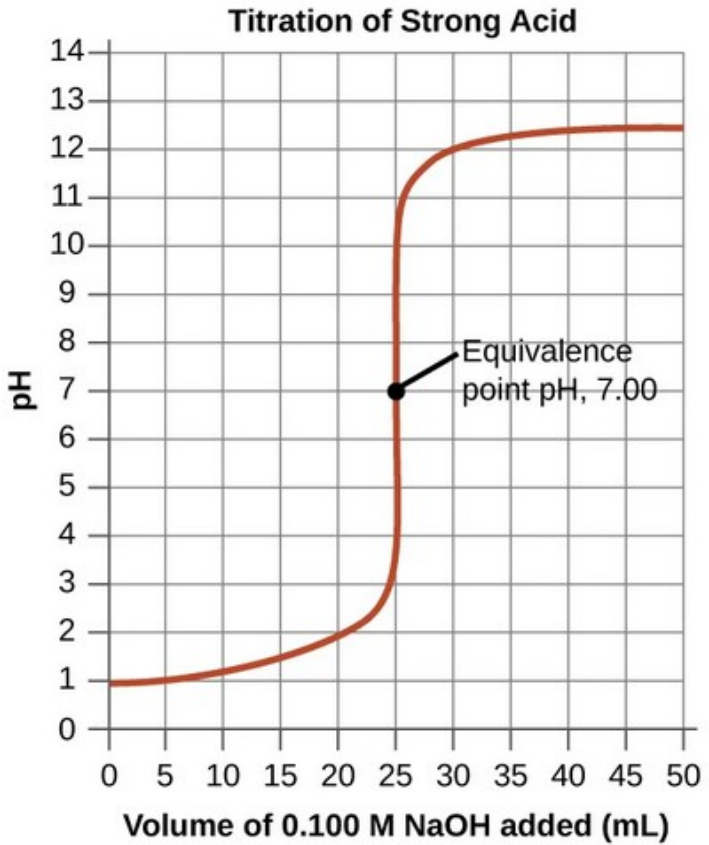
Titration Steps

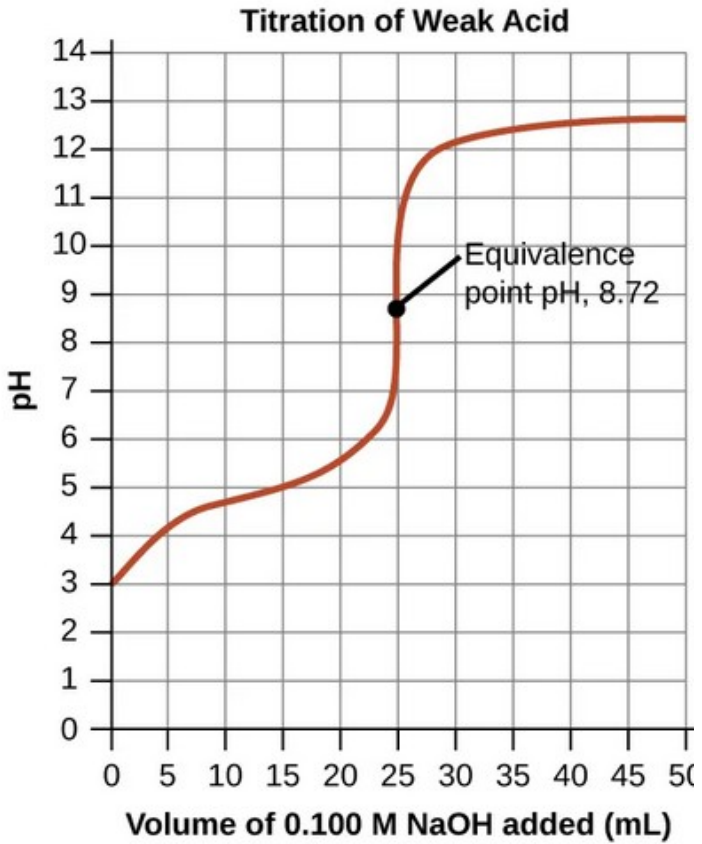
1) Initial state (added titrant volume = 0 mL): pH is determined by the acid being titrated
   - When concentrations are held equal, stronger acids will have a lower pH.
2) Pre-Equivalence Point: solution pH increases gradually and the acid is consumed by reaction with added titrant
   - composition includes unreacted acid, the reaction product and its conjugate base

Titration Steps

3) Equivalence Point: a drastic rise in pH is observed as the solution composition transitions from acidic to either neutral or basic
   - pH is determined by ionization constant of the conjugate base of the acid
4) Postequivalence Point: pH is determined by the amount of excess strong base titrant added

Picturing Titration





Acid-Base Indicators

- Certain organic substances change color in dilute solution when the hydronium ion concentration reaches a particular value.
- These substances are called **acid-base indicators** and can be used to determine the pH of a solution.

Indicator Example

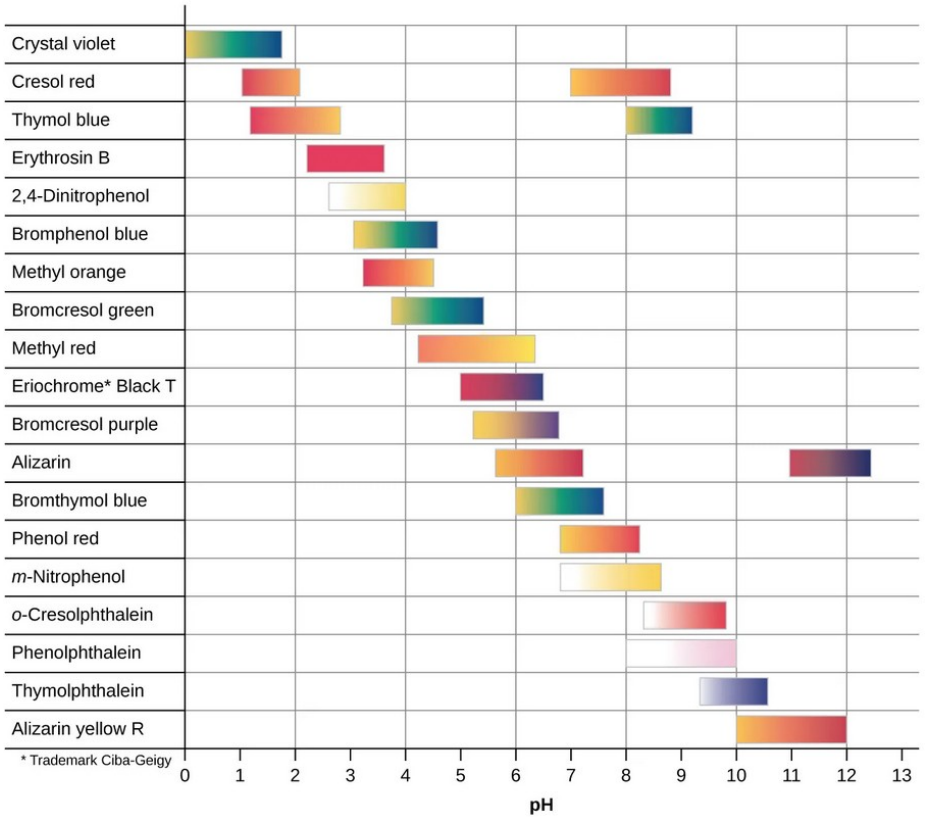
- The equilibrium in a solution of the acid-base indicator methyl orange can be represented by an equation in which we use HIn as a simple representation:

$$\underset{\text{red}}{\mathrm{HIn}(aq)} + \mathrm{H_2O}(l) \rightleftharpoons \mathrm{H_3O^+}(aq) + \underset{\text{yellow}}{\mathrm{In^-}(aq)}$$

$$K_a = \frac{[\mathrm{H_3O^+}]\,[\mathrm{In^-}]}{[\mathrm{HIn}]} = 4.0 \times 10^{-4} \qquad \mathrm{pH} = \mathrm{p}K\mathrm{a} + \log\left(\frac{[\mathrm{In^-}]}{[\mathrm{HIn}]}\right)$$

Color Change Interval

- The **color change interval** (or pH interval) for an acid-base indicator is defined as the range of pH values over which a change in color is observed
- For most indicators this range is approximately pK_a ± 1.



Selecting an Indicator

- An appropriate indicator should have a color change interval that encompasses the equivalence point.