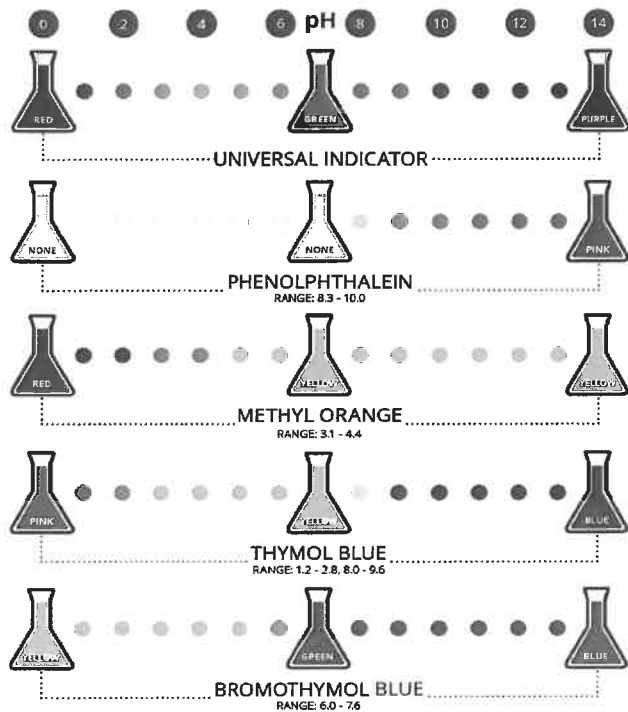


# Indicators & Titration Curves

## Indicators

Indicators are dyes that change colour under varying pH.



## Common Acid-Base Indicators

| Indicator        | Approximate pH Range for Color Change | Color Change      |
|------------------|---------------------------------------|-------------------|
| methyl orange    | 3.2-4.4                               | red to yellow     |
| bromthymol blue  | 6.0-7.6                               | yellow to blue    |
| phenolphthalein  | 8.2-10                                | colorless to pink |
| litmus           | 5.5-8.2                               | red to blue       |
| bromcresol green | 3.8-5.4                               | yellow to blue    |
| thymol blue      | 8.0-9.6                               | yellow to blue    |

Example: A solution turns methyl orange yellow, litmus blue, and phenolphthalein dark pink. What is the approximate pH of the solution?

- Methyl orange is yellow ... above pH 4.4
- Litmus is blue ... above pH 8
- Phenolphthalein is dark pink ... above pH 10

∴ pH is 10+

Example: A solution was tested with three indicators to determine its approximate pH. The results are given in the table. What is the approximate pH of the solution?

| Indicator        | Colour |
|------------------|--------|
| phenol red       | yellow |
| bromothymol blue | yellow |
| methyl red       | yellow |

pH < 6.6  
pH < 6.0  
pH > 6.0

∴ pH is ~ 6

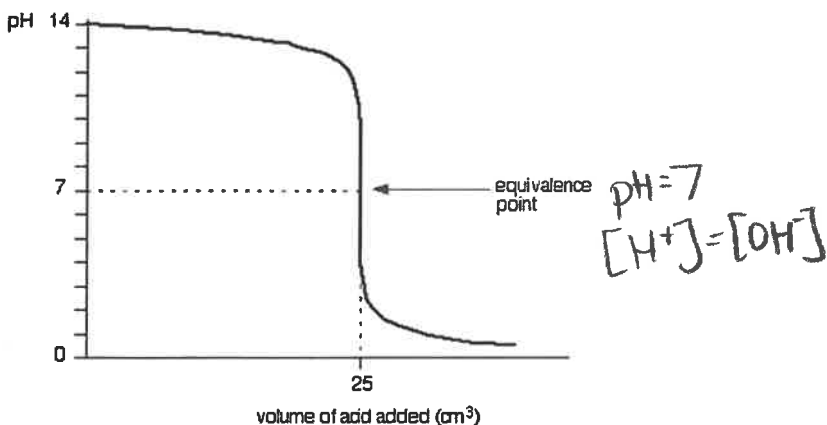
In acid-base titration, an indicator is used to tell when the acid and base have neutralized each other. When the indicator changes color, this is described as the end point of the titration.

## Titration Curves & Choosing the Best Indicators

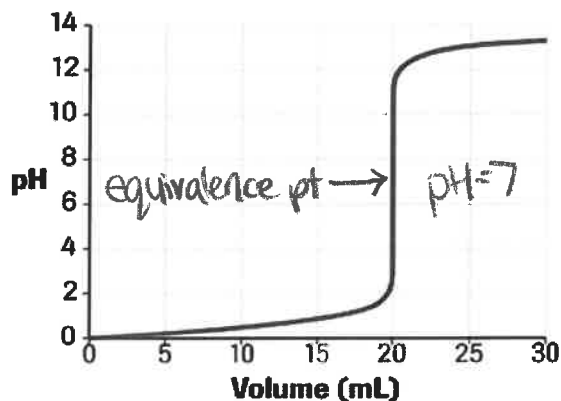
A graph of pH versus volume of titrant added is called a titration curve. The center of the vertical region of the titration curve indicates the equivalence point.

An indicator needs to be chosen so that its endpoint is as close as possible to the equivalence point.

(a) Strong Acid into Strong Base



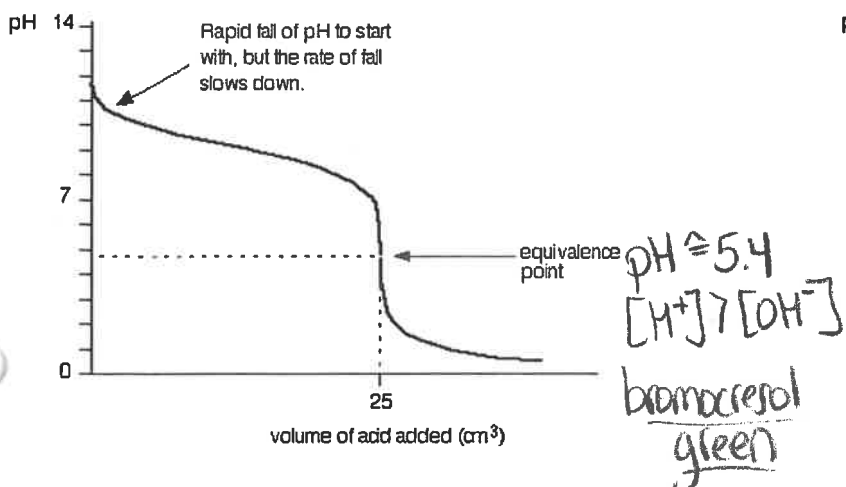
(b) Strong Base into Strong Acid



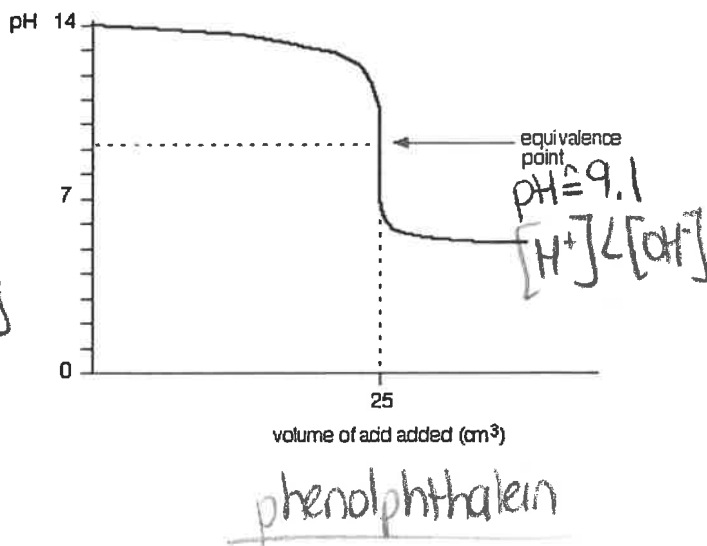
What indicator would be a good choice for these titrations? endpoint = equivalence point ideally  
 → very rapid change from high to low pH (or vice versa); ∴ any indicator that changes colour along this pH range is suitable ∴ phenolphthalein or bromthymol blue

Only when a strong acid and a strong base are combined will the resulting solution be neutral. As such, the choice of indicator varies from titration to titration depending on the strength of the acids and bases involved.

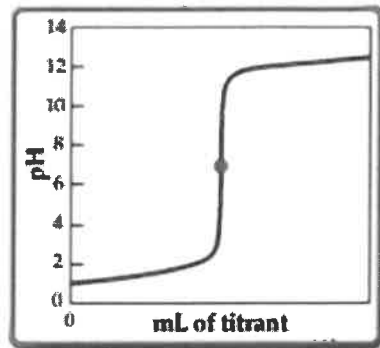
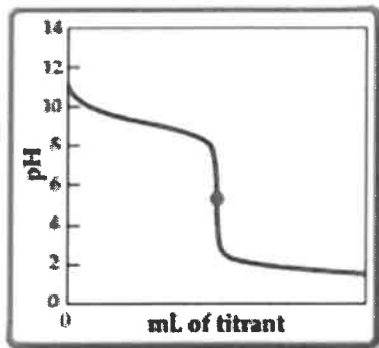
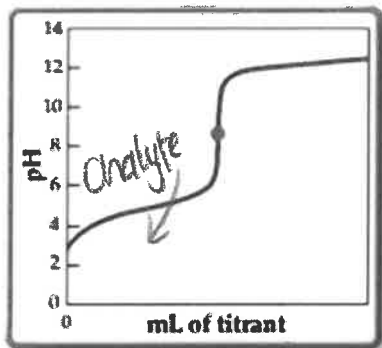
(c) Strong Acid into Weak Base



(d) Weak Acid into Strong Base



Example: Determine the analyte and titrant for each of the following titration curves.



Analyte:

weak acid

weak base

strong acid

Titrant:

strong base

strong acid

strong base

Example: Choose an appropriate indicator for the titration of acetic acid and sodium hydroxide.

weak acid + strong base  
equivalence point ~ 9.1

indicator phenolphthalein/thymolphthalein