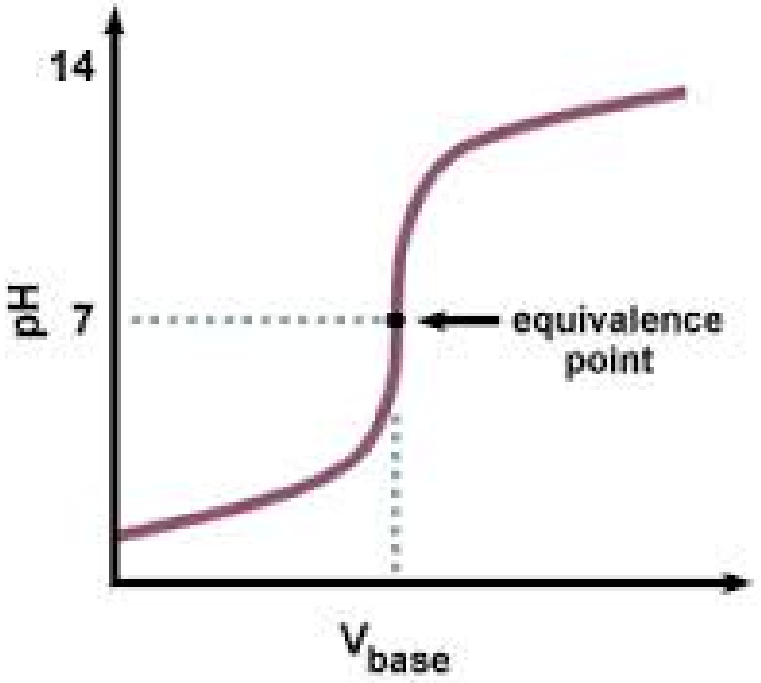
Titration Curves…



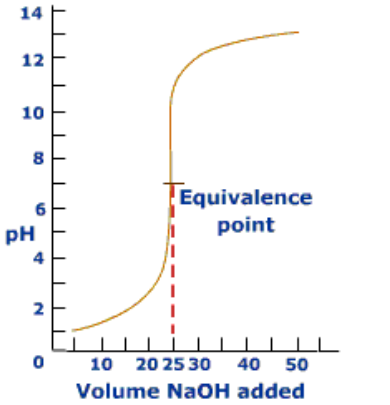
Outcomes:

- Using a standardized acid, determine the concentration of an unknown base.
- Perform a lab to demonstrate the stoichiometry of a neutralization reaction between a strong acid and base

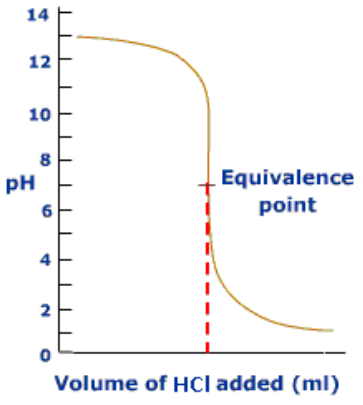
Titration Curves:

A **TITRATION CURVE** is a graph of the **pH** as a function of the **AMOUNT** of **TITRANT** (**ACID** or **BASE**) being **ADDED**.

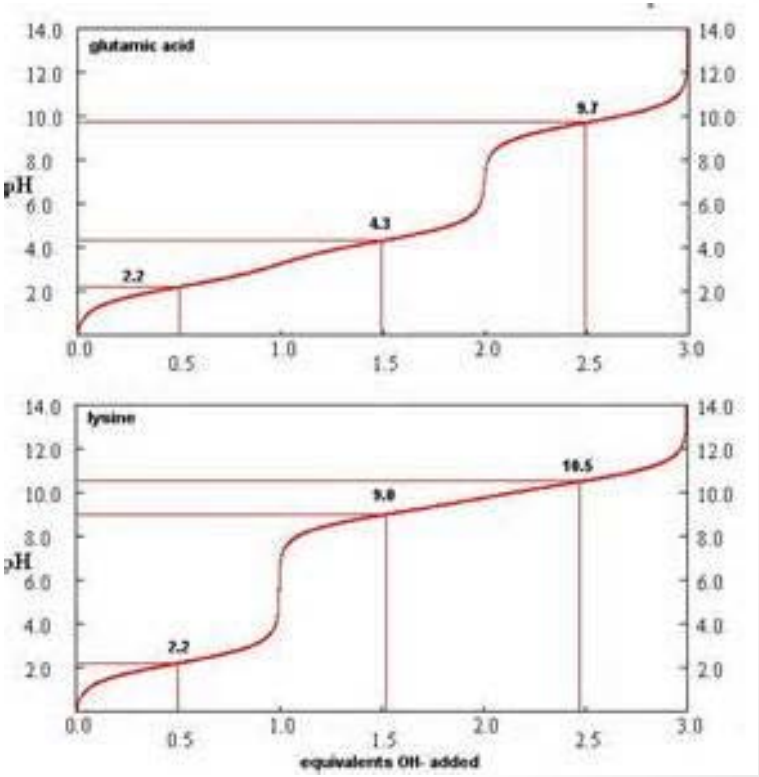
Titration curves have different shapes based on the **STRENGTH** of the **TITRANT** and **SAMPLE**.



Titration curve of strong acid (HCl) with a strong base (NaOH)



Titration curve of strong base (NaOH) with strong acid (HCl)



Titration Curves:

1. Strong Acid-Strong Base Titrations:

In this example, 25.0mL of an HCl solution is titrated with a 0.100M NaOH solution. The equation is:

$$HCl(aq) + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$$

At equivalence, $[H_3O^+] = [OH^-]$. The expected titration curve is below:

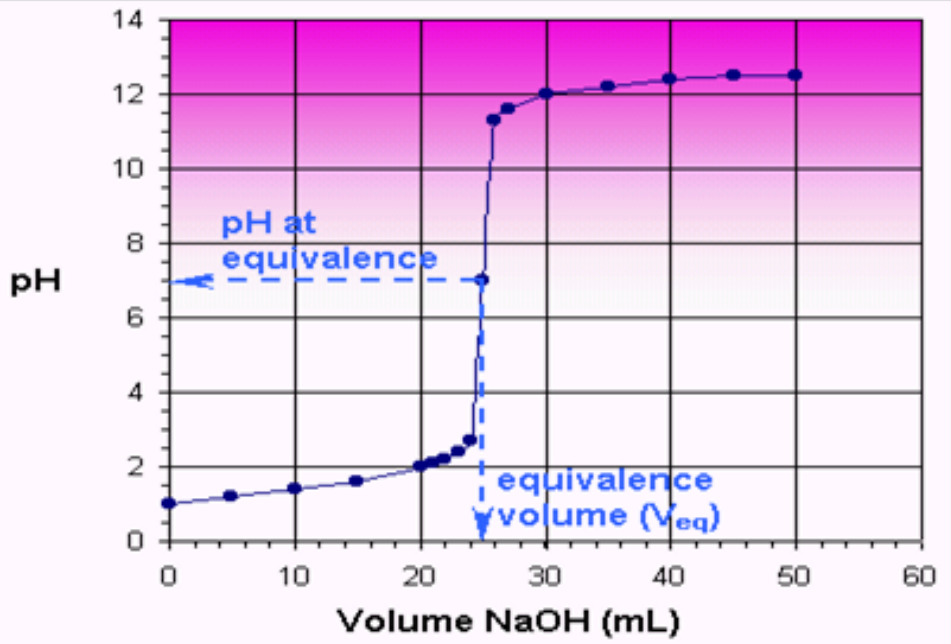


Figure 4. HCl titrated with 0.100 mol/L NaOH.

Titration Curves:

- The equivalence point is found ***at the center of the steepest portion of the curve*.**

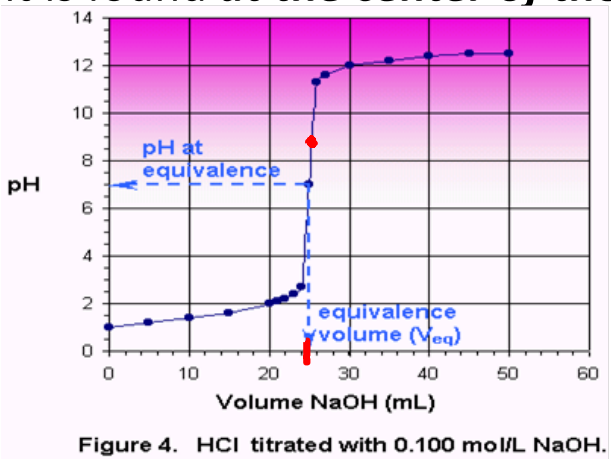


Figure 4. HCl titrated with 0.100 mol/L NaOH.

- In this example, the equivalence volume is **<u>25.0mL</u>** of **<u>NaOH.</u>** Since the stoichiometry is 1:1…

$HCl + NaOH \rightarrow NaCl + H_2O$

25ml 25mL 0.1mol/L

$0.1\ \frac{mol}{L} \times 0.025L = 0.0025\ mol \times \frac{1}{1} = \frac{0.0025\ mol\ HCl}{0.025L}$

$= 0.1\ \frac{mol}{L}\ HCl$

- A titration curve of a **<u>STRONG</u>** **<u>BASE</u>** with a **<u>STRONG</u>** **<u>ACID</u>** would be the **<u>SAME</u>**, but only **<u>REVERSED</u>**.

Titration Curves:

Selecting an Indicator:

- A suitable indicator for a titration should change colour **NEAR** the **EQUIVALENCE POINT**.
- Indicators change **GRADUALLY** over a **pH RANGE**. Some typical indicators are given in the table below:

Indicator	Colour Change	pH Range
Bromocresol Green	**Yellow → Blue**	**3.6 – 5.2**
Methyl Red	**Red → Yellow**	**4.8 – 6.0**
Bromothymol Blue	**Yellow → Blue**	**6.0 – 7.6**
Phenol Red	**Yellow → Red**	**6.8 – 8.4**
Phenolphthalein	**Colourless → Pink**	**8.0 – 9.8**

- Because it is **IMPOSSIBLE** to select an indicator that changes at **EXACTLY** the equivalence point, we choose an indicator that:

→ ***Changes just past the equivalence point.***

→ ***Changes within the steepest part of the curve.***

Titration Curves:

For the model titrations shown, what would be suitable indicators?

1. HCl with NaOH: (equivalence point at pH = 7)

    - ***Any of bromothymol blue, phenol red, or phenolphthalein***

2. Acetic acid with NaOH: (equivalence point at pH=8)

    - ***phenolphthalein***

3. NH_3 with HCl: (equivalence point at pH = 5.5)

    - ***methyl red, or bromocresol green***