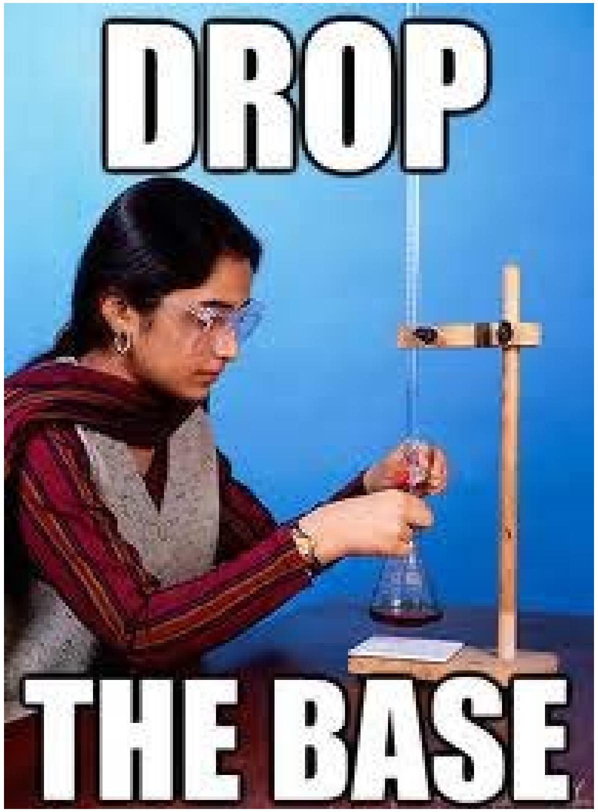
Titrations Introduction…

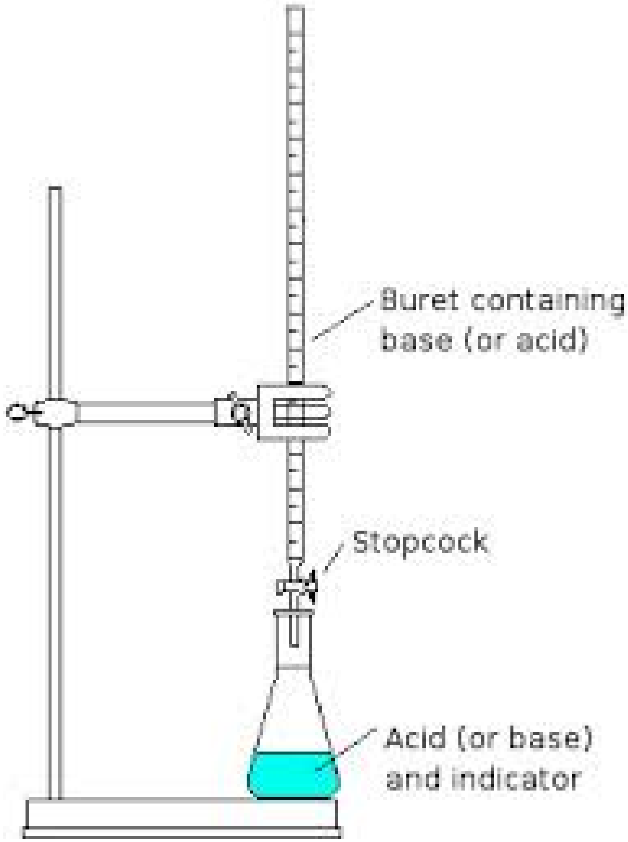


Outcomes:

- 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

Titrations:

A **TITRATION** is the **PRECISE** addition of a **STANDARD SOLUTION** of known **CONCENTRATION** (called the **TITRANT**) from a **BURET** into a **MEASURED** volume of a **SAMPLE** solution (the **SAMPLE**).

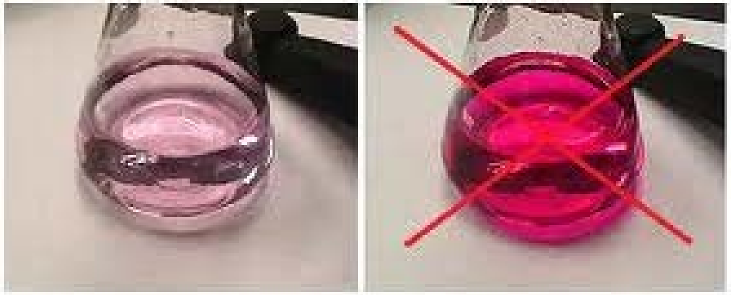


Equivalence Point & Endpoint:

- Recall that when an **ACID** or **BASE** is just **NEUTRALIZED**, the **MOLES** of **HYDRONIUM** and **HYDROXIDE** ions are **EQUAL**. We call the point at which the standard solution **JUST NEUTRALIZES** the sample the **EQUIVALENCE POINT.**

- We can determine the **EQUIVALENCE POINT** by using an **INDICATOR** or a **pH METER** to measure pH change as the titration progresses.

- If an **INDICATOR** is used, the point at which the desired colour forms is called the **ENDPOINT**. We choose indicators so the **ENDPOINT** and **EQUIVALENCE** point are **CLOSE**.



Good Endpoint   Bad Endpoint (Overly Titrated)

Note:

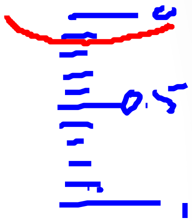
- The **ENDPOINT** and **EQUIVALENCE** point are **NOT** the **SAME** thing.

Titration Procedure:

Example:

Titration of an unknown HCl solution with a standardized (known) 0.100M NaOH solution.

1. We measure a sample (***aliquot***) of the unknown HCl solution and place in an Erlenmeyer flask.



2. Fill a buret with our standard NaOH solution.
3. We will use phenolphthalein as our indicator by putting a few drops into the flask.
4. Phenolphthalein turns pink at pH = 8.2. This is our ***endpoint***.
5. We ***slowly*** add NaOH to the flask, with swirling, until the solution in the flask turns light pink.
6. We then take a reading on the buret to find the amount of base used.

8.41ml

7. We repeat the procedure until we have several pieces of consistent data.

Titration Procedure:

Example:
Titration of an unknown HCl solution with a standardized (known) 0.100M NaOH solution.

Data:

Concentration of NaOH:	$0.1 \frac{mol}{L}$
Volume of NaOH used to neutralize HCl	$8.41 - 0.19 = 8.22 mL$
Volume of HCl aliquot (sample)	10ml

$$HCl + NaOH \rightarrow NaCl + H_2O$$

0.01L $\quad 0.1 \frac{mol}{L}$

$\frac{mol}{L} \quad 0.0822 L$

$$0.0822L \times \frac{0.1 \text{ mol}}{1 \text{ L}} = 0.00822 \text{mol NaOH} \times \frac{1}{1} = 0.00822 \text{mol HCl}$$

$$\frac{0.00822 \text{ mol HCl}}{0.01 \text{ L}} = 0.0822 \frac{mol}{L}$$

Titration Examples:

1. Determining concentration:

A titration was performed using a standard solution of 0.10M NaOH into an unknown HCl solution. The following data was obtained:

Volume of unknown: 11.44mL

Volume NaOH used: 13.83mL

Determine the concentration of the acid:

$$HCl + NaOH \rightarrow NaCl + H_2O$$

0.01144L $\quad 0.1\,\frac{mol}{L}$

$\frac{mol}{L}$ $\quad$ 0.01383 L

$$0.01383\,L \times \frac{0.1\,mol}{L} = 0.001383\,mol\ NaOH \times \frac{1}{1} = 0.001383\,mol\ HCl$$

$$\frac{0.001383\,mol}{0.01144\,L} = 0.121\,\frac{mol}{L}$$

Titration Examples:

2. Determining mass of unknown:

A student receives a sample of a monoprotic acid HA (molar mass 97.09g/mol) and dissolves the sample in enough water to make 100mL of solution. The student takes a 12mL aliquot and titrates with 0.0985M NaOH. If 13.38mL NaOH is needed to reach the endpoint, what is the mass of the sample of acid?

$$HA + NaOH \longrightarrow NaA + H_2O$$

12 ml $\qquad 0.0985\ \frac{mol}{L}$

0.01338 L

$$0.01338L \times \frac{0.0985\,mol}{1\,L} = 1.32\times10^{-3}\,mol\ NaOH \times \frac{1}{1} = 1.32\times10^{-3}\,mol\ HA$$

$$\frac{1.32\times10^{-3}\,mol\ HA}{0.012\,L} = 0.11\ \frac{mol}{L} = [SAMPLE]$$

$$0.1L \times 0.11\ \frac{mol}{L} = 0.011\,mol \times \frac{97.09g}{1\,mol} = 1.07g\ \text{Sample}$$