# Titration

**Objective**

In this experiment, we aim to determine the concentration of triethylamine by titrating 1% acetic acid. From the amount of used acetic acid, the concentration of triethylamine can be calculated.

**Introduction**

Titration is commonly used to determine unknown concentration of solution. Titrant of known concentration is added to unknown analyte until the end point is reached. Titration can be used to find the precise amount of acid needed to neutralize base, and vice versa. In this experiment, standard acetic acid is used to determine the concentration of triethylamine.

Neutralization is the reaction between acid and base to form salt and water. In the process of neutralization, $H^+$ ion from acid reacts with $OH^-$ ion from base and it is an exothermic reaction which means heat is released. Acid-base titration is one of the most well-known titrations. In fact, titration has various applications in daily life such as analysis of wastewater samples, rain acidity analysis, determination of nutrition etc.

**Theory**

- Titration is one of the methods to determine the concentration of analyte solution. This is conducted by adding standard solution until the endpoint is reached. With the addition of indicator, endpoint can be observed with an observable color change.

- Trimethylamine and ethanoic acid are used in this experiment. Trimethylamine is a strong base that neutralization occurs with ethanoic acid, and its structure is similar to $NH^3$.

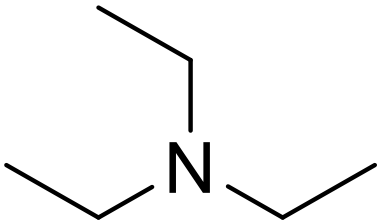
- pH is a quantitative unit of measure to describe the acidity of a substance with a scale of 0 to14, with 0 means the most acidic and 14 least. The equation of pH is pH= -log$[H^+]$

- pH meter, pH indicator and pH paper can be used to determine the pH of solutions and different method have different accuracy on pH. In this case, phenolphthalein is used. Phenolphthalein is colorless at condition under pH 8.2 and a pink at condition over pH 8.2.

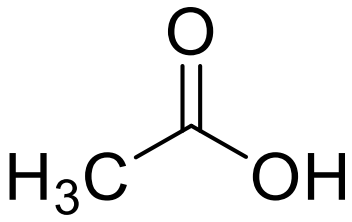
- It is better to conduct a trial before collection of data. In the case of titration, it should be carried out quickly to determine the approximate volume used that reach the endpoint. It is then easier to find the precise volume for titration and less time consuming.

**Chemical Reagents**

- Unknown concentration of trimethylamine solution
- 1% ethanoic acid
- Phenolphthalein



**Triethylamine**




**Ethanoic acid**

**Procedure**

1. Log in the experiment module "Titration" on the Borderless Lab 365 platform. https://stem-ap.polyu.edu.hk/remotelab/
2. In this experiment, pump is used instead of burette. There are two modes for the pump, 0.24cm$^3$ flow and 0.024cm$^3$ flow for adding acid to the alkaline. Maximum amount of adding acid is 3cm$^3$.
3. Use the 0.024cm$^3$ option when you find the accurate and precise volume.

Start the experiment

Trial

4. Wash the glass tube by pressing "WASH". (Note: you can wash the glass tube 4 times only throughout the session.)
5. Add 1.44cm$^3$ of triethylamine (Base) into the test tube by pressing "1.44cm$^3$" under the column of "Adding Base".
6. Perform the trial by adding acid to the base by pressing "0.24cm$^3$" under "Adding Acid" until there is an observable color change
7. Press "SHAKE" to shake the test tube to ensure there is reaction between acid and base.
8. Record the volume used, the approximate volume of acetic acid required to neutralize triethylamine.

Experiment

9. Wash the glass tube by pressing "WASH".
10. Add 1.44cm$^3$ of triethylamine (Base) into the test tube by pressing "1.44cm$^3$" under the column of "Adding Base".
11. With acknowledgment of the approximate amount of acid required, use the 0.24cm$^3$ flow to add acid to the base until the volume of acid added is close to the approximate volume

12. Use the 0.024cm$^3$ flow slowly until the end point is reached
13. Press “SHAKE” to shake the test tube to ensure the acid react with the base
14. Record the volume used.
15. Repeat step 9 to 14 again.
16. Wash the glass tube again at the end of experiment, and then press “LOGOUT” on the left.

**Experimental Data**

Color change: _____ to _____

| | **Trial** | **Test 1** | **Test 2** |
|---|---|---|---|
| **Amount of acetic acid used (mL)** | | | |

Average acetic acid used: _____

**Discussion**

1. State the chemical equation involved.
2. What is the mole ratio of trimethylamine to ethanoic acid?
3. Write down the ionic equation for this experiment.
4. Given that the molarity of 1% ethanoic acid is 0.175M. Calculate the concentration in molarity for triethylamine.
5. Suggest a possible error for the experiment.