ScienceCube

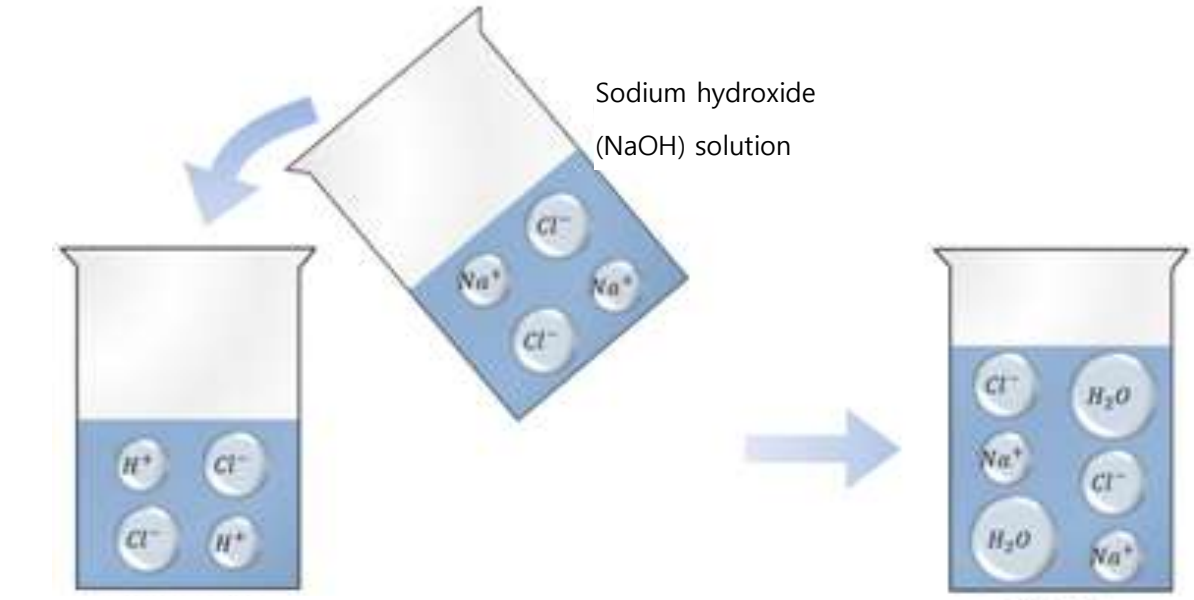
Neutralization Reaction

1. **Explain the temperature change during a neutralization reaction.**
2. **Understand the ionic reaction of neutralization and express it using an ionic equation.**

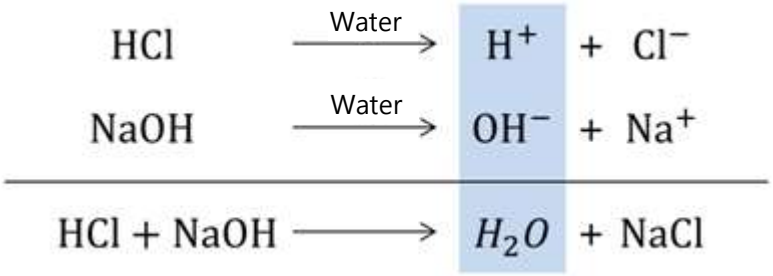
Fundamental Concept

1. Neutralization Reaction

A reaction in which an acid and a base react to form water and a salt..



<Neutralization Reaction of Hydrochloric Acid and Sodium Hydroxide>



<Ionic Reaction of Hydrochloric Acid and Sodium Hydroxide>

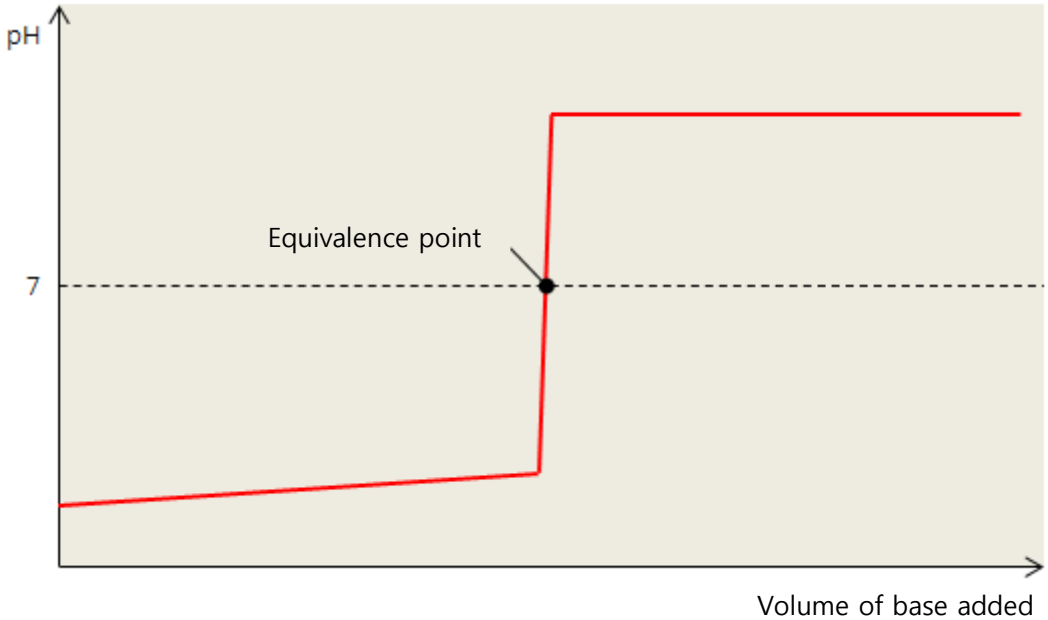
① Net Ionic Equation:

$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

H+ and OH- react in a 1:1 ratio.

② Equivalence Point:

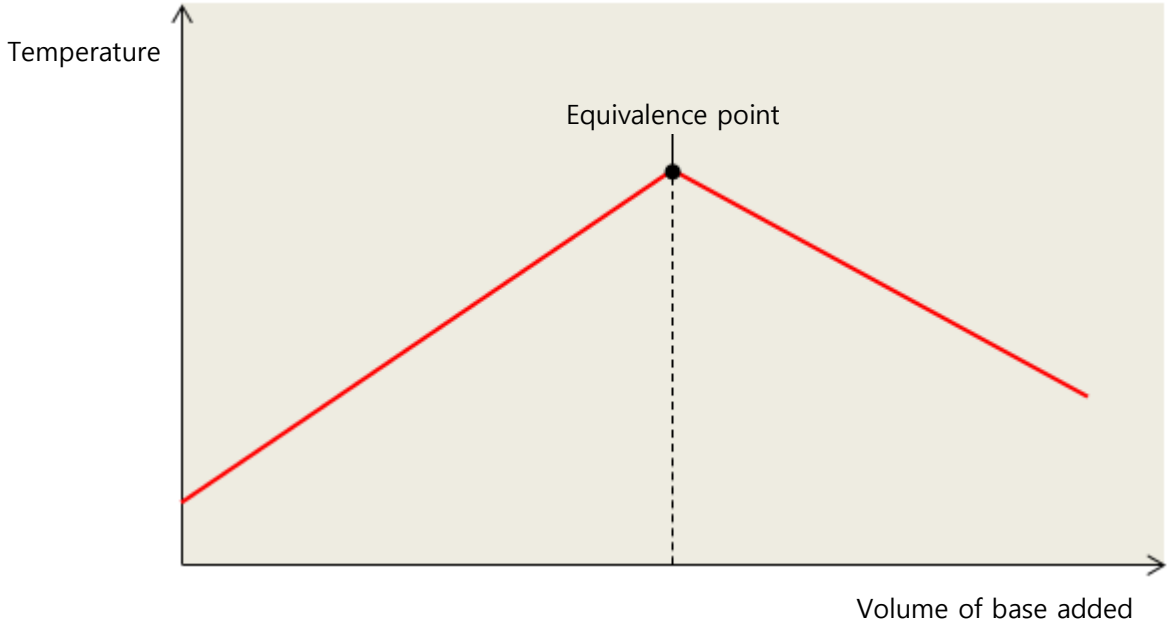
The pH increases gradually and then rises sharply at the equivalence point. At this point, hydrogen ions (H+) and hydroxide ions (OH-) always react in a 1:1 molar ratio to form water.



< Neutralization Reaction pH Curve >

③ Heat of Neutralization:

The heat generated during a neutralization reaction. When a given amount of acid is neutralized by a base, the temperature initially rises, reaching its peak at the equivalence point, and then gradually decreases as no further neutralization occurs.



< Neutralization Reaction Temperature Curve >

Experiment

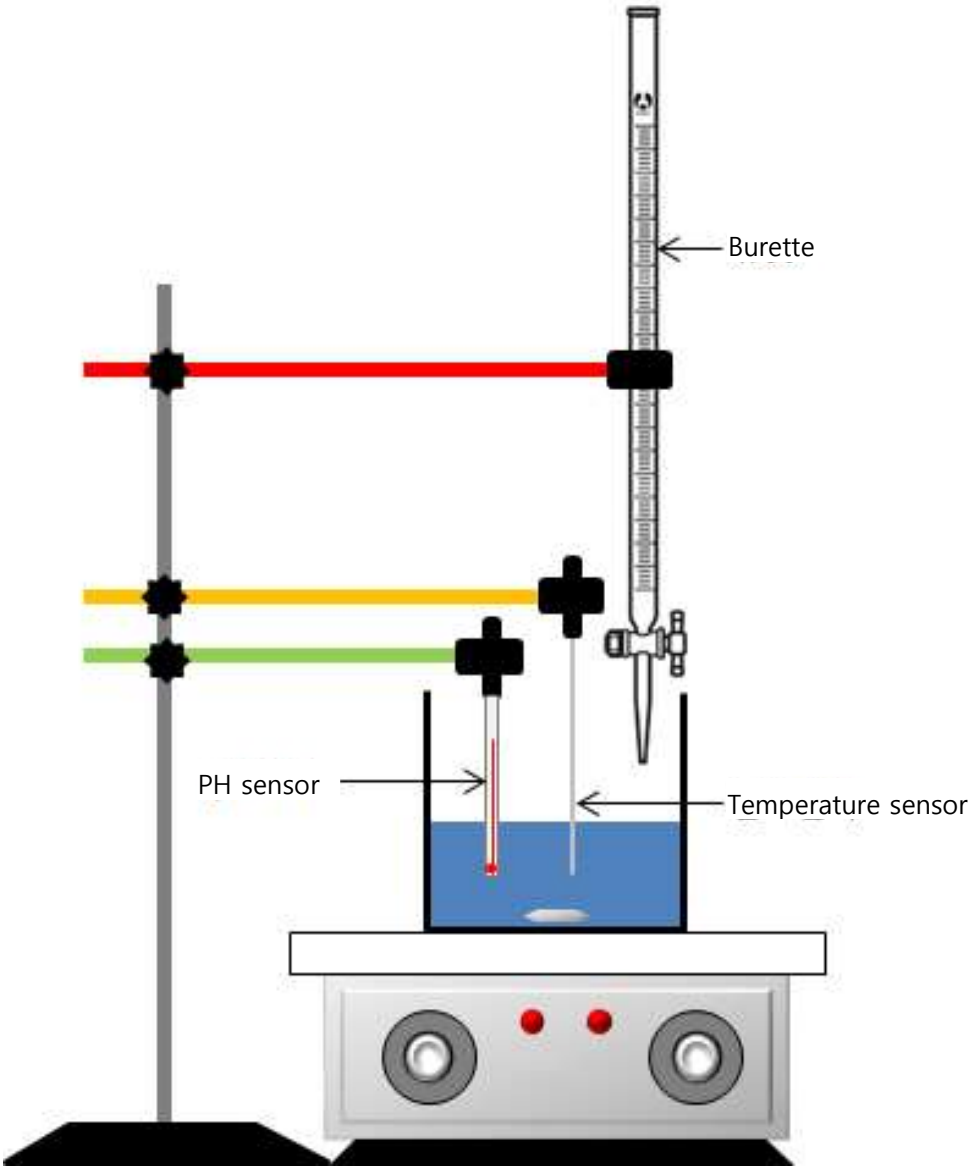
Materials Needed

Interface, Science# Program, pH Sensor, Temperature Sensor, 0.1M Hydrochloric Acid (50 mL), 0.1M Sodium Hydroxide (60 mL), pH Standard Solutions (pH 4, pH 7, pH 10), 100 mL Burette, Stirrer, Stirring Magnet, 250 mL Beaker, Distilled Water, Dropper, Filter Paper, Stand, Clamps (3)

Preparation of Experimental Setup

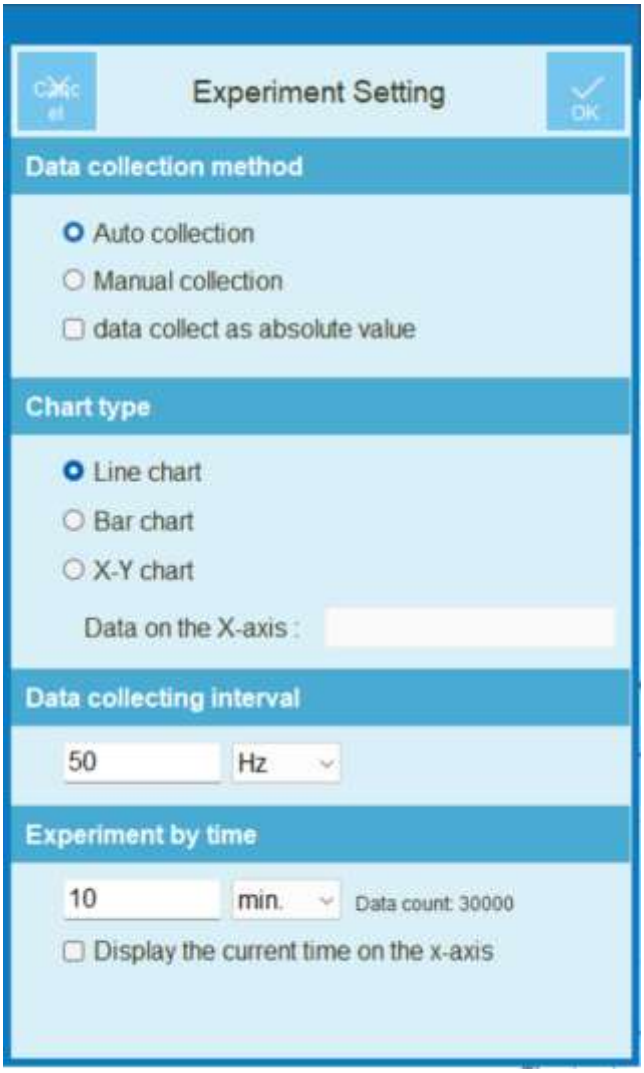
1. Add 50 mL of hydrochloric acid solution (HCl) to a beaker and place it on the stirrer.
2. Add the stirring magnet to the beaker.
3. Fill the burette with 60 mL of sodium hydroxide (NaOH) and fix it to the stand.
4. Rinse the pH sensor electrode with distilled water and lightly dry it with filter paper.
5. Fix the pH sensor and temperature sensor in the stand so that they are submerged in the hydrochloric acid.

   Tip: Adjust the position to prevent the stirring magnet from hitting the sensors.



Interface Setup

1.  Launch the Science# program.
2. Connect the pH sensor and temperature sensor to the interface..
3.  Press to calibrate the pH sensor..
4. To calibrate the pH sensor, immerse it in a pH 10 standard solution and press  to calibrate.
5. Calibrate with pH 7 and pH 4 standard solutions in the same way, and press  to complete the calibration.
6.  Press to set up the experimental environment as shown below, or use the automatic setting option. 



Automatic setup

Data Collection

1. Press to start data collection.
2. Adjust the burette to release 3-5 drops per second.
3. Observe the changing pH and temperature values over a fixed period.

Data Analysis

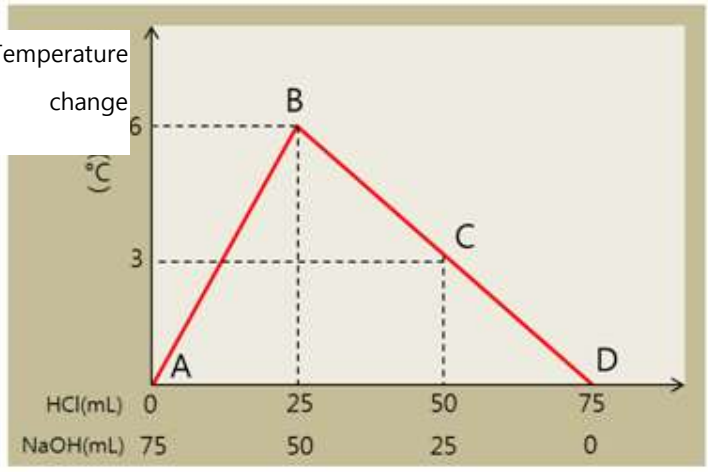
Recording Data

1. Neutralize the hydrochloric acid solution (HCl) by adding the sodium hydroxide solution (NaOH) and plot the changing temperature and pH values over time on a graph.

2. Describe how the temperature and pH values changed at the equivalence point..

Data Application and Extension Activities

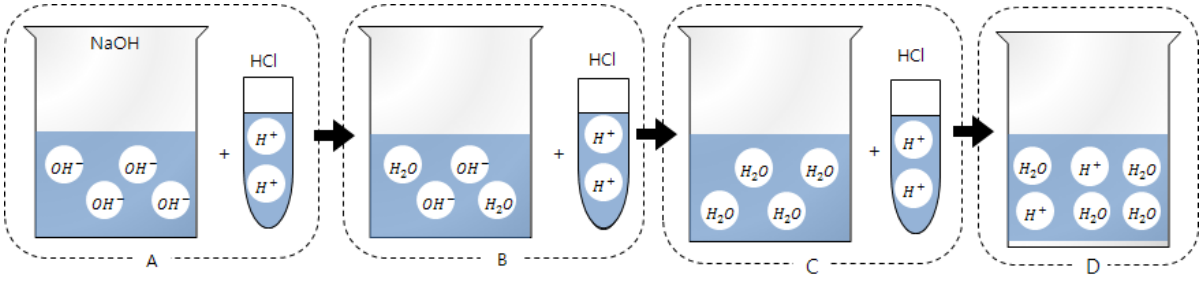
1. The following graph shows the temperature changes of various mixed solutions with different volumes of hydrochloric acid (HCl) and sodium hydroxide (NaOH) solutions. Calculate the ratio of Cl- to Na+ ions in solution C and explain the reason using the concentration ratio of HCl and NaOH solutions. (Assume the initial temperature of all solutions is the same.)



2. The following table shows the volumes of the same concentration of dilute hydrochloric acid and sodium hydroxide solutions mixed differently. Use inequality signs to compare solutions A, B, and C based on the following factors..

Solution	A	B	C
Dilute Hydrochloric Acid Solution (mL)	20	25	30
Sodium Hydroxide Solution (mL)	30	25	20

3. The following diagram shows the model of hydrogen ions and hydroxide ions in a sodium hydroxide (NaOH) solution when a dilute hydrochloric acid (HCl) of the same concentration is gradually added. (Na+ and Cl- are not shown.)



Explain the change in the number and concentration of Na+ from stage A to D.