Creating a Titration Curve Using Hydrochloric Acid and Sodium Hydroxide

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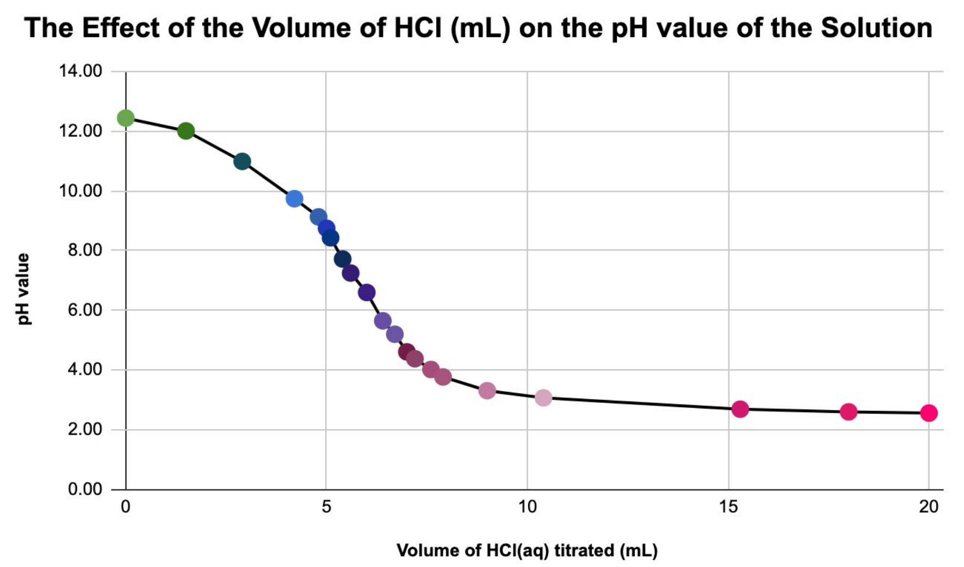
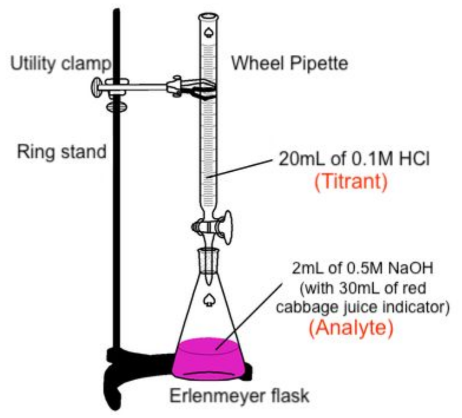
Titration Curve (graph)

The below graph shows the effect of the volume of HCl (mL) on the pH value of the solution and displays the color of the pH indicator in each pH value of the data points.



Titration Lab Set-Up

Setup Picture

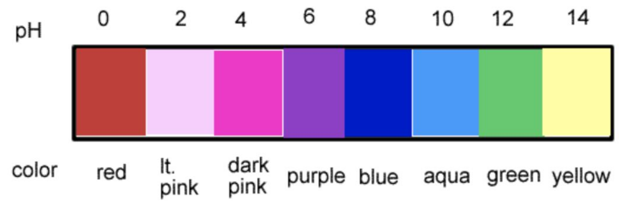


Description of setup and how equipments are used

The titration setup looks like the picture on the left. First, the ring stand is set on the table and the utility clamp is attached on the top part of the ring stand. Then, the wheel pipette containing 20 mL of 0.1M $HCl_{(aq)}$ is held by the utility clamp. The Erlenmeyer flask containing 2 mL of 0.5M $NaOH_{(aq)}$ and 30 mL of red cabbage juice pH indicator is placed directly below the wheel pipette.

Background Information of the Red Cabbage Juice pH Indicator

Red Cabbage Color changes with pH

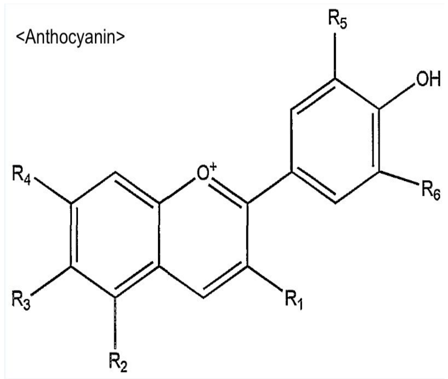


1. What does it look like?

A pH indicator is a substance that changes color based on the pH level of the solution. In this titration experiment, the liquid red cabbage juice was used as the pH indicator for representing the approximate pH of the titrated solution. The red cabbage juice indicator is seen as purple-bluish color when the pH is equal to or near 7, indicating that the substance is neutral. Its color becomes red and pink when the pH is below 7, indicating that the substance is acidic. Finally, the color becomes blue, green, and yellow when the pH is above 7, indicating that the substance is basic.

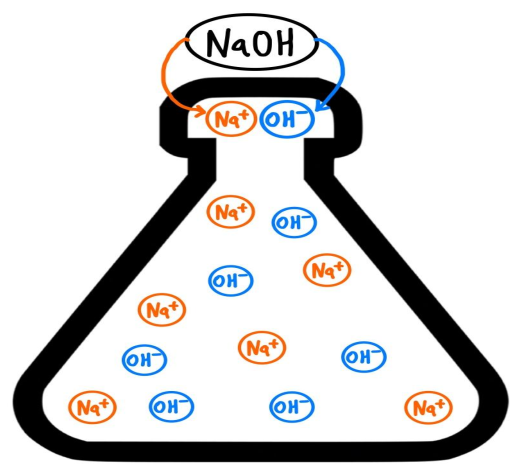
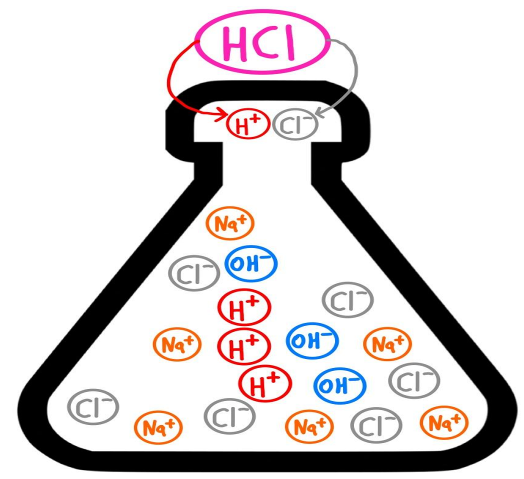
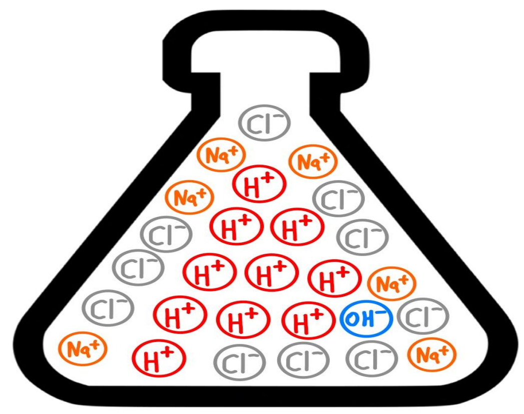
2. How does it work?

The red cabbage juice contains anthocyanin, which is a water-soluble pigment. Anthocyanin is the substance that actually forms the purple color of the red cabbage. Furthermore, anthocyanin also has a property of changing its color to red and pink when acidic, and to blue, green, and yellow when basic by shifting its molecular structure. Therefore, the red cabbage juice works as an indicator for this acid-base titration lab.



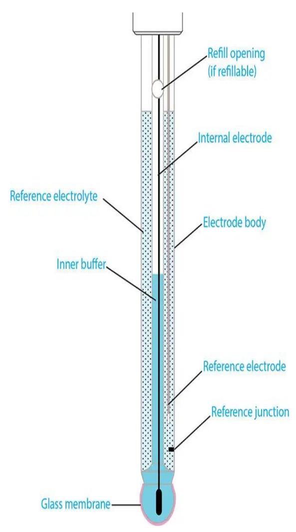
Balanced Neutralization Reaction (chemical equation)

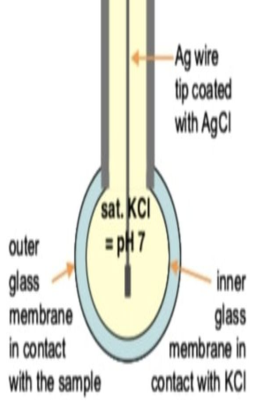
$$NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(\ell)}$$

Beginning	Middle	End
Base (pH > 7)	**Neutral (pH = 7)**	**Acid (pH < 7)**
		
The ratio of Na^+ ions and OH^- ions are equal (1:1) because the ions are dissociated in equal amounts. The pH is close to 12 at this point, meaning that the solution is basic containing almost no H^+ ions.	In the neutral state of the solution, the molarity of H^+ and the molarity of OH^- are equal (1:1) because the pH and pOH are both equal to 7. H^+ and OH^- neutralize each other, producing water molecules. There are some remaining H^+ and OH^- in solution.	The molarity of H^+ ions is much higher than the molarity of OH^- ions, indicating that the solution is acidic. As a result, the pH of the solution is close to 2. There are very little OH^- ions remaining in the solution.

pH probe Diagrams and Descriptions

<pH probe with parts labeled>





<Description of Parts>

① **Internal Electrode**: A silver wire covered with silver chloride. (Ag/AgCl wire)
② **Reference Electrode**: Usually same material with the internal electrode. (Ag/AgCl wire)
③ **Glass Membrane**: Contains the buffer solution of KCl (pH = 7) inside the probe with the Ag/AgCl wire.

<How It Works>

The glass membrane contacts the solution and measures $[H^+]$. The probe compares the measured $[H^+]$ with the [H+] of the neutral buffer solution (KCl). Then, the internal electrode measures the voltage caused by the difference of those molarity, which is translated to the pH value.

Concentration of $[H_3O^+]$ and $[OH^-]$ at pH of 7 in analyte solution

①
pH = 7
pOH: 14 - 7 = 7

②
$-\log([H_3O^+]) = pH$
$-\log([OH^-]) = pOH$

③
$[H_3O^+] = 10^{-pH}$
$[OH^-] = 10^{-pOH}$

④
$[H_3O^+] = 10^{-7}$
$[OH^-] = 10^{-7}$

$[H_3O^+] = 1 \times 10^{-7}$

$[OH^-] = 1 \times 10^{-7}$

Initial pH value of the HCl solution

① Given Molarity of HCl: 0.1M

② Initial pH of HCl solution: -log([HCl])

③ -log(0.1) = 1

Initial pH of HCl solution = 1

Works Cited

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