

6. Preparing Standard Acid and Base

Hydrochloric acid and sodium hydroxide are the most common strong acids and bases used in the laboratory. Both reagents need to be standardized to learn their exact concentrations. Section 10-5 in the textbook provides background information for the procedures described below. Unknown samples of sodium carbonate or potassium hydrogen phthalate (available from Thorn Smith²) can be analyzed by the procedures described in this section.

Reagents

50 wt% NaOH: (3 mL/student) Dissolve 50 g of reagent-grade NaOH in 50 mL of distilled water and allow the suspension to settle overnight. Na_2CO_3 is insoluble in the solution and precipitates. Store the solution in a tightly sealed polyethylene bottle and handle it gently to avoid stirring the precipitate when liquid is withdrawn.

Phenolphthalein indicator: Dissolve 50 mg in 50 mL of ethanol and add 50 mL of distilled water.

Bromocresol green indicator: Dissolve 100 mg in 14.3 mL of 0.01 M NaOH and add 225 mL distilled water.

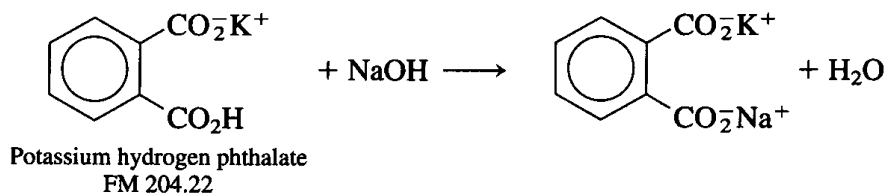
Concentrated (37 wt%) HCl: 10 mL/student.

Primary standards: Potassium hydrogen phthalate (~2.5 g/student) and sodium carbonate (~1.0 g/student).

0.05 M NaCl: 50 mL/student.

Standardizing NaOH

1. Dry primary standard grade potassium hydrogen phthalate for 1 h at 105°C and store it in a capped bottle in a desiccator.

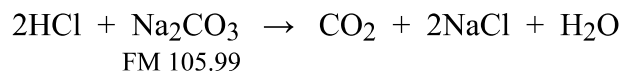


2. Boil 1 L of distilled water for 5 min to expel CO_2 . Pour the water into a polyethylene bottle, which should be tightly capped whenever possible. Calculate the volume of 50 wt% NaOH needed to prepare 1 L of 0.1 M NaOH. (The density of 50 wt% NaOH is 1.50 g per milliliter of solution.) Use a graduated cylinder to transfer this much NaOH to the bottle of water. (**CAUTION:** 50 wt% NaOH eats people. Flood any spills on your skin with water.) Mix well and cool the solution to room temperature (preferably overnight).
3. Weigh four samples of solid potassium hydrogen phthalate and dissolve each in ~25 mL of distilled water in a 125-mL flask. Each sample should contain enough solid to react with ~25 mL of 0.1 M NaOH. Add 3 drops of phenolphthalein to each flask and titrate one rapidly to find the end point. The buret should have a loosely fitted cap to minimize entry of CO_2 from the air.
4. Calculate the volume of NaOH required for each of the other three samples and titrate them carefully. During each titration, periodically tilt and rotate the flask to wash all liquid from the walls into the bulk solution. Near the end, deliver less than 1 drop of titrant at a time. To do so, carefully suspend a fraction of a drop from the buret tip, touch it to the inside wall of the flask, wash it into the bulk solution by careful tilting, and swirl the solution. The end point is the first appearance of faint pink color that persists for 15 s. (The color will slowly fade as CO_2 from the air dissolves in the solution.)
5. Calculate the average molarity (\bar{x}), the standard deviation (s), and the percent relative standard deviation ($= 100 \times s/\bar{x}$). If you were careful, the relative standard deviation should be $< 0.2\%$.

Standardizing HCl

1. Use the table inside the cover of the textbook to calculate the volume of ~37 wt% HCl that should be added to 1 L of distilled water to produce 0.1 M HCl and prepare this solution.
2. Dry primary standard grade sodium carbonate for 1 h at 105°C and cool it in a desiccator.
3. Weigh four samples, each containing enough Na_2CO_3 to react with ~25 mL of 0.1 M HCl and place each in a 125-mL flask. When you are ready to titrate each one,

dissolve it in ~25 mL of distilled water. Add 3 drops of bromocresol green indicator and titrate one rapidly to a green color to find the approximate end point.



4. Carefully titrate each sample until it turns from blue into green. Then boil the solution to expel CO_2 . The color should return to blue. Carefully add HCl from the buret until the solution turns green again and report the volume of acid at this point.
5. Perform one blank titration of 50 mL of 0.05 M NaCl containing 3 drops of indicator. Subtract the volume of HCl needed for the blank from that required to titrate Na_2CO_3 .
6. Calculate the mean HCl molarity, standard deviation, and percent relative standard deviation.