# 6. Preparing Standard Acid and Base


Green Profile
See Section 0

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 11-7 in the textbook provides background information for the procedures described below. Unknown samples of sodium carbonate or potassium hydrogen phthalate can be analyzed by the procedures described in this section.

**NOTE**: for expediency the KHP and $Na_2CO_3$ primary standards should both be dried for an hour at 105˚C and stored it in a capped bottle in a desiccator at least one day before beginning the laboratory procedure. The chemical storeroom personnel will do this for the class.

**NOTE**: similarly it is advisable to boil the 1 L of distilled water for preparing the dilute NaOH solution prior to beginning the lab.

**Do not discard the solutions which you are preparing. They are used in Exp. 7 and 8!**

### Reagents

*50 wt% NaOH:* (6 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solution in a tightly sealed polyethylene bottle and handle it gently to avoid stirring the precipitate when liquid is withdrawn.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.

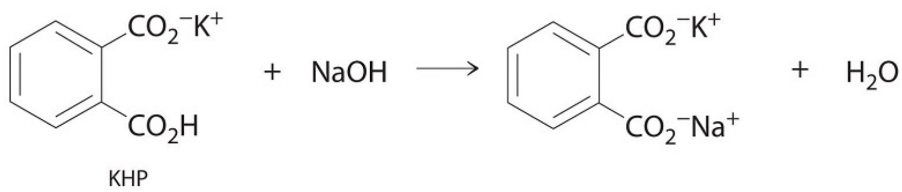
*Bromocresol green indicator:* Dissolve 100 mg in 14.3 mL of 0.01 M NaOH and add 225 mL distilled water.

*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




Potassium hydrogen phthalate
FM 204.22

**2.** Boil 1 L of distilled water for 5 min to expel $CO_2$. (**prepare boiled water before lab**) 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 (or cover with plastic wrap).

**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. (**dry before lab**)
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.

$$2HCl + \underset{\text{FM } 105.99}{Na_2CO_3} \rightarrow CO_2 + 2NaCl + H_2O$$

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 $Na_2CO_3$. This step can be omitted.
6. Calculate the mean HCl molarity, standard deviation, and percent relative standard deviation.

**Be sure to save the acid and base solutions you have standardized. They will be used in Exp. 7 and 8.**