ChemCollective: Standardization of NaOH with a KHP solution: Acid Base Titration
UIC, Department of Chemistry

Learning Objectives:
To apply principle of titration to accurately quantify concentration of a strong base solution (NaOH).

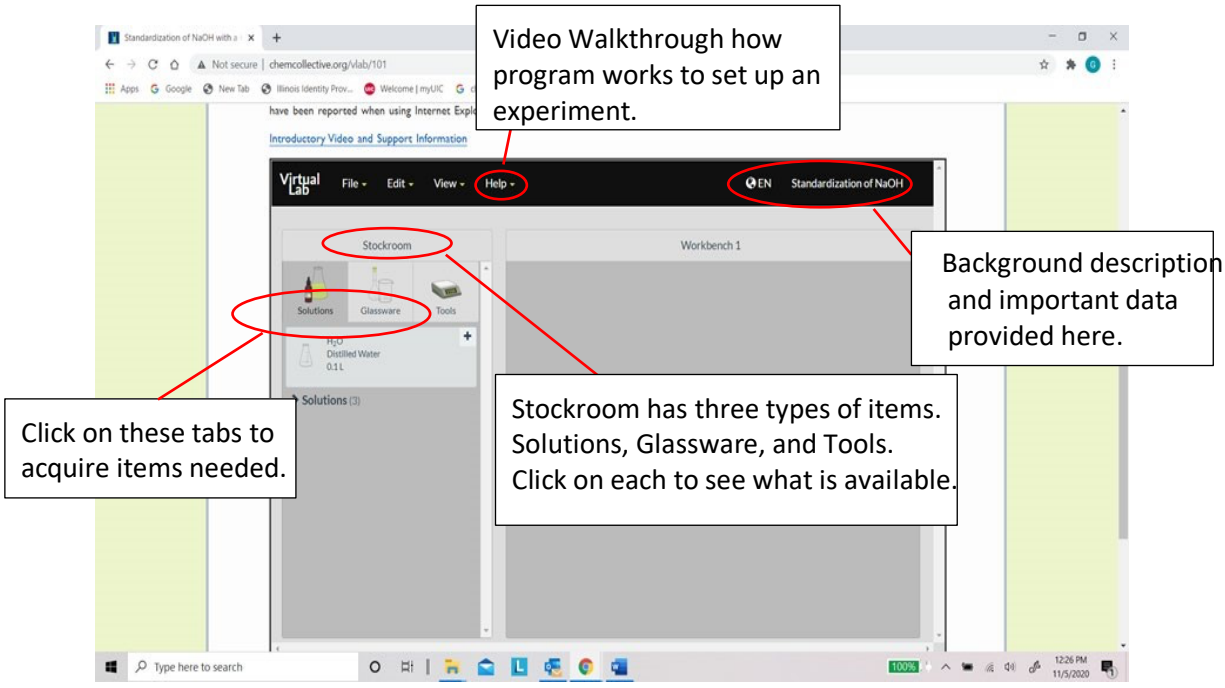
Experimental Objectives:
Quantitatively measure out a known mass of a primary standard, potassium hydrogen phthalate or "KHP" for short and titrate it with NaOH solution to accurately determine NaOH concentration.

Background Conceptual References:

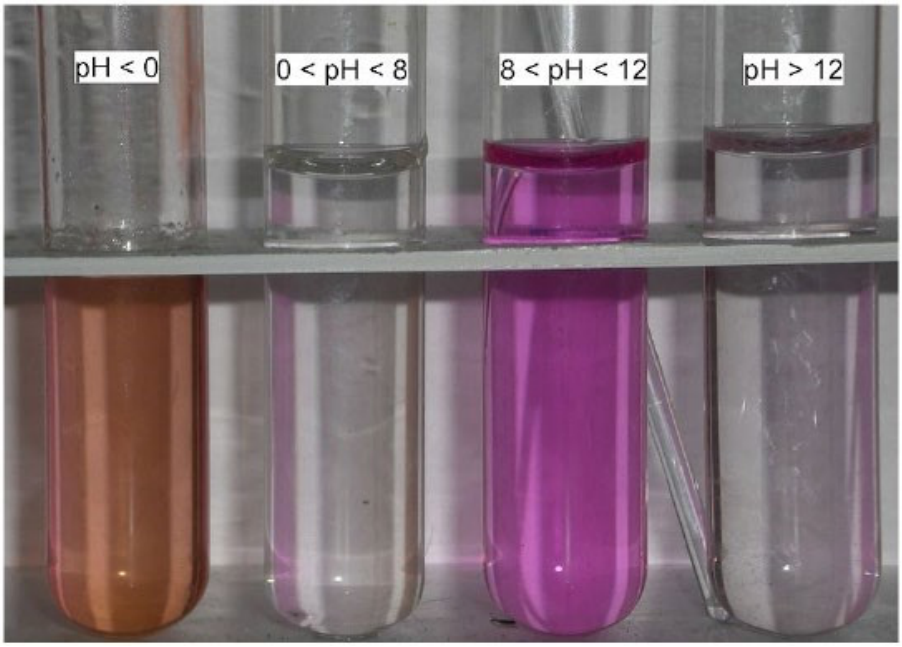
1. For general information on
Stoichiometry of Acid-Base Reactions: Acid-Base Titration go to Chem 122 textbook: Chemistry The Molecular Nature of Matter and Change, Advanced Topics, 9th ed. Chapter 4, Sect. 3 pages 169-171.

2. For calibration procedure of a glass buret and standardization of NaOH with KHP see:
https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Analytical_Sciences_Digital_Library/Active_Learning/Shorter_Activities/Buret_Calibration_and_Stardardization_of_NaOH_Solution

Procedure:
Go to http://chemcollective.org/vlab/101 and click on "Standardization of NaOH" in the upper right-hand corner. There you will find an overview how to do this experiment.



In this virtual experiment, you will need to set up an acid-base titration using "KHP" solution (actually the anion of KHP, hydrogen phthalate ion) as the weak acid and NaOH solution as strong base. Here we will use the NaOH as titrant (solution in buret) and KHP solution as the analyte (solution under buret). You will use phenolthalein as the color indicator to determine the end point of the titration. Phenolthalein is clear in mildly acidic solution and has a persistent, faint light pink color when endpoint of titration is reached. (pH slightly above pH=7). When endpoint over-shot the solution with indicator turns dark pink as shown in Figure below.

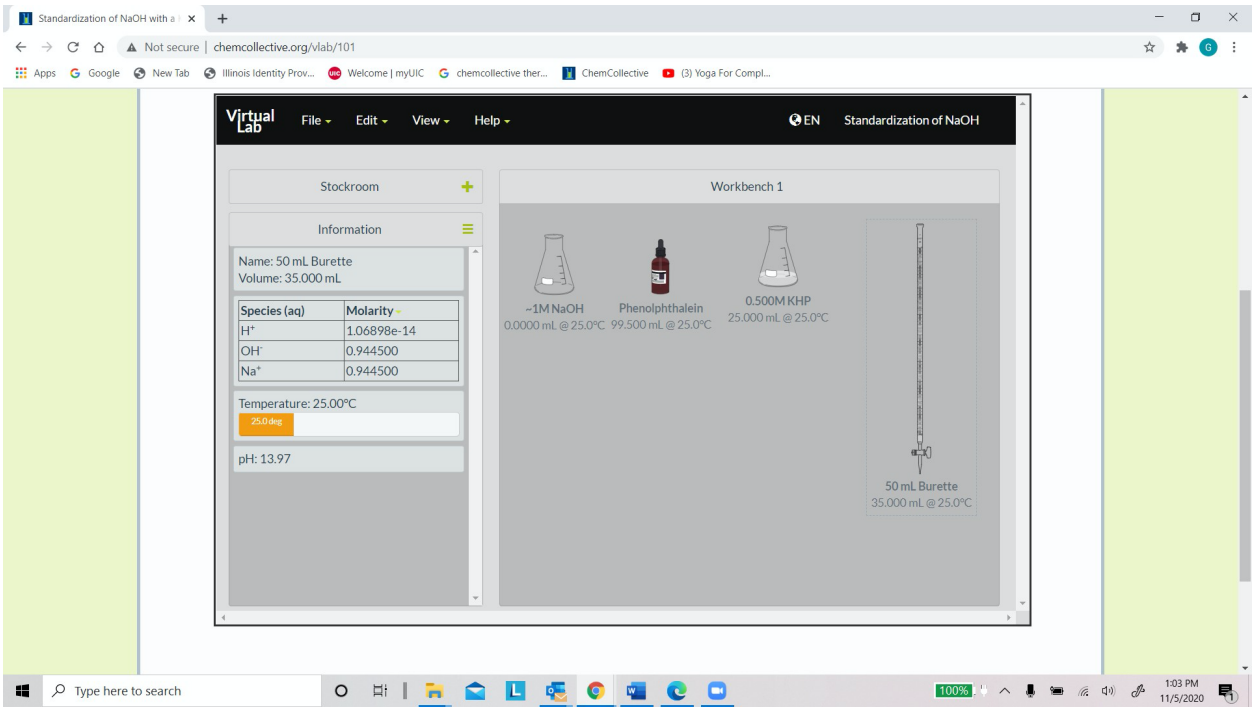


Color of phenolthalein solution as function of pH taken from:
https://chem.libretexts.org/Bookshelves/General_Chemistry/Book%3A_ChemPRIME_(Moore_et_al.)/14%3A_Ionic_Equilibria_in_Aqueous_Solutions/14.09%3A_Indicators.

Reagents:
Now to set-up the titration you will need from the stockroom the following items.
Click on the + sign to the right of items you want on your workbench

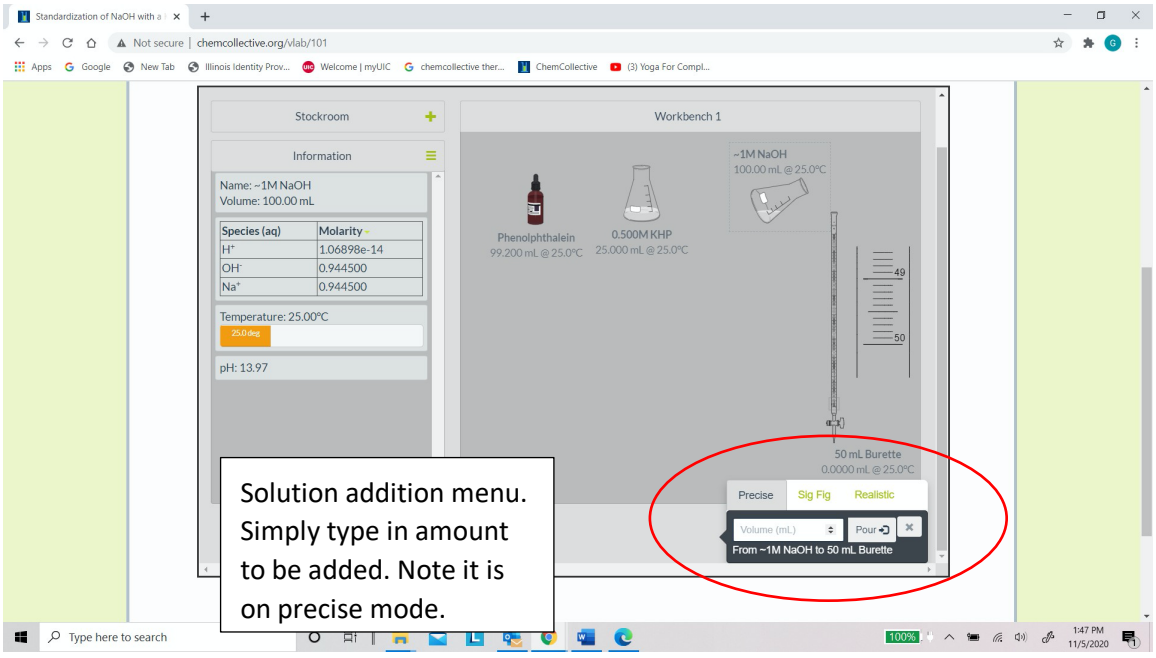
- under solutions tab:
  - 25.00 mL of 0.500 M "KHP"
  - solution of ~ 1 M NaOH
  - solution of phenolthalein indicator under glassware tab:
- under glassware tab (listed under "other"):
  - 50 mL buret
  - Despite what instructions say, you will not need disposable pipette

Do a print screen of your virtual lab bench with the required items on your workbench as below. Do not make it look identical to that below.



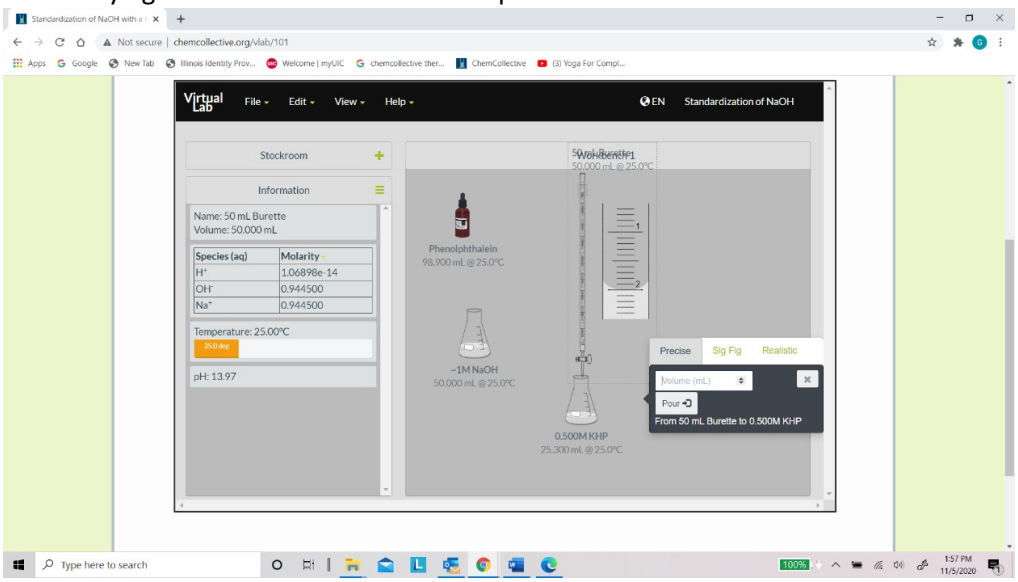
Here is the detailed procedure to follow.

1) Fill the buret with 50.00 mL of ~1 M NaOH. Do this by click and dragging the ~1 M NAOH to the top of buret and you should see a solution addition menu pop up as shown below. Type in 50.00 mL and press enter on keyboard. Each time you press enter on keyboard the amount on display is added. **The buret will likely show volume reading of 2.00 mL after 50.00 mL addition**. **This is your initial buret reading.** It doesn't show 0.00 mL because some solution volume is taken up in volume region around stopcock. Note that <u>below the buret</u> you will see the volume of solution it contains.



2) Add ~ 0.3 mL of phenolthalein solution to the "KHP" solution in similar way. Click and drag phenolthalein solution to top on KHP solution and the bottle automatically opens and a dropper is in position to add to KHP solution. Note you should see the new volume of KHP with added phenolthalein added below the KHP solution after addition is made.

3) Here is the tricky part. The program is a little finicky here. Click and drag the filled buret to the top of the KHP solution containing phenolthalein. You may have to actually lower the tip of the buret to the top of the KHP solution to get this. If doesn't work first time try moving the items to different position and try again. You should see the set-up similar to that below.



Do a print screen and save this image for you report as well before titration.

4) Now the procedure in ChemCollective says to add 0.5 mL amounts of NaOH from the buret to the KHP solution. That will be a lot of additions and quite painstaking in a real lab titration. We can do better than that by being smart. In your notebook, calculate the expected volume of NaOH required to reach the endpoint of titration assuming the NaOH is 1.00 M. That will give you an approximate volume of NaOH to reach endpoint. **You'll need to show this calculation in your lab report.** Then add ~75% of that amount. From there, add 0.20 mL amounts of NaOH until you see color change of the KHP solution.

Do a print screen of your set-up at the endpoint you reached for your report.

Congratulations! You did the titration and can now accurately calculate the concentration of the NaOH from your titration data. The volume of NaOH added to reach endpoint should be calculated as final buret reading minus initial buret reading. You will, of course, **need to show this calculation in your report with all numbers with units and correct sig figs.**

In a real lab experiment, this would be done multiple times to access precision in the results. For this report, once is sufficient.

Lab Report Expectations:

Report to be typed or neatly handwritten/printed or combination of both. In the end, the entire report needs to be composed into a single pdf document including post-lab questions and uploaded.

For your lab report, make sure to organize into the following components as a single file document such as Word. Then convert it into a single pdf file and upload into Labflow.

Header Information: Your FULL name, Lab section (TA/day/time), FULL name of expt., date of expt.

Procedure: In your own words provide a brief description of how you set-up the titration including glassware, solutions, and amounts. Do not need to explain how to use ChemCollective controls – just how the experiment is set-up. **Copy and paste your print screen images in this section of report and label them accordingly. You need 3 screenshots all together.**

Results:

Present the data in tabular form. Show both your approximate calculation of volume of NaOH required (assuming 1 M NaOH) and your calculation of actual concentration of NaOH used in the titration. Make sure to use correct sig figs and all numbers have units.

Conclusion: Summarize results by giving the concentration of NaOH with correct sig figs and units.

Answer post-lab questions below.

Post Lab questions:

Indicate how your calculated NaOH concentration would be in error (is it higher, lower, or unaffected by the following details of the titration. In each case, explain your reasoning.

a) You over-shot the endpoint
b) While titrating you noticed drops of solution clinging on the inner walls of the buret above the solution level
c) You added ~10 mL of water to the KHP solution while titrating
d) You noticed an air bubble trapped in stopcock which is no longer present at end of titration.