Experiment 4: Practice Titration

A "*titration*" is a common laboratory method of quantitative chemical analysis that is used to determine the unknown concentration of a known analyte. Titrations belong to class of analytical techniques known as "volumetric analysis". Since volumes can be precisely delivered and measured using standard laboratory equipment, titration techniques can yield both accurate and precise measurements if care is taken by the analyst. Accuracy is defined as the closeness of a result (usually the average of several measurements) to a known accepted value. Precision relates the closeness of the measurements themselves. In any analytical experiment, one strives for both accuracy and precision to validate the results.

In this experiment you will be graded on both your accuracy (how close you are to the actual value) and the precision of your results. (how reproducible they are)

In a titration an analyst titrates a solution of unknown concentration with a solution of known concentration (aka a standard solution). The stoichiometry of the reaction between the standard and the analyte is known.

Using a calibrated "buret" to add the standard solution, it is possible to determine with accuracy the amount of analyte present in the unknown solution when the titration endpoint is reached. The endpoint of a titration is that point at which the titration is complete. The endpoint is generally signaled by an indicator (see below) that was added to the analyte solution. This is ideally the same volume or very close to as the equivalence point—the volume of added titrant at which the number of moles of titrant is equal to the number of moles of analyte, or some multiple thereof. In the classic strong acid-strong base titration, the endpoint of a titration is the point at which the pH of the reactant is just about equal to 7, and often when the solution takes on a persisting solid color as in the pink of phenolphthalein indicator used in this experiment.

At the equivalence of a titration, the moles of the analyte are calculated which may yield quantitative information such as concentration (moles/L) or molar mass (g/mol).

The ability to perform a titration experiment well is a crucial skill that all general chemistry students must master. You will be conducting a titration for the next lab and, since most of you have yet to perform such experiments, we are offering you a chance to practice beforehand. Recall, as they say, “practice makes perfect.”

The goal of this experiment will be to practice and perfect your volumetric techniques using pipetes and a buret in preparation for experiment 5.

Your lab instructor will demonstrate proper pipet and titration techniques.

Please pay close attention. You may wish to practice filling a pipet with deionized water before you start.

Experimental:

1. Using a volumetric pipet and a bulb, pipet 5.00 mL of 0.5 M HCl(aq) into a 125 mL Erlenmeyer flask (record the exact concentration (moles/L) written on the container).

Add ~20 mL of deionized water to the Erlenmeyer flask. This addition of water does not have to be exact. The water is added to provide enough volume to clearly see the indicator color change at the endpoint of the titration. Add **2 or 3** drops of phenolphthalein indicator to the flask.

2. Retrieve a buret from the wooden case in your lab. Inspect it carefully to see that the glass end to the stopcock is not plugged and that the stopcock does not leak. Empty the buret into the sink (save the stopper) and rinse your buret with a small amount of deionized water (~10 mL) three times.

Retrieve ~100 mL of the "Practice Base" in a 250 mL beaker. **BE SURE TO USE THE BASE IN THE CARBOY LABELED <u>PRACTICE</u> BASE**.

Close the stopcock and rinse your buret with a small amount of the practice base (~5 mL) three times. On the third rinse, allow the base to drain from the stopcock. You can use one of your large beakers to collect waste. Empty the waste beaker into the sink at the end of the experiment.

3. Fill your buret with the practice base (~0.1 M NaOH(aq)), making sure that there are no air bubbles in the stopcock tip. **(Make sure that the stopcock is closed first!)**

Record the initial buret reading on the data sheet provided. **All volume recordings should be to ±0.05 mL!** Carefully place your stir bar into the Erlenmeyer flask, placing the flask on a stir plate under your buret. Turn on the stir knob so that the bar gently spins. Add the base slowly with until you see a **FAINT** pink color remain. (Alternatively you may swirl the flask by hand if you wish) When the faint pink persists you have reached the titration endpoint. Record the final buret reading (±0.05mL). If you empty an entire buret and no pink is seen, then you have likely forgotten the indicator. Start over! A bright or dark pink means you added too much base, overshooting the endpoint. If this happens ignore this run and perform another trial. There should be sufficient base left in your buret to run another trial without refilling your buret. Use your final reading from this trial to be the initial reading for the next titration. This will reduce waste.

4. Use your titration data to calculate the "standardized" concentration (accurate and precise concentration) of the practice base.

$$\underset{\uparrow}{\text{mL } H^+} \rightarrow \underset{\uparrow}{\text{mols } H^+} = \underset{\uparrow}{\text{moles } OH^-} \rightarrow \text{M(mols/L) NaOH}$$

$M(HCl)$ Mole Ratio Vol of Base

5. Show your lab instructor your average standardized base concentration to check with the known value.

Practice Titration Data Sheet **Name**: _____
(Due at the end of the lab period) **Section:** _____

	Trial 1	**Trial 2**	**Trial 3**
Initial buret reading	_____	_____	_____
Final buret reading	_____	_____	_____
Volume base added	_____	_____	_____

Concentration of Acid: _____ M HCl(aq) (from the container)

Calculated moles of acid (H^+)in **5.00 mL** aliquot: _____
(show your calculations)

Calculated M (mols/L) of practice base:

Trial 1	Trial 2	Trial 3
_____	_____	_____

(show a sample calculation for one trial)

Average standardized practice base concentration (M) _____

Instructor date and initial: _____