This experiment will let us explore and acid-base titration.

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**Titration**

In a titration, we need at least two solutions. One is the analyte. This substance has an unknown value, such as concentration that we need to determine. The other is a standard. We know the concentration of that solution.

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**Titration**

Chang defines titration as “the gradual addition of a solution of accurately known concentration to another solution of unknown concentration until the chemical reaction between the two solutions is complete.” This is a very long way of saying: we have a known and an unknown. We’re going to add one slowly to the other.

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**Picture**

This picture shows how to set up a buret for use. When you dispense liquid from a buret, you are able to accurately and precisely determine the exact volume that is dispensed. Generally, your known, or standard solution will go into the buret, while your unknown or analyte solution will go into a flask or beaker beneath the buret. You will need to use a buret clamp to hold the buret as well as a ring stand to support it. There is a more detailed video on the correct use of a buret located on Blackboard. Please review this video for the details of how to use a buret.

(slide transition)

**Picture**

One of the main things that makes a buret different from other types of glassware is that the volume is measured from the top to the bottom. If you look at the sketch on the left, you’ll see that there is a meniscus in the fluid and that there is a dotted line that shows the bottom of the meniscus. This is where we’ll determine the volume from. When we look at the volume markings on the buret, we see that it starts at zero and goes to one. This marking on the glassware is the 0.5 marking and we see that we’re seven tenths...0.7. The markings on the glassware are to the tenth. We can estimate one additional decimal place beyond those markings. It looks like it’s about 0.74mL on the buret reading. It is always assumed that the last digit is an estimate. It’s ok if it’s not exact. This just indicates that it’s more
than 0.7, but less than 0.8. This is the initial volume of the buret before any liquid is dispensed. On the right side, this is what the buret would look like after the volume has been dispensed. This will be the final volume. If we look at this, we see that we’re between 20 and 21. This time it looks like it’s a bit closer to the 0.7 line than it was in the first diagram. It’s going to be 20.72mL. Remember that second decimal place is an estimate of how far it is between markings on the glassware.

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**Acid-base Titration**

There are different types of titrations that you can do. In this experiment we’ll be looking at an acid base titration. When you react an acid and a base, your products are salt and water. This is also called a neutralization reaction. The exact reaction we’ll be looking at today is the reaction between hydrochloric acid and sodium hydroxide. When they react, it forms the products of sodium chloride and water.

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**Monitor pH**

In order to measure the progress of this reaction, we’ll be looking at the pH. Because this is a neutralization reaction, we will know when the reaction is complete based on the information about the pH. We’ll actually be using a beaker to collect our liquid. We’ll have our buret set up on the ring stand with the buret clamp. We’ll also use another clamp to hold the pH sensor because we don’t want it hitting the bottom of the beaker. It’s okay to attach the clamp for the pH meter to the same ring stand as the buret clamp.

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**Equivalence Point**

This is an example of what you’d see for an acid base titration such as the one we’re doing in lab today. The red line starts at a pH of approximately two. It increases slowly until it reaches the near the equivalence point. Then it increases rapidly. It finishes at a pH of almost 12. At this point, we have far more base in the solution than acid, whereas at the beginning of the reaction, we had far more acid than base. What we want to find out from this graph is the equivalence point. The equivalence point is the point at which the moles of H+ equal the moles of OH-. This doesn’t necessarily mean that the moles of acid equal the moles of base depending on the formula of acid and base. The moles of H+ equal the moles of hydroxide. The red line shows you the actual curve. The blue line is actually the second derivative curve. For those of you that have had calculus, you’re probably familiar with the term second
derivative. For those of you that haven’t, that’s okay. We’re just using the second derivative as a means of helping you identify the equivalence point. When you look at the second derivative curve, you look at the point where the value of the second derivative curve goes from positive to negative. If we trace across here, we’ll see the zero line. Where I’ve drawn the ‘x’ is the equivalence point. We look at the volume based on the data in the data table. In this case, it’s going to be about 3.2. However, I can determine that with more accuracy by looking at the actual data table

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**Stoichiometry**

Now, we know the equivalence point and how much of our unknown solution we used, and we know the concentration and the volume of the known solution we used. Now we need to find the concentration of the unknown. That’s the whole point of doing a titration. We look at the stoichiometry. This is going to be like many other stoichiometry problems you’ve done. The big difference between this stoichiometry problem and others you’ve done is that you’ve looked at the amount of reactant and looked at how much product you’re forming. In this case, we’re going to be comparing the two reactants. For stoichiometry problems, it doesn’t matter whether you’re looking at two reactants, two products or a reactant and a product- as long as you start from a balanced, chemical equation.

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**Experiment Tips**

Now just a few tips to help you along in the experiment:

You need to get two good titration curves. Add small amounts so that you can accurately determine the equivalence point. If you add a large amount and pass up the equivalence point quickly, your data will not be as good. You will have unclear data and an unclear second derivative curve. Always read your volumes carefully. Remember to estimate one more decimal place beyond the markings on your glassware. Rinse your sensor with distilled water between trials. Please use care when handling the pH sensors. They are fragile and can break.

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**Storage of a pH sensor**

When storing the pH sensor, always replace the storage bottle. Make sure it’s approximately half full with the storage solution. Please note that the storage solution is not water. It is a specific solution at a constant pH. The solution is green to help you identify it correctly. If you need additional solution, contact your TA. Once you return the storage bottle back to the pH sensor, make sure that the tip is submerged in the solution. Always store the pH sensors upright so that the tip of the pH sensor remains
wet in the storage solution. If you need help with your storage solution, the calculations, with the second derivative curve or any aspect of this experiment, please check with your TA, go to the learning center, or contact the lab supervisor.