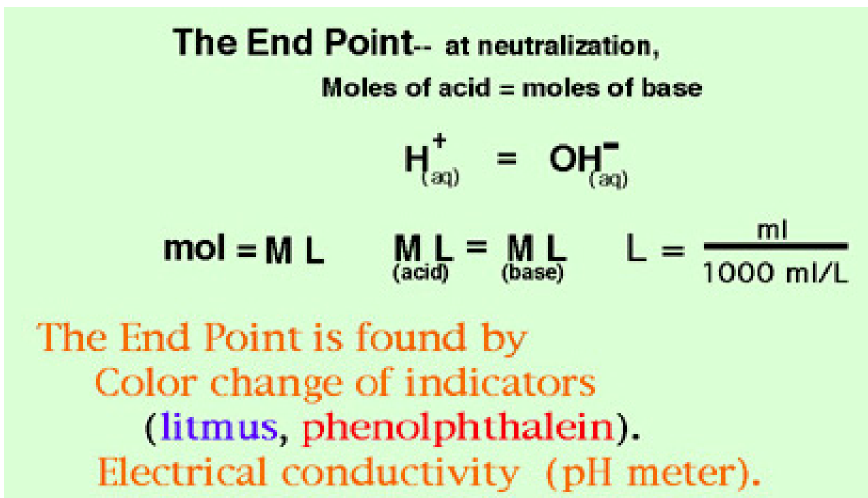
# Experiment 23, Titration

Name ________________________________________ Per ___

*Each student is requested to bring one small sample, about 20 ml, of an acid or base from home. Partners at each table should decide in advance who brings what so that there are no duplicates. Home samples include: ammonia, vinegar, wine, detergent, soap, soft drink, juice.*

**Introduction:** Titration is the process of determining the concentration of a substance in solution by reacting it with a standard reagent of known concentration until the ***EndPoint*** is reached as shown by a color change or by electrical measurement, and then calculating the unknown concentration.

For Acid-Base Titration, the **EndPoint** is the condition at which the moles of acid exactly cancel out the moles of base. Hence the solution is neutral. We shall use the color changes of litmus and phenolphthalein to determine the EndPoint.




**Purpose:** To find the concentration of an unknown base by titrating with an acid whose concentration is known. Then we shall use the base to find the concentration of an a saturated solution of solid acid. Finally we shall use our known acids and bases to find the concentration of samples brought from home.

**Part I:** Finding the concentration of a standard solution of NaOH. **GOGS ON!**

a. Obtain two burets and set them up on the ringstand with a buret clamp. WARNING! Do not accidentally hit the "Bomb Release Mechanism". Burets are expensive! Attach the buret clamps to the rubber tubes and test them with a few ml of water from your wash bottle. No leaks, please.

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Fill the **right hand buret** to about the zero mark with the Standard Acid, **0.1 M HCl**. Fill the **left hand buret** to about the zero mark with the Unknown base, **x M NaOH**. Reading from the bottom of the meniscus, record the **exact** readings for both the **acid** and the **base** to the nearest **0.1 ml**.

Acid = _________ ml .......................... Base = _________ ml

b. Let about 10 ml of the HCl solution to flow into an erlenmeyer flask. Do not record the buret reading at this time. Add **15 ml of distilled water** and **3 drops of phenolphthalein**. Notice that phenolphthalein is colorless in acid and will become pink in base.

c. Titrate to the EndPoint by **slowly** dripping the Unknown Base into the flask while **constantly swirling the flask**.

If you pass the EndPoint, you may **back titrate** by slowly adding more acid to the flask while **constantly swirling.**

d. **The Challenge: At this point we shall see who are the champion titrators:** Those who can make the EndPoint change back and forth such that only one drop of acid or base will make the change. BUT... The weak pink color must last!

e. Now, reading from the bottom of the meniscus, record the **exact** readings for both the **acid** and the **base** to the nearest **0.1 ml**.

Acid = _________ ml .......................... Base = _________ ml

f. Calculate, by taking the difference in readings between **a** and **e** above, the number of ml of acid and base needed to reach the EndPoint.

**Total Acid used _____ ml ........... Total Base used ____ ml**

**Calculations for Part I,** the concentration of the unknown base.

Using the following formula, calculate the **concentration, M, of the NaOH** solution: **The M for the HCl is 0.1 M.** Show your work:

**The End Point-- at neutralization,**

**Moles of acid = moles of base**

$$H^{+}_{(aq)} = OH^{-}_{(aq)}$$

$$\text{mol} = M\,L \qquad \underset{(acid)}{M\,L} = \underset{(base)}{M\,L} \qquad L = \frac{\text{ml}}{1000\ \text{ml/L}}$$

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**So the [NaOH] is ______ M.** This will now by your **Standard Base** for the rest of the lab. Please verify this with Boom or X to be sure that you didn't blow it.

## Part II: Titration of an unknown acid.

a. Obtain a vial of unknown solid acid from The Boom or X. Mass the vial with the crystals to the nearest 0.01 g. Pour the crystals into a clean flask. Do not wash the vial. Mass the empty vial, record its mass, and return it to The Boom or X.

Vial with crystals: ______ g, Empty Vial: ______ g, **Mass of Crystals ______ g.**

b. Dissolve the crystals in the flask with **50 ml of distilled water** and **add 3 drops of phenolphthalein**. (If all the crystals do not dissolve, no panic, they will dissolve during the titration).

c. Refill the **left hand Base buret** with the **NaOH standard base** whose concentration you calculated above.

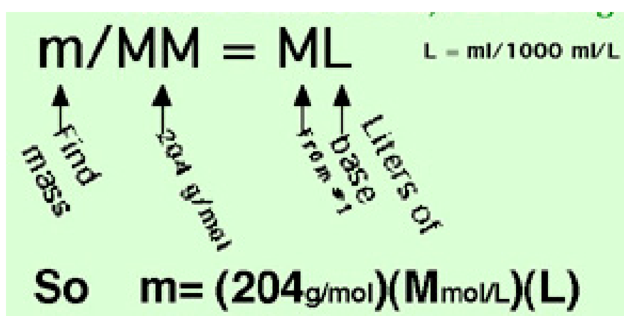
d. Record below in Calculation #1, the **exact** reading for the standard **base** before and after the titration. Find the ml used by taking the difference.

e. **Titrate to the EndPoint.** Be careful, you will not be able to back titrate here.

f. **Calculations for Part II:**

1. Base before = ____ ml ...... Base after = ____ ml ........ **Base used= ____ ml**

2. Solid acid unknown: at the **EndPoint: Mol of acid = mol of base**. So **Solve for the mass of acid whose MM = 204 g/mol.**

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3. Find the **Percentage Error** between your **calculated mass** and the **measured mass** (on the balance) in **Part IIa** above. The error is the difference between your calculated mass and the measured mass.

$$\text{\%-age error} = \frac{\text{error}}{\text{mass weighed}} \times 100\%$$

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## Part III: Samples from home:

a. Using a graduated cylinder, measure 10 ml of your sample into the flask. If your sample is a solid, make a saturated solution of it, then pour 10 ml of it into the flask.

b. Determine whether the sample is an acid or a base by using litmus paper. Remember to dip a stirring rod into the sample and touch it to the litmus papers. This way the paper can be used many times. Return used litmus to The Boom or X for recycling. **Litmus turns reD in aciD, Blue in Base.**

c. If your sample is an acid, titrate it with the Standard Base, if it is a base, titrate it with the Standard Acid. Follow the same procedures and calculations that you used in Part I above to find the concentration of the unknown. Show your work:

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## Write a Critique for this lab: