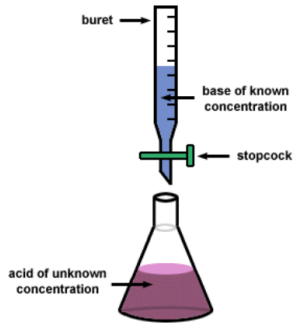
**Chemistry 20 Unit D - Qualitative Changes in Chemical Reactions**

# Titratio




May 31-1:07 PM

**Dr. Martyn Poliakoff**
**Proudly Presents:**

# The Periodic Table Movie of the Day!!!

Dec 14-10:56 AM

## Review of Rxn Principles: The Haber Process (pg 325)

**Reactions are assumed to be:**

1. **Spontaneous**
2. **Fast**
3. **Quantitative**
4. **Stoichiometric**

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# POS Checklist:

- ☐ perform a titration to determine the concentration of an acid or a base restricted to strong monoprotic acid-strong monoprotic base combinations

Dec 14-10:56 AM

# Titrations

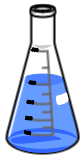
**A titration is a lab procedure used to determine the concentrations of solutions.**

**We determine concentration by adding a carefully measured amount of a known solution (called the titrant) to a solution with an unknown concentration (called the sample).**

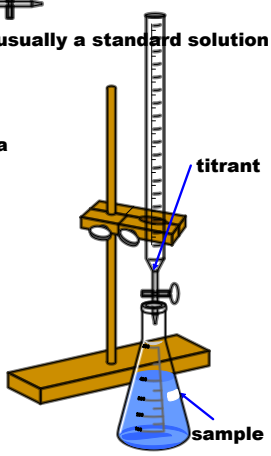
**The analysis of this lab uses stoich to help determine the concentration of the unknown solution.**

May 31-1:09 PM

**In the burette goes a titrant, usually a standard solution (known concentration).**



**In the Erlenmeyer is the sample, usually a solution of unknown concentration.**

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**We titrate (add titrant) until we get to a point where some sort of change takes place (i.e. indicator colour change). This point is called the endpoint.**

**The volume of titrant added to get to the endpoint is called the equivalence point.**

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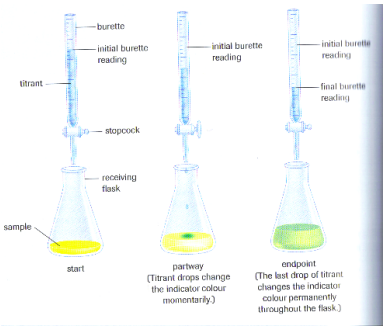


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**At the equivalence point, we have the exact stoichiometric amount of titrant needed to react with all of the unknown sample.**

**This equivalence point volume is then used in a stoich calculation to determine the concentration of the unknown.**

**Yay! More Stoich!**


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**Acid-base reactions are often used in titrations because:**

**- acids and bases are very common reactants.**
**- there are a lot of acid-base indicators to show the endpoint.**

**For example, let's watch a titration of sodium hydroxide with hydrochloric acid.**

May 31-1:18 PM

**Let's look at a reaction between sodium carbonate (base) and hydrochloric acid (acid).**

**ex) 10.00 mL samples of a 0.150 mol/L solution of $Na_2CO_{3(aq)}$ taken and titrated with $HCl_{(aq)}$ of an unknown concentration. Using the data below, what is the concentration of the $HCl_{(aq)}$?**

| Trial | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| final burette reading (mL) | 13.3 | 26.0 | 38.3 | 13.4 |
| initial burette reading (mL) | 0.2 | 13.3 | 26.0 | 0.6 |
| volume of $HCl_{(aq)}$ added (mL) | 13.1 | 12.7 | 12.8 | 12.8 |
| indicator colour (methyl orange used) | red | orange | orange | orange |

***Draw Me!***

Dec 14-11:25 AM

**Let's look at some details of this problem:**

**Q) Why is there an initial and final burette reading?**

**A) When you fill up a burette, you don't have to fill it exactly to the top. You can just throw in enough to get it close to the top and record this as the initial volume. Then, if you record the final volume and subtract the two, you'll know how much of the titrant you added.**

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**Q) Why are there 4 trials? And why are the numbers different for each trial?**

**A) We repeat the trials to get accurate results. The numbers are different because it is difficult to measure out exactly the same volume of unknown each time. We will be taking the closest volumes and averaging them later in the analysis.**

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**Q) What does the indicator colour have to do with anything?**

**A) The colour change in the indicator tells us when to stop adding titrant. This indicator changes colour around pH 3.5. At this pH, all of the weak base has reacted with the acid.**

**Next day, you will learn about how to choose an appropriate indicator solution.**

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**Now, let's get down to brass tacks:** 

**To determine the [$HCl_{(aq)}$], we're going to do a stoich calculation using the data in the table:**

**Step 1: Write a balanced chemical eqn.**

**Step 2: Write down the info given in the table.**

$$Na_2CO_{3(aq)} + 2\ HCl_{(aq)} \longrightarrow H_2CO_{3(aq)} + 2\ NaCl_{(aq)}$$

c = 0.150 mol/L  c = ?
v = 10 mL

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**Step 3: Using the table, determine the volume of titrant (HCl)added in each trial. Take the average of the closest values. If any value is far off the others, omit it.**

| Trial | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| final burette reading (mL) | 13.3 | 26.0 | 38.3 | 13.4 |
| initial burette reading (mL) | 0.2 | 13.3 | 26.0 | 0.6 |
| volume of $HCl_{(aq)}$ added (mL) | 13.1 | 12.7 | 12.8 | 12.8 |
| indicator colour (methyl orange used) | red | orange | orange | orange |

$v_{HCl}$ = (12.7 mL + 12.8 mL + 12.8mL) / 3 = 12.8 mL

**This is the volume of the unknown in the stoich calculation.**

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**Step 4: Using stoich, find the concentration of the unknown:**

**Using the equation method:**

a) Find the moles of the known

$n_{known} = cv$
$n_{known} = (0.150\ mol/L)(0.010\ L)$
$n_{known} = 0.0015\ mol$

b) Use unknown / known

$$\frac{n_{HCl}}{0.0015\ mol} = \frac{2}{1}$$

c) Convert moles to [unknown]

$$c_{HCl} = \frac{n}{v}$$

$$c_{HCl} = \frac{n}{v} = \frac{0.0030\ mol}{0.0128\ L}$$

$c_{HCl}$ = 0.234 mol/L

**Using the unit canceling method:**

$$0.010\ L\ Na_2CO_3 \times \frac{0.150\ mol}{1\ L} \times \frac{2\ HCl}{1\ Na_2CO_3} \times \frac{1}{0.0128\ L} = 0.234\ mol/L$$

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**These same steps can be used to complete any titration analysis. Try this one:**

**ex) What is the concentration of potassium hydroxide?**

Titration of 10.0 mL of $KOH_{(aq)}$ with 0.150 mol/L $H_2SO_{4(aq)}$

| Trial # | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Final reading (mL) | 12.5 | 25.3 | 37.9 | 50.0 |
| Initial reading (mL) | 0.2 | 12.8 | 25.3 | 37.9 |
| Volume added (mL) | | | | |

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**ex) What is the concentration of this barium hydroxide solution?**

Titration of 20.0mL $KOH_{(aq)}$ with 0.150mol/L $CH_3COOH_{(aq)}$

| Trial | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Final Reading | 12.8mL | 25.3mL | 37.9mL | ---- |
| Initial Reading | 0.2mL | 12.8mL | 25.3mL | ---- |
| Total | | | | |

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**Practice:**

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and

**Assignment**

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Dec 17-11:27 AM