Titrations

A titration is a laboratory technique in which a solution of known concentration is used to determine the concentration of another solution.

(Based on the concept that acids neutralize bases, and bases neutralize acids.)

Neutralization of Bug Bites

Wasp - stings with base

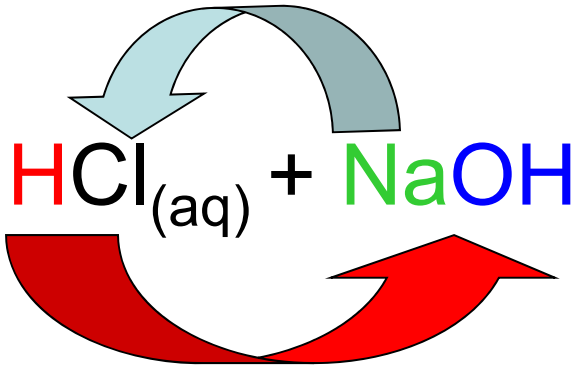
(neutralize with lemon juice or vinegar)

Red Ant - bites with acid

(neutralize with baking soda)

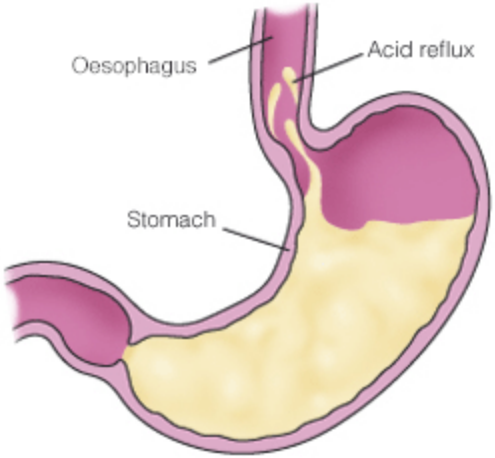
In order to do a titration we need to look at neutralization reactions or acid base reaction which is a double replacement reaction

Acid + Base → Salt + Water



$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + HOH_{(l)}$

NEUTRALIZATION



Stomach acid + antacid → RELIEF

$2\,HCl_{(aq)}$ + $Mg(OH)_{2\,(aq)}$ → $MgCl_{2\,(aq)}$ + $2\,HOH_{(l)}$

Stomach acid

Maalox

a "salt"

water

ionic compounds are called salts

$$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + HOH_{(l)}$$

- When 1 mol of HCl is in the presence of 1 mol of NaOH, a neutral solution is made.

$$2\ HCl_{(aq)} + Mg(OH)_{2\ (aq)} \rightarrow MgCl_{2\ (aq)} + 2\ HOH_{(l)}$$

What is the molar ratio between this acid and base to produce a neutral solution?

2 moles of HCl for every 1 mole of Mg(OH)2

How do you know WHEN you have neutralized an acid?

Use an indicator!

Phenolphthalein is clear in an acid

Phenolphthalein is magenta in a base

Phenolphthelein is just a hint of pink when neutral

Your Turn

What color will the following be in the presence of phenolpthaelin?

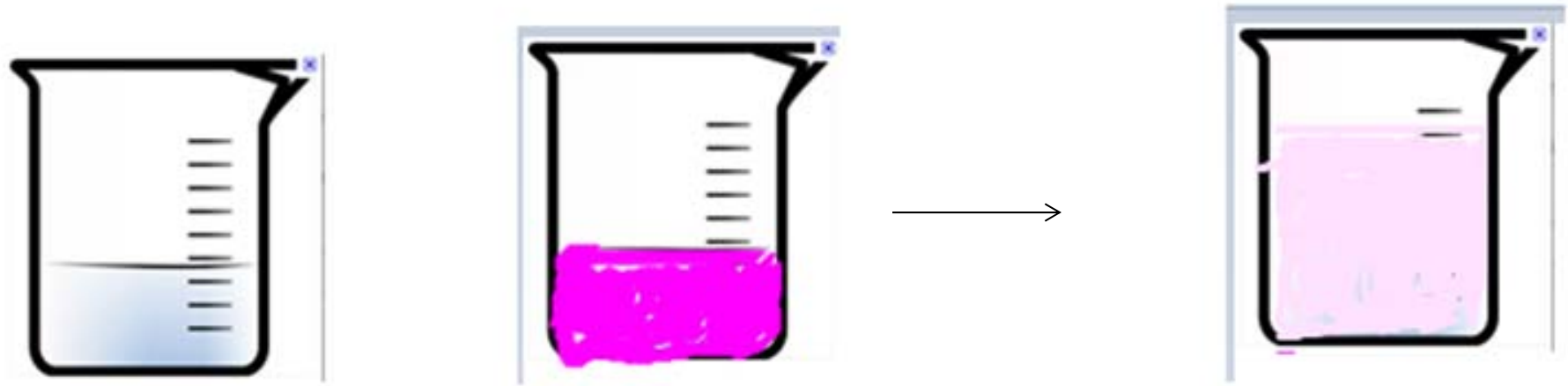
a. HCl clear

b. H_3PO_4 clear

c. $Ca(OH)_2$ magenta

Now let's try an example:

23.9 mL of 2.1 M $Mg(OH)_2$ was used to titrate 15.21 mL aqueous HNO_3. What is the molarity of the HNO_3?



15.21 mL HNO_3 + 23.9 mL **2.1 M** $Mg(OH)_2$

Acid base neutral

UNKNOWN
only volume

KNOWN
vol. and conc.

Calculations for Titrations

There are four main steps for doing titration calculations:

1. Write a complete, **balanced chemical equation** (include states of matter)

2. Solve for **moles** of the **KNOWN** (has both volume used and Molarity given) by using the M= mol/L formula.

3. Use **stoichiometry** to determine how many moles of UNKNOWN were added.

4. Use the M= mol/L formula to **solve for the missing information** (either volume or Molarity of the unknown).

Now let's try an example:

23.9 mL of 2.1 M $Mg(OH)_2$ was used to titrate 15.21 mL aqueous HNO_3. What is the molarity of the HNO_3?

1. Write the neutralization reaction between HNO_3 and $Mg(OH)_2$.

$$2\ HNO_3(aq) + Mg(OH)_2\ (aq) = 2\ HOH\ (l) + Mg(NO_3)_2\ (aq)$$

2. Solve for moles of known ($Mg(OH)_2$). 23.9 mL of 2.1 M $Mg(OH)_2$

M = mols / L 2.1M $Mg(OH)_2$ = $\frac{x}{0.0239L\ Mg(OH)_2}$ x= 0.050 mol $Mg(OH)_2$

3. Use STOICH to solve for moles of unknown (HNO_3) using moles of known ($Mg(OH)_2$).

$$0.050\ mol\ Mg(OH)_2 \times \frac{2\ mol\ HNO_3}{1\ mol\ Mg(OH)_2} = 0.10\ mol\ HNO_3$$

4. Calculate molarity of unknown (HNO_3), using moles from stoich and volume from original problem

M = mols / L $\frac{0.10\ mol\ HNO_3}{0.01521\ L} = 6.6\ M$

Stop for Today

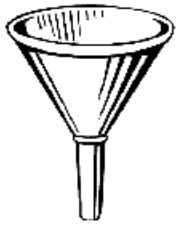
Work on problems in your packet on p. 24 #1-7 and p. 25 #1 and #2.

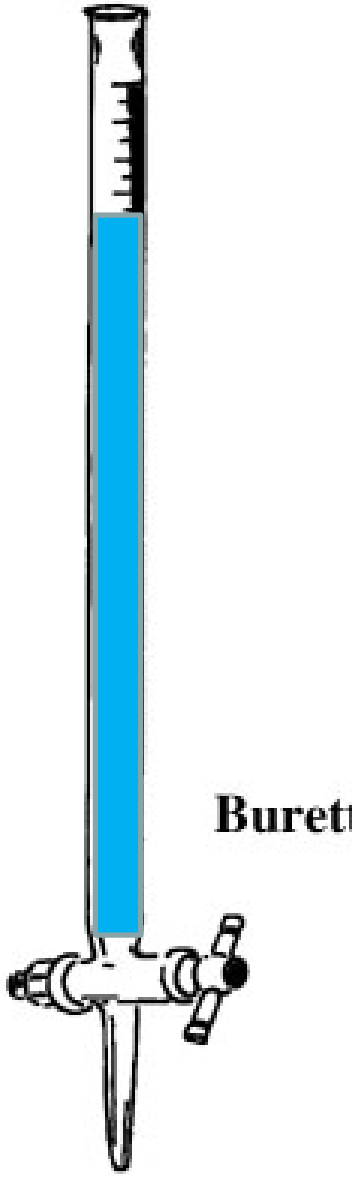
Lab Technique

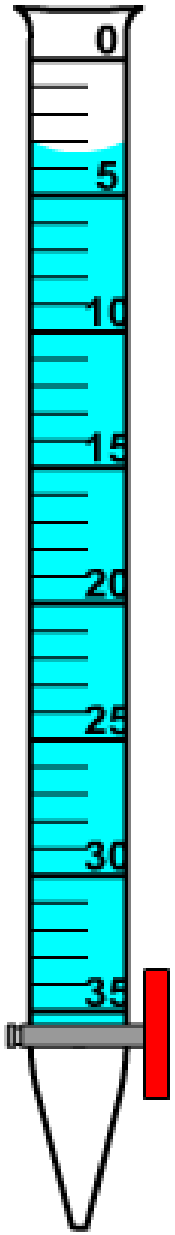
Buret

A buret is used to transfer solutions to the reaction flask in a titration.

Fill the buret with base from the top using a funnel.



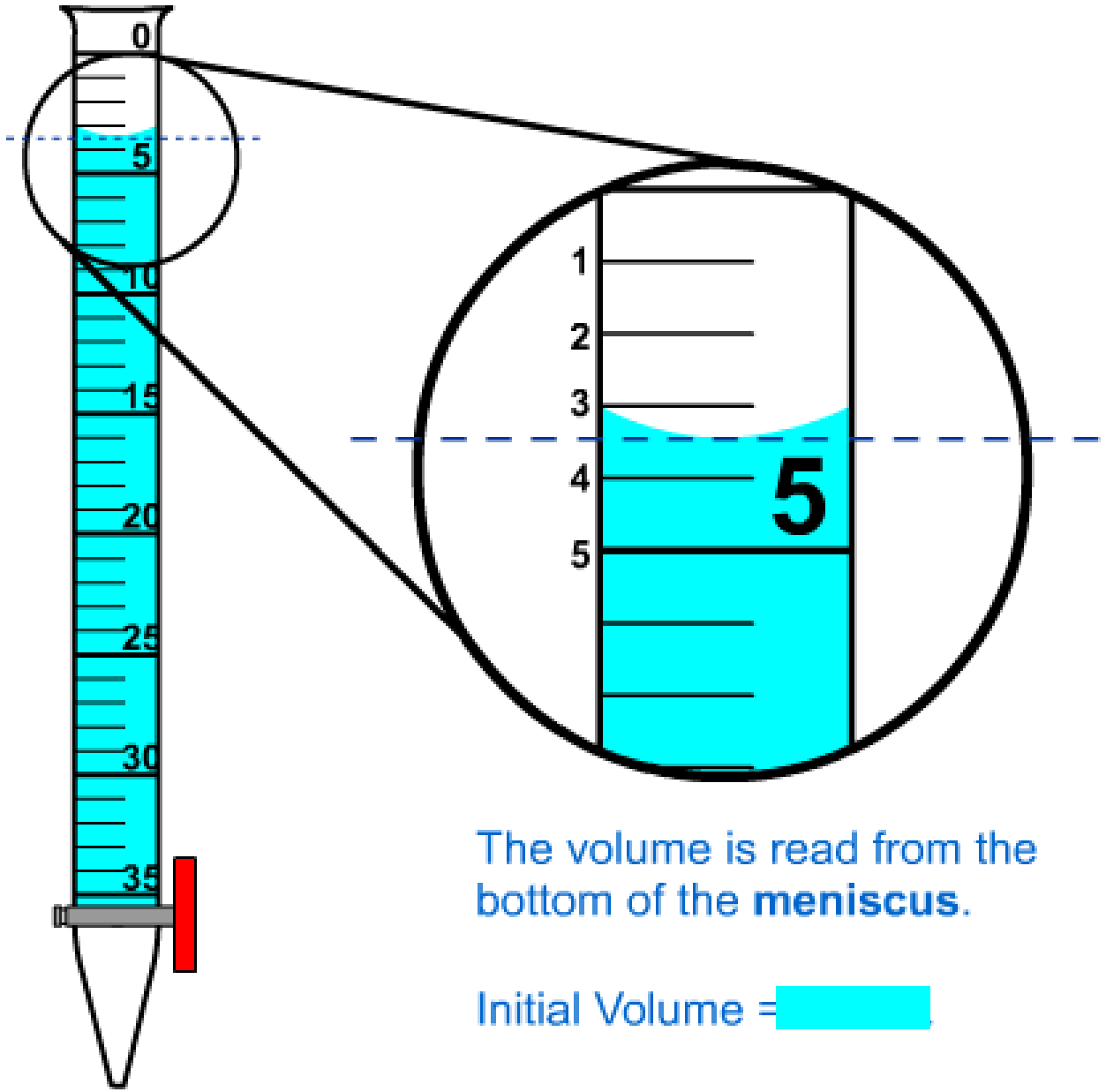




Record the initial volume of buret before releasing any solution from the valve at the bottom.

IMPORTANT!!!

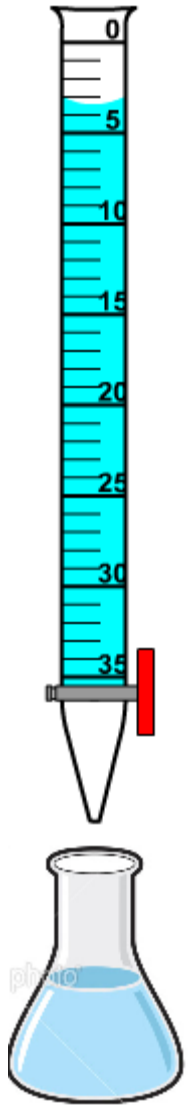
Notice that the markings read from top down.

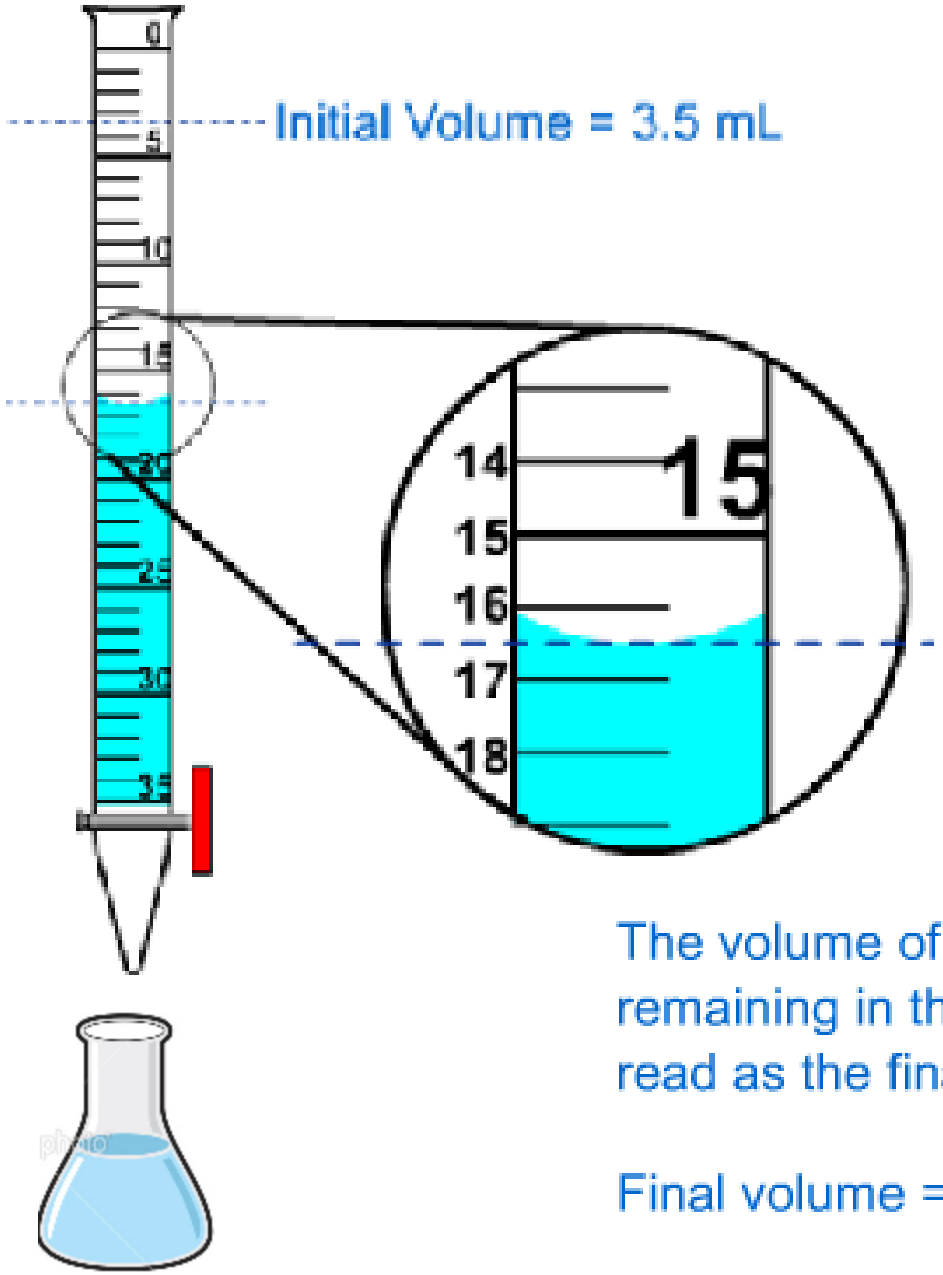


The volume is read from the bottom of the **meniscus**.

Initial Volume =

Release some solution into the flask by opening the valve.





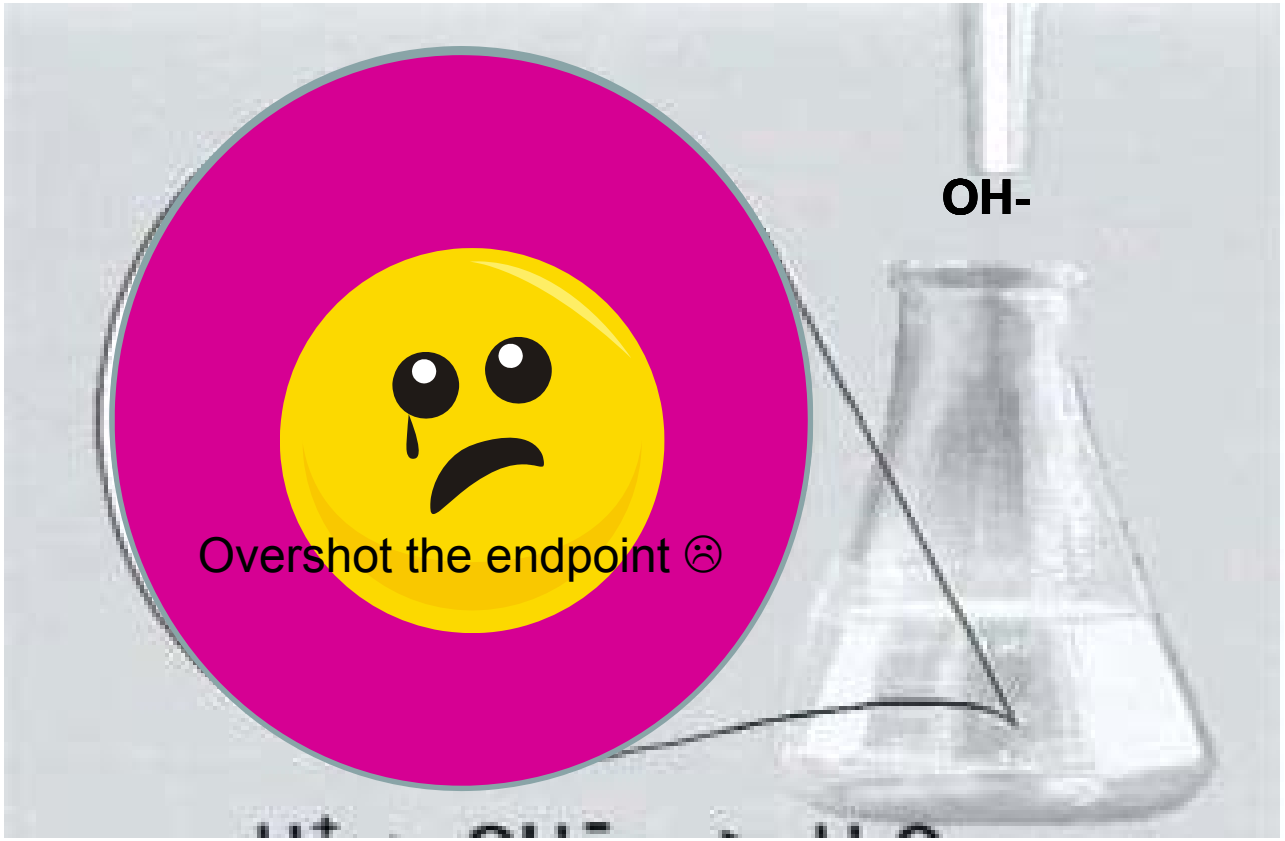
The volume of titrant remaining in the buret is read as the final volume

Final volume = 16.5 mL

Calculate volume transferred to flask by….

Final Volume	16.5 mL
- Initial volume	-3.5 mL
Volume in flask	13.0 mL

Continue adding base drop by drop.



$H^+ + OH^- \rightarrow H_2O$