Acid Base Titrations

J. KROPAC

Reactions Involving Acids

* Active metals react with acids in a single displacement reaction

* active metal + acid → hydrogen + ionic compound

* $Mg_{(s)} + 2HCl_{(aq)} \rightarrow H_{2(g)} + MgCl_{2(aq)}$

Reactions Involving Acids

- All acids react with carbonates in a double displacement reaction
- carbonate + acid → carbon dioxide + water + ionic compound
- $Na_2CO_{3(s)} + 2HNO_{3(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)} + 2NaNO_{3(aq)}$

Reactions Involving Acids

* Acids undergo precipitation reactions with some ionic compounds

* ionic compound + acid → precipitate + acid

* $Pb(NO_3)_{2(aq)} + 2HI_{(aq)} \rightarrow PbI_{2(s)} + 2HNO_{3(aq)}$

Reactions Involving Acids

* Acids react with bases in another double displacement reaction often called a neutralization reaction
* base + acid → ionic compound (salt) + water
* $NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

Reactions Involving Acids

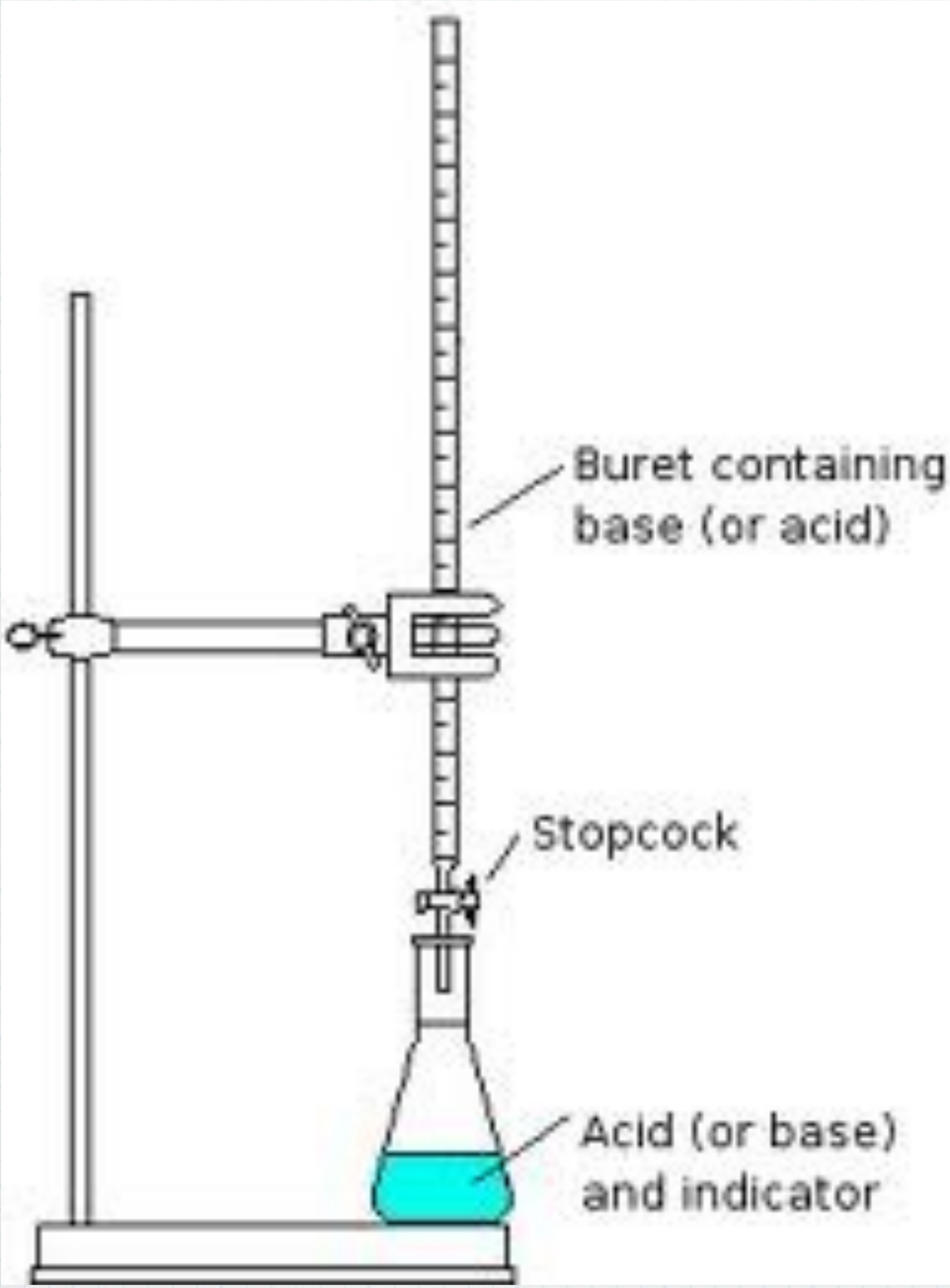
- During a neutralization reaction H^+ ions from an Arrhenius acid and OH^- ions from an Arrhenius base combine to form water.
- The metal cation from the base and and the ion from the acid combine to form a salt.

Titration

* A laboratory procedure involving the carefully measured and controlled adding of a solution from a buret into a measured volume of a sample solution
* It is used to determine the concentration of substances in solution

Titrant

* the solution in the buret during a titration (standard solution with KNOWN concentration)



In the buret → standard solution (KNOWN concentration)

In the flask → precise volume (UNKNOWN concentration)

In the flask → indicator to detect the end point

Equivalence Point

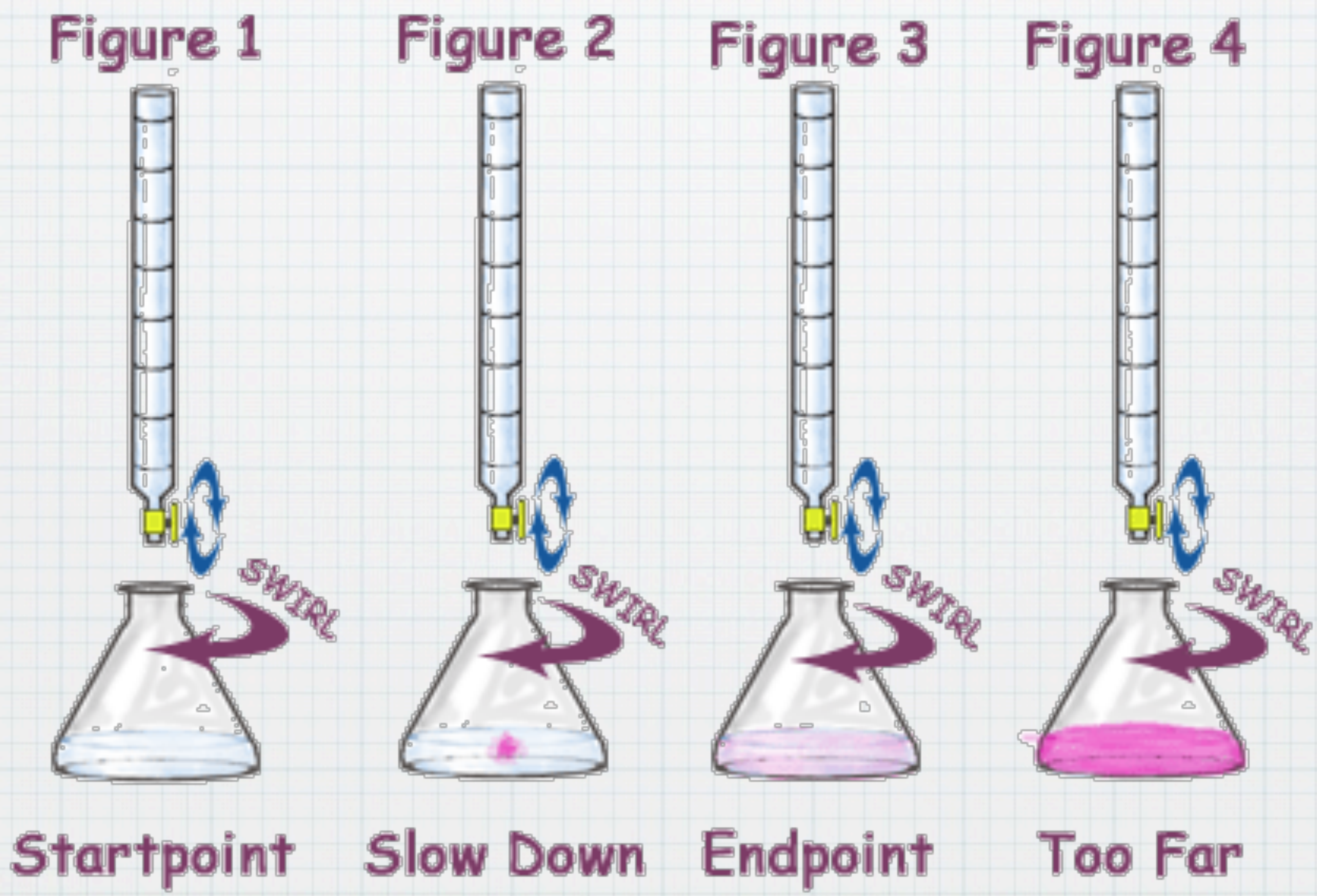
* the point at which the amount of titrant is just enough to react with all the reactant in the sample.

The Endpoint

* the point in a titration at which the indicator changes colour
* this is at, or close to, the point at which the titrant and sample in the flask have completely reacted

Titration of an Acid with a Base

using phenolphthalein indicator



Steps in Titration

* Place standard solution in buret
* Place a precise volume of a solution of unknown concentration in a flask
* Add an indicator to the flask
* Record the volume in the buret as your initial reading
* Open the stopcock of the buret and allow the standard solution to enter the flask, while swirling the flask
* Slow down the flow of standard solution being added to ensure you don't surpass the endpoint by too much
* Once the end point is reached, record the final volume in the buret
* Subtract the initial volume from the final volume in the buret to obtain the total volume of standard solution used to neutralize the unknown solution.

Determining Concentration Using

* A 0.1250 mol/L solution of hydrochloric acid, $HCl_{(aq)}$, was used to neutralize a 25.00 mL sample of the potassium hydroxide solution. The average volume of hydrochloric acid required was 32.86 mL. Determine the concentration of the potassium hydroxide solution, $KOH_{(aq)}$.

Step 1: Write Balanced Equation

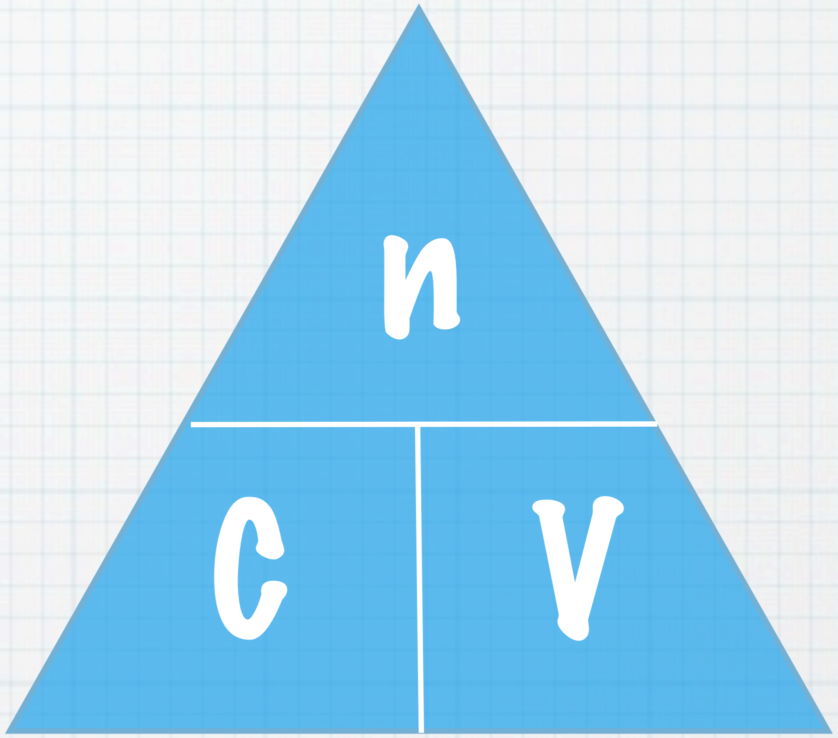
* $KOH_{(aq)} + HCl_{(aq)} \rightarrow H_2O_{(l)} + KCl_{(aq)}$

Step 2: List Given Values

* V_{KOH} = 25.00 mL
* V_{HCl}=32.86 mL
* C_{HCl} =0.1250 mol/L
* C_{KOH}= ?

Step 3: Calculate Number of Moles of Titrant

* V_{HCl}=32.86 mL
* C_{HCl} =0.1250 mol/L



$$n = c \times V$$

$$n = \frac{0.123 \text{ mol}}{\text{L}} \times 0.0386 \text{ L}$$

$$n = 0.004748 \text{ mol}$$

Therefore there are 0.004748 mols of HCl

Step 4: Molar Ratio

* How much potassium hydroxide is required needed to neutralize the hydrochloric acid?
    * $KOH_{(aq)} + HCl_{(aq)} \longrightarrow H_2O_{(l)} + KCl_{(aq)}$

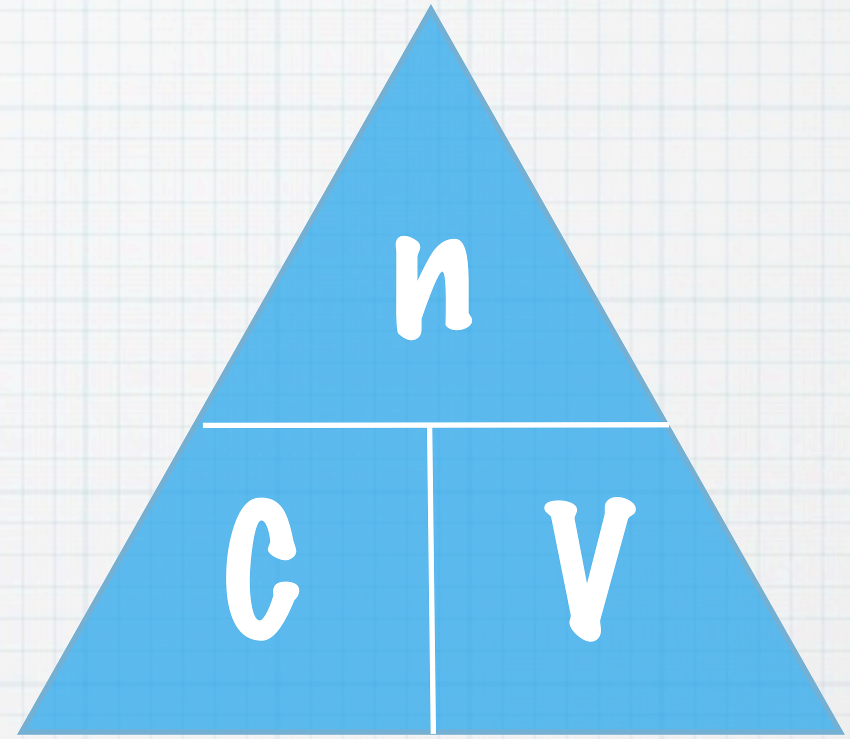
$$\frac{1}{1} = \frac{0.004748 \text{ mols}}{n_{KOH}}$$

$$n_{KOH} = 0.004748 \text{ mols}$$

Step 4: Determine Unknown

- V_{KOH} = 25.00 mL
- n_{KOH} = 0.004748 mol

$$C = \frac{n}{V}$$



$$n = \frac{0.004748\ \text{mol}}{0.02500\ \text{L}}$$

$$n = 0.1643\ \text{mol/L}$$

Therefore the concentration of KOH is 0.1643 mol/L.

Homework

* p 466 1, 2, 3, 4