Chemistry 11

Solution Chemistry III

Name: Notes
Date:
Block:

1. **Titrations**
2. **Titrations Equipment**

Titrations

Warm up…

1. Balance the following neutralization equation:

$$\_\_\_\_\ H_2SO_4 + \underline{2}\ NaOH \rightarrow \underline{2}\ H_2O + \_\_\_\_\ Na_2SO_4$$

2. Write the formulas for the acid and base that will react to give K_2CO_3 and water.

The salt breaks up to become: K^+ CO_3^{2-}

Acid: H_2CO_3 Base: KOH

Acid-Base Titration:

- A method to determine the concentration of an unknown solution by reacting it with another substance of known concentration.
- The solution whose concentration is known is called the standard solution.

Example 1.

A student completely reacted 10.0 mL of HCl with 18.25 mL of 0.100 M NaOH. Calculate the [HCl]. (Standard soln)

⇒ Balanced equation:

$$HCl + NaOH \rightarrow H_2O + NaCl$$

⇒ Calculate the moles of the standardized solution:

$$18.25\,mL\,NaOH \times \frac{1\,L}{1000\,mL} \times \frac{0.100\,mol\,NaOH}{1\,L} = 0.00183\,mol\,NaOH$$

⇒ Find the moles of the unknown solution:

$$0.00183\,mol\,NaOH \times \frac{1\,mol\,HCl}{1\,mol\,NaOH} = 0.00183\,mol\,HCl$$

⇒ Find the concentration of the unknown solution:

$$\frac{0.00183\,mol\,HCl}{10.0\,mL} \times \frac{1000\,mL}{1\,L} = \boxed{0.183\,M\,HCl}$$

⇒ In one step…

$$18.25\,mL\,NaOH \times \frac{1\,L}{1000\,mL} \times \frac{0.100\,mol\,NaOH}{1\,L} \times \frac{1\,mol\,HCl}{1\,mol\,NaOH} \times \frac{1}{10.0\,mL} \times \frac{1000\,mL}{L}$$

Practice 1:

If 46.2 mL of 2.50 M NaOH is required to neutralize 1.54 M of a phosphoric acid solution, H_3PO_4, what volume of phosphoric acid was needed to reach the equivalence point?

$$3NaOH + H_3PO_4 \rightarrow 3H_2O + Na_3PO_4$$

$$46.2\,mL\,NaOH \times \frac{1\,L}{1000\,mL} \times \frac{2.50\,mol\,NaOH}{1\,L\,NaOH} \times \frac{1\,mol\,H_3PO_4}{3\,mol\,NaOH} \times \frac{1\,L\,H_3PO_4}{1.54\,mol\,H_3PO_4}$$

$$= \boxed{0.0250\,L\,H_3PO_4 = 25.0\,mL\,H_3PO_4}$$

Practice 2:

If 8.60 mL of 0.0994 M HNO_3 is required to neutralize 25.00 mL of a strontium hydroxide solution, what is the molarity of the strontium hydroxide?

$$2HNO_3 + Sr(OH)_2 \rightarrow 2H_2O + Sr(NO_3)_2$$

$$8.60\,mL\,HNO_3 \times \frac{1\,L}{1000\,mL} \times \frac{0.0994\,mol\,HNO_3}{1\,L} \times \frac{1\,mol\,Sr(OH)_2}{2\,mol\,HNO_3} = 4.27\times10^{-4}\,mol\,Sr(OH)_2$$

$$\frac{4.27\times10^{-4}\,mol\,Sr(OH)_2}{25.00\,mL} \times \frac{1000\,mL}{1\,L} = \boxed{0.0171\,M\,Sr(OH)_2}$$

Practice 3:

Calculate the molarity of an acetic acid solution (CH_3COOH) if 34.57 mL of this solution are needed to neutralize 25.19 mL of 0.1025 M sodium hydroxide.

$$CH_3COOH + NaOH \rightarrow H_2O + NaCH_3COO$$

$$25.19\,mL\,NaOH \times \frac{1\,L}{1000\,mL} \times \frac{0.1025\,mol\,NaOH}{1\,L} \times \frac{1\,mol\,CH_3COOH}{1\,mol\,NaOH} = 2.582\times10^{-3}\,mol\,CH_3COOH$$

$$\frac{2.582\times10^{-3}\,mol\,CH_3COOH}{34.57\,mL} \times \frac{1000\,mL}{1\,L} = \boxed{0.07469\,M\,CH_3COOH}$$

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Practice 4:

Consider the following results from a titration lab.

Standard soln

5.00 g of NaOH was dissolved to make a 200. mL solution ? [ ]

Below is the volume of the NaOH solution needed to neutralize 25.0 mL H_3PO_4.

	Trial #1	Trial #2	Trial #3
Initial reading of burette (mL)	0.00	12.45	24.94
Final reading of burette (mL)	12.45	24.94	37.36
Volume of NaOH added (mL)	12.45	12.49	12.42

a) What is the proper balanced equation?

$3NaOH + H_3PO_4 \rightarrow 3H_2O + Na_3PO_4$

b) What is the concentration of the standardized solution of NaOH?

$$\frac{5.00\ g_{NaOH}}{200.\ mL} \times \frac{1\ mol_{NaOH}}{40.00\ g_{NaOH}} \times \frac{1000\ mL}{1\ L} = 0.625M_{NaOH}$$

c) What was the average volume of NaOH was needed?

$$\frac{12.45 + 12.49 + 12.42}{3} = 12.45\ mL_{NaOH}$$

d) What is the concentration of the acid?

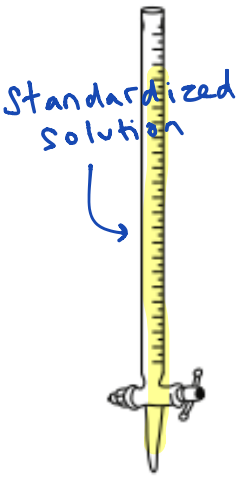
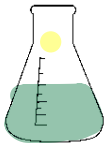
$$12.45\ mL_{NaOH} \times \frac{1\ L}{1000\ mL} \times \frac{0.625\ mol_{NaOH}}{1\ L} \times \frac{1\ mol_{H_3PO_4}}{3\ mol_{NaOH}}$$

$$= 2.59 \times 10^{-3}\ mol_{H_3PO_4}$$

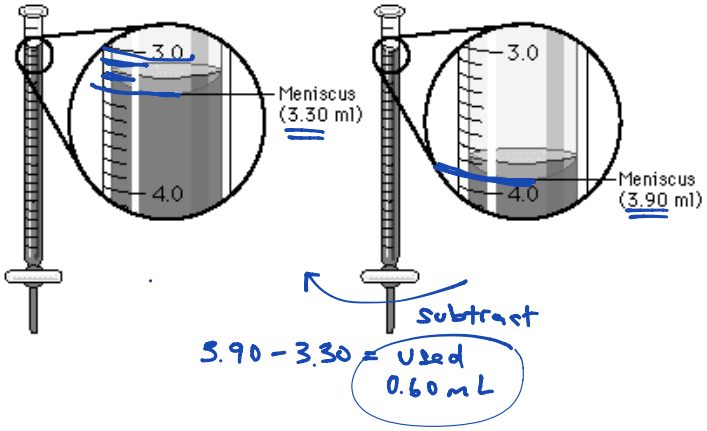
Titrations Worksheet

$$\frac{2.59 \times 10^{-3}\ mol_{H_3PO_4}}{25.0\ mL} \times \frac{1000\ mL}{1\ L} = 0.104M_{H_3PO_4}$$

Titration Equipment

Glassware	Notes
Burette 	• Used for measuring volumes of liquids • Delivers various volumes through a valve called a stopcock • More precise than a graduated cylinder ↳ measures to a precision of 0.00mL
Erlenmeyer Flask 	• Used for holding liquids • The shape helps avoid loss due to splashing • Sizes : 125, 250, 500mL Equivalence Point: • Occurs when moles of H^+ = moles of OH^- • When the indicator changes colour, the endpoint is reached
Pipette 	• Used for measuring volumes of liquids • May be graduated / volumetric (designed to deliver one specific volume) • Liquid is drawn up w/ a pipette bulb or a suction device • Measures to a precision of 0.00mL

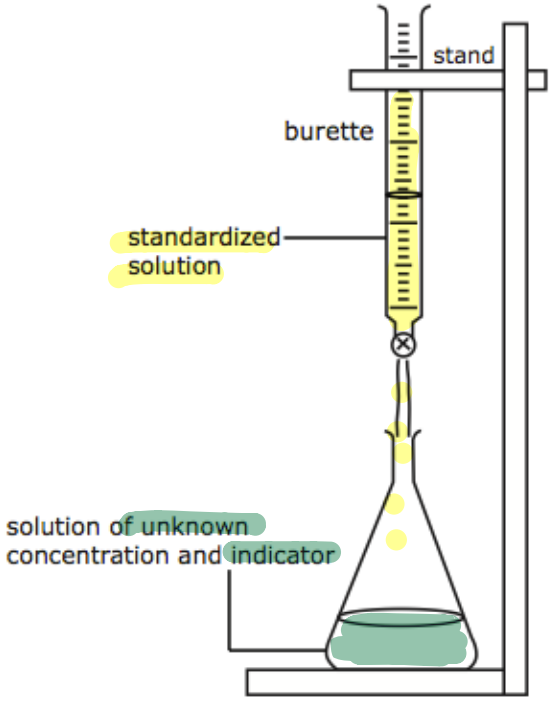
Reading a Burette



- ✓ Make sure to read the bottom of the meniscus
- ✓ Take data from at least 3 trials.
- ✓ Your values from each trial should be close together. If they are not, take another reading to double check!

±0.50mL

Titration set-up:



- ➢ **Preparing your glassware:**
  1. Rinse with WATER
  2. Rinse with CHEMICAL
  3. Fill with CHEMICAL