

Acid - Base Titrations

Aim: Determining the unknown concentration of a solution using acid-base titrations.

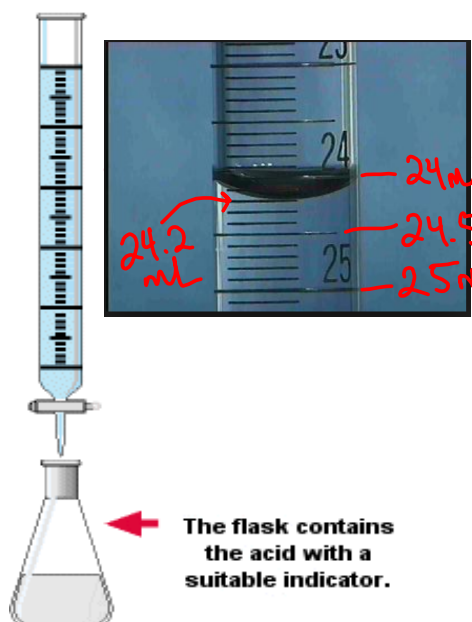
What is a Titration?

Titration: A lab technique that uses a substance with a known concentration to determine an unknown concentration.

Set up of a Titration

A buret is used to perform a titration.

Burets are read from the top down because liquid is drained out of the bottom.



Titration Formula

$$M_a V_a = M_b V_b$$

M_a = molarity of H^+ ions

V_a = volume of acid

M_b = molarity of OH^- ions

V_b = volume of base

How does it work?

During a titration, the acid and the base are combined until they neutralize each other. (moles of H^+ = moles of OH^-)

Equivalence point- the point in the titration where $[H^+]=[OH^-]$



An indicator is used to determine when the equivalence point is reached.

Use a titration experiment to find all missing values and solve for concentration of the acid, base or whichever variable is asked.

How does it work?



$$M_a V_a = M_b V_b$$

1. A student is titrating **60.0 mL of H_2SO_4** with **0.200 M NaOH**. What is the concentration of the acid if **45.0 mL of NaOH** was used to reach the equivalence point.

- $V_a = 60.0 \text{ mL}$
- $M_a = ?$
- $V_b = 45.0 \text{ mL}$
- $M_b = 0.200 \text{ M}$

$$M_a V_a = M_b V_b$$

$$M_a(60.0 \text{ mL}) = (0.200 \text{ M})(45.0 \text{ mL})$$

$$M_a = \frac{(1)(0.200)(45.0)}{(1)(60.0)} = 0.15 \text{ M}$$

The acid molarity, M_a equals 0.15 M

Acid-Base Titration Introduction Practice

Titration	$M_A V_A = M_B V_B$ M_A = molarity of H^+ M_B = molarity of OH^- V_A = volume of acid V_B = volume of base
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1) 30 mL of 2.4 M HCl was neutralized completely by 2.4M NaOH. What was the volume of the base added?

Acid-Base Titration Introduction Practice

Titration	$M_A V_A = M_B V_B$ M_A = molarity of H^+ M_B = molarity of OH^- V_A = volume of acid V_B = volume of base
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2) 25 mL of 2.0 M H_2SO_4 was neutralized completely by 4.0 M KOH. What was the volume of the base added?

Acid-Base Titration Introduction Practice

3) A student adds three drops of phenolphthalein to a flask containing 25.00 mL of HCl. The student adds 0.150 M NaOH(aq) to the flask until the indicator turns the solution light pink. The student determines that a total volume of 20.20 milliliters of NaOH(aq) was used in this titration. Calculate the molarity of the HCl(aq) used in this titration

ACID-BASE TITRATION

1. A 25.0 mL sample of HCl was titrated to the endpoint with 15.0 mL of 2.0 M NaOH. What was the molarity of the HCl?

2. A 10.0 mL sample of H_2SO_4 was exactly neutralized by 13.5 mL of 1.0 M KOH. What is the molarity of the H_2SO_4 ?

ACID-BASE TITRATION

3. How much 1.5 M NaOH is necessary to exactly neutralize 20.0 mL of 2.5 M H_3PO_4 ?

4. How much of 0.5 M HNO_3 is necessary to titrate 25.0 mL of 0.05 M $\text{Ca}(\text{OH})_2$ solution to the endpoint?

ACID-BASE TITRATION

5. What is the molarity of a NaOH solution if 15.0 mL is exactly neutralized by 7.5 mL of a 0.02 M $\text{HC}_2\text{H}_3\text{O}_2$ solution?

6. What is the molarity of a solution of HCl if 25 mL are titrated to the end point by 10. mL of 0.2 M NaOH solution?

EXTRA PRACTICE

7. If, during the titration of 35 mL of 0.3 M NaOH, 21 mL of acid were used, what is the molarity of the acid?

8. How many mL of 0.15 M basic solution are required to neutralize 30. mL of a 0.5 M solution of an acid?

EXTRA PRACTICE

9. A chemistry student finds that it takes 34 mL of a 0.5 M acid solution to neutralize 10. mL of a sample of household ammonia. What is the molarity of the ammonia solution?

10. How many liters of 0.5 M HCl are needed to neutralize 40. mL of 0.8 M NaOH?

EXTRA PRACTICE

11. 20. mL of 7-Up is neutralized by 250 mL of 0.1 M NaOH. How acidic is the soda?

12. Calculate the number of grams of NH_4OH required to neutralize 40. mL of 2 M HNO_3 . (Hint: use mole and molarity formulas)

Practice Calculations

2) What is the concentration of a strong base, if 15mL of the base was neutralized by 60mL of 1.5M acid?

3) A student performs an acid base titration to determine the concentration of 40 mL of an unknown acid. The titration requires the student to use 46mL of 3.0M NaOH to completely neutralize the acid. What was the concentration of the acid?

4) In a titration 3.0M HCl is completely neutralized by 25mL of 4.0M NaOH. What was the volume of the acid titrated?