LESSON MAKER PRO

Find the Unknown

Use titration volumes to find an acid or base concentration.

HIGH SCHOOL · CHE.6.e

CHE.6.e "Plan and carry out a strong acid-strong base titration to determine the concentration of an unknown acidic or basic solution."

NAME _____ DATE _____

MATCH THE MOLES

At the equivalence point, a strong acid with one acidic hydrogen reacts with a strong base with one hydroxide ion in a 1:1 mole ratio. Use $M_{acid} \times V_{acid} = M_{base} \times V_{base}$, with both volumes in the same units. To find the volume delivered from a buret, subtract its initial reading from its final reading.

WORKED EXAMPLE

You titrate 16.0 mL of HCl with 0.300 M NaOH. The buret reads 2.00 mL before the titration and 14.00 mL at the endpoint. Find the HCl concentration.

1. NaOH delivered: 14.00 mL − 2.00 mL = 12.00 mL.
2. $M_{acid} \times 16.0\ mL = 0.300\ M \times 12.00\ mL$.
3. $M_{acid} = (0.300 \times 12.00) / 16.0 = 0.225\ M$.

Answer: 0.225 M HCl

PRACTICE 6 problems

1 You titrate 20.0 mL of NaOH with 10.0 mL of 0.400 M HCl. What is the NaOH concentration?

ANSWER _____

2 You titrate 30.0 mL of KOH with 15.0 mL of 0.100 M HNO_3. What is the KOH concentration?

ANSWER _____

3 You titrate 40.0 mL of HCl with 10.0 mL of 0.200 M NaOH. What is the HCl concentration?

ANSWER _____

4 You titrate 15.0 mL of HNO_3 with 20.0 mL of 0.150 M KOH. What is the HNO_3 concentration?

ANSWER _____

5 You titrate 25.0 mL of HNO_3 with 0.100 M NaOH. The buret reads 3.20 mL initially and 23.20 mL at the endpoint. Find the volume of NaOH delivered and the HNO_3 concentration.

ANSWER _____

6 Two titrations of 20.0 mL HCl samples use 9.95 mL and 10.05 mL of 0.250 M NaOH. Find the mean NaOH volume and use it to find the HCl concentration.

ANSWER _____

APPLY IT Show your work

1 A robotics team needs to check a lab-prepared HCl solution before using it to remove rust from a metal part. A 30.0 mL sample reaches the endpoint with 0.200 M NaOH. The buret reading changes from 1.40 mL to 16.40 mL. What is the HCl concentration?

WORK SPACE

ANSWER _____

2 A school lab checks a NaOH solution used to neutralize acidic waste. Students titrate two 20.0 mL samples with 0.150 M HNO_3. Use the buret readings to find the mean acid volume delivered and the NaOH concentration.

HNO3 BURET READINGS

Trial	Initial (mL)	Final (mL)
1	1.00	12.95
2	0.50	12.55

ANSWER _____

CHALLENGE One step up

An HCl solution is too concentrated to titrate directly. A student dilutes 5.00 mL of it to a total volume of 50.0 mL, then titrates 10.0 mL of the diluted solution with 15.0 mL of 0.100 M NaOH. What was the original HCl concentration? Show how you use the titration result and the dilution.

WORK SPACE AND ANSWER

Find the Unknown

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	You titrate 20.0 mL of NaOH with 10.0 mL of 0.400 M HCl. What is the NaOH concentration?	**0.200 M NaOH**
2	You titrate 30.0 mL of KOH with 15.0 mL of 0.100 M HNO_3. What is the KOH concentration?	**0.0500 M KOH**
3	You titrate 40.0 mL of HCl with 10.0 mL of 0.200 M NaOH. What is the HCl concentration?	**0.0500 M HCl**
4	You titrate 15.0 mL of HNO_3 with 20.0 mL of 0.150 M KOH. What is the HNO_3 concentration?	**0.200 M HNO_3**
5	You titrate 25.0 mL of HNO_3 with 0.100 M NaOH. The buret reads 3.20 mL initially and 23.20 mL at the endpoint. Find the volume of NaOH delivered and the HNO_3 concentration.	**20.00 mL NaOH delivered; 0.0800 M HNO_3**
6	Two titrations of 20.0 mL HCl samples use 9.95 mL and 10.05 mL of 0.250 M NaOH. Find the mean NaOH volume and use it to find the HCl concentration.	**10.00 mL mean NaOH volume; 0.125 M HCl**

PART 2 · APPLY IT

1. **0.100 M HCl** The buret delivered 16.40 − 1.40 = 15.00 mL of NaOH. The HCl concentration is (0.200 × 15.00) / 30.0 = 0.100 M.
2. **12.00 mL mean HNO_3 volume; 0.0900 M NaOH** The trials delivered 11.95 mL and 12.05 mL, for a mean of 12.00 mL. The NaOH concentration is (0.150 × 12.00) / 20.0 = 0.0900 M.

CHALLENGE

The diluted HCl is (0.100 × 15.0) / 10.0 = 0.150 M. Dilution increased the volume by a factor of 50.0 / 5.00 = 10.0, so the original HCl concentration was 0.150 × 10.0 = 1.50 M.

Accept equivalent numerical forms with the correct molarity units. For the challenge, the original concentration must account for the tenfold dilution.