DATE: NAME: CLASS:

CHAPTER 8	Investigation 8.C: Standardizing a Hydrochloric Acid Solution	BLM 8.3.4
HANDOUT		

Hydrochloric acid, HCl(aq), has the common name of muriatic acid. It is used for cleaning concrete and removing stains on driveways. In industry, hydrochloric acid is often used to neutralize basic waste waters. Metal electroplating facilities use it to clean rust from steel. In this investigation, you will determine the concentration of a sample of HCl(aq) by titrating it with an aqueous sodium carbonate standard solution in the presence of a few drops of the indicator, phenolphthalein.

Question

What is the molar concentration of the HCl(aq) samples that are to be standardized?

Prediction

Your teacher will tell you the approximate molar concentration of the acid. Once you have completed Procedure Step 1, calculate the approximate volume of base that you expect to add to reach the endpoint.

Safety Precautions

Hydrochloric acid and sodium carbonate solutions are corrosive. Wash any spills on your skin or clothing with plenty of cool water, and inform your teacher immediately.

Materials

- 100 mL of HCl(aq), concentration unknown
- samples of $Na_2CO_3(s)$, no more than 2 g needed
- dropper bottle of phenolphthalein
- wash bottle of deionized or distilled water
- 50 mL burette
- 10 mL volumetric pipette
- 50 mL beaker
- 250 mL beaker
- 125 mL Erlenmeyer flasks (2)
- 100 mL volumetric flask
- scoopula or spatula
- glass stirring rod
- funnel
- meniscus reader
- pipette bulb
- retort stand
- burette clamp
- electronic balance

Procedure

1. Use the electronic balance to obtain 0.90 g to 1.20 g of $Na_2CO_3(s)$ in a clean, dry 50 mL beaker. Record the mass of the sodium carbonate.

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(continued)

2. With the aid of the stirring rod, dissolve the $Na_2CO_3(s)$ in a minimum volume of distilled water.

3. Transfer the solution from Procedure Step 2 to the 100 mL volumetric flask and prepare a standard 100.00 mL solution. (Be sure to use a funnel and add all the washing of the glassware you have used to the volumetric flask.) Calculate the molar concentration of $Na_2CO_3(aq)$.

4. Record your observations in the table below.

Volumes of Standard $Na_2CO_3(aq)$ Solution Added to 10.00 mL Samples of HCl(aq)

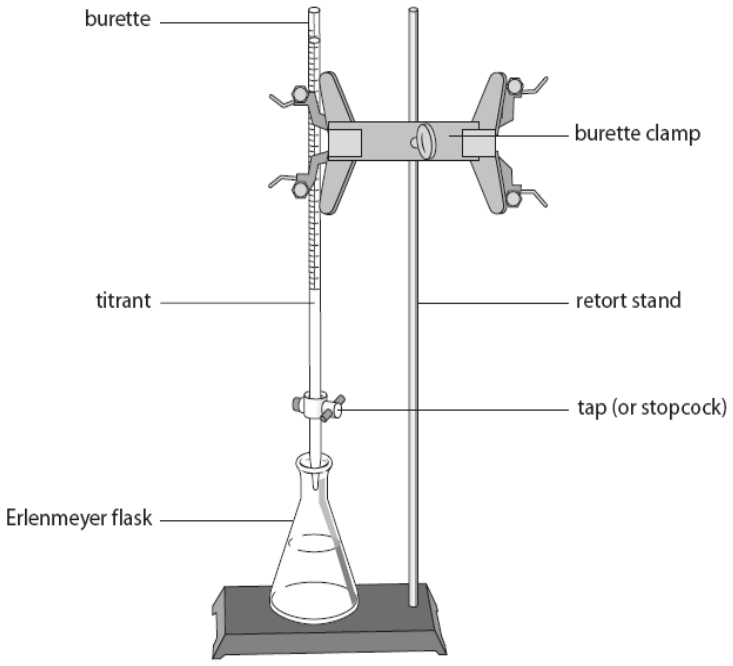
Trial #	1	2	3	4
Final burette volume (± 0.1 mL)				
Initial burette volume (± 0.1 mL)				
Indicator colour at endpoint				
Mass of $Na_2CO_3(s)$ standard =	Total volume of $Na_2CO_3(aq)$ standard =			

5. Clean and rinse the burette with the $Na_2CO_3(aq)$, and then fill it with fresh $Na_2CO_3(aq)$, making sure there is no air bubble in the burette tip. Record the initial volume of titrant in the burette to the nearest 0.05 mL. (It need not be 0.00 mL!)

6. With a clean, dry 10.00 mL volumetric pipette, obtain a 10.00 mL sample of the HCl(aq).

7. Deliver the 10.00 mL HCl(aq) sample to an Erlenmeyer flask and add two drops of indicator.

8. Position the flask under the burette as shown. With a sheet of white paper under the flask, slowly titrate the $Na_2CO_3(aq)$ standard into the HCl(aq) sample with gentle swirling. As the endpoint is approached, you will see a slight colour change that will disappear with swirling. Now add the $Na_2CO_3(aq)$ drop by drop.



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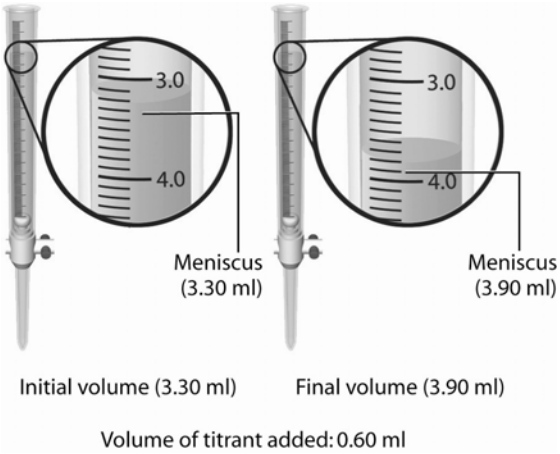
(continued)

You have reached the endpoint when the indicator permanently changes colour. Record the final volume of titrant in the burette and the indicator colour.

9. Repeat Procedure Steps 5–8 three more times or until you have several results in which the volumes of titrant added are the same to within ± 0.2 mL. (The volume of titrant added is the difference between the initial and final burette volumes.)

10. When you have completed at least four titrations, dispose of all the excess chemicals as directed by your teacher. Clean and rinse all the glassware thoroughly and leave the burette, tap open, and the pipette upside down in the burette clamp to dry.



Analysis

1. (a) Using the trials that agree to within ± 0.2 mL, calculate the average volume of $Na_2CO_3(aq)$ added.

(b) Why is it advisable to carry out multiple trials?

2. Write the balanced chemical equation for the reaction of $Na_2CO_3(aq)$ and HCl(aq).

3. Perform a stoichiometric calculation to determine the concentration of HCl(aq).

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(continued)

4. Post your results. As a class, determine the average [HCl(aq)]. (Discard any results that seem unreasonable.)

Conclusion

5. Report the average [HCl(aq)].

6. Compare [HCl(aq)] to the value provided by your teacher.

7. List several likely sources of error in this investigation.

Extension

8. In addition to being useful as a primary standard, sodium carbonate is also the principal ingredient of most dishwasher detergents. Use the Internet to find the common name of sodium carbonate and suggest why it is used as a dishwashing detergent. ICT