

CHAPTER 6	Investigation 6.E: The Effect of Dilution on the $[\text{H}_3\text{O}^+(\text{aq})]$ and pH of an Acid	BLM 6.3.9
HANDOUT		

In this investigation, you will predict the pH of a strong acid as it is diluted by a series of 10-fold dilutions.

### Question

How does diluting a strong acid affect its pH?

### Prediction

Calculate  $[\text{H}_3\text{O}^+(\text{aq})]$  and predict the pH for:

(a) the original 0.10 mol/L hydrochloric acid

(b) the hydrochloric acid after one 10-fold dilution

(c) the hydrochloric acid after each of six more 10-fold dilutions

### Safety Precautions



- Hydrochloric acid is corrosive. Wash any spills on skin or clothing with plenty of cool water. Inform your teacher immediately.
- Dispose of all materials as directed by your teacher.

### Materials

- 0.10 mol/L hydrochloric acid 
- distilled water
- two 10 mL graduated cylinders (or graduated pipette)
- 100 mL beaker
- small beaker or large test tube
- universal indicator paper (pH paper)
- pH meter (optional)
- stirring rod

### Procedure

1. Create a table on the next page with the following headings:  $[\text{HCl}(\text{aq})]$ ,  $[\text{H}_3\text{O}^+(\text{aq})]$ , predicted pH, pH measured with a universal indicator, and pH measured with pH meter (optional). Record your predictions in the table.
2. Pour about 10 mL of 0.10 mol/L hydrochloric acid into a clean, dry 100 mL beaker. Dip a piece of universal indicator paper into the acid. Compare the colour against the colour chart to determine the pH and record it in your table.

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3. If possible, measure and record the pH of the acid using a pH meter. Rinse the electrode with distilled water after making the measurement.
4. Measure 1.0 mL of the acid from Procedure Step 2 and dilute to 10.0 mL with water. The resulting 10 mL of solution is one-tenth as concentrated as the acid from Procedure Step 2. Mix thoroughly.
5. Use universal indicator paper and a pH meter (if available) to measure the pH. Record your results.
6. Dispose of the more concentrated acid solution as directed by your teacher and rinse and dry the beaker or test tube so you can use it for the next dilution.
7. Repeat Procedure Step 3 using your diluted acid instead of the 0.10 mol/L hydrochloric acid. Repeat Steps 4 through 6.
8. Make further dilutions and pH measurements until the hydrochloric acid solution is  $1.0 \times 10^{-9}$  mol/L.

### Analysis

1. Which do you think gave the more accurate pH: the universal indicator paper or the pH meter? Explain.

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2. Compare the pH values you predicted with the measurements you made. If there were differences for the first few dilutions, how can you explain them?
3. What was the pH of the solution that had a concentration of  $1.0 \times 10^{-8}$  mol/L and  $1.0 \times 10^{-9}$  mol/L? Explain the pH you obtained.
4. What effect does a ten-fold dilution of a strong acid (hydrochloric acid) have on  $[\text{H}_3\text{O}^+(\text{aq})]$  and the pH of the acid?
5. Use a spreadsheet program to construct a graph (use an *xy* scatter plot) to compare pH and hydronium ion concentration and describe the relationship. **ICT**

### Conclusions

6. Write a statement or statements to explain how changes in the concentration of  $\text{H}_3\text{O}^+(\text{aq})$  relate to changes in the pH of the solution.