

Serial Dilution - LQ

Two quantities that one measures in Chemistry are pH and Percent Transmission of Light. In this lab we will investigate both and look for relationships between them.

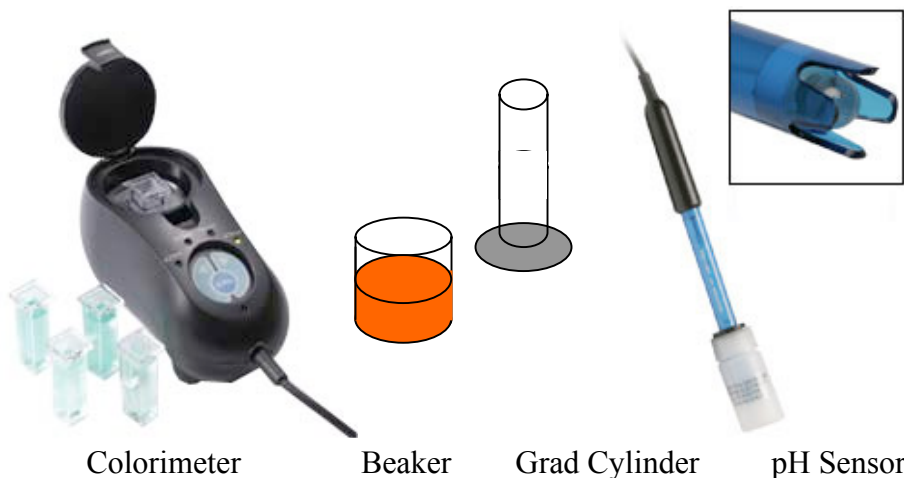
OBJECTIVES

- Analyze the behavior of pH as one dilutes an acidic solution
- Analyze the behavior of % Transmission of light as one dilutes a solution
- Compare the two behaviors to arrive at further understanding of the two quantities

MATERIALS

LabQuest
LabQuest App
pH Sensor
Colorimeter
Stir rod

Stock solution
Beaker – 150 mL
Graduated Cylinder – 50 mL
Cuvette



PRELIMINARY QUESTIONS

1. If you are given a solution and test it to be pH 4, this is considered to be
 - a. Acidic
 - b. Neutral
 - c. Basic
2. If the solution is then diluted by adding water, the condition in the solution will become
 - a. More acidic
 - b. Less acidic
 - c. Move basic
 - d. Less basic
 - e. No change
3. You are given a solution and your tests show that it transmits 60% of the light that strikes it. If the solution is then diluted, the transmission of light

- a. increases perhaps to 70%
- b. decreases perhaps to 50%
- c. doesn't change

PROCEDURE

1. Connect the pH Sensor and the Colorimeter to the LabQuest. Tap on the Colorimeter red rectangle on the meter screen and change the units to “% Transmission”. On the Colorimeter, press the right- or left-arrow until the 430 nm light is turned on. You will be using the blue light for this investigation.
2. Place a cuvette with plain water in the Colorimeter and press the CAL button. This calibrates the sensor which is completed when the red LED turns off.
3. Tap the data collection setup rectangle and change the **Mode** to **Events w/ Entry**. The entry name will be “Concentration” and the units will be “%”.
4. Obtain a 100-mL sample of stock solution in the beaker.
5. Pour a small amount from the beaker into a cuvette until it is 0.75 full. Place the cuvette in the Colorimeter. (Be sure to wipe any spill on the side of the cuvette off so you don't contaminate the Colorimeter.)
6. Pour 50.0 mL of the sample into the graduated cylinder, leaving about 50 mL in the beaker.
7. Rinse and dry the pH sensor bulb, then place the sensor in the remaining liquid in the beaker.
8. Begin data collection. When the readings are steady, tap on the KEEP button. When asked, the concentration will be “100%”.
9. Empty the rest of the beaker into the WASTE and rinse the beaker. Pour the contents of the graduated cylinder into the beaker and then add an additional 50.0 mL of distilled water. Stir the contents to mix well. The concentration will now be half of what it was before. Rinse and dry the cuvette.
10. Follow steps 5-9, each time diluting the solution by half (50%, 25%, 12.5%, 6.25%, etc.). After 6 dilutions, stop data collection. Rinse and dry your cuvette, beaker and graduate cylinder and return materials to their designated locations. Move on to Analysis.

ANALYSIS

1. Were the answers you gave in the preliminary section upheld during the lab? Explain any discrepancies that arose.
2. You should have 2 graphs on the screen, pH and % Transmission. Tap on **Graph > Show Graph > Graph 1**. If the graph that you see is pH versus Concentration, tap on the y-axis label and then tap on **% Transmission**.
3. How does the transmission of light through your sample change as the concentration changes? (During the lab you reduced the concentration but the graph reverses that pattern)

Is there a mathematical relationship between the two? Test your thinking by doing a curve fit for % Transmission vs. Concentration. Report your results. Does this relationship make sense to you? Explain.

4. Change the graph to pH vs. Concentration by tapping on the y-axis label then choosing **pH**.
5. Describe the graph. Is it the same shape as your % Transmission graph? If the pH increases, what does this say about the acidity of the sample, or if it decreases, what does that mean? Describe in words the affect on the acidity of your sample produced by diluting it.
6. What would happen to the pH if you continued diluting the solution a very large number of times?
7. If you instructor directs, continue the mathematical analysis as suggested in the Extension.

EXTENSION

Use the **Model** function under **Analyze** to investigate the relationship between pH and concentration. By definition, pH involves logarithms, so you may wish to model the graph using a log function. Report your best result and interpret the results.

TEACHER NOTE

In this lab, the author envisions using a mildly acidic solution including some yellow food coloring. Dilution will reduce the concentration of yellow as well as diluting the acid. Variations can be made using different colors, basic solutions or different acids. Finally, one could use absorption rather than transmission in this study, yielding a different mathematical relationship from that obtained with transmission.

This lab was suggested by a participant in an on-site workshop the author conducted in 2010. It was reviewed by a chemist and deemed to have merit. If you use this lab, please forward your results and other feedback to the author for fine tuning. Thank you!

C.Bakken
January 2011