

7. BUFFERS IN BIOLOGICAL SYSTEMS

Why are buffers important for survival?

Objectives

- Explain how buffers play a role in maintaining homeostasis in living things.

Materials and Equipment

- Data collection system
- pH sensor
- Beaker, 250-mL
- Graduated cylinder, 10-mL
- Graduated cylinder, 100-mL
- Ring stand or base and support rod
- Test tube clamp or electrode support
- Magnetic stirrer with magnetic stir bar
- Club soda, 100 mL
- Vinegar, 20 mL
- Distilled water, 100 mL
- Wash bottle filled with distilled water

Safety

Follow these important safety precautions in addition to your regular classroom procedures:

- Wear safety goggles at all times.
- Dispose of chemicals as directed by your instructor.

Procedure

1. Select Sensor Data in SPARKvue.
2. Connect the pH sensor to your device.
3. Choose the Graph template.
4. Remove the storage bottle and cap from the pH sensor. Rinse the probe with distilled water.
5. Place the stir bar in the beaker and set the beaker on a magnetic stirrer near the ring stand.
6. Use a clamp or electrode support to position the pH sensor near the inside edge of the beaker, avoiding the stir bar as shown in Figure 1.
7. Add 100 mL of distilled water to the beaker.
8. Turn on the magnetic stirrer to a low speed.
9. Adjust the pH sensor so the glass bulb at the end of the probe is submerged in water.
10. Measure 10 mL of vinegar in a graduated cylinder and set it aside. In Table 1, record your prediction of what will happen to the pH of the water when you add vinegar to the beaker.

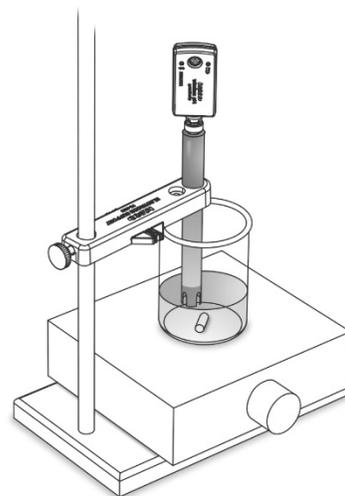


Figure 1: Beaker setup

11. Use the live pH reading in the bottom-left corner to record initial pH in Table 2.
12. Select Start to begin collecting data, and slowly pour the vinegar from the graduated cylinder into the beaker. Continue to record the pH for an additional 10 seconds after adding the vinegar and then stop collecting data.
13. Record the final pH and the time elapsed in Table 2.
14. Remove the pH sensor from the beaker and thoroughly rinse it with distilled water.
15. Remove the stir bar from the beaker and dispose of the beaker contents as directed. Thoroughly rinse and dry the beaker.
16. Repeat Steps 5-15 using club soda in place of water. Rinse the graduated cylinder after pouring the club soda in the beaker.
17. Calculate the change in pH for each run and record the result in Table 2. Use the equation:

$$\text{Change in pH} = \text{Final pH} - \text{Initial pH}$$
18. Show both runs in SPARKvue and scale the display. Sketch your results in Graph 1. Include numbers, labels, and units on the x- and y-axes. Add a key to identify each run.

Data Collection

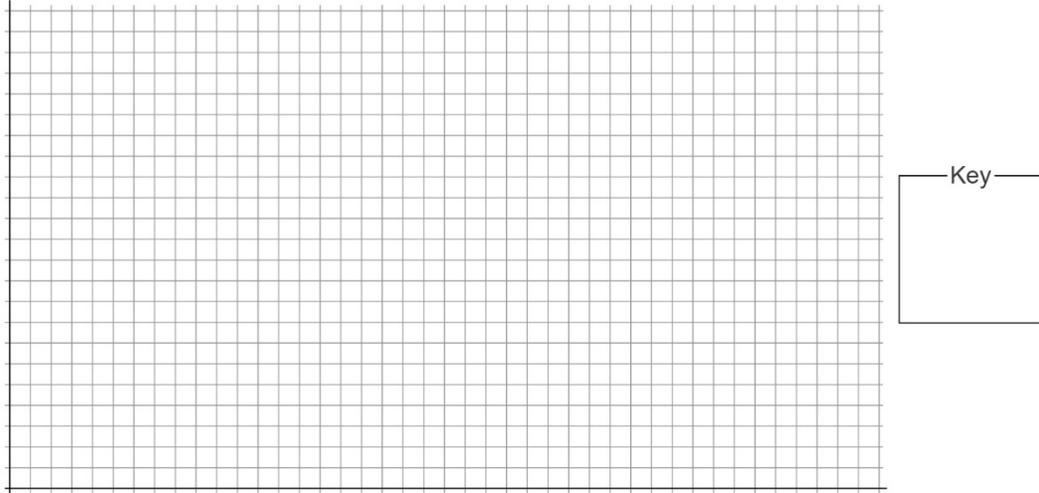
Table 1: Predictions before starting each run

Beaker Contents	How will the pH change when vinegar is added to each beaker? Explain your prediction.
Water	
Club Soda	

Table 2: Change in pH in water and club soda when vinegar is added

Beaker Contents	Initial pH	Final pH	Change in pH
Water + Vinegar			
Club Soda + Vinegar			

Graph 1: Change in pH in water and club soda when vinegar is added



Questions and Analysis

1. The role of a buffer is to resist change in pH. Which liquid is a better buffer: distilled water or club soda? Defend your answer with data.
2. Distilled water contains no dissolved minerals; club soda contains water and dissolved substances including sodium bicarbonate and carbonic acid; tap water contains dissolved substances including calcium and chloride ions. Predict the results if you repeated this investigation with a third run using tap water instead of distilled water. Explain your prediction and comment on your confidence in this prediction, taking your predictions during this investigation into account.
3. Explain how the club soda in this experiment represents the buffering ability of blood.

4. Based on the results of your experiment, why are buffers important in biological systems?