

Activity 3.2.1 Acids and Bases

Purpose

You are exposed to acids and bases everyday in life. Is the orange juice you may have drank this morning an acid or a base? Was the soap you washed your hands with after lunch yesterday an acid or a base? Explore those questions to develop an understanding of acids, bases, and their relation to pH.

Substances that release a hydrogen ion in a solution are called an acid. Those substances that combine with a hydrogen ion are called bases. Think of a water molecule that has two hydrogen atoms and one oxygen atom. If hydrogen is released from a water molecule, it is on its own and has a positive charge (H^+). What is left behind is OH^- or what is called a hydroxyl ion. If other atoms, such as calcium, take the place of the missing hydrogen atom on the hydroxyl ion what is left behind is a high concentration of H^+ . This makes the substance acidic. An example is stomach acid that breaks food down in your body.

The reverse of this process forms the basic or alkaline solutions. If OH^- molecules build up a high concentration, the solution becomes basic, such as soap and baking soda. A pH scale is used to classify substances based on their acid or base concentration. The pH scale range is 0–14 with zero representing the strongest acid and 14 as the strongest base. Pure water would be seven on the pH scale representing the neutral point where hydrogen atoms are in balance.

If a substance is acidic, adding a base to the substance should cause the acidity level to move toward neutral. If a substance is basic, adding an acid to the substance should help neutralize the base. The change toward neutral is called buffering. Substances that are not easily neutralized are said to have strong buffering properties. Use LabQuest2 to determine the pH of common substances.

Materials

Per class:

- Antacid solution
- Aspirin solution
- Baking soda solution
- Cola
- Distilled water
- Milk
- Orange juice

Per student:

- Safety glasses
- Lab apron
- Disposable gloves
- Pencil
- *Agriscience Notebook*

Per pair of students:

- LabQuest
- Vernier pH sensor
- 2 250 ml beakers
- Buffer solution
- 3 50 ml beakers
- 7 small paper cups
- Rinse bottle with distilled water
- 0.10 M HCl (acid) dropper bottle
- 0.10 M NaOH (base) dropper bottle
- Permanent marker pen
- Tape

Procedure

You and a partner will determine if samples of liquids are acids or bases. Then, you will conduct a controlled test to determine how the addition of an acid or base can neutralize a substance.

Part One – Is it an acid or a base?

1. Obtain and wear safety glasses, disposable gloves, and a lab apron because of exposure to corrosive and caustic substances.
2. Label the paper cups with the following substances.
 - Antacid
 - Aspirin
 - Baking soda
 - Cola
 - Distilled water
 - Milk
 - Orange juice
3. Obtain a sample of each substance in the appropriate cup.
4. Pour 100ml of buffer solution in the 250ml beaker.
5. Remove the pH sensor from the solution bottle by twisting the cap loose and sliding the sensor out.
6. Before **each** use of the pH sensor, rinse the tip of the sensor thoroughly with distilled water. Hold the pH sensor above a rinse beaker and use the rinse bottle to rinse the sensor tip thoroughly.
7. Place the tip of the sensor in the paper cup with distilled water. When the reading is stable, record the pH in Table 1. It may take 30 seconds for the sensor to stabilize.
8. Return the sensor to the beaker of buffer solution.
9. Select another substance to test. Place the tip of the sensor in the substance. When the reading is stable, record the pH in Table 1.
10. Rinse the tip of the sensor with distilled water over the empty 250ml beaker.
11. Return the sensor to the beaker of buffer solution.
12. Repeats Steps 9-12 for each substance.
13. Determine if each substance is an acid, a base, or neutral and record in Table 1.
14. Chart each substance on the pH scale in Table 2.

Part Two – Influence of Acids and Bases on Water

CAUTION: Handle the hydrochloric acid with care. Painful burns may occur with skin contact. Sodium hydroxide solution is caustic. Handle with care and avoid spilling it on skin or clothing.

1. Set up the LabQuest2 for data-collection.
 - On the Meter screen, tap “Mode”. Change the data-collection mode to Events with Entry.
2. Enter the Entry Label (drops) and leave the Units field blank.
3. Use the permanent marker pen and tape to label a 50ml beaker *acidic*.
15. Place 20ml of distilled water in the beaker.
16. Rinse the pH sensor thoroughly with distilled water and then place it into the beaker to be tested.
17. Start data collection. Monitor the pH readings displayed to the right of the graph. When the readings are stable, tap “Keep”.
18. Using the numerical keyboard displayed on the screen, Enter **0** as the number of drops you have added. Select “OK” to store the first data pair for this experiment.

19. Add 5 drops of HCl (acid) to the beaker. Stir the solution thoroughly after addition.
20. Place the sensor in the solution.
21. When the LabQuest readings are stable, tap "Keep". Enter the total number of drops of HCl added to the water in the beaker and select "OK".
22. Rinse the pH sensor thoroughly and place the sensor into the beaker of buffer solution.
23. Repeat Steps 8–11 adding 5 drops each time until you have added a total of 30 drops.
24. Stop data collection.
25. To examine the data pairs on the displayed graph, select any data point. As you select each data point, the pH and drop number values are displayed to the right of the graph. Tap each point and record the pH values in Table 3.
26. Label the second 50ml beaker *basic*. Place 20 ml of distilled water in the beaker.
27. Repeat Steps 5–14, substituting NaOH (base) for HCl.

Part Three – Neutralizing Acids and Bases

You have just completed a buffering trial for distilled water by adding 30 drops of acid and 30 drops of base to measure the concentration rate for each treatment. You should notice that water is very easily influenced by the addition of acids or bases. Now you will conduct a test to determine how easily neutralized other substances are. Your teacher will assign you one substance from Part One to test the buffering ability of that substance.

1. Use the clean 50 ml beaker. Place 20 ml of the substance assigned by your teacher in the beaker.
4. If the substance is a base, use HCl to neutralize the substance. If the substance is an acid, use NaOH.
5. Record your substance and if you will be using an acid or a base in Table 3.
6. Repeat Steps 5–14 from Part Two above.

When you have completed all data trials, clean up your work area, store equipment, and dispose of chemicals according to your teacher's directions.

Part Four – Data Comparisons

1. Record your test values on the board for the substance you tested.
28. Record the data collected by your classmates for the substances you did not test in Table 4.
29. In Table 5, rank the substances from most acidic to most basic.
30. In Table 6, rank the substances from greatest buffering change to least change.

Conclusion

1. Which of the substances indicated the highest acid concentration?

The baking soda water had the highest.

31. Describe the chemical nature of a basic substance.

High in acid and toxic

32. What do you suppose would happen to the pH of the antacid if you added NaOH?

The acid level would rise

33. What did you learn about pH in this activity that you did not know before? I learned that there is acid in almost every liquid you see.

Name: _____

Activity 3.2.1 Student Worksheet

Table 1 Data

Substance	pH	Acid or Base?
Distilled water	8.36	Base
Orange Juice	3.91	Acid
Baking Soda	8.90	Base
Milk	6.74	Acid
Cola	2.60	Acid
Antacid	7.08	Base
Asprin	7.81	Base

Table 2 pH Scale

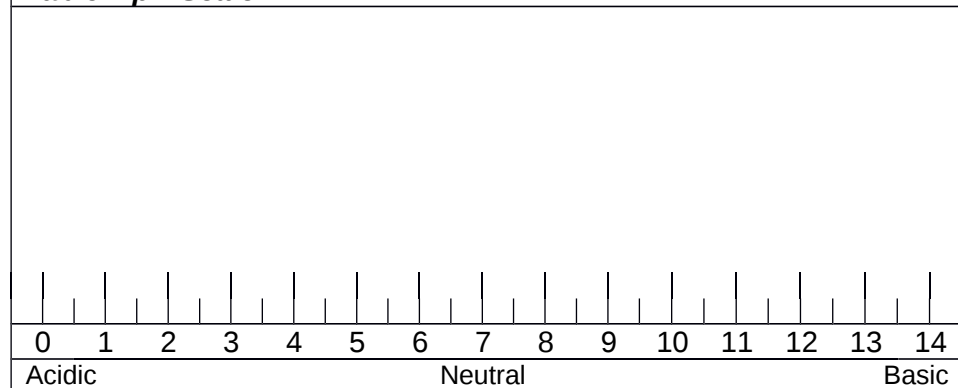


Table 4 Class Comparisons

Material	Add	pH, after adding this many drops							
	Acid or base	0	5	10	15	20	25	30	Δ pH
Distilled Water*	acid								
	base								
Antacid									
Aspirin									
Baking Soda									
Cola									
Milk									
Orange Juice									

* Use data you collected in Table 3.

Table 5 Acidity Ranking

Rank	Initial pH	Material
(most acidic)1	8.90	Baking Soda
2	8.36	Distilled water
3	7.81	Asprin

Table 6 Change in pH

Rank	Δ pH	Material
(greatest Δ)1		
2		
3		

Table 3 Data									
Material Tested	Add	pH, after adding this many drops							
	Acid or base	0	5	10	15	20	25	30	Δ pH
Distilled Water	acid	8.24	7.1	6.65	6.32	5.92	5.17	3.51	4.73
	base	8.22	9.46	9.9	10.2	10.5	10.8	11.0	
OJ	base	3.96	3.98	4.06	4.04	4.07	4.07	4.07	

4	7.08	Antacid
5	6.74	Milk
6	3.91	OJ
(least acidic)7	2.60	Cola

4		
5		
6		
(least Δ) 7		