Connected Chemistry
Acids & Bases Unit
Lesson 3: Strong and Weak Acids & Bases

Student's Lesson at a Glance

Lesson Summary

This lesson contains four activities to help students understand how acids and bases are classified. Acids and bases are often classified as "weak" or "strong" based on how much the acid or base dissociates in water. After a brief Connecting Activity, students will look at computer simulations of different substances in water. Students will create sketches and record their observations. The lesson ties these activities together by asking the students to create definitions of weak acid, strong acid, weak base, and strong base based on their observations of the computer simulations.

SWBAT (Students Will Be Able To)

- Know that according to the Brønsted-Lowry theory of acids, strong acids dissociate completely in water into hydronium ions and conjugate bases
- Know that according to the Brønsted-Lowry theory of acids, strong bases dissociate completely in water into hydroxide ions and conjugate acids
- Know that according to the Brønsted-Lowry theory of acids, weak acids and weak bases do not dissociate completely in water

Essential Vocabulary

Keep a list of all important words from this lesson. This list, in addition to the lists from other lessons, will make studying easier and improve scientific communication skills. The essential vocabulary from the unit is in **bold**. Additional words that will expand your scientific vocabulary are in *italics*.

CCC Reminder

- When acids dissociate, they produce ions, which are represented by halos in the simulation.
- Not all substances are dissociated completely in a solution. Acids and bases also vary in their levels of dissociation. The classification of strong or weak acids and bases is based on these levels of dissociation in water.
- When drawing keys for sketches, make sure to include ions and neutral atoms.

Notes

Homework

Upcoming Quizzes/Tests

Activity 1: Connecting

1. What ions do you think the following salts dissociate into when mixed with water?

$NaF\ (s) + H_2O\ (l) \rightarrow$ _____

$MgCl_2\ (s) + H_2O\ (l) \rightarrow$ _____

$Ba(NO_3)_2\ (s) + H_2O\ (l) \rightarrow$ _____

Following the prompts in the headers of the table below, complete a sketch that illustrates how water promotes the dissociation of ionic compounds.

Draw a submicroscopic picture of an ionic compound dissociating in water.	Create a written explanation of your sketch.
Key	

You may have noticed that acidic foods tend to have a sour taste. For example, lemon juice, coffee, and cola all have a sour taste because each of these foods contain acids. Although there are many compounds in each of these solutions that give them their respective flavors, it is the acids that give them their sour taste. Because of this, many people add sweeteners to such foods to make them more ***palatable***. You may realize that lemon juice is much more sour than coffee. To understand why some foods taste more sour than others, we need to examine how different acids

react when they are dissolved in water.

In prior chemistry lessons, you may have encountered the concept of dissociation. **Dissociation** is the process by which ionic compounds separate into their component ions. Recall that in CCC simulations, ions have grey halos. Most commonly, this occurs when an ionic compound is mixed with water as a solvent to form an aqueous solution. For example, when solid sodium chloride (NaCl) mixes with water, the compound dissociates into aqueous Na^+ and Cl^- ions. Similarly, acids and bases also dissociate when they are mixed with water. However, not all acids and bases dissociate in the same manner, as you will see in the next simulation activity.

Like water-soluble ionic compounds, strong acids and strong bases dissociate completely in water into their constituent ions. Weak acids and weak bases, however, do not dissociate completely; weak acids and bases only partially dissociate in water. Recall that pH is a measure of acidity or basicity of a solution. However, the pH of a solution does not inform us if the solution contains a **strong acid**, **weak acid**, **strong base,** or **weak base**. To classify an acid or base as strong or weak, knowledge of how the compound dissociates is necessary. You will use the next few simulations to discover how to distinguish between the strong and weak acids and bases.

Activity 2: Demonstration

Set 1: *Use Simulation 3,* ***Set 1***

- *Your teacher will display a simulation for you to view.*
- *After pausing the reaction, create a "before" submicroscopic sketch of the reaction.The before sketch is made after pausing the simulation at ~2-3 seconds.*
- *Play the reaction for 30 seconds and then pause.*
- *Create a submicroscopic sketch after the reaction has been paused. Record your observations and the data from monitors.*

	Before Reaction				After Reaction			
Submicroscopic Sketch								
# of Molecules	HCl		H_3O^+		HCl		H_3O^+	
	OH^-		H_2O		OH^-		H_2O	
	Cl^-				Cl^-			
Chemical Equation	$HCl\ (l) + H_2O\ (l) \rightarrow$ _____							
Observations								
Key								

Using the simulations that you just viewed, answer the following questions.

2. Describe the interaction as the hydrochloric acid (HCl) molecules collide with the water molecules (H_2O).

3. Are the numbers of HCl molecules larger, smaller, or staying the same compared to the number of H_3O^+ molecules?

4. Do you observe any OH^- ions being formed in this reaction?

5. Would you describe HCl as an acid or base? *Support your claim with evidence.*

6. Based on your evidence, is HCl is a (*circle one, and support your claim with evidence*).

   - Strong Acid
   - Weak Acid
   - Strong Base
   - Weak Base

Activity 3: Simulations

Set 2: *Use Simulation 3,* ***Set 2***

- Pause the reaction then create a "before " submicroscopic sketch of the reaction.
- Play the reaction for 30 seconds and then pause.
- Create a submicroscopic sketch after the reaction has been paused.
- Record your observations and the data from monitors.

	Before Reaction				After Reaction			
Submicroscopic Sketch								
# of Molecules	HF		H_3O^+		HF		H_3O^+	
	OH^-		H_2O		OH^-		H_2O	
	F^-				F^-			

Chemical Equation

$HF\ (l) + H_2O\ (l) \rightarrow$ _____

Observations

Key

Using the simulations that you just viewed, answer the following questions.

7. Describe the interaction as the hydrofluoric acid (HF) molecules collide with the water molecules (H_2O).

8. How is the collision of HF with H_2O different than what you observed when hydrochloric acid (HCl) collides with H_2O?

9. Are the numbers of HF molecules larger, smaller, or staying the same compared to the number of H_3O^+ molecules?

10. Compared with the H_3O^+ molecules formed from HF, what do you observe about the number of H_3O^+ molecules formed from HCl?

11. Do you observe any OH^- molecules being formed in this reaction?

12. Would you describe HF as an acid or a base? *Be sure to include which theory you used to make this determination.*

13. Based on your evidence, HF is a *(circle one, and support your claim with evidence).*

    1. Strong Acid
    2. Weak Acid
    3. Strong Base
    4. Weak Base

Set 3: *Use Simulation 3,* ***Set 3***

	Before Reaction				After Reaction			
Submicroscopic Sketch								
# of Molecules	$NaOH$		H_3O^+		$NaOH$		H_3O^+	
	OH^-		H_2O		OH^-		H_2O	
	Na^+				Na^+			
Chemical Equation	$NaOH\ (s) + H_2O\ (l) \rightarrow$ _____							
Observations								
Key								

Using the simulations that you just viewed, answer the following questions.

14. Describe the interaction as the sodium hydroxide (NaOH) compound collides with the water molecules (H_2O).

15. Are the numbers of NaOH molecules larger, smaller, or staying the same compared to the OH^- ions?

16. Do you observe any H_3O^+ ions being formed in this reaction?

17. Would you describe NaOH as an acid or base? *Be sure to include which theory you used to make this determination.*

18. Based on your evidence, is NaOH a *(circle one, and support your claim with evidence)*.

    1. Strong Acid
    2. Weak Acid
    3. Strong Base
    4. Weak Base

Set 4

Use Simulation 3, ***Set 4***

	Before Reaction				After Reaction			
Submicroscopic Sketch								
# of Molecules	NH_3		H_3O^+		NH_3		H_3O^+	
	OH^-		H_2O		OH^-		H_2O	
	NH_4^+				NH_4^+			

Chemical Equation

$NH_3\ (l) + H_2O\ (l) \rightarrow$ _____

Observations

Key

Using the simulations that you just viewed, answer the following questions.

19. Describe the interaction as the ammonia (NH_3) molecules collide with the water molecules (H_2O).

20. How is the collision of NH_3 with H_2O different than what you observed when NaOH collided with H_2O?

21. Are the numbers of NH_3 molecules larger, smaller, or the same compared to the number of OH^- ions?

22. Compared with the OH^- molecules formed from NaOH, what do you observe about the number of OH^- molecules formed from NH_3?

23. Would you describe NH_3 as an acid or a base? *Be sure to include which theory you used to make this determination.*

24. Based on your evidence, is NH_3 a *(circle one, and support your claim with evidence).*

    1. Strong Acid
    2. Weak Acid
    3. Strong Base
    4. Weak Base

Activity 4: Teacher Facilitated Discussion

25. Based on the submicroscopic observations and the numbers you reported, how can we define the following terms?

Strong Acid

Weak Acid

Strong Base

Weak Base

26. What do strong acids and weak acids have in common?

27. What do strong bases and weak bases have in common?

Lesson Reflection Questions

28. Is there a relationship between pH and the strength of an acid? *Support your claim with evidence.*

29. Draw a submicroscopic picture of a weak acid and a strong acid at equal concentrations to show the difference between them. *Be sure to describe your pictures.*

Draw a submicroscopic picture of a weak acid.	Draw a submicroscopic picture of a strong acid.
Description of drawing:	**Description of drawing:**