

**Teacher’s Guide**

 **Bath Bombs: The Chemistry Behind the Fizz**

***December 2021***

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Activate students’ prior knowledge and engage them before they read the article.

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These questions are designed to help students read the article (and graphics) carefully. They can help the teacher assess how well students understand the content and help direct the need for follow-up discussions and/or activities. You’ll find the questions ordered in increasing difficulty.

[Graphic Organizer 5](#_Graphic_Organizer)

Thishelps students locate and analyze information from the article. Students should use their own words and not copy entire sentences from the article. Encourage the use of bullet points.

[Answers 6](#_Answers_to_Reading)

Access the answers to reading comprehension questions and a rubric to assess the graphic organizer.

[Additional Resources 9](#_Additional_Resources_1)

Here you will find additional labs, simulations, lessons, and project ideas that you can use with your students alongside this article.

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# Anticipation Guide

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Directions: *Before reading the article*,** in the first column, write “A” or “D,” indicating your **A**greement or **D**isagreement with each statement. Complete the activity in the box.

As you read, compare your opinions with information from the article. In the space under each statement, cite information from the article that supports or refutes your original ideas.

|  |  |  |
| --- | --- | --- |
| **Me** | **Text** | **Statement** |
|  |  | 1. Water is needed as a solvent for bath bombs to work.
 |
|  |  | 1. Bath bombs and Alka-Seltzer are based on a simple acid-base reaction.
 |
|  |  | 1. Baking soda is a weak acid.
 |
|  |  | 1. Citric acid is a strong acid.
 |
|  |  | 1. Water is a polar molecule because hydrogen is more electronegative than oxygen.
 |
|  |  | 1. Cool bath water causes the bath bomb fizz faster than warm water.
 |
|  |  | 1. Epsom salts soothe rashes.
 |
|  |  | 1. Epsom salts contain magnesium.
 |
|  |  | 1. Both artificial and naturally derived fragrances can cause contact dermatitis.
 |
|  |  | 1. Linalool, found in lavender and citrus, is a compound composed of only carbon, hydrogen, and oxygen.
 |

# Student ReadingComprehension Questions

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Directions**: Use the article to answer the questions below.

1. Explain how a water molecule “pulls apart” the sodium bicarbonate molecule into its separate ions.

2. What are some uses for citric acid (and other similar weak acids)?

3. State some health benefits from Epsom salts. What are some “claimed” (but not yet confirmed benefits?

4. Why is the element magnesium so important to the human body?

5. What are some ways a bath bomb could affect a person’s skin?

6. Think of how molecules move, and the effect of temperature on their movements. Explain how a bath bomb would react more quickly in warm water versus cold water, in terms of molecular motions.

7. What are some reasons that you would not get a chemical or acid burn from the citric acid in the bath bombs?

8. Look at a model of the water molecule. Explain why its angular/bent shape allows the water molecule to be polar. If the molecule was linear, how would that affect the polarity of water?

9. Explain why citric acid is a weak acid and hydrochloric acid is a strong acid (you may need to research on the differences between strong and weak acids).

10. Look up the definition of “spectator ion.” What is a spectator ion? Look at the reaction in the section called “The Fizz Effect.” What ion (or ions) could be considered a spectator ion, and why?

**Student Reading Comprehension Questions, cont.**

11. Research the concept of Bronsted acids and bases. Define what a Bronsted acid is, and what a Bronsted base is. Explain why the reaction in the section “The Fizz Effect” is an example of a Bronsted acid/base reaction. Label the compounds as either Bronsted acids or bases.

**Questions for Further Learning**

***Write your answers on another piece of paper if needed.***

1. Do internet research on aromatic hydrocarbons. What is the common structure of an aromatic hydrocarbon molecule? Find some examples of these compounds, and the odor they create.

2. One of the uses for citric acid is to prevent the browning of some fruits, especially apples. Research and explain why browning occurs and how citric acid prevents it.

# Graphic Organizer

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Directions**: As you read, complete the graphic organizer below to describe the chemicals often found in bath bombs.

|  |  |  |
| --- | --- | --- |
| **Ingredient** | **Chemical Formula** | **Purpose** |
| **Baking soda** |  |  |
| **Citric acid** |  |  |
| **Epsom salts** |  |  |
| **Fragrance(s)** |  |  |

**Summary:** On the back of this sheet, write a tweet (280 characters or less) about what to look for when choosing bath bombs.

# Answers to Reading Comprehension Questions & Graphic Organizer Rubric

1. **Explain how a water molecule “pulls apart” the sodium bicarbonate molecule into its separate ions.**

*The oxygen atom, which has a partial negative charge, will attract the positive sodium ions, and the more positive hydrogen end of the water molecule would attract the negative bicarbonate ion (HCO3-1).*

2. **What are some uses for citric acid (and other similar weak acids)?**

*Citric acid is the natural acid found in citrus fruits. It is also used as an additive to preserve other foods (i.e. adding lemon juice to apples to keep them from browning).*

3**. State some health benefits from Epsom salts. What are some “claimed” (but not yet confirmed benefits?** *Epsom salts (MgSO4) helps to soothe skin rashes. Other claims, such as relieving stress or improving sleep, have not been officially confirmed.*

4. **Why is the element magnesium so important to the human body?**

*Magnesium is such an important mineral for the human body. It is needed in many enzymatic reactions, for nerves, muscles, and heart.*

5. **What are some ways a bath bomb could affect a person’s skin?**

*The essential oils in the bath bombs could affect people with sensitive skin, causing irritations and rashes.*

6. **Think of how molecules move, and the effect of temperature on their movements. Explain how a bath bomb would react more quickly in warm water versus cold water, in terms of molecular motions.**

*When temperature increases, molecules speed up. In a reaction, the faster molecules collide with more frequency, which causes the reaction to happen at a quicker rate. When you put a bath bomb in warm water, this is causing the sodium bicarbonate and citric acid molecules to warm up and move faster. They will thus react at a faster pace.*

7. **What are some reasons that you would not get a chemical or acid burn from the citric acid in the bath bombs?**

*The citric acid will not burn the skin for a variety of reasons. First, the small amount of citric acid dissolved in a large amount of water dilutes the acid. Second, the sodium bicarbonate reacts with the acid to neutralize it.*

8. **Look at a model of the water molecule. Explain why its angular/bent shape allows the water molecule to be polar. If the molecule was linear, how would that affect the polarity of water?**

*Because of the angular shape of the water molecule, the negative oxygen is on one end of the molecule, and the two hydrogens are at the other end. This gives the water molecule definitive positive and negative ends, thus making it polar.*

*If the molecule was linear, then the two hydrogen atoms would be 1800 apart from each other, on either side of the oxygen atom. This would not create definite positive and negative ends. Carbon dioxide is an example of a molecule that is not polar because of its linear shape.*



9. **Explain why citric acid is a weak acid and hydrochloric acid is a strong acid (you may need to research on the differences between strong and weak acids).**

*A strong acid is an acid that dissociates 100%. This means that 100% of the acid molecules produce a hydrogen ion (H+) which gives the molecule its acid properties. For example, hydrochloric acid (HCl) splits 100% into H+ and Cl- ions in water. No HCl molecules are present. In a weak acid, like citric acid, only a small percentage of acid molecules produce a hydrogen ion. For citric acid (C6H8O7), some molecules would split into H+ and C6H5O7-. Others would not dissociate at all, and remain C6H8O7. Therefore, the less hydrogen ions produced, the weaker the acid.*

10. **Look up the definition of “spectator ion.” What is a spectator ion? Look at the reaction in the section called “The Fizz Effect.” What ion (or ions) could be considered a spectator ion, and why?**

*A spectator ion is an ion in a reaction that remains unchanged in any way. The spectator ion will keep its ionic charge, and remain unbonded to other ions. Consider the reaction on page 6:*

*3NaHCO3 + C6H8O7 🡪 Na3C6H5O7 + H2CO3*

*The ionic equation is as follows:*

*3Na+ + 2HCO3- + C6H8O7 🡪 3Na+ + C6H5O7-3 + H2CO3*

*Sodium remains the same on both sides of the reaction. Therefore it is a spectator ion.*

11. **Research the concept of Bronsted acids and bases. Define what a Bronsted acid is, and what a Bronsted base is. Explain why the reaction in the section “The Fizz Effect” is an example of a Bronsted acid/base reaction. Label the compounds as either Bronsted acids or bases.**

*A Bronsted acid is a molecule that donates a hydrogen ion (H+) to another molecule. The molecule that accepts the hydrogen ion is a Bronsted base. Using the ionic equation from above:*

*3Na+ + 2HCO3- + C6H8O7 🡪 3Na+ + C6H5O7-3 + H2CO3*

*The citric acid molecule, C6H8O7, loses 3 hydrogen ions to become C6H5O7-3. The bicarbonate ion, HCO3-, gains the hydrogens to become H2CO3.*

**Questions for Further Learning**

1**. Do internet research on aromatic hydrocarbons. What is the common structure of an aromatic hydrocarbon molecule? Find some examples of these compounds, and the odor they create.**

*Aromatic hydrocarbons (or aromatic compounds) are organic compounds that create an odor. There are many artificial smells that are made by these aromatic compounds. All aromatic compounds contain a benzene ring in them. An online search can yield many examples.*

**2. One of the uses for citric acid is to prevent the browning of some fruits, especially apples. Research and explain why browning occurs and how citric acid prevents it.**

*The process is called enzymatic browning. Specific enzymes react and cause the fruit or vegetable to turn brown. The students can find the chemical reaction for enzymatic browning and find ways to slow or prevent it in foods.*

**Graphic Organizer Rubric**

If you use the Graphic Organizer to evaluate student performance, you may want to develop a grading rubric such as the one below.

|  |  |  |
| --- | --- | --- |
| **Score** | **Description** | **Evidence** |
| 4 | Excellent | Complete; details provided; demonstrates deep understanding. |
| 3 | Good | Complete; few details provided; demonstrates some understanding. |
| 2 | Fair | Incomplete; few details provided; some misconceptions evident. |
| 1 | Poor | Very incomplete; no details provided; many misconceptions evident. |
| 0 | Not acceptable | So incomplete that no judgment can be made about student understanding |

# Additional Resources

**Simulations**

**Acid/Base Solutions PhET Simulation**: Students can learn about acid and base strengths and learn how different tools such as a pH meter and pH paper can help identify whether a solution is an acid or base. Students cand determine whether a solution is a strong or weak acid or base and whether a solution is concentrated or diluted.

<https://phet.colorado.edu/en/simulations/acid-base-solutions>

**Lessons and lesson plans**

**Esterfication Lab:** Students will make at least six esters from different combinations of available organic acids and alcohols. In addition, they will attempt to identify the scent of each ester that is created.

<https://teachchemistry.org/classroom-resources/esterfication>

**Calculating Acid in Lemon-Lime Soda Lab:** students will investigate the molarity of citric acid in a clear, lemon-lime flavored soft drink through titrations with 0.10M NaOH and an indicator

<https://teachchemistry.org/classroom-resources/calculating-acid-in-lemon-lime-soda>

**Science of Bath Bombs Video: Learn about the acid-base chemistry in bath bombs.**

<https://youtu.be/UT1qWPeY5mA>

**Other Resources**

**Enzymatic Browning: A resource explaining the process of enzymatic browning in food.**

<https://nieonline.com/downloads/fighting_with_food/keeping_it_fresh.pdf>

**Why do apple slices turn brown after being cut?:**

<https://www.scientificamerican.com/article/experts-why-cut-apples-turn-brown/>

**A Guide to Acids, Acid Strength, and Concentration Compound Interest Infographic:**

<https://www.compoundchem.com/2016/09/28/acids/>

**Table of esters and their smells:**

<https://jameskennedymonash.files.wordpress.com/2013/12/table-of-esters-and-their-smells.jpg>

**Projects and extension activities**

**How to make bath bombs at home:**

<https://www.popsci.com/how-to-make-your-own-bath-bombs/>

# Chemistry Concepts, Standards, and Teaching Strategies

**Connections to Chemistry Concepts**

The following chemistry concepts are highlighted in this article:

* Acid-base reactions
* Strong vs. weak acids/bases
* Solute/solvent
* Electronegativity

**Correlations to Next Generation Science Standards**

This article can be used to achieve the following performance expectations of NGSS:

|  |
| --- |
| **HS-PS1-2.**  Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.  |

**Disciplinary Core Ideas:**

* PS.1.B: Chemical Reactions

**Crosscutting Concepts:**

* Patterns
* Structure and function
* Cause and effect

**Science and Engineering Practices:**

* Constructing explanations and designing solutions

**Nature of Science:**

* Science addresses questions about the natural and material world

**Correlations to Common Core State Standards**

See how *ChemMatters* correlates to the[**Common Core State Standards** online](https://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/teachers-guide.html).

**Teaching Strategies**

Consider the following tips and strategies for incorporating this article into your classroom:

* **Alternative to Anticipation Guide:** Before reading, ask students if they have ever used bath bombs, and why they think they are useful. Their initial ideas can be collected electronically via Jamboard, Padlet, or similar technology.
	+ As they read, students can find information to confirm or refute their original ideas.
	+ After they read, ask students what they learned about the ingredients in bath bombs.
* After students have read and discussed the article, ask students how they will use the information from the article in the future.
	+ Will they use bath bombs? If so, how will they decide which ones to buy?
	+ What other consumer products (besides bath bombs and Alka-Seltzer) can they think of for the reaction between a weak acid and a weak base?