

**Teacher’s Guide**

**How Did the Battery Get Its Name?**

***April 2024***

**Table of Contents**

[***Anticipation Guide***](#_1fob9te)***2***

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

[***Reading Comprehension Questions***](#_3znysh7) ***3***

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***](#_9f8azrtnp6p5) ***5***

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***](#_djipzn7z1r1b) ***6***

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

[***Additional Resources***](#_8qbtv1wio6jt) ***9***

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

[***Chemistry Concepts and Standards***](#_gy1yjx1c39og) ***10***



# Anticipation Guide

**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.

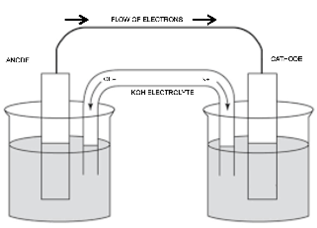
As you read, compare your opinions with information from the article. In the space under each statement, cite information from the article that supports or refutes your original ideas.

| **Me** | **Text** | **Statement** |
| --- | --- | --- |
|  |  | 1. Alessandro Volta coined the term “battery.” |
|  |  | 2. Batteries change chemical energy to electricity. |
|  |  | 3. Volta’s first battery was a voltaic pile consisting of zinc, copper or silver, and salt water. |
|  |  | 4. Zinc is oxidized at the anode of many batteries. |
|  |  | 5. The electrolyte in many alkaline batteries is NaOH. |
|  |  | 6. The electrolyte in a battery provides a path for electron flow. |
|  |  | 7. Alkaline batteries are named according to size. |
|  |  | 8. Batteries of different sizes have different voltages. |
|  |  | 9. Button and coin batteries were developed in the 1970s. |
|  |  | 10. The numbers in coin batteries tell the size of the battery in cm. |

# Student Reading Comprehension Questions

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

1. What was the name of the scientist who came up with the name “battery”? What is the original definition of the word?
2. In Volta’s battery or any voltaic cell, what causes the electrons to move? Write the two half reactions that occur in Volta’s battery? Which reaction is the oxidation and which reaction is the reduction?
3. Why are the more common non-reusable batteries called “alkaline batteries”?
4. Define anode and cathode and briefly explain their roles in electron transfer.
5. Briefly describe the original naming/lettering system for batteries. Briefly explain the new naming procedure. Why do we not see any B batteries?
6. Explain what it means for voltage to be an “intrinsic” property.
7. Explain the difference between voltage and current. Using these terms, why do we have different sizes of batteries?
8. Explain, in terms of current and power, why it is necessary to use multiple batteries in a device.
9. Examine the diagram below of a voltaic cell. Notice the direction of flow of electrons, as well as the flow of the electrolyte solution (KOH). Explain why the ions in the electrolyte are needed for the cell to work.



1. Consider the equation:

Zn(s) + 2OH-(aq) → ZnO(s) + H2O(l) + 2e-

When the reactant, Zinc, has been completely converted to zinc oxide (ZnO), what will happen to the reaction, and the battery? With this in mind, how do you think rechargeable batteries work?

**Student Reading Comprehension Questions, cont.**

**Questions for Further Learning**

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

1. Research and describe the similarities and differences between series and parallel. What are some examples of devices that use either of these set-ups?

# Graphic Organizer

**Directions**: As you read, complete the graphic organizer below to define terms from the article, with examples.

|  | **Definition** | **Example or Interesting Fact** |
| --- | --- | --- |
| **Battery** |  |  |
| **Voltaic Pile** |  |  |
| **Alkaline Battery** |  |  |
| **Electrolytic Cell** |  |  |
| **Voltage** |  |  |
| **Anode** |  |  |
| **Cathode** |  |  |

**Summary:** On the back of this sheet, write three interesting facts you learned about naming batteries.

# Answers to Reading Comprehension Questions & Graphic Organizer Rubric

1. What was the name of the scientist who came up with the name “battery”? What is the original definition of the word?  
   Benjamin Franklin coined the term “battery.” The term battery is originally a military term meaning weapons working together.
2. In Volta’s battery or any voltaic cell, what causes the electrons to move? Write the two half reactions that occur in Volta’s battery? Which reaction is the oxidation and which reaction is the reduction?  
   The difference in potential for reduction between the zinc and the copper causes the electrons to move and produce electricity.

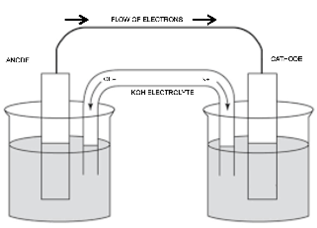
Oxidation: Zn → Zn2+ + 2e-

Reduction: 2H+ + 2e- → H2

1. Why are the more common non-reusable batteries called “alkaline batteries”?  
   The most common batteries are called alkaline because they contain potassium hydroxide as the electrolyte. (Metal hydroxides are labeled alkaline).
2. Define anode and cathode and briefly explain their roles in electron transfer.  
   Anode: the part of the cell/battery where the electrons leave (or, where the chemicals are oxidized).

Cathode: the part of the cell/battery where the electrons are accepted (or, where the chemicals are reduced).

1. Briefly describe the original naming/lettering system for batteries. Briefly explain the new naming procedure. Why do we not see any B batteries?   
   The original naming system was based on the letters of the alphabet. The larger the battery, the higher up on the lettering scale. Now, we use a new code, which contains letters (for the chemical and the shape of the battery) and numbers (for the size). A and B batteries used to exist, but devices have changed and they are no longer used.
2. Explain what it means for voltage to be an “intrinsic” property.  
   An intrinsic property is independent of the amount of the material present. Concentration is a good example, if you pour a glass of juice from a bottle into an empty glass, the concentration remains the same in the glass as it was in the bottle. The voltage produced by a substance will be the same no matter how much of the substance is present.
3. Explain the difference between voltage and current. Using these terms, why do we have different sizes of batteries?  
   Voltage measures the potential difference between two different chemical species, whereas current is the amount of electrons flowing past a point per unit of time in a circuit. Even though batteries of different sizes have the same voltage, larger batteries have a higher current. If the current is larger, then a larger amount of electrons are available to run larger devices.
4. Explain, in terms of current and power, why it is necessary to use multiple batteries in a device.  
   The power of a battery is the combination of both current (the number of electrons moving through the circuit) and voltage, the potential difference between the chemical species being oxidized and reduced. To increase the voltage, multiple batteries may be needed. The larger voltage provides a larger amount of power for the devices.
5. Examine the diagram below of a voltaic cell. Notice the direction of flow of electrons, as well as the flow of the electrolyte solution (KOH). Explain why the ions in the electrolyte are needed for the cell to work.



When electrons flow to one end (the cathode), there is an imbalance of negative charge in the cell. To rebalance the charges, the cations (positive ions) in the electrolyte move towards the cathode to counter the increased negative charge. The anions (negative ions) in the electrolyte flow to the anode, to replace the negative charges lost by the removal of the electrons.

1. Consider the equation:

Zn(s) + 2OH-(aq) → ZnO(s) + H2O(l) + 2e-

When the reactant, Zinc, has been completely converted to zinc oxide (ZnO), what will happen to the reaction, and the battery? With this in mind, how do you think rechargeable batteries work?  
When the zinc has been completely used up, there is no more material to produce electrons. The reaction will end, and the battery will not work anymore (“the battery died”). With rechargeable batteries, an outside power source (i.e. electrical outlet) reverses the reaction so it can start over again.

1. Research and describe the similarities and differences between series and parallel. What are some examples of devices that use either of these set-ups?  
   A series connection is made when the batteries are connected end to end. When this happens, the voltage of each battery is added. This provides more power to devices. The current stays the same, so the batteries will last longer. This is good for many devices found in home or school (remotes, calculators, toys, etc).

A parallel connection is made when all the positives are connected to one wire, and all negatives are connected to another wire. The voltage remains the same, but the current increases overall. This is good for larger devices (i.e. car batteries) that need a large amount of current to run.

The following are 2 resources to check out.

<https://ca.renogy.com/blog/batteries-in-series-vs-parallel-what-are-the-differences/#:~:text=Connecting%20batteries%20in%20series%20increase,ampere%20hour%20ratings(capacity)>

<https://www.quora.com/Why-do-we-use-3-AAA-instead-of-1-or-2-AA-batteries-Is-there-a-huge-output-difference#:~:text=If%20you%20connect%20three%20AA,charge%20capacity%20and%20energy%20capacity>

**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 and Teaching Strategies

**Additional Resources**

* **Labs and demonstrations**
  + <https://www.acs.org/content/dam/acsorg/education/outreach/celebrating-chemistry/2024-ccew/batteries-from-nature.pdf>
  + <https://www.acs.org/education/outreach/celebrating-chemistry-editions/2024-ccew/build-a-battery-workshop-explore-electrolytes.html>
* **Lessons and lesson plans**
* <https://teachchemistry.org/classroom-resources/battery-basics>
* <https://teachchemistry.org/classroom-resources/columbia-dry-cell-battery>
* <https://teachchemistry.org/classroom-resources/what-powers-your-world>
* <https://teachchemistry.org/classroom-resources/hybrid-and-electric-cars-video-questions>
* **Simulations**
  + <https://teachchemistry.org/classroom-resources/voltaic-cells>

**Teaching Strategies**

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

* **Alternative to Anticipation Guide:** Before reading, ask students when they think batteries were invented. Also ask them if they know what’s inside a flashlight battery and what different battery sizes mean. 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 development of batteries, and why there are so many kinds of batteries.
* After students have read and discussed the article, ask students what information they would like to share with friends and family about battery choices.
* **Note to teachers:** This article refers to naming household batteries, not larger batteries. However, 9V batteries were not mentioned. These are 9V alkaline batteries, which are basically six alkaline cells like those described in the article wrapped together in a bundle.

# Chemistry Concepts and Standards

**Connections to Chemistry Concepts**

The following chemistry concepts are highlighted in this article:

* Anode
* Cathode
* Electricity
* Electrolytic cells
* Oxidation
* Reduction

**Correlations to Next Generation Science Standards**

This article relates to the following performance expectations and dimensions of the NGSS:

**HS-PS1-4.** Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends on the changes in total bond energy.

**HS-ETS1-3.** Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

**Disciplinary Core Ideas:**

* PS.1.A: Structure and Properties of Matter
* PS.1.B: Chemical Reactions
* ETS.1.C: Optimizing the Design Solution

**Crosscutting Concepts:**

* Systems and system models
* Energy and matter
* Structure and function

**Science and Engineering Practices:**

* Constructing explanations (for science) and developing solutions (for engineering)

**Nature of Science:**

* Science is a human endeavor.

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).