



**Reading Supports**

**Teacher’s Guide:**

**“How Glass Changed   
the World”**

*October/November 2018*

<http://www.acs.org/chemmatters>



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# Reading Supports

The pages that follow include reading supports in the form of an Anticipation Guide, a Graphic Organizer, and Student Reading Comprehension Questions. These resources are designed to help students prepare to read the article, and then locate and analyze information from the article.

* **Anticipation Guide (p. 5):** The Anticipation Guide helps to engage students by activating prior knowledge and stimulating student interest before reading. If class time permits, discuss students’ responses to each statement before reading each article. As they read, students should look for evidence supporting or refuting their initial responses.

**Or** consider the following ideas to engage your students in reading:

**How Glass Changed the World**

* Before reading, ask students about where we find glass in our everyday lives, and how glass is made.
* As they read, students can add examples from the reading to their lists.
* **Graphic Organizer (p. 6):** The Graphic Organizer is provided to help students locate and analyze information from the article. Student understanding will be enhanced when they explore and evaluate the information themselves, with input from the teacher, if students are struggling. Encourage students to use their own words and avoid copying entire sentences from the article. The use of bullets helps them do this.

If you use the aforementioned organizers 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 |

* **Student Reading Comprehension Questions (p. 7):** The Student Reading Comprehension Questions are designed to encourage students to read the article (and graphics) for comprehension and attention to detail, to provide the teacher with a mechanism for assessing how well students understand the article and/or whether they have read the assignment, and, possibly, to help direct follow-up, in-class discussion, or additional, deeper assignments.

Some of the articles in this issue provide opportunities, references, and suggestions for students to do further research on their own about topics that interest them.

To help students engage with the text, ask students which article **engaged** them most and why, or what **questions** they still have about the articles. The “Web Resources for More Information” section of the Teacher’s Guide: Tools and Resources provides sources for additional information that might help you answer these questions.

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

## Anticipation Guide

**Directions:**  ***Before reading the article*,** in the first column, write “A” or “D,” indicating your agreement or disagreement with each statement. 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. Glass is made from sand. |
|  |  | 1. Glass is a crystalline solid. |
|  |  | 1. Glass has a definite melting point. |
|  |  | 1. Glass is a poor electrical insulator. |
|  |  | 1. Humans learned how to make glass thousands of years ago. |
|  |  | 1. Different types of glass are made by mixing in different chemicals. |
|  |  | 1. Lead crystal glassware made today has a crystalline structure and contains lead compounds. |
|  |  | 1. Some types of glass occur naturally. |
|  |  | 1. Most glass today is made using molds. |
|  |  | 1. Glassware found in chemistry labs is inert to strong acids. |

## Graphic Organizer

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

**Directions**: As you read the article, complete the graphic organizer below to describe what makes glass special, and how it is made.

|  |  |
| --- | --- |
| ***Structure of glass*** |  |
| ***Special properties of glass*** |  |
| ***How is soda-lime glass made and where is it used?*** |  |
| ***How is borosilicate glass made and where is it used?*** |  |
| ***How are other types of glass made?*** |  |
| ***How is glass blown to create special shapes?*** |  |
| ***How is laboratory glassware made?*** |  |

**Summary:** On the back of this paper, write a one-sentence summary (15-18 words) about the importance of glass.

## Student Reading Comprehension Questions

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

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

* 1. What type of bond is present in silicon dioxide, SiO2?
  2. Compare at the molecular level the freezing of water to the cooling of molten sand.
  3. Name three traits of glass that can be attributed to its amorphous state.
  4. At what temperature does sand melt?
  5. (a) Describe the purpose of fluxes, and (b) give 3 examples.
  6. What compounds are substituted for lead in the creation of lead-free crystal?

**Student Reading Comprehension Questions, cont.**

* 1. What compounds are used in the manufacture of the heat-resistant glass, Pyrex?
  2. Describe three types of glass that occur naturally.
  3. When was glass blowing invented?
  4. Give three reasons why borosilicate is glass used for laboratory glassware.

**Critical-Thinking Question**

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

* + 1. How does the internal structure of glass contribute to its non-conductivity?

## Answers to Reading Comprehension Questions

1. **What type of bond is present in silicon dioxide, SiO2?**

Strong covalent bonds are present in silicon dioxide.

1. **Compare at the molecular level the freezing of water to the cooling of molten sand.**

When water cools, the molecules are drawn together in an orderly solid crystal structure, whereas when glass cools, the molecules do not regain an orderly structure but one that is called an amorphous solid.

1. **Provide three traits of glass that can be attributed to its amorphous state.**

Three traits of glass attributed to its amorphous state are:

1. It does not have a defined melting point and, when heated, softens gradually,
2. it is transparent to visible light, and
3. it does not conduct electricity and therefore is an excellent insulator.
4. **At what temperature does sand melt?**

Sand melts at approximately 1700 °C or 3000 °F.

1. **(a) Describe the purpose of fluxes, and** **(b) give three examples.**
   1. Fluxes are substances that are added to sand in the glass-making process to lower the melting point by promoting the liquefaction of the solid sand.
   2. Three examples of fluxes are calcium oxide (CaO), calcium carbonate (CaCO3), and sodium carbonate (Na2CO3).
2. **What compounds are substituted for lead in the creation of lead-free crystal?**

Barium oxide (BaO), zinc oxide (ZnO), or potassium oxide (K2O) are substituted for lead in the creation of lead-free crystal.

1. **What compounds are used in the manufacture of the heat-resistant glass, Pyrex?**

Silica, boron trioxide (B2O3), sodium oxide (Na2O), and aluminum oxide (Al2O3) are combined to make Pyrex.

1. **Describe three types of glass that occur naturally.**

The three types of naturally-occurring glass are:

1. obsidian, a jet-black mineral formed by volcanos when lava with high silica content cools,
2. tektites, rocks that formed when meteors struck the Earth millions of years ago, and
3. fulgarites, tubes formed when lightning strikes sandy areas.
4. **When was glass blowing invented?**

Glass blowing was invented in the first century BCE.

1. **Give three reasons why borosilicate glass is used for laboratory glassware.**

Three reasons why borosilicate glass is used for laboratory glassware are:

1. because it does not react with the strongest and most corrosive acids, therefore keeping the contents of the container pure,
2. solutions can be boiled, evaporated, or reacted while the glass remains unchanged, and
3. borosilicate glass is reusable and relatively easy to clean.

**Critical-Thinking Question**

1. **How does the internal structure of glass contribute to its non-conductivity of electricity?**

Electricity requires the free movement of electrons or charged particles. Silicon dioxide, the material from which glass is made, has an internal structure composed of strong covalent bonds. In this structure, all the electrons present are located in bonds and are not free to move; therefore sand would not conduct electricity. In the process of melting, the covalent bonds are not broken and electrons would still not be free to conduct electricity, even though the original organized internal structure has become distorted.