

**Teacher’s Guide**

**Chemistry and the Sandy Seashore**

***April 2023***

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

[***Reading Comprehension Questions***](#_Student_Reading_Comprehension) ***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***](#_Graphic_Organizer) ***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***](#_Answers_to_Reading) ***6***

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

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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

**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. Sea breezes are a result of land heating up faster than water during the day. |
|  |  | 2. Many compounds containing sulfur have an unpleasant smell. |
|  |  | 3. In the hydrological cycle, water evaporates from plants as well as bodies of water. |
|  |  | 4. The only salt in seawater is sodium chloride. |
|  |  | 5. Fish maintain their bodies at a higher level of salt content than the water in which they live. |
|  |  | 6. White sand is formed from limestone and fragments of coral and mollusk shells. |
|  |  | 7. The salts in ocean water help hold sandcastles together. |
|  |  | 8. The Turing principle explains both patterns in ripples of sand and patterns in colors of seashells. |
|  |  | 9. The ocean is becoming more acidic, weakening the ability of mollusks to build their shells. |
|  |  | 10. Increased sea surface temperatures help corals grow. |

# Student Reading Comprehension Questions

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

1. A gentle sea breeze is something that brings joy and nostalgia to beach lovers each summer. What science phenomena is responsible for the breeze we enjoy?
2. The smell of the ocean is very distinct. What chemicals contribute to the cabbage-like smell of the ocean?
3. Briefly explain the natural water cycle, also known as the hydrological cycle.
4. How do fish adapt to changing levels of salinity as they migrate through the oceans? What is the average amount of salt in one liter of ocean water?
5. What are the primary components of tropical and continental seaboard sand?
6. If you have ever walked on the beach on a windy day, you might have noticed ripples forming in the sand. What causes these ripples and what factors influence the size and spacing of the ripples.
7. What are morphogens and how do they influence colors and patterns on seashells and animal skins?
8. Many sea creatures live in shells made out of primarily calcium carbonate. Natural ocean acidification is caused by carbon dioxide in the atmosphere reacting with water to produce carbonic acid (H2CO3). In what ways have humans accelerated ocean acidification and what are the consequences of lowering the pH level of the ocean?
9. Ocean temperatures have gradually increased over the past few decades. This has negatively impacted many marine species and habitats, particularly coral reefs. How have humans contributed to increasing ocean temperatures and what are the consequences of declining coral reef habitats?
10. Consider the following scenario:

*You walk out of the forest and onto a long stretch of white sand.... the sand is very soft powder.... imagine taking off your shoes, and walking through the hot, white sand toward the water....as you approach the water the sand cools and your feet start to feel better (less hot).*

Explain the scenario based on the principles of specific heat capacity and thermochemistry.

**Student Reading Comprehension Questions, cont.**

**Questions for Further Learning**

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

1. Create a “Chemistry of the Seashore” infographic using information from the article. Be sure to discuss the chemistry behind the sea breeze and smells on the beach. Ocean acidification, increased ocean temperatures, and the composition of seashells and salt water.

# Graphic Organizer

**Directions**: As you read, complete the graphic organizer below to describe how chemistry can explain phenomena we experience at the seashore.

|  |  |
| --- | --- |
| **Phenomenon** | **Chemical explanation** |
| **Sea Breeze** |  |
| **Ocean smell** |  |
| **Salinity** |  |
| **Osmosis** |  |
| **Diffusion** |  |
| **Sand color** |  |
| **Patterns of color in seashells** |  |
| **Seashell formation** |  |
| **Coral Reefs** |  |

**Summary:** On the back of this sheet, write three new things you learned about chemistry at the seashore.

# Answers to Reading Comprehension Questions & Graphic Organizer Rubric

1. A gentle sea breeze is something that brings joy and nostalgia to beach lovers each summer. What science phenomena is responsible for the breeze we enjoy?  
   The sun heats the land faster than the sea due to the high heat capacity of the ocean water. As the temperature of the air above the land increases, it rises due to expansions (lower density). The cooler air above the ocean rushes in as wind takes the place of the rising warm air creating a wonderful cool breeze.
2. The smell of the ocean is very distinct. What chemicals contribute to the cabbage-like smell of the ocean?  
   The smell is due to the presence of dimethyl sulfide which comes from phytoplankton and algae.
3. Briefly explain the natural water cycle, also known as the hydrological cycle.  
   Energy from the sun causes water to evaporate from oceans, lakes, plants, etc. The water vapor rises into the atmosphere where it cools and condenses into clouds. The vapor eventually returns to the land as precipitation (rain or snow). The liquid water flows across land in the form of run-off, rivers, streams, etc, into bodies of water collecting minerals and salts along the way.
4. How do fish adapt to changing levels of salinity as they migrate through the oceans? What is the average amount of salt in one liter of ocean water?  
   Fish have kidneys that remove excess salt. Fish can also remove excess salt through their gills and skin. The average liter of ocean water contains 35 grams of dissolved salt.
5. What are the primary components of tropical and continental seaboard sand?  
   Tropical sand is typically composed of CaCO3 while continental seaboard sand is composed of SiO2
6. If you have ever walked on the beach on a windy day, you might have noticed ripples forming in the sand. What causes these ripples and what factors influence the size and spacing of the ripples.  
   The ripples are caused by wind. The amount of wind and amount of sand displacement determine the size and spaces of the ripples.
7. What are morphogens and how do they influence colors and patterns on seashells and animal skins?  
   Morphogens are compounds that impact the color of melanin. There are two types of morphogens, an inhibitor and an activator. The diffusion rate, concentration, and type of interactions between the inhibitor and activator morphogens are responsible for the wide variety of patterns we see on shells and animal hides.
8. Many sea creatures live in shells made out of primarily calcium carbonate. Natural ocean acidification is caused by carbon dioxide in the atmosphere reacting with water to produce carbonic acid (H2CO3). In what ways have humans accelerated ocean acidification and what are the consequences of lowering the pH level of the ocean?  
   Acids dissolve calcium carbonate which would limit marine life’s ability to build shells and skeletons. The burning of fossil fuels by humans has increased the amount of CO2 in the atmosphere and thus the amount dissolved in the oceans. Ocean acidification could result in the loss of many marine species who are unable to adapt to changing pH and salt concentrations.
9. Ocean temperatures have gradually increased over the past few decades. This has negatively impacted many marine species and habitats, particularly coral reefs. How have humans contributed to increasing ocean temperatures and what are the consequences of declining coral reef habitats?  
   The burning of fossil fuels, cement production, and deforestation have increased the amount of greenhouse gasses in the atmosphere which are contributing factors of global warming, including warming of the oceans. Coral reefs are home to many marine species and losing coral reefs would disrupt many ocean food chains which is extremely problematic.
10. Consider the following scenario:

*You walk out of the forest and onto a long stretch of white sand.... the sand is very soft powder.... imagine taking off your shoes, and walking through the hot, white sand toward the water....as you approach the water the sand cools and your feet start to feel better (less hot).*

Explain the scenario based on the principles of specific heat capacity and thermochemistry.

The sand when you first step onto the beach has very low water content due to the distance to the ocean. The heat capacity of silicon dioxide and other components of sand is significantly less than water and therefore heats up quickly in the sun. As you move closer to the ocean, the water content of the sand increases. Water has a high heat capacity and takes more energy to increase in temperature. This causes the sand near the ocean to be significantly cooler than the sand near the dunes.

1. Create a “Chemistry of the Seashore” infographic using information from the article. Be sure to discuss the chemistry behind the sea breeze and smells on the beach. Ocean acidification, increased ocean temperatures, and the composition of seashells and salt water.  
   Answers will vary.

**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 |

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# Additional Resources and Teaching Strategies

**Additional Resources**

* **Articles and lesson plans**
  + Ocean Acidification Activity

<https://teachchemistry.org/classroom-resources/how-do-pollutants-affect-our-oceans>

* + Radioactive Decay and Seafloor Activity

<https://teachchemistry.org/classroom-resources/radioactive-decay-and-seafloor-data>

* + Ocean Plastic Article

<https://teachchemistry.org/chemmatters/october-2020/the-search-for-hidden-plastics>

* + Carbon Dioxide and Our Ocean Article

<https://teachchemistry.org/chemmatters/february-2018/acidic-seas-how-carbon-dioxide-is-changing-the-oceans>

* + Oil Spill Activity

<https://teachchemistry.org/classroom-resources/how-do-we-clean-up-an-oil-spill>

**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 been to the seashore, and what natural phenomena they might see there. Ask students how chemistry might explain some of their observations. 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 how a knowledge of chemistry is helpful in explaining what we see and feel at the seashore.

# Chemistry Concepts and Standards

**Connections to Chemistry Concepts**

The following chemistry concepts are highlighted in this article:

* Physical properties
* Chemical properties
* Acids
* Gas laws
* Kinetic molecular theory
* Mixtures

**Correlations to Next Generation Science Standards**

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

**HS-PS1-3.** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

**HS-ESS3-6.** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

**Disciplinary Core Ideas:**

* PS.1.A: Structure and Properties of Matter
* PS.2.B: Types of Interactions
* ESS3.D: Global Climate Change

**Crosscutting Concepts:**

* Patterns
* Cause and effect
* Systems and system models
* Stability and change

**Science and Engineering Practices:**

* Obtaining, evaluating, and communicating information

**Nature of Science:**

* Scientific knowledge assumes an order and consistency in natural systems.

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).