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**Teacher’s Guide**

**Flatus: Chemistry in the Wind**

***October 2023***

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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. Flatus is a subject of serious scientific study. |
|  |  | 2. Pilots flying at high altitudes in World War II were not allowed to have dried beans, vegetables in the cabbage family, or carbonated drinks prior to flying. |
|  |  | 3. Most people pass less than 5 milliliters of gas each day. |
|  |  | 4. Vegetarians produce less gas than meat eaters. |
|  |  | 5. People who are lactose intolerant produce less gas than others. |
|  |  | 6. Almost all gases in flatus are odorless. |
|  |  | 7. Some people produce methane gas, and their stools float in water. |
|  |  | 8. Methane has more global warming capacity than carbon dioxide. |
|  |  | 9. Sulfur-containing compounds give flatus an odor. |
|  |  | 10. All chemical products that relieve gas symptoms contain enzymes. |

# Student Reading Comprehension Questions

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

1. Define Boyle’s Law (You can use your textbook for assistance). What two variables are measured? What one variable is kept constant?
2. On average, approximately how many times does a person have flatulence per day? Is this number different for males and females?
3. What are the most common gases found in the human body digestive system?
4. What gases commonly cause the bad odor of flatulence?
5. Give a brief explanation of these different chemical identifying processes: gas chromatography, infrared spectrometry, and mass spectrometry.
6. What is the enzyme needed to digest dairy products? For people who do not have this enzyme, how do they deal with this issue?
7. Explain why vegetarians produce more flatulence.
8. Explain how Beano and Lactaid work differently than Gas-X.
9. What are farmers trying to do to help limit the amount of methane emitted into the atmosphere?
10. The scientist Amedeo Avogadro stated that the volume of a gas (or a mixture of gases) decreases when the number of moles decrease (and vise-versa). For the following reaction that produces methane, use Avogadro’s principle to explain what happens to the volume of the gases.

4H2 (g) + CO2(g) –> CH4(g) + 2H2O(g)

1. Patients are instructed to not eat or drink before a surgery (typically 12 hours before). Why is this important?
2. According to scientists, methane is approximately 25 times worse for global warming than carbon dioxide. However, carbon dioxide (CO2) seems to be discussed more in discussions on greenhouse gases. Why do you think this is the case?

**Student Reading Comprehension Questions, cont.**

**Questions for Further Learning**

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

1. Deep Sea divers sometimes experience a painful effect called “the bends”. Research and give a brief explanation of what happens when a diver gets the bends, how to get rid of the bends, and how the name “the bends” was coined.

# Graphic Organizer

**Directions**: As you read, complete the graphic organizer below to describe the chemistry of flatus.

|  |  |
| --- | --- |
| **Concept** | **Connection to the article** |
| **Boyle’s Law** |  |
| **Enzymes** |  |
| **Bacteria** |  |
| **Flatus gases** |  |
| **Methane** |  |
| **Sulfur compounds** |  |
| **Gas relief** |  |

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

# Answers to Reading Comprehension Questions & Graphic Organizer Rubric

1. Define Boyle’s Law (You can use your textbook for assistance). What two variables are measured? What one variable is kept constant?  
   Boyle’s Law states that the pressure and volume of a gas are indirectly proportional. The two measured variables are pressure and volume. Variables that remain constant are temperature and amount of gas.
2. On average, approximately how many times does a person have flatulence per day? Is this number different for males and females?  
   The average person passes gas between 5-15 times each day. This number is the same for both men and women.
3. What are the most common gases found in the human body digestive system?  
   The most common gases found in the human body are nitrogen, oxygen, hydrogen, carbon dioxide and methane.
4. What gases commonly cause the bad odor of flatulence?  
   The gases that cause the foul odor of flatulence are hydrogen sulfide (the most common one), methanethiol, and methyl sulfide.
5. Give a brief explanation of these different chemical identifying processes: gas chromatography, infrared spectrometry, and mass spectrometry.  
   Gas chromatography: identifies the different compounds in a complex gas mixture.  
   Infrared spectrometry: molecules are identified through interacting with infrared radiation.  
   Mass spectrometry: chemicals are identified by measuring molecular masses.
6. What is the enzyme needed to digest dairy products? For people who do not have this enzyme, how do they deal with this issue?  
   The enzyme needed to digest dairy products is lactase. Those who are “lactose intolerant” need to take medicines such as Beano, Lactaid, and Gas-X.
7. Explain why vegetarians produce more flatulence.  
   Vegetarians produce more flatulence because their diet has a larger amount of carbohydrates. These carbohydrates are what produce gas in the digestive system.
8. Explain how Beano and Lactaid work differently than Gas-X.  
   Beano and Lactaid medicines contain enzymes that will help break down the sugars in the body that produce gases. Gas-X, however, has a special ingredient (simethicone) that lessens the surface tension of bubbles, which prevents them from forming, or breaks the bubbles down.
9. What are farmers trying to do to help limit the amount of methane emitted into the atmosphere?  
   Methane is a greenhouse gas, so farmers need to limit the amount of this gas produced by cows. Farmers are doing this by finding different feed to give the cows that will limit the amount of methane produced in the cow’s digestive system.
10. The scientist Amedeo Avogadro stated that the volume of a gas (or a mixture of gases) decreases when the number of moles decrease (and vise-versa). For the following reaction that produces methane, use Avogadro’s principle to explain what happens to the volume of the gases.

4H2 (g) + CO2(g) –> CH4(g) + 2H2O(g)

In the reaction, there are 5 moles of gas on the reactant side (4 moles of hydrogen and 1 mole of carbon dioxide). These produce three moles of gas (1 mole methane and 2 moles water). The drop in the number of moles will decrease the overall volume of the gases.

1. Patients are instructed to not eat or drink before a surgery (typically 12 hours before). Why is this important?  
   By not eating before surgery, the body has no food to digest, thus no gases will be produced in the digestive system. This will keep the patient safe from any issues involving releases of gases from the body.
2. According to scientists, methane is approximately 25 times worse for global warming than carbon dioxide. However, carbon dioxide (CO2) seems to be discussed more in discussions on greenhouse gases. Why do you think this is the case?  
   (Answers may vary). A common answer would be that gas powered machines (cars, airplanes, etc) produce large amounts of CO2. So even though methane is worse, carbon dioxide is produced in much larger amounts.

**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**

* **Labs and Simulations**
  + Phet Gas Intro  
    <https://phet.colorado.edu/en/simulations/gases-intro>
  + Phet Gas Properties (more complex)  
    <https://phet.colorado.edu/en/simulations/gas-properties>
  + AACT Gas Law Simulation  
    <https://teachchemistry.org/classroom-resources/the-gas-laws-simulation>
  + Boyle’s Law Activity  
    <https://teachchemistry.org/classroom-resources/boyle-s-law>

* **Lessons and lesson plans**
  + AACT Gas Law Unit Plan

<https://teachchemistry.org/classroom-resources/the-gas-laws-unit-plan>

* + Robert Boyle Video

<https://teachchemistry.org/classroom-resources/robert-boyle-video>

* + Compound Chem Odor infographic

<https://www.compoundchem.com/2014/04/07/the-chemistry-of-body-odours-sweat-halitosis-flatulence-cheesy-feet/>

* + YouTube Science of Farts

<https://youtu.be/GTvnjaUU6Xk?si=Zgq_KQpnNbXBOiIR>

* + Scientific American article on flatulence

<https://www.scientificamerican.com/article/in-and-out-demonstrating-boyles-law/>

**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 wondered how science can answer questions about flatus. Ask students how chemistry might help us understand how to reduce flatus. 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 the chemistry of our digestive system.

# Chemistry Concepts and Standards

**Connections to Chemistry Concepts**

The following chemistry concepts are highlighted in this article:

* Physical properties
* Gas laws
* Enzymes

**Correlations to Next Generation Science Standards**

This article relates to the following performance expectations and dimensions of the 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.A: Structure and Properties of Matter
* PS.1.B: Chemical Reactions

**Crosscutting Concepts:**

* Patterns
* Cause and effect
* Systems and system models

**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).