

**Teacher’s Guide**

**Mad Scientists and Misinformation**

***February 2024***

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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***](#_fbh2674qb7v5) ***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.

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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. Being scientifically literate helps people make good decisions about things such as nutrition and the environment. |
|  |  | 2. Fulminated mercury will explode if thrown on the ground. |
|  |  | 3. All unstable compounds are explosive. |
|  |  | 4. Hydrofluoric acid is the strongest acid. |
|  |  | 5. Hydrofluoric acid moves through skin easily. |
|  |  | 6. *MythBusters* busted the *Breaking Bad* scenarios in the episodes with fulminated mercury and hydrofluoric acid. |
|  |  | 7. The TV series *Breaking Bad* did not have a science advisor. |
|  |  | 8. Chemists can help find new ways to treat substance abuse disorder. |
|  |  | 9. The movie *Elemental* attempted to base the movie on real science, even though there were only four elements in the movie: fire, earth, air, water. |
|  |  | 10. Science and math experts are often hired by TV and movie companies to ensure special effects and depictions of scientists are realistic. |

# Student Reading Comprehension Questions

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

1. How is fulminated mercury made?
2. What are the original four Greek elements?
3. Name three properties of explosive reactions.
4. What is activation energy?
5. What is fentanyl?
6. Name two of fluorine’s characteristics that cause it to be highly reactive.
7. Why is scientific literacy important?
8. What does fulminated mercury decompose into after an explosive reaction?
9. What two goals did ACS have for establishing connections in Hollywood?

**Student Reading Comprehension Questions, cont.**

**Questions for Further Learning**

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

1. Define Charles’ Law.
2. Describe at least two ways that the entertainment industry and scientists can work together.
3. Explain the connection between four original Greek elements and the states of matter.
4. Chemistry is represented in a variety of media. Find an example of chemistry in the media (movies, television, social media, etc.) and do some fact checking. Describe the aspect of chemistry portrayed and analyze the accuracy of the portrayal.

# Graphic Organizer

**Directions**: As you read, complete the graphic organizer below to describe how people who understand science (including you!) can influence public opinions and ideas about science.

|  | **Examples or Definition** | **How can science consultants increase public understanding of this topic?** |
| --- | --- | --- |
| **“Mad Scientists”** |  |  |
| **Scientific Literacy** |  |  |
| **Chemistry in *Breaking Bad*** |  |  |
| **Fentanyl** |  |  |
| **Hollywood Stories and Special Effects** |  |  |

**Summary:** On the back of this sheet, write a short summary (20 words or less) of the article.

# Answers to Reading Comprehension Questions & Graphic Organizer Rubric

1. How is fulminated mercury made?  
   Fulminated mercury is made when red mercury oxide is dissolved in concentrated nitric acid and ethanol is added, it precipitates as a gray solid.
2. What are the original four Greek elements?  
   The four original Greek elements are fire, water, earth, and air.
3. Name three properties of explosive reactions.  
   Explosive reactions are fast, exothermic, and produce gasses that expand quickly.
4. What is activation energy?  
   Activation energy is the minimum amount of energy required to start a chemical reaction.
5. What is fentanyl?  
   Fentanyl is an opioid that is more potent than morphine.
6. Name two of fluorine’s characteristics that cause it to be highly reactive.  
   Fluorine is highly reactive because of its small size and electronegativity.
7. Why is scientific literacy important?  
   Scientific literacy is important because it helps people make informed decisions about various aspects of their lives.
8. What does fulminated mercury decompose into after an explosive reaction?  
   After an explosive reaction, fulminated mercury decomposes into carbon dioxide, nitrogen gas, and metallic mercury.
9. What two goals did ACS have for establishing connections in Hollywood?  
   ACS wanted to influence Hollywood to include more science in the media and represent science in a more positive and realistic manner.
10. Define Charles’ Law.  
    Charles’ law states that when the pressure on a sample of a dry gas is held constant, the Kelvin temperature and the volume will be directly proportional. Gasses expand when heated and contract when cooled.
11. Describe at least two ways that the entertainment industry and scientists can work together.  
    The entertainment industry can help bring the voices of scientists to the public in an accessible and realistic way. Scientists can help media with special effects as well as consulting to ensure the scientific accuracy of movies and shows.
12. Explain the connection between four original Greek elements and the states of matter.  
    The four elements align with the four states of matter: solid (earth), liquid (water), gas (air), and plasma (fire).
13. Chemistry is represented in a variety of media. Find an example of chemistry in the media (movies, television, social media, etc.) and do some fact checking. Describe the aspect of chemistry portrayed and analyze the accuracy of the portrayal.  
    Student 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**

* **Simulations**
  + [AACT Gas Laws Simulation](https://teachchemistry.org/classroom-resources/the-gas-laws-simulation) – Students can use this simulation to investigate Boyle’s Law, Charles’ Law and Gay-Lussac’s Law by visually examining the impact of changing the associated variables of pressure, volume, or temperature.
  + [AACT Ionic and Covalent Bonding Simulation](https://teachchemistry.org/classroom-resources/ionic-covalent-bonding-simulation) - This simulation can be used to help students understand the bonds that fluorine can make with other elements, as described in the article.
  + [PhET Gas Properties Simulations](https://phet.colorado.edu/sims/html/gas-properties/latest/gas-properties_all.html) - This simulation allows students to explore the relationships between a variety of characteristics of gasses.
* **Lessons and lesson plans**
  + [The Gas Laws Unit Plan](https://teachchemistry.org/classroom-resources/the-gas-laws-unit-plan) - This AACT unit plan can be used to help students better understand gas laws through the exploration of videos, simulations, and activities.
* **Projects and extension activities**
  + [Be Media Wise: How to Evaluate Scientific Claims Shared Online](https://www.pbs.org/newshour/classroom/lesson-plans/2023/02/lesson-plan-how-to-fact-check-scientific-claims-that-you-see-online) – This PBS lesson teaches students to use lateral reading to identify false scientific claims.

**Teaching Strategies**

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

* **Alternative to Anticipation Guide:** Before reading, ask students what scientific errors they have noted in movies or TV programs. Ask them why it’s important to separate real science from fiction. 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 importance of scientific literacy, and how science advisors assist moviemakers and television producers to create more believable programs while keeping the programs entertaining.
* After reading, ask students how they might use information from the article when watching new movies and TV episodes in the future.
* Consider asking students to read the “Open for Discussion” article on page 4 of this issue to learn ways to evaluate scientific information for accuracy.

# Chemistry Concepts and Standards

**Connections to Chemistry Concepts**

The following chemistry concepts are highlighted in this article:

* Strong vs. weak acids
* Chemical change
* Chemical properties
* Scientific literacy

**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-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
* ETS1.C: Optimizing the Design Solution

**Crosscutting Concepts:**

* Cause and Effect
* Structure and Function

**Science and Engineering Practices:**

* Constructing explanations (for science) and designing 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).