

## Showing Evidence Unit Plan

**Title:** The Case of the Mysterious Malady

**Description:** Chemistry students act as investigators when they analyze evidence and apply gas laws to determine the most likely source of a potential toxin. Students use the *Showing Evidence Tool* to organize clues and draw conclusions. They then argue their cases in a mock court of law.

### At a Glance

**Grade Level:** 10–12

**Subject sort (for Web site index):** Science

**Subjects:** Chemistry

**Topics:** Environmental Science

**Higher-Order Thinking Skills:** Evaluation, Argumentation, Synthesis

**Key Learnings:** Evaluating Scientific Claims, Applying Gas Laws, Toxins

**Time Needed:** 2 weeks of instruction, 3 periods per week, 90-minute periods

**Background:** California, United States

### Unit Summary

Students act as consulting investigators for the Environmental Protection Agency (EPA) to evaluate the illnesses of a family in the area. They receive memos with clues that guide them through their team's research of a potential toxin. Students use previous experience with gas laws and apply their knowledge to determine the source of the illness. Students evaluate four different claims and find research that either strengthens or weakens each claim. They use the *Showing Evidence Tool* to organize their evidence and come to a conclusion as to what is causing the illnesses. Students' research and persuasive skills are put to the test as teams argue their conclusions in a mock trial.

### Curriculum Framing Questions

#### Essential Question

- How do we decide which scientific claims to believe?

#### Unit Questions

- How does one gather and process scientific data to support a claim?
- How can we apply gas laws to help us solve a problem?
- Why might symptoms not provide enough information when we are trying to diagnose an illness?

#### Content Questions

- What is a toxin?
- How does the random motion of molecules explain diffusion of gases such as carbon monoxide, chlorofluorocarbons, and radon?
- How does the Ideal Gas Law apply to the diffusion of toxic gas indoors?

## Assessment Processes

View how a variety of student-centered [assessments](#) are used in The Case of the Mysterious Malady Unit Plan. These assessments help students and teachers set goals; monitor student progress; provide feedback; assess thinking, processes, performances, and products; and reflect on learning throughout the learning cycle.

## Instructional Procedures

### Prior to the Unit

Students should have prior experience studying gas behavior using the ideal gas law, Charles' law, Avogadro's law, and Boyle's law. Students should also understand how pressure, volume, and temperature affect gas behaviors.

### Look at Scientific Claims

Review the concept of scientific claims with students by taping a few television commercials or choosing a few magazine ads that make claims that could be scientifically proven. Review the advertisements in class and ask the following questions to determine students' understanding of how to evaluate scientific claims in persuasive media:

- *What claims are made about the product being advertised?*
- *Do you believe in the claims made about these products? Why or why not?*
- *What makes some of the claims more effective than others?*
- *What evidence is provided to support the claims?*
- *How do you gather scientific data to support a claim?*

After students discuss the commercials, introduce the Essential Question, *How do we decide which scientific claims to believe?* Have students record their thoughts about the question in their science journals. Pair each student with a peer and have students share their ideas. Follow with a class discussion and record students' thoughts on chart paper.

### Set Up the Project

Prior to introducing the activity to students, become familiar with the [Showing Evidence Web site](#). Familiarize yourself with the tool and read associated resources, such as Walk Through an Example, Try Out the Tool, Classroom Strategies, Project Examples, and Benefits. Before proceeding with the next activity, click [here](#) to set up the Mysterious Malady project in your workspace.

### Introduce the Task

Explain to students that they will take on the role of consulting investigators for the Environmental Protection Agency while evaluating the sickness of a family in the area. Tell students that they will evaluate four different claims concerning the cause of the illness and apply what they know from studying gas laws to determine the source of the illness. Various memos describe the symptoms and the situation of the family being investigated to guide student research.

Divide students into teams of two or three. Give students the [timeline handout](#) to help them assimilate the large number of symptoms, potential sources, and side effects they will be tracking. Use this handout to do informal checks of students' organization and information tracking. Demonstrate the use of the *Showing Evidence*

*Tool* by discussing the sample case together or creating a sample project to go over as a class. Show students how to add, describe, and rate evidence and claims. Be explicit in teaching students what is expected of them while using *Showing Evidence*. Discuss with them how much evidence will be needed to either strengthen or weaken a claim. Come to a consensus as a class if necessary. Work together with students to create an understanding of rating evidence reliability—create a rubric with the class to determine what one star means versus five stars as a rating of reliability. An [example rating rubric](#) is provided. Ask students to describe their understanding of claims and evidence in their journals.

### **Research the Claims**

Provide students with [memo 1](#) and read it aloud in class while student teams track the information on the [timeline handout](#). The first memo introduces symptoms Sally Citizen is suffering from and the possibility of black mold as a potential cause of Sally's afflictions. Lead students in a discussion of the kinds of questions medical professionals ask when they are diagnosing someone's illness. Create a group discussion around the following questions:

- *Why might symptoms not provide enough information when you are trying to diagnose an illness?*
- *What other type of information might be needed?*

Record students' thoughts on chart paper, and post the paper in the classroom for students to use as a reference during research time.

Present the [evidence rubric](#) and ask students to use the rubric to periodically self- and peer-assess their evidence as they work through the project. Direct students to the list of [resources](#) and have them begin to research the first claim, The kinetic molecular theory explains that black mold spores are being spread throughout the home by air molecules and causing Sally's allergic reactions.

Allow time for peer review of each team's work after each phase of student research. Peer review groups read and assess work of the group assigned to them. Each review group makes constructive comments and corrections where needed to the evidence and to the support or nonsupport of the claim. Refer to the discussion of scientific claims at the beginning of the unit. Encourage students to generate comments for their peer review sessions based on some of the ideas they came up with during the initial discussion. Periodically ask students to record their thoughts about the process of finding, evaluating, and using evidence to make decisions in their journals.

Continue with this research process as students receive [memo 2](#), [memo 3](#), and [memo 4](#). As students read through each memo, have them input specifics into their [timeline handout](#). Remind students that they should evaluate the symptoms detailed in the memo and research the source of the toxin causing the illness. If needed, review with students how gas laws can be applied to the situation being researched.

### **Examine the Showing Evidence Activity**

The *Showing Evidence Tool* space below represents one team's investigation in this project. The case you see is functional. You can double-click the evidence to read the team's descriptions.

[insert live tool view here—see [file management spreadsheet](#)]

## Draw Conclusions

After students complete their research for each of the claims, they must synthesize what they learned to make a recommendation to the EPA as to the most-likely cause and source of the sickness affecting all members of the Citizen family. Students write their conclusions in the Comment section of *Showing Evidence*. Each conclusion should clearly state the most likely claim, include one or two sentences summarizing the evidence that supports the claim, and address why the evidence does not support the other claims. While students work in teams, use the [collaboration observation checklist](#) to assess collaboration skills.

Each team defends its claim in a grand jury mock trial. For the trial, join teams with the same conclusion. Each group presents its findings in a 5 to 8 minute oral presentation with a multimedia component. See a portion of [one team's presentation](#). The group may use any supporting evidence gathered during research. The multimedia presentation should include the following:

- Evidence used to determine the most likely cause and source of the toxin
- Diagram(s) to explain how the toxin gets from its source into Sally Citizen's body
- Explanation of how gas laws were applied to help solve the problem

Hand out the [multimedia presentation rubric](#) to help guide the process. After the presentation is created, ask students to self-assess their collaboration skills using the [collaboration self-assessment rubric](#).

## Set Up the Simulation

Tell students the mayor of Sally's town is being investigated by a civil grand jury. Students act as expert witnesses in the mock trial and testify as to the most likely cause and source of the Citizen family's illness. Distribute the [grand jury investigation memo](#) and [grand jury presentation rubric](#), and review the procedures and expectations for the mock trial. Explain to students that they will play two roles:

- Expert witnesses when their teams give testimony as to the most likely cause of the illness
- Voting members of the grand jury

After all testimony is complete, the entire grand jury votes on the cause of the family's illness, the source of the toxicant, the method by which the toxicant gets into the bloodstream, and whether indictments should be issued. Students vote by using the [grand jury ballot](#).

## Wrap Up

Ask students to reflect on the trial and consider whether another group presented a claim with evidence that convinced them to change their original opinion. If so, have students reflect in their journals and share the reasons that made them change their mind. Share with students that this unit is based on an actual case. The EPA found that an air conditioner was actually leaking Freon, which thermally reacted with the fire from the pilot light and created the WWII nerve gas called phosgene. If the homeowners had actually used the central air conditioner, the Freon would have been depleted, and the air conditioner would have gone out, leading them to the leak.

Have students discuss whether their claim and outcome of the trial was similar to that of the actual results of the case. Have students reflect on their team's claim, if it has changed, and how this exercise relates to the Essential Question, *How do we decide which scientific claims to believe?*

### **Prerequisite Skills**

- Exposure to gas behavior, including the ideal gas law, Charles' law, Avogadro's law, and Boyle's law
- Experience completing practice problems using the gas laws
- Knowledge regarding how pressure, volume, and temperature affect gas behaviors

### **Differentiated Instruction**

#### **Resource Student**

- Provide the student with additional templates or scaffolds to ensure project success
- Place the student in cooperative groups that will help the student achieve
- Provide extra time for study
- Reduce the amount of evidence required or preselect research materials

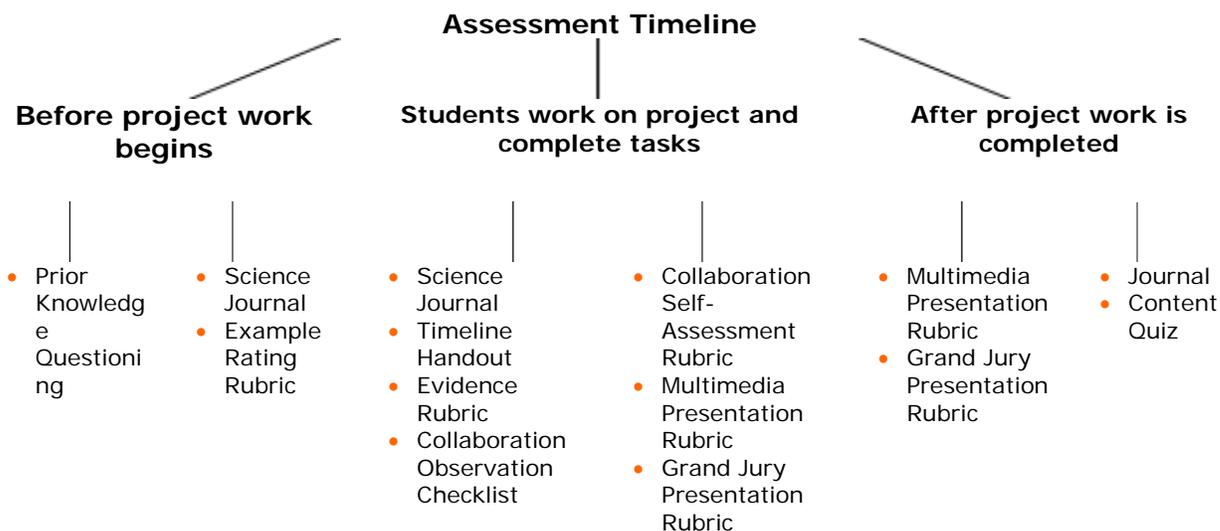
#### **Gifted Student**

- Provide the student with the option to substitute or participate in enhanced components of each project throughout the unit
- Expand the research components to accommodate the student's interests and ability level
- Encourage the student to find news items about toxic chemicals in the environment and relate the news items to the project

#### **English Language Learner**

- Provide a starter set of resources to help the student begin researching
- Allow the student to conduct research in the student's first language
- Encourage the student to ask clarification questions from team members and work with native English speaking students

## Assessment Plan



Determine students' initial understanding of the components of effective argumentation through a discussion of the claims made in contemporary media and through writing in their science journals. Continue using the journals throughout the unit to assess students' understanding of chemistry content and the process of argumentation. Use the [timeline handout](#) to informally check students' organization and information tracking. Use the [example rating rubric](#) to explain the criteria for evaluating evidence and the [evidence rubric](#) to help students assess their progress as they perform the various parts of the project.

When students begin working on the project in teams, distribute the [multimedia presentation rubric](#) to guide the creation of their presentations. In addition, explain that group process skills are assessed using the [collaboration observation checklist](#) and that they use the [collaboration self-assessment rubric](#) to assess their individual and group performance at the end of the project. When students plan their presentation of their findings to the grand jury, provide the [grand jury presentation rubric](#) to help them prepare effectively.

After the presentations to the grand jury, students reflect on any information they heard that influenced their opinions about the cause of the family's illness. When the project is completed, the [content quiz](#), the [multimedia presentation rubric](#), and the [grand jury presentation rubric](#) are used to assess students' performances, products, and knowledge.

### Credits

Debra Power teaches Chemistry and Physics in Placerville, California. She participated in the Intel® Teach Program, which resulted in this idea for a classroom project. A team of teachers expanded the plan into the example you see here.

### THINGS YOU NEED (highlight box)

#### Targeted Content Standards and Benchmarks

## California State Science Content Standards—Grades 9–12

[www.cde.ca.gov/be/st/ss/scmain.asp](http://www.cde.ca.gov/be/st/ss/scmain.asp)\*

### Gases and Their Properties

The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gases. As a basis for understanding this concept:

- Students know the random motion of molecules and their collisions with a surface create the observable pressure on that surface.
- Students know the random motion of molecules explains the diffusion of gases.
- Students know how to apply the gas laws to relations between the pressure, temperature, and volume of any amount of an ideal gas or any mixture of ideal gases.

### Investigation and Experimentation

- Formulate explanations by using logic and evidence.
- Recognize the usefulness and limitations of models and theories as scientific representations of reality.
- Recognize the cumulative nature of scientific evidence.
- Analyze situations and solve problems that require combining and applying concepts from more than one area of science.
- Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings.

### Student Objectives

Students will be able to:

- Apply gas laws to solve real-world problems
- Investigate and evaluate the credibility of claims
- Identify flaws of reasoning within arguments
- Present oral arguments

## Materials and Resources

### Internet Resources

- Tox Town  
<http://toxstown.nlm.nih.gov/town/main.html>\*  
Animated resource providing an introduction to toxic chemicals and environmental health risks you might encounter in everyday life
- U.S. Environmental Protection Agency  
[www.epa.gov/iaq/molds/moldresources.html](http://www.epa.gov/iaq/molds/moldresources.html)\*  
Topics addressing the issue of mold
- EPA: Radon  
[www.epa.gov/iaq/radon/pubs](http://www.epa.gov/iaq/radon/pubs)\*  
Radon-specific publications and resources

- National Safety Council  
[www.nsc.org/ehc/radon.htm](http://www.nsc.org/ehc/radon.htm)\*  
Collection of radon resources
- EPA: Indoor Air Pollution  
[www.epa.gov/iaq/pubs/hpguide.html#combustion%20products](http://www.epa.gov/iaq/pubs/hpguide.html#combustion%20products)\*  
Publication offering an overview of indoor air pollution challenges—includes diagnostic references
- Chlorofluorocarbons  
[www.cmdl.noaa.gov/noah/publictn/elkins/cfcs.html](http://www.cmdl.noaa.gov/noah/publictn/elkins/cfcs.html)\*  
Brief history of chlorofluorocarbons use in refrigeration devices
- Freon  
<http://inventors.about.com/library/inventors/blfreon.htm>\*  
Brief article on the history of Freon
- EPA: Phosgene  
[www.epa.gov/ttn/atw/hlthef/phosgene.html](http://www.epa.gov/ttn/atw/hlthef/phosgene.html)\*  
Background information on phosgene
- eMedicine  
[www.emedicine.com/emerg/topic849.htm](http://www.emedicine.com/emerg/topic849.htm)\*  
Exploration of the toxicity of phosgene

### **Other Resources**

Guest presenters, such as Environmental Protection Agency enforcement specialists, physicians, and environmental lawyers

### **Technology—Hardware**

- Computer with Internet connection to access the *Showing Evidence Tool*
- Projection system to show students how to use the *Showing Evidence Tool*

### **Technology—Software**

- Multimedia software to create presentations for the grand jury investigation