



## Natural Gas Safety World | Teacher's Guide

### Site Overview

Along with parents, teachers play a key role in helping kids learn to stay safe around natural gas. This section contains the resources you need to put this website to work for your class. We've included content standards-based information and experiments, plus worksheets to help you assess students' understanding of key science and safety concepts.

- Site Overview
- Natural Gas FAQs
- Experiment Tips
- Worksheets
- Going Further

**Natural Gas Safety World** uses information, experiments, games, and activities to teach students natural gas science and safety principles.

This site is geared for a range of interests and reading levels and can be used by students in elementary and middle school. (Students can click on highlighted vocabulary words to access pop-up definitions.) Nonreaders will need adult assistance to play the games.

The site features four main areas:

- **Games**—Interactive games that simulate common indoor and outdoor natural gas hazards, giving students a chance to put safety principles into practice.
- **For Kids**—Key science and safety content, organized into thematic sections. Each section is self-contained and includes relevant experiments or activities.
- **For Parents**—Tips for how to get the most out of this site with kids. Includes handy checklists for home use, and links to useful safety websites.
- **For Teachers**—You're in this area now! Tools and tips for educators.

Other helpful features include "Tell Me More," a section for students doing reports and research; a Safety Certificate that students can use to track their progress through the site; a handy Glossary; and a page of links to related energy websites.

## Natural Gas FAQs (Frequently Asked Questions)

1. What's in natural gas?
2. What is methane?
3. What makes natural gas a clean fuel?
4. How much of our country's energy needs are served by natural gas?
5. Are more homes heated by natural gas or electricity?
6. Where in the United States is natural gas located?
7. How much natural gas is produced in the world?
8. How much natural gas do we use?
9. How long will our natural gas supplies last?
10. Why is natural gas used to run electric power plants?
11. How many miles of natural gas pipelines are there in the U.S.?
12. When was natural gas first used in the United States?
13. Why does natural gas smell like rotten eggs?
14. What is "liquefied natural gas?"
15. What is a "smart pig?"
16. How fast does natural gas move through pipelines?

### **1. What's in natural gas?**

Natural gas found in the ground contains methane, ethane, propane, butane, pentane, and traces of hexane and heptanes. Gas utilities remove almost everything but the methane so the natural gas delivered to your home will burn cleanly.

### **2. What is methane?**

Methane is a **molecule** made up of one carbon atom and four hydrogen atoms. Its chemical formula is CH<sub>4</sub>.

### **3. What makes natural gas a clean fuel?**

The main products released when natural gas is burned are carbon dioxide and water vapor. Coal and oil are more chemically complex than natural gas, so when burned they release a variety of potentially harmful chemicals into the air.

### **4. How much of our country's energy needs are served by natural gas?**

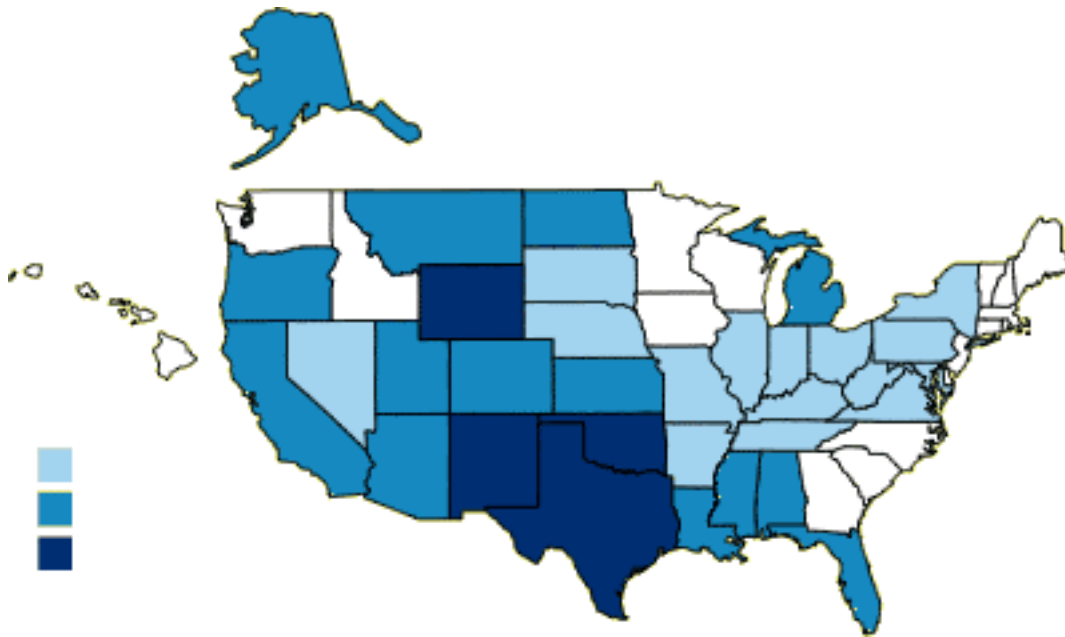
Natural gas supplies about 24 percent of all energy used in the United States. It supplies more than half the energy consumed by residential and commercial customers, and about 40 percent of the energy used by U.S. industry.

### **5. Are more homes heated by natural gas or electricity?**

More homes in the U.S. are heated by natural gas than by electricity.

## 6. Where in the United States is natural gas located?

Natural gas is found in 33 states. The **dark blue** states on this map show you where large amounts of natural gas are **extracted**. In the **medium blue** states, moderate amounts of natural gas are extracted. And in the **light blue** states, just a little natural gas is extracted. Natural gas is not extracted at all in the **white** states.



## 7. How much natural gas is produced in the world?

Natural gas is found in about 50 countries. About 2,600 billion cubic meters of natural gas was taken out of the ground and processed for use in 2003. Here is a breakdown of how much of that was produced by various countries and regions:

United States	21.0 %
Canada	7.0 %
Mexico	1.4 %
Central and South America	4.5 %
Europe and Eurasia	17.0 %
Russian Federation	22.1 %
Middle East	9.8 %
Africa	5.4 %
Asian and Pacific Countries	11.9 %

(Source: BP Statistical Review of World Energy 2004)

### **8. How much natural gas do we use?**

About 2,600 billion **cubic meters** of natural gas was used in the world in 2003. Here is a breakdown of how much of that was used by various countries and regions:

United States	24.3 %
Canada	3.4 %
Mexico	1.8 %
Central and South America	4.2 %
Europe and Eurasia	26.1 %
Russian Federation	15.7 %
Middle East	8.6 %
Africa	2.6 %
Asia and Pacific Countries	13.3 %

(Source: BP Statistical Review of World Energy 2004)

### **9. How long will our natural gas supplies last?**

If natural gas production continues throughout the world at the level it did in 2003, the world's gas reserves are expected to last about 67 years. (Source: *BP Statistical Review of World Energy 2004*)

### **10. Why is natural gas used to run electric power plants?**

In the 1970s and 1980s, most electric power plants were fueled by coal or nuclear power. But due to environmental concerns, by the 1990s, about 60 percent of new electric power plant capacity was fueled by natural gas. Today natural gas is the primary energy source for powering new electricity generating plants in the U.S because it is a clean-burning and competitively priced fuel. (Source: American Gas Association)

### **11. How many miles of natural gas pipelines are there in the U.S.?**

About 2.2 million miles of underground pipelines deliver natural gas to 68 million customers in the U.S. (Source: American Gas Association)

### **12. When was natural gas first used in the United States?**

The first use of gas energy in the United States occurred in 1816, when gaslights illuminated the streets of Baltimore, Maryland.

### **13. Why does natural gas smell like rotten eggs?**

In its natural state, natural gas has no odor. Utility companies add a chemical odorant called "mercaptan" to natural gas to help make gas leaks easier to notice. If you have a natural gas stove, you may have smelled this rotten egg odor when the pilot light has gone out.

### **14. What is "liquefied natural gas?"**

When natural gas is cooled to 260 degrees below zero, it changes from a gas into a liquid. Liquid natural gas takes up much less space than natural gas, making it easy to transport and convenient to store. Six hundred cubic feet of natural gas turns into just one cubic foot of liquid gas!

### **15. What is a “smart pig?”**

A smart pig is an electronic device that can be used to inspect the insides of natural gas pipelines. The device travels through a pipeline and transmits images of the inside of the pipeline so inspectors can tell if the pipeline needs repairs.

### **16. How fast does natural gas move through pipelines?**

Natural gas travels through pipelines at the slow and steady pace of 15 miles per hour.

## **Experiment Tips**

Here you’ll find guidance and tips for the science experiments and activities on this site:

- **Rocks That Trap Gas**
- **Making Methane**
- **Natural Gas Distribution System**
- **Become an Appliance Safety Expert**
- **Appliance Survey**

### **Basic Experiment: Rocks That Trap Gas**

The basic experiment, *Rocks That Trap Gas*, is designed for students in grades 3-5. It appears in the section “Natural Gas Science.”

#### **Materials:**

Students will need the materials listed on the website:

- Sand
- Clay
- Two 8-oz. wide-necked glass jars or beakers
- 8 oz. of water in a measuring cup
- Magnifier

#### **Objective:**

Students will learn to recognize that sand is more porous than clay. They will draw parallels between these materials and the types of underground rock layers that allow natural gas to collect. They will understand that sand behaves like reservoir rock—it lets the water pass through it like the reservoir rock allows water to seep into it. And that clay behaves like cap rock—it stops the water like the cap rock stops the gas from dispersing.

#### **Getting It Across:**

Have students read the information and follow the steps on the page.

- Make sure they understand the concept of porousness—that some materials are full of pores that are permeable by water and gas.

## Questions and Answers:

1. Feel the sand and clay with your hands. How do they feel different from each other? (Students should notice that the sand feels grainier than the clay.)
2. Use your magnifier to examine the sand and clay. What differences do you see? (*With the magnifier, students may be able to see spaces between grains of sand—a clue that the sand is more porous than the clay.*)
3. Fill one jar almost full to the top with sand and the other almost full with clay. (*Make sure students leave some space at the top of the jar.*)  
Are the jars full? What do you think will happen if you add water to them? (*After students fill the jars they will both appear nearly full. Some students will know that the jars contain air as well as sand and clay, and that the water will displace some of the air between the sand grains when it is poured in, but will just sit on top of the clay.*)
4. Fill each jar to the top with water. Where does the water go? (*The water goes between the grains of sand. It sits on top of the clay and may go into spaces, if any, that are between chunks of clay.*)

## Analysis:

In order for natural gas to accumulate underground, there needs to be porous rock for the gas to seep into (called reservoir rock), and a layer of very dense rock (called cap rock) above the reservoir rock to keep the gas from leaking to the surface. Which of your jars behaves like reservoir rock? Which behaves like cap rock? (*The jar with sand behaves like reservoir rock. The jar with clay behaves like cap rock. However, while the water in this experiment flows down through the sand, in a gas trap the gas rises upward through the reservoir rock until it is stopped by the cap rock.*)

## Advanced Experiment: Making Methane

The advanced experiment, *Making Methane*, is for students in grades 6-7. It appears in the section "Natural Gas Science."

## Materials:

Students will need the materials listed on the website:

- 6 identical small-necked bottles (plastic water or soda bottles work well)
- 6 large party balloons, not inflated
- 1-1/2 cups of soil
- 2 cups of a mixture of vegetable scraps and grass clippings
- Duct tape
- Funnel
- Measuring cup
- Permanent marker

**Objective:**

Students will understand that both natural gas and the biogas formed in the experiment come from the decomposition of dead plants and other organic matter, and that in both situations, heat is a key factor that lets gas form.

**Getting It Across:**

Make sure students thoroughly mix the soil and vegetable scraps. There will be some material left over after students put 1/2 cup into each bottle.

- It's very important that the balloon be securely sealed to the mouth of the bottle. Remind students to check for tears or holes around the neck of the balloon.

**Questions and Answers:**

1. What was the relationship between the levels of the mixtures and what happened to the balloons? (*The balloons that inflated with gas should have gotten bigger as the level of the mixture in their bottles got lower. Ask students to share their results. Were the results the same? If not, why not? Answers will vary. Be sure the experimental setup was not at fault.*)
2. In which locations did the balloons grow biggest, and why? In which locations did the balloons grow the least, and why? (*The locations where the balloons grew biggest should have been those with the most heat: i.e., in sunlight, near a heat source. The balloons should have grown the least in the colder areas: i.e., in the refrigerator and freezer. Again, ask students to share their results and to determine whether their experiment setup could account for any extreme differences in findings.*)
3. Compare your experiment's results and the conditions that allowed for the formation of natural gas deposits millions of years ago. (*The conditions that allowed natural gas to form included organic matter decomposing in hot conditions, and a rock configuration that allowed the gas to accumulate rather than to disperse.*)

**Activity: Natural Gas Distribution System**

This activity appears in the section "The Travels of Natural Gas." Have students read the "Get Small" page in this section before printing this page and attempting this activity. Students should label the parts of the gas distribution system as follows:

1. Well
2. Processing Plant
3. Transmission Pipes
4. Compressor Station
5. Storage Tank
6. Utility
7. Distribution Main
8. Service Line
9. Gas Meter
10. Appliance

**Activity: Become an Appliance Safety Expert**

This activity appears in the section "Using Gas Safely." Students are asked to find gas appliance manuals and locate recommended safety measures for appliance installation and use. If students can't find an appliance manual and wish instead to use the website to list ways to be safe around a specific gas appliance, encourage them to refer to the sections "Using Gas Safely" and "Home Safety Inspection" for ideas.

**Activity: Appliance Survey**

This activity appears in the section "Using Gas Efficiently." Students are asked to interview the adults in their household about why certain natural gas appliances were purchased and whether they have performed as expected. You may use this activity as a point of departure for discussing what guides consumers' purchasing decisions. Were the gas appliances purchased on the basis of features? Price? Convenience? The activity also asks students to tally which gas appliance is most common among classmates. Explore with students possible reasons for tally results.

## Student Worksheets

- Natural Gas Science
- The Travels of Natural Gas
- Gas Pipeline Safety
- Using Gas Safely
- Using Gas Efficiently
- Tell Me More
- Answer Key for All Worksheets

These worksheets review the key science principles and safety practices from the main thematic sections of *Natural Gas Safety World*. They are designed to print on one page each for your convenience. Here are some ideas for how to use them with your class:

- For younger students, use the questions to verbally review basic information with the whole group.
- For older students, use as a pre/post-test to assess student understanding of key facts and principles before and after visiting specific sections of *Natural Gas Safety World*.
- Put students into small groups and assign each group several questions; ask them to use the website to find the answers in the sections shown.
- After all students have completed all sections of the website and you have reviewed the worksheets, organize the class like a game show. Contestants can continue to answer questions until they get one incorrect, at which point a new contestant takes their place.

**Natural Gas Safety World  
Student Worksheet #1**

**Natural Gas Science**

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

1. Natural gas is the same gas you use in your car. (True or False) \_\_\_\_\_

2. Circle the two things listed below that formed natural gas.

- a) clouds                      c) water animals
- b) swamp plants          d) gold

Did these things exist before or after the dinosaurs? \_\_\_\_\_

3. Natural gas service is usually interrupted during heavy storms. (True or False)  
\_\_\_\_\_ Why or why not? \_\_\_\_\_

4. Natural gas smells the way it does because \_\_\_\_\_  
\_\_\_\_\_

5. Match the three fossil fuels listed below with their states.

- 1. coal                              A. gas
- 2. natural gas                  B. liquid
- 3. oil                                C. solid

6. Draw a cartoon with three or four panels that shows how natural gas was formed.

**Natural Gas Safety World  
Student Worksheet #2**

**The Travels of Natural Gas**

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

Following is a list of the major parts of the natural gas distribution system. Choose one term from each of the four groups and describe or draw that part of the system.

- |                     |                    |                    |                    |
|---------------------|--------------------|--------------------|--------------------|
| <u>Group One:</u>   | processing plant   | transmission pipes | compressor station |
| <u>Group Two:</u>   | storage tanks      | utility            | distribution main  |
| <u>Group Three:</u> | service line       | gas meter          | gas line           |
| <u>Group Four:</u>  | pressure regulator | valve              | pilot light        |

Group One:	Group Three:
Group Two:	Group Four:

**Natural Gas Safety World  
Student Worksheet #3**

**Gas Pipeline Safety**

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

1. Why is it important to call your Utility Locator Service before starting a major digging project?
  
  
  
  
  
  
  
  
  
  
2. List 5 signs of an outdoor gas pipeline leak.
  
  
  
  
  
  
  
  
  
  
3. What should you do if you suspect an outdoor gas pipeline leak?
  
  
  
  
  
  
  
  
  
  
4. If you see a colored flag stuck in the ground while you are out playing, you should
  - a) call your utility to report it
  - b) use it in your play
  - c) leave it alone
  - d) take it inside to show your parents
  
  
  
  
  
  
  
  
  
  
5. Which of the following is unsafe to do to your home's gas meter?
  - a) climb on it
  - b) tie your pet's leash to it
  - c) cover it with a tarp
  - d) all of the above
  
  
  
  
  
  
  
  
  
  
6. Choose a natural gas safety tip. Make a poster that explains this tip to display at home or in your classroom.

**Natural Gas Safety World  
Student Worksheet #4**

**Using Gas Safely**

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

1. What does a normal flame on a gas appliance look like?  
a) steady, not flickering                      c) blue in color  
b) cone-shaped                                      d) all of the above
  
2. If someone in your home has flu-like symptoms without fever and you think they may have carbon monoxide (CO) poisoning, what should you do?
  
  
  
  
  
  
  
  
  
  
3. What could happen if kids play with oven knobs?
  
  
  
  
  
  
  
  
  
  
4. On the back of this sheet, draw a picture that shows an unsafe situation near a gas water heater.
  
  
  
  
  
  
  
  
  
  
5. Explain what you should not do if you smell natural gas in your home.
  
  
  
  
  
  
  
  
  
  
6. Explain what you should do if you smell natural gas in your home.

**Natural Gas Safety World  
Student Worksheet #5**

**Using Gas Efficiently**

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

1. A cubic foot would hold about \_\_\_\_\_ gallons of liquid.
2. Natural gas is a nonrenewable resource. (True or False) \_\_\_\_\_
3. How does the gas company know how much to charge your family for natural gas each month?
4. List five household appliances that use natural gas. Circle the appliances that you have in your home.
  - 1.
  - 2.
  - 3.
  - 4.
  - 5.
5. Choose a strategy for saving energy with natural gas. Make a poster that demonstrates this tip to display in your classroom.
6. Why is it important to save energy and conserve natural gas?

## Natural Gas Safety World Student Worksheet #6

### Tell Me More

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

1. Below are some things found in natural gas. Cross out the things that are removed by the gas company before the gas is delivered to your home.

**Butane      Ethane      Methane      Pentane      Propane**

2. Natural gas is a cleaner-burning fuel than coal or oil. (True or False) \_\_\_\_\_

3. Write the name of your state here \_\_\_\_\_. According to the map on this website, how much natural gas is extracted from your state? (check one)

large amounts       moderate amounts  
 small amounts       none

4. What percentage of the energy used in the United States is supplied by natural gas?

a) 4%      b) 10%      c) 24%      d) 32%

5. Make a timeline giving the dates and descriptions of five events in the history of developing and using natural gas. Add at least three events from the history of your own family and/or general American history.

6. On the back of this sheet, create a job description for one career in the natural gas industry. Write the description in the form of a help wanted advertisement. Include a description of the skills needed to do the job as well as the duties involved.

**Natural Gas Safety World  
Worksheet Answer Key #1**

**Natural Gas Science**

1. False. Gasoline used in cars is a liquid. Natural gas is a gas.
2. Tiny water animals and swamp plants were buried and formed natural gas. These plants and animals lived before the dinosaurs.
3. False. The pipes that carry natural gas are buried underground, so service is not interrupted by storms.
4. Natural gas smells the way it does because a chemical is added to natural gas by the gas company to make it smell. That way natural gas leaks can be detected.
5. 

1. coal →	C. solid
2. natural gas →	A. gas
3. oil →	B. liquid
6. Illustrations should show animals and plants being buried and decaying.

## **Natural Gas Safety World Worksheet Answer Key #2**

### **The Travels of Natural Gas**

#### **Group One:**

Processing plant—A place where natural gas is treated to remove impurities.

Transmission pipes—A network of large steel pipes that carries natural gas from processing plants to utilities.

Compressor station—A station that pressurizes (“squeezes”) the natural gas as it flows through the transmission pipes so that the volume is reduced and it can flow faster.

#### **Group Two:**

Storage tanks—Holding tanks at gas distribution companies that store extra gas that has been brought up from the ground but is not yet needed by individual utilities.

Utility—A company that delivers natural gas to homes and businesses.

Distribution main—Small pipes originating at the gas utility that run below the street to the service line.

#### **Group Three:**

Service line—A narrow pipeline leading from the distribution main to a house.

Gas meter—A device for measuring the amount of gas used in the home.

Gas line—A pipe leading from a house’s gas meter to the individual appliances within.

#### **Group Four:**

Pressure regulator—A device that reduces the pressure of the gas traveling along a service line just before entering a house’s gas meter.

Valve—A movable part that controls the flow of a liquid or gas through a pipe or other channel.

Pilot light—A small flame or spark used to ignite gas at a burner. Most new appliances have electric pilots; older appliances have a small permanent flame.

## **Natural Gas Safety World Worksheet Answer Key #3**

### **Gas Pipeline Safety**

1. The Utility Locator Service makes sure underground pipelines and other utilities are clearly marked ahead of time so people can dig a safe distance away from them. This helps prevent serious accidents, because if people dig into these pipelines, they can be damaged and natural gas can leak out. Even a small leak can cause a fire hazard.
  
2. The five signs of an outdoor gas pipeline leak are:
  - 1) A "rotten egg" smell.
  - 2) A hissing sound.
  - 3) Dirt being blown up into the air.
  - 4) Continual bubbling in a pond, river, or creek.
  - 5) Plants that seem to be dead or dying for no reason.
  
3. If you suspect an outdoor gas pipeline leak:
  - 1) Do not use fire or electricity. Even the tiniest spark from a cell phone, flashlight, match, or other source could ignite the gas.
  - 2) Leave the area immediately.
  - 3) Once you are away from the pipeline, ask an adult to report the leak to 911 and your local natural gas utility right away.
  - 4) Do not go back to the area.
  
4. c) If you see a colored flag, you should leave it alone. These flags show people where buried utilities are located so they can dig safely away from them.
  
5. d) all of the above
  
6. Posters will vary.

**Natural Gas Safety World  
Worksheet Answer Key #4**

**Using Gas Safely**

1. d) all of the above
2. If you or someone in your home has CO poisoning, get out of the house right away. Call 911, your local fire department, or local emergency medical service from a nearby phone.
3. If kids play with oven knobs, they could turn the gas on by mistake.
4. Answers will vary.
5. If you smell natural gas in your home, you should not use, turn on, or turn off anything that might create a spark, such as matches, lighters, light switches, phones (including cell phones), flashlights, or any electrical equipment, even computers. Even the tiniest spark from these devices could ignite the natural gas and cause a fire.
6. If you smell natural gas in your home, you should leave your home immediately and take others with you. Go to a neighbor that you know or to a nearby pay phone and call your local natural gas utility to report the odor.

**Natural Gas Safety World  
Worksheet Answer Key #5**

**Using Gas Efficiently**

1. A cubic foot would hold about eight liquid gallons.
  
2. True. Natural gas is a nonrenewable resource.
  
3. The gas company knows how much to charge your family for gas each month because the natural gas that goes into your home is measured with a gas meter. The gas meter determines how many cubic feet of gas has been used.
  
4. Natural gas-using household appliances include:

Furnaces	Water heaters
Pool and spa heaters	Stoves/Ranges
Clothes dryers	Fireplace logs
Outdoor lights	Patio heater
Fire pits or barbecues	
  
5. Posters will vary.
  
6. Natural gas is a nonrenewable resource and limited in supply. By using energy wisely and conserving natural gas, we can make it last longer.

**Natural Gas Safety World  
Worksheet Answer Key #6**

**Tell Me More**

1. The gas company removes everything but methane before delivering it to your home. Students should cross out all the words except "methane."
2. True. Natural gas is a cleaner-burning fuel than coal or oil.
3. Answers will vary.
4. c) Natural gas supplies approximately 24% of the energy used in the United States.
5. Timelines will vary.
6. Job descriptions will vary.

## **Going Further**

Here are some assignment ideas to help your students take their natural gas safety savvy to the next level:

- Prepare a one-minute presentation or play for your class on the basics of how natural gas travels from the well to appliances in people's homes.
- Prepare a poster showing natural gas leaking out of a pipeline and what people should do if they notice this.
- Think of three ways you can convince your friends to be safe around natural gas. Share them with the class.
- Create a radio commercial about outdoor or indoor natural gas safety.