Learn About Natural Gas: A Safety & Science Activity Booklet
Teacher's Guide

Introduction
Learn About Natural Gas describes how to safely use natural gas in daily life and explains natural gas science concepts and energy efficiency practices. The booklet supports *Next Generation Science Standards* for both Earth & Space Sciences and Physical Sciences, along with *Common Core State ELA Standards* for Reading Informational Text.

This teacher's guide provides the objective for each page of the booklet along with background information, puzzle answers, and ideas for classroom discussion and follow-up activities. Some activities require only a pencil or pen and the booklet itself. Others call for everyday items that are on hand in most homes or classrooms. If completed in its entirety, this booklet serves as a two-week interactive unit of study on natural gas and energy efficiency. If time is limited, teachers are free to pick and choose from the activities presented. Teachers should preview all materials before assigning for student use.

Page 2: Natural Gas Is a Source of Energy
Objectives: Introduce natural gas as an energy source and convey the importance of energy in our lives. Get students thinking about natural gas safety.

Background: Energy is the ability to do work or to change or move matter. Without energy there would be no motion, no light, and no heat, and life would not exist. Most of the energy on earth originates from the sun. We need energy to move, work, and play. Our own bodies get energy from food. Some appliances in our homes get energy from natural gas; these include clothes dryers, stoves and ovens, furnaces, water heaters, pool or spa heaters, barbecue grills, and fireplaces.

Discussion: Explain to students that natural gas is a fuel that can be burned in appliances to produce heat. Ask: What other kinds of fuels can you think of that produce heat? *(Oil, wood, gasoline, charcoal, propane.)* What other sources of energy can run the appliances in our homes? *(Electricity.)*

Going Further – Thinking About Natural Gas Safety Activity: After all students complete this activity, have them make a *Know/Want to Know/Learned (KWL)* chart using the template provided on the last page of this guide.

Page 3: How Natural Gas Gets to Us
Objectives: To familiarize students with the natural gas distribution system so they understand how gas gets from underground wells to their homes. To describe mercaptan, which helps people detect gas leaks.

Background: Explain to students that natural gas is obtained by drilling wells through deep holes in the earth, usually about a mile deep. The gas is pumped to processing plants, where it is cleaned and then pumped through pipelines to power plants, factories, businesses, schools, and homes. This network of pipes is called the natural gas distribution system. These pipelines run under streets, sidewalks, yards, and homes. Smaller pipes in our buildings bring the gas to our appliances.

Discussion: Ask: Have you ever smelled leaking gas? What did it smell like? *(Responses will vary.)* Explain that a chemical called mercaptan is added to natural gas to make it smell like sulfur or rotten eggs. Why do we want natural gas to smell bad? *(So that we will know when it's leaking and can protect ourselves.)* Point out that there are other signs of an outdoor gas leak, which we'll cover on page 7 of the booklet.

Natural Gas Math Answers:
Question 1: 4 x 4 = 16 4 x 6 = 24 16 + 24 = 40 40 miles are drilled
Question 2: 25,000 x 120 = 3,000,000 There are 3 million miles of natural gas pipelines in the U.S.

Page 4: Older Than Dinosaurs
Objectives: Understand that natural gas comes from tiny plant and animal remains from millions of years ago that are held deep in the earth's crust. Understand the layers of the earth through a construction paper activity.

Background: Natural gas is known as a fossil fuel because it was formed from the fossilized remains of organic materials that were present on earth long ago and buried under lakes and oceans. Fossils are the naturally preserved remains or traces of animals or plants that lived in the geologic past. For natural gas to be formed from them, fossils undergo heat, shifting, and pressure, which create natural gas. Using the illustration in the book, explain that the earth's crust is where natural gas is trapped.

Discussion: Ask students to name the three kinds of fossil fuels. *(Natural gas, oil or petroleum, coal).*

Activity: For Step 5 of the model activity, have students refer back to page 3 to look at the wellhead. This is represented by the dark gray rectangle with rounded edges above the pipe coming from the ground. (Another pipe goes out to the right of it, towards the houses.) Actual wellheads look different than this (more like extended fire hydrants), so this is just an approximate image.

Going Further: This activity illustrates the process of decomposition (decay) of organic materials, such as fossils undergo on a much greater time scale. Ask students to bury organic (*plant food waste such as orange peels or lettuce leaves*) and nonorganic (*plastic, metal*) materials in soil placed in a large jar or plastic bin, or in an outdoor compost pile. Have students record observations of these materials at two- or three-day intervals over a week or two. Invite them to share their observations of the decay of the organic materials.

Page 5: Natural Gas Flames
Objectives: Learn that natural gas appliances and equipment use a flame, what a normal natural gas flame looks like, and what to do if you have an abnormal one.

Discussion: Ask: What does it mean if your gas range has a large, yellow, or flickering flame? (*It is not working properly, and you should call a repairperson.)*

Safety Message Answers: If your gas flame is large, yellow, and flickering, ask an adult to have the range checked by a qualified repairperson.

Going Further: Ask students to create a small poster illustrating (in color) and labeling the flames in a campfire, a stovetop burner, and another appliance, such as a water heater.

Page 6: Natural Gas Heating & Cooking
Objectives: Recognize important gas safety practices in and around the home.

Background/Discussion: Discuss safe practices for using a gas range, such as keeping the flame no bigger than the pot. Ask: Why should you keep papers, fabrics, and toys away from a gas range top? *(If these come in contact with the stovetop flame, they could catch fire.)* Why is it dangerous to store flammable objects near gas appliances? *(Gas appliances use a flame and some, like an oven or heater, can get hot enough to set fire to something flammable that is close by. Also the fumes of flammable liquids could be ignited by the flame or pilot light inside a gas appliance.)* Why shouldn't you play with oven knobs or hang things from gas pipes? *(You could turn on the gas by mistake or damage the pipes and cause a gas leak.)*

Page 7: Gas Leak Safety
Objectives: Recognize the hazards of gas leaks. Explain how to detect and respond to an indoor gas leak and how to do the same for an outdoor gas pipeline leak.

Background/Discussion: Natural gas is a safe fuel when used properly. However, if natural gas leaks from an appliance or pipeline and is ignited by a flame or spark, a catastrophic fire or explosion may result. It is everyone's responsibility to be safe around natural gas, and to learn how to recognize and respond to the rare occurrence of either a leak inside a building, or a leak from a natural gas pipeline outdoors.

Ask: Why should you tell an adult when you smell gas? *(There is danger of fire or explosion*.) If you smell gas when no adult is home, what should you do? *(Leave and take everyone with you. Don't use a light switch, TV, remote controller, garage door opener, candle, flashlight, radio, or even a phone, as a spark from any of these could ignite leaking gas. Go to a safe location and ask a trusted adult to report the leak to 911 and the local natural gas utility. Don't go back home until safety officials say it is safe to do so.)*

Review:
A leak from a natural gas pipeline, although rare, can be a fire hazard. Remind students to be alert for any of the following signs, and explain what to do if they notice any of these:

Gas leak warning signs:
- A smell of sulfur or rotten eggs. This comes from the odorant mercaptan.
- A hissing, whistling, or roaring sound. The sound will vary with the size and pressure of the pipe.
- Dirt spraying or blowing into the air as gas is released from a pipe underground.
- Continuous bubbling in water. This may occur in a pond, creek, or even along the side of the road.
- Grass or plants dead or dying for no apparent reason in an otherwise moist area.

What to do:
- Do not use electricity or fire. Even the tiniest spark from a phone, flashlight, electrical device, or match could ignite leaking gas.
- Go far away from the area immediately. Do NOT go back until safety officials say it is safe.
- Ask a trusted adult to report the leak to 911 and the local natural gas utility.

Page 8: The Nature of a Gas
Objectives: Describe the characteristics of solids, liquids, and gases. Experiment with the behavior of a gas.

Background/Discussion: Ask: What is matter? *(Anything that takes up space or has a mass of any kind. Everything you can touch is made of matter.)* A solid has a definite shape and volume. A liquid has a definite volume but takes the shape of its container. A gas can change its shape and volume. While a gas has no defined shape or volume, and is invisible, it is still considered to be matter.

Going Further – Balloon Activity: Use the behavior of the balloon as an analogy for the way gas molecules behave. As a demonstration for students, blow up one balloon, tie it, and toss it into the air. Ask them to observe how the balloon moves freely, bouncing off the surfaces of its container (the room). Then blow up two more balloons and toss them up against each other simultaneously, further showing how gas molecules bounce off each other.

Page 9: Density Exploration: Sink or Float?
Objectives: Familiarize students with the science concept of density and make the connection to the three states of matter. Encourage them to make predictions and draw conclusions about the density of an object and the substance it is submerged in.

Discussion: The carrot sinks in fresh water, and floats in water with a lot of salt in it. Have students notice the point at which the carrot hovers in the middle of the glass of salt water. This is when the density of the salt water and that of the carrot are about equal. When the carrot sinks, it is more dense than the water around it; when it floats, it is less dense than the water.

Page 10: Stay Safe Around Underground Utilities
Objectives: Familiarize students with the 811 service that should be called before any digging project, and raise awareness about yellow gas pipeline flags.

Background/Discussion: If people dig into the underground gas pipeline system, pipes can be damaged and natural gas can leak out. Even a small leak can cause a fire or possibly an explosion. Protecting underground utility lines from damage is everyone's job, so we all need to take care not to damage underground gas pipes with digging equipment.

Remind students that if someone they know is planning a digging project, they must call the 811 utility locator service by dialing 811 several days ahead of time so underground utilities can be marked and people can dig a safe distance away from them.

Explain to students that after the 811 service receives a request to have underground utilities marked, a utility worker comes to the site and uses either colored spray paint or flags to indicate the location of buried utility lines. Natural gas lines are marked in yellow. Remind students that they should never tamper with these utility flags or markings, as they are put there to prevent damage to underground utility lines and to keep people safe.

Ask for examples of types of digging projects that would warrant a call to the 811 service. *(Planting a tree or garden; grading a driveway; installing a sprinkler system; building a home or an addition to a home; installing a fence.)*

Math Activity Answers:
11 x 3 = 253 248 + 157 = 405 3 feet in a yard 95 ÷ 5 = 19 50 states in the United States

Before digging, call 811 to have underground **utility** lines marked so that you can dig safely.

Page 11: Pipeline Markers Keep Us Safe
Objective: To familiarize students with yellow pipeline markers and their purpose.

Discussion: Knowing about pipeline markers is an important aspect of pipeline safety. While the local natural gas utility monitors, maintains, and repairs this system for safety, emphasize that these yellow markers always have an emergency number on them for reporting any suspicious activity.

Pulling It Together Activity: Have each pair of students (or larger groups if preferred) deliver their presentations to the whole class, or to another classroom at your school.

Pages 12–13: Make This Home Safer
Objective: To reinforce what students have learned so far about natural gas safety in and around the home.

Activity Answers: The six hazards are: 1) boy playing with yellow flag outside; 2) man nearby digging a hole and hitting gas pipeline; 3) materials marked with "hazardous" symbol positioned outside water heater in basement; 4) clothing, and girl, hanging from gas pipe in basement; 5) flame beneath pot on gas range in kitchen too large relative to pot size; 6) kids warming themselves with an open oven

Bonus Answers: 1) put yellow flag back in the ground where it was; 2) stop digging near yellow pipeline flag markers; 3) remove hazardous materials from area near water heater; 4) remove clothes from pipe and tell girl not to hang from it; 5) reduce size of flame beneath pot on stove; 6) close oven and suggest kids put on sweaters to stay warm

Pages 14: Why Save Energy?
Objective: To offer some environmental and financial reasons for saving energy.

Background/Discussion: A lot of the energy we use at home, at school, and for transportation comes from fossil fuels that were created millions of years ago. There is only a limited amount of these fuels, and we are using them up very fast. Using energy more efficiently will allow our fossil fuel supplies to last longer. Using energy efficiently also helps the environment by reducing the amount of pollution that is related to energy use. And using energy efficiently saves you money. Your family pays for the energy you use, so using less means you have more money to spend on other things.

World Puzzle Answer: We **should conserve energy to** help the earth.

Page 15: Be a Natural Gas Saver
Objective: To provide students with age-appropriate tips for reducing home and school energy use.

Discussion: Students may need some help in understanding the link between hot water and energy. Explain that water heaters use natural gas or electricity to heat the water we use in our homes, so using less hot water saves energy. Ask: How many students have low-flow showerheads at home, or use a clothesline or drying rack instead of a clothes dryer? Ask: Why do you think restricting the flame beneath a pot to no bigger than the size of the pot saves energy? *(If the gas flame is bigger than the pot, more gas is used, but the gas escapes into the air and doesn't further heat the pot.)* Ask: Why does quickly closing doors to the outside when the heat is on save energy? *(Cold air comes into the house when the door is open, thus reducing the indoor temperature, and making the furnace work harder to keep the house warm.)*

Going Further: Encourage students to share this page with their families, and to commit to doing at least three of the actions at home.

Back Cover: How Natural Gas Wise Are You?
Objective: To encourage students to review the important gas safety concepts covered in the booklet.

Activity Answers: 1) energy; 2) mercaptan; 3) wells; 4) decomposed; 5) appliances; 6) flammable; 7) ventilation; 8) smell; 9) 911; 10) 811; 11) markers; 12) conserve

Going Further: After completing the puzzle, have students return to their KWL charts and add all the things they learned in the "Learned" column.

Natural Gas Safety K-W-L Chart

In the first box, list what you know about being safe around natural gas. In the next box, think of some things you want to know and list them. When you have finished studying this booklet, write the new things you have learned in the last box.