

## SUGGESTED REFERENCES

- *Classic Chemistry Experiments*  
LearnNet  
[http://www.chemsoc.org/networks/learnnet/classic\\_exp.htm](http://www.chemsoc.org/networks/learnnet/classic_exp.htm)
- *What Do Concentrations Mean? Comparing Concentrations of Gases in Our Atmosphere*  
University Corporation for Atmospheric Research  
[http://www.ucar.edu/learn/1\\_4\\_2\\_14t.htm](http://www.ucar.edu/learn/1_4_2_14t.htm)
- Energy Information Administration  
<http://www.eia.doe.gov>
- *Hydrogen General Information*  
Alternative Fuels Data Center  
[http://www.afdc.nrel.gov/altfuel/hyd\\_general.html](http://www.afdc.nrel.gov/altfuel/hyd_general.html)

## NATIONAL SCIENCE EDUCATION STANDARDS

Science Content Standards:

- 5 - 8 Structure of the Earth System
- 9 -12 Chemical Reactions

## CREDITS

The producers thank Channel 4 Television Corporation/4 Learning for materials used in this program.

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# SCIENCE SCREEN REPORT

*Science Brought To Life In The Classroom*

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## VOLUME 32 ISSUE 5 FUELS AND GASES



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## SYNOPSIS

We rarely think about the gases that form the earth's atmosphere. However, their properties help us to heat our homes, cook, use transportation, and access entertainment.

This issue investigates gases and fuels, and how they contribute to our lives. It explains how hydrogen and helium can lift an airship into the atmosphere. Experiments address questions such as which gases are both non-flammable and lighter than air, whether air has mass, how fast a smell travels, and what byproducts are released from burning coal. It also discusses how gases can be compressed, diffused, and liquefied to better serve our needs.

## CURRICULUM UNITS

- CHEMISTRY
- EARTH SCIENCE
- INTEGRATED SCIENCE
- PHYSICAL SCIENCE

## RUNNING TIME

14:21

## BACKGROUND

Gases are defined as free moving molecules that take the shape of their container, and, at the same time, fill a container's entire volume. Because they are free moving, they have much more energy available than a solid or liquid. This special property makes gases useful for many purposes.

Atoms of helium are lighter than those of the nitrogen and oxygen found in our atmosphere. They allow us to lift an airship into the air. An experiment that tests which gas is both lighter than air and non-flammable demonstrates why helium is a good choice for airships. While more expensive than hydrogen, it is not flammable and, therefore, much safer to handle.

Gases are highly compressible. An illustration shows how air is compressed in a syringe by pressing on the pump, and how compressed air is used in hydraulic lifts of amusement park rides.

The program shows how gases are stored at great pressure in specially designed tanks that, for example, might hold helium to fill balloons. To compress gas even further, it can be cooled until it liquefies. As a liquid, carbon dioxide is thousands of times more compact than in the gaseous state, and we see how it is trucked into a soda pop bottling plant in liquid form and then reformulated into a gas before being added to syrup and water.

The atmosphere is the source of most liquid carbon dioxide as well as oxygen and nitrogen. Companies "mine" the atmosphere by taking in air, filtering out particulate matter, and then cooling it. Since gases cool at different temperatures, a specific gas can be captured as a liquid as it condenses.

To address whether air has mass, a deflated balloon is weighed, and then weighed again when it is filled with air. While one molecule doesn't weigh very much, the balloon has trapped millions of molecules of air which can be weighed and which prove that air, indeed, does have mass.

Diffusion states that molecules will move from an area of high concentration to an area of low concentration until the concentration is equal between the two areas. The principle of diffusion is demonstrated by using a bicycle tire in which the air pressure is higher inside the tire than outside. As the valve is opened, air escapes quickly to equalize concentration on both sides. Another experiment demonstrates the rate of diffusion by using students' sense of smell. After a can of deodorant is sprayed, blindfolded students, positioned in two rows, signal when they smell the deodorant, indicating a time-lapse as the scent moves from one row to the other.

The video shows how natural gas is extracted from coal, and how this gas can be used as an inexpensive source of energy for electricity, cooking and heating. As a gas, it is easily transported through pipelines and stored efficiently in large tanks at low pressure. Natural gas does not possess a smell that can be detected by humans, so an odorant is added to it which is both distinctive and smelly.

Other gases can be obtained from fossil fuels. However, along with the energy they produce, there are several byproducts. An experiment shows a chunk of coal being burned and its smoke being captured in an upside down funnel. Attached to the funnel are three containers, each with its own indicator. Students see by direct evidence that water, carbon dioxide, sulfur oxide and nitric oxide are found in the smoke.

The program also discusses alternative methods of obtaining gas used in parts of the world where fossil fuels are of poor quality, or too expensive to obtain. Two methods discussed are the breaking down of cow dung to release methane for cooking and electricity, and fermenting sugar cane to produce alcohol for burning.

The gases in the atmosphere are often taken for granted. But, they are "behind the scenes" workers that keep our world going. As technology advances, gases will be used far more for transportation. Methane, now obtained from fossil fuels, may be replaced with gases produced from the decay of garbage or animal wastes. This would make the air cleaner to breathe and make energy generation almost completely recyclable.

## ADVANCED ORGANIZERS

Prior to viewing this video, students should have some understanding of the following benchmarks that can be found in the Atlas of Science Literacy, 2001, American Association for the Advancement of Science.

1. Air is a substance that surrounds us and takes up space.
2. All matter is made up of atoms which are too small to see directly through a microscope.
3. Atoms may stick together in well-defined molecules or may be packed together in large arrays. Different arrangements of atoms compose all substances.
4. Heating and cooling cause changes in the properties of materials.
5. Atoms and molecules are perpetually in motion. Increased temperature means greater average energy of motion, so most substances expand when heated.
6. Most substances can exist in a solid, liquid or gas depending on temperature. In solids, the atoms or molecules are closely locked into position and can only vibrate. In liquids, they have higher energy, are more loosely connected, and can slide past one another; some molecules may get enough energy to escape into a gas. In gases, the atoms or molecules have still more energy and are free of one another except during occasional collisions.

## CRITICAL THINKING EXERCISES

1. Explain the difference between the lift provided by helium in airships and the lift provided by the wings and engines of a jet plane.
2. Design an experiment to test the question: Which has more mass per set volume, carbon dioxide or air? You can use balloons, a scale and a tank of gas.
3. Design an experiment to test the rate of diffusion of air out of a ball. Does air diffuse faster out of a larger ball or a smaller ball? What effect does pressure have on the rate of diffusion?
4. How long does it take carbon dioxide to move out of solution in soda pop and escape as a gas? When we refer to a soda being flat, we are talking about the fact that most of the carbon dioxide has escaped. Do different sodas exhibit a different rate of carbon dioxide loss? Design an experiment to test this question.
5. Outline the risks and benefits of using natural gas for cooking, electricity and heating.
6. Explain why methane gas from cow dung contributes less to global warming than methane from natural gas.

## VOCABULARY

Acidic  
Carbon Dioxide  
Compressed  
Diffusion  
Flammable  
Global Warming

Helium  
Hydrogen  
Lift  
Methane  
Odorant

## CAREER POSSIBILITIES

- CHEMIST
- ENGINEER
- SCIENCE TEACHER