

SUGGESTED REFERENCES

- International Fire Service Training Association
Richard Hall (editor) Barbara Adams (Editor)
Essentials of Fire Fighting
1998, 4th Edition
- James G. Quintiere
Principles of Fire Behavior
International Thomson Publishing, 1998
- *FireNet Information Network*
<http://www.csu.edu.au/firenet/>
- *National Fire News*
<http://www.nifc.gov/fireinfo/nfn.html>
- *US Forest Service Fire and Aviation Management*
<http://www.fs.fed.us/fire/index.html>
- *How Smoke Detectors Work*
<http://home.howstuffworks.com/smoke.htm>

NATIONAL SCIENCE EDUCATION STANDARDS

5 - 8

Physical Science
Transfer of energy

Science in Personal and Social Perspectives
Natural Hazards

9 - 12

Physical Science
Chemical Reactions

Science in Personal and Social Perspectives
Personal and Community Health

*Source: *National Science Education Standards, 1996, National Academy Press*

CREDITS

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www.jets.org

SYNOPSIS

This program explores the elements necessary to create fire. The fire triangle consists of heat, fuel and oxygen. Firefighters demonstrate how to put out different types of fires, with a particularly dramatic example of why you should never put water on an oil fire. Firefighters show how using a thermal imaging camera helps to identify the source of a fire. A gel containing water filled bubbles is shown protecting houses from burning.

The positive use of fire is demonstrated through the internal combustion engine and the oxygen-acetylene torch. The chemistry of the reaction between gasoline and oxygen provides the energy for the engine. Students can see how the combustion of gasoline can lead to different products. The torch is used to cut steel underwater.

CURRICULUM UNITS

- CHEMISTRY
- ECOLOGY
- ENVIRONMENTAL SCIENCE
- INTEGRATED SCIENCE
- PHYSICAL SCIENCE
- PHYSICS
- PUBLIC HEALTH

RUNNING TIME

21:30

BACKGROUND

Man began to domesticate fire over a million years ago. Even though we have exploited fire for our own uses, it is still dangerous. Understanding the nature of fire and how to control it is the goal of scientists all over the world.

This program provides an excellent demonstration of the fire triangle. The triangle consists of a heat source, fuel and oxygen. A segment shows how gasoline evaporates easily at standard temperature and pressure. The video shows how the gasoline vapors react with the flame to burn, while the liquid gasoline does not burn. Teachers can use this to show how the fire itself will become a chain reaction as the heat from the fire causes more of the liquid gasoline to vaporize and then react with the flame.

A couch set on fire shows how quickly a fire can spread from the source to the surrounding area. Recognizing that the fire triangle exists, firefighters and scientists use specific techniques to stop each kind of fire. To control most fires, firefighters remove the source of heat that is creating the energy for the chain reaction. This usually involves putting water on the fire. Spraying water on a burning object will reduce the heat. Spray enough water and the temperature of the burning object will decrease so that it no longer burns.

Scientists have developed a special thermal imaging camera to allow firefighters to find the source of the fire so that water can be directed onto it. This camera allows the firefighter to "see" through the smoke and find the source by looking for the hot spot. Once the hot spot is found, the water can be directed onto it.

Scientists have discovered that the polymer used in baby diapers to absorb water can also be used to protect things from burning. The polymer is a gel consisting of water filled bubbles. Spray it on something and it keeps the heat from reaching the fuel. Students can see where a corner of a house sprayed with the gel did not burn when a fire spread through the area.

Some fires should not be extinguished using water. Burning oil reacts explosively with water and placing just a small amount of water on an oil fire can cause it to splatter, carrying the flames with it. This is shown in the video with a dramatic demonstration. Taking away the oxygen instead of the heat puts out oil fires. A firefighter takes the same oil fire and places a fire blanket over it. The fire goes out almost instantly.

Two specific examples of domesticating fire are demonstrated in the video. Students are shown how an internal combustion engine works. The chemistry of combustion is described with a demonstration comparing an older car with a newer car. Students can see how an oxygen-acetylene torch works underwater when a diver uses the torch to cut through a steel plate.

Studying the ways that fire can be controlled has allowed us to reduce the number of deaths and injuries that result from accidental fires. Firefighters are constantly working on new ways to attack fires. The development of the thermal imaging camera and the fire resistant gel are just two examples of the science of fighting fires.

ADVANCED ORGANIZERS

Prior to viewing this video, students should have some understanding of the following Benchmarks for Science Literacy, Oxford University Press, which are excerpted and, in some cases, abbreviated below. Refer to the Benchmarks for more information.

Benchmark 4: The physical setting

Section D - The structure of matter

Know by Grade 8

- There are groups of elements that have similar properties, including highly reactive metals, less reactive metals, highly reactive nonmetals (such as chlorine, fluorine, and oxygen), and some almost completely nonreactive gases (such as helium and neon). An especially important kind of reaction between substances involves combination of oxygen with something else-as in burning or rusting.

Section E - Energy Transformations

Know by Grade 8

- Energy cannot be created or destroyed, but only changed from one form into another.
- Heat can be transferred through materials by the collisions of atoms or across space by radiation. If the material is fluid, currents will be set up in it that aid the transfer of heat.
- Energy appears in different forms. Heat energy is in the disorderly motion of molecules; chemical energy is in the arrangement of atoms; mechanical energy is in moving bodies or in elastically distorted shapes.

Know by Grade 12

- Transformations of energy usually produce some energy in the form of heat, which spreads around by radiation or conduction into cooler places. Although just as much total energy remains, its being spread out more evenly means less can be done with it.

Benchmark 8: The Designed World

Section C - Energy Sources and use

Know by Grade 12

- A central factor in technological change has been how hot a fire could be made. The discovery of new fuels, the design of better ovens and furnaces, and the forced delivery of air or pure oxygen have progressively increased the available temperature.
- At present, all fuels have advantages and disadvantages so that society must consider the tradeoffs among them.

**Benchmarks can be found at www.project2061.org/tools/benchol/bolintro.htm*

CRITICAL THINKING EXERCISES

- Explain how the chain reaction begins in a fire.
- Describe three ways that firefighters can put out a fire.
- Discuss whether wildfires should be stopped or allowed to burn in national forests.
- Explain how an oxygen-acetylene torch can burn under water.
- Oxygen is required for a fire to burn, but the air is only about 20% oxygen. If you made a fire in a 1-liter glass container, how much of the air would be converted to carbon dioxide? State the hypothesis and design an experiment to test this question.
- Discuss the difference between a smoke alarm and a carbon monoxide detector. Describe how each one functions.

VOCABULARY

Backdraft

Carbon dioxide

Carbon monoxide

Chain reaction

Evaporate

Fire blanket

Fire break

Fuel

Heat

Hydrocarbons

Oxygen

Oxygen-acetylene flame

Thermal image camera

CAREER POSSIBILITIES

- CHEMIST
- ECOLOGIST
- FIRE FIGHTER
- FIRE SCIENTIST