



Smithsonian

Wildfires

TCM | Teacher
Created
Materials

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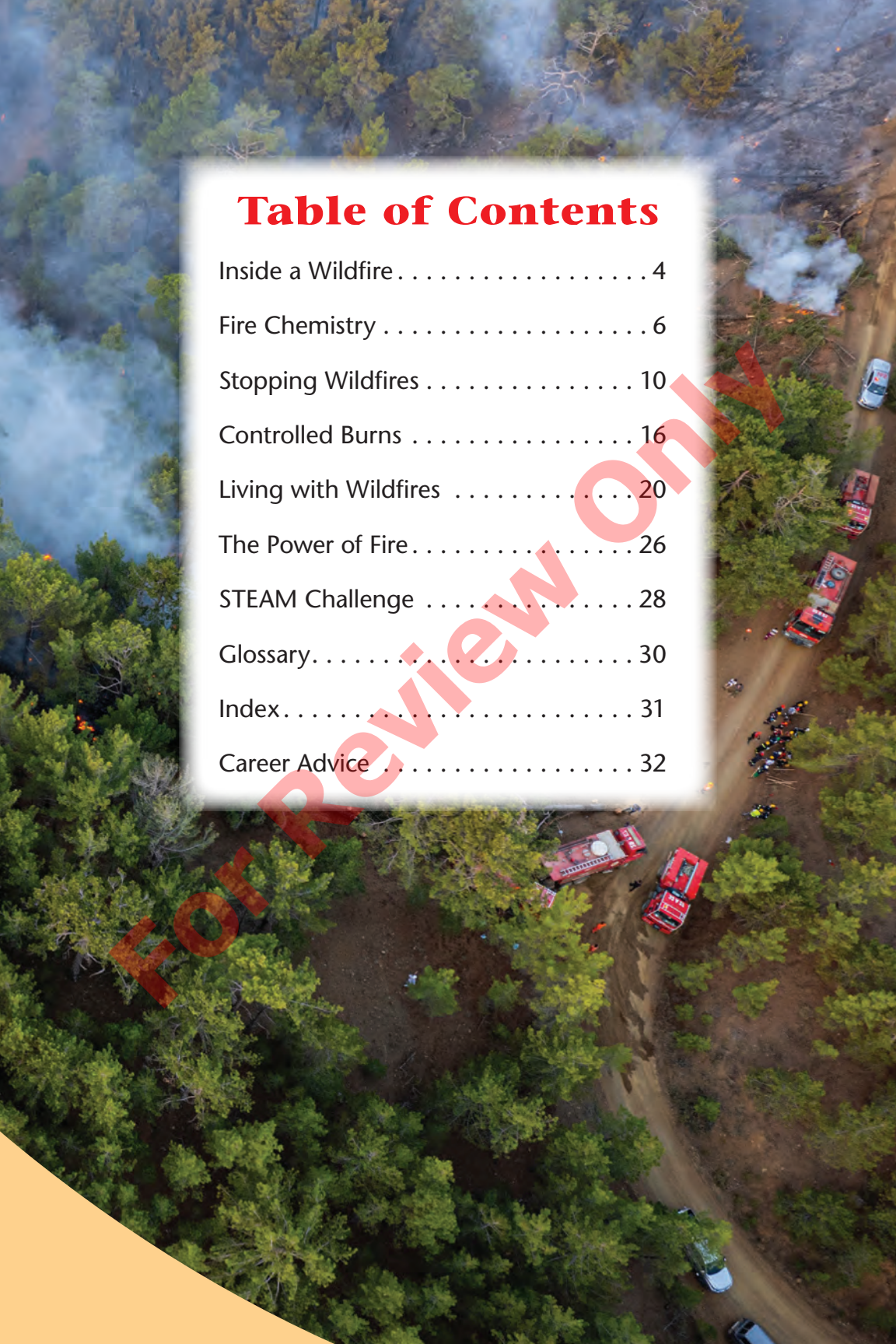


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Inside a Wildfire

A fiery **inferno** burns out of control, spreading breathtakingly fast. Orange and red flames flicker and dance. The air is scorching hot with the temperature measuring over 1,093 °C (2,000 °F). Animals flee, and humans **evacuate**. Homes burn to the ground. Thousands of trees turn into ash and charcoal. This is what a wildfire looks like. And wildfires are becoming more common as our climate changes.

In the United States alone, two million hectares (five million acres) of land are affected by wildfires each year. Wildfires are most common in areas with trees and **brush** where there are droughts, or periods of little rain. Hot, dry conditions make it easier for fires to start and spread.

a wildfire at night





Wildfires destroy the glass and plastics in cars, leaving behind only ruined metal.

Wildfires affect humans, animals, and plants. Wildfire smoke is a health hazard that lowers air quality and irritates people's lungs. Wildfires destroy homes, vegetation, and habitats for animals. They can affect sources of drinking water and even cause death. During wildfires, entire ecosystems can be affected.

Wildfires have occurred on our planet throughout time. Learning about the chemistry of wildfires helps firefighters know how to stop them and create planned fires that have some surprising benefits. Plus, knowing the risks and effects of wildfires allows people to prepare for them, predict them, and stay safe from them.

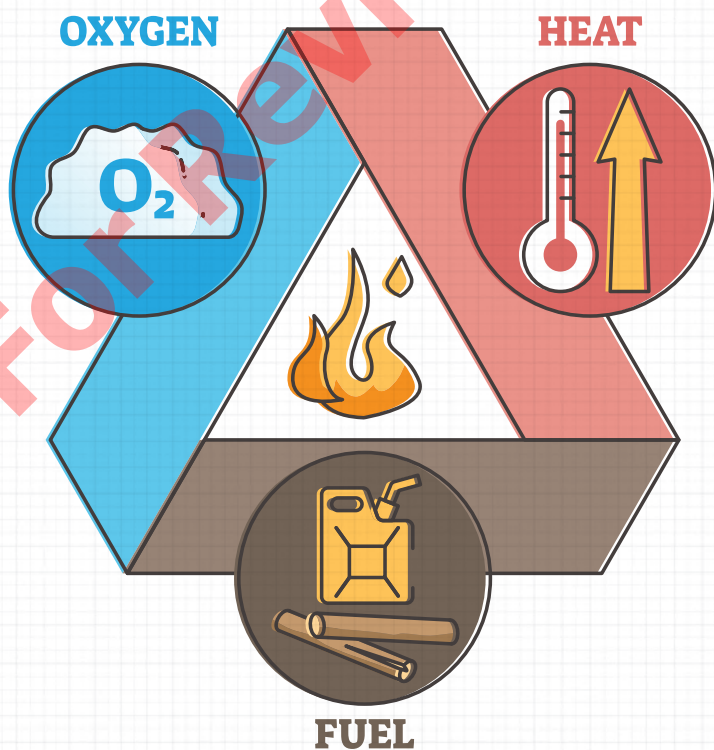


Large wildfires can be seen from space.

Fire Chemistry

Every fire needs three essential ingredients to start **combustion**: fuel, oxygen, and heat. These ingredients make up a model called the *fire triangle*. If any of these ingredients are missing, a fire cannot burn.

In wildfires, fuel can include tree resin, vegetation, dry grasses, leaves, litter, or anything that burns. The next ingredient, oxygen, is found in the air. The air we breathe is made up of 21 percent oxygen, and a fire only needs 16 percent oxygen in the air to start. The final ingredient is heat. Sometimes, it comes from a natural source, such as lightning. Other times, heat comes from a human-made source. Campfires, cigarettes, fireworks, damaged power lines, and **arson** have all sparked wildfires. When these three ingredients come together, a wildfire can **ignite**.



A Closer Look

You may have seen a small campfire or candle flame before. The same flames that occur in those small fires can be seen in large-scale wildfires, too. In a wildfire, flames destroy trees and break them down. A fire's temperature and the chemical makeup of the trees determine how much of the wood burns and how much turns to **char** or ash. The parts that burn turn into gases or smoke. The parts that turn into char form a solid black substance, and the parts that turn into ash become powdery and gray.



FUN FACT

The color of a fire's flames depends on the fuel source and temperature. Wildfire flames are usually red, orange, or yellow. The color of a fire's smoke also depends on the fuel source. Black smoke is caused by burning plastic or rubber. Lighter gray or white smoke is caused by burning wood and straw.

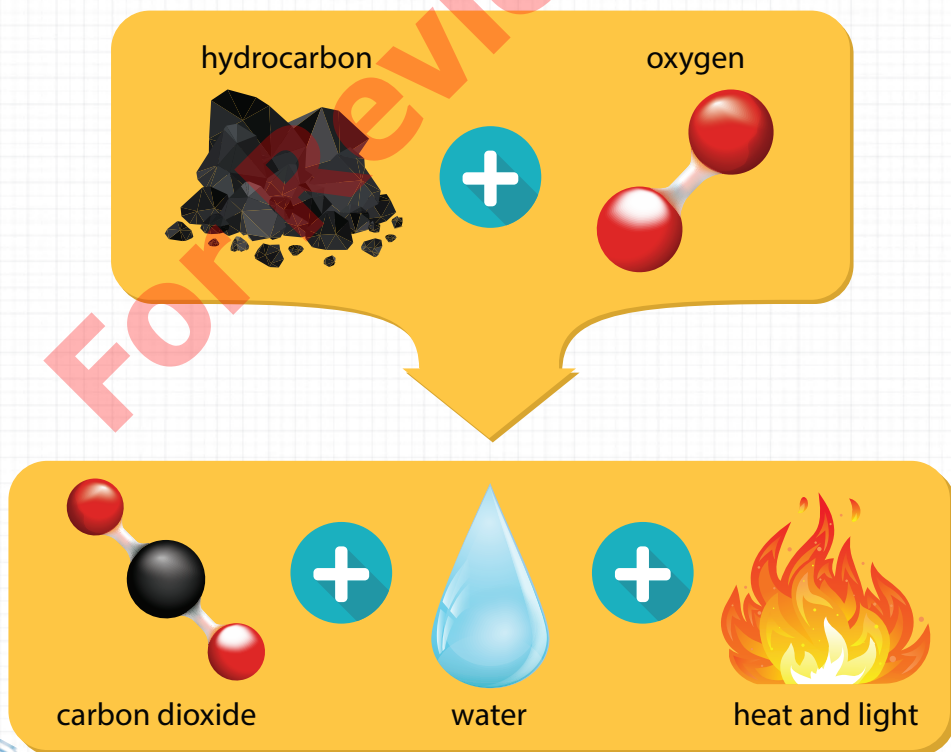


Exothermic Reaction

Even though wildfires destroy trees and homes, they do not destroy energy. Instead, they transform energy. Wildfires are the effect of a chemical reaction called an *exothermic reaction*. In this process, substances that burn react together. They release energy as heat and light. This is why you can warm your hands by a fire or see a campfire lighting up a campsite.

During this reaction, fuel and oxygen act as **reactants**. Flames heat the fuel and break down molecules inside. Complex gases made of hydrogen, carbon, and oxygen are burned. These molecules break down into atoms. Then, different molecules form and emerge in the flames. Carbon dioxide and water are the **products**. This is an intense, complex process.

Combustion Reaction



Emissions produced by a wildfire depend on the type of fuel burned. For example, savanna grasslands tend to produce large amounts of black carbon. Trees in fresh, green forests produce ammonia and nitrogen dioxide when they burn.

Peatland fires can burn underground and produce methane and carbon monoxide. In large quantities, all these emissions are harmful to the environment.



smoke and flames
from a peatland fire

Environmental Conditions

Because wildfires produce heat, they can burn for a long time if their fuel and oxygen sources are uninterrupted. Weather conditions, such as wind or high temperatures, can make wildfires more severe.

A climate feedback loop exists with wildfires. Climate change creates longer fire seasons during months when air is warm and dry. And longer fire seasons put more harmful emissions like carbon dioxide into the air, speeding up the rate of climate change.



STEAM CHALLENGE

Define the Problem

Fire safety is not just limited to wildfires—it's important to keep yourself safe from fire danger in the kitchen. One challenge is preventing burns from the handles of hot pots and pans. Cookware manufacturers are seeking design ideas from engineers for innovative pot and pan grips. They want to prevent the handle of a pot or pan from getting too hot while still allowing food to cook inside. Your task is to create a pot or pan grip that will slow or stop the transfer of heat energy to protect your hands.



Constraints: You may only use the materials that are provided to you.



Criteria: Your pan grip must fit over the handle of a cooking pot or pan. It should also maintain room temperature after exposure to a heat source.



CAREER ADVICE

from Smithsonian

Do you want to have a career in environmental science?

Here are some tips to keep in mind for the future.

"Embrace your curiosity and ask questions about everything!"

–Dr. Katrina Lohan, Coastal Disease Ecologist,
Smithsonian Environmental Research Center

"Joining environmental or green clubs and volunteering with similar kinds of organizations can be a great way to learn and meet other people who are also interested in environmental science."

– Dr. Alison Cawood, Director of Public Engagement,
Smithsonian Environmental Research Center



Read and Respond

1. What are the three ingredients of the fire triangle, and how does the fire triangle work?
2. Describe an exothermic reaction and how it occurs in a wildfire.
3. What are some of the methods that firefighters use to stop wildfires?
4. Why are controlled burns an important tool in wildfire prevention?
5. How can you practice fire safety at home?
6. Do you think wildfires will become more or less severe in the coming years? Explain your reasoning.

