HOT TOPICS:
Wildfires & You

Aligned to 6th Grade California State Standards
Adaptable - Grades 4-8

The Forest Foundation *www.calforestfoundation.org*

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Welcome to *Hot Topics: Wildfires & You:* We are glad you selected this curriculum to implement in your classroom and invite you to review this page before beginning this four-lesson series. Hot Topics uses the Constructivist Learning Approach, which assesses students' preconceptions, presents students with motivation and an opportunity for exploration of new information while facilitating the refinement of naïve conceptions. The brainstorming refinement process may differ from your usual routine, but it is a tremendous opportunity for students to investigate and acquire new knowledge. The information below serves as a road-map for navigating the four exciting lessons ahead.

In This Unit: Preview each lesson before you begin. Lessons 1-3 teach important standards-based concepts regarding heat, fuel and fire. Lesson 4 serves as a hands-on lab for students to apply knowledge gained. If you prefer, you may elect to set up the lab for lesson 4 at the beginning of this unit, in order to collect data at the end of your 4 days. **A lab kit for lesson 4 may be borrowed from The Forest Foundation. Call toll free, 1-866-241-8733.**

In each lesson you will find the following components.

- **Conceptually Based Learner Outcomes:** Lesson objectives, aligned to California Standards for 6th Grade
- **Overview:** A brief description of the activities and major concepts explored.
- **Prep Time and Activity Time:** A suggested timeframe for preparation and completion of the activity.
- **Space Requirements:** Specific space needed in order to accomplish the objectives.
- **Vocabulary:** A list of content-specific vocabulary to introduce and review.
- **Materials and Setup:** A check-list to ensure that all materials are prepared.

- **Strategies to Increase Universal Access:** At the beginning of each lesson, you will be presented with a description of strategies to increase universal access and meet the needs of diverse learners. Throughout the lesson, look for the icon (at right) as an indication of a time to implement one of these strategies.

- **Pacing Guidelines:** Each section of the lesson will include a suggested pacing time in order to complete the activity in the time allotted. Please remember this is only a proposed pacing guideline, and every class may respond differently.

- **Teaching Tips:** Tips for incorporation of resources or reinforcement of core concepts are located in rounded text boxes throughout the lesson.
- **Enrichment Activities and Teaching Resources:** Additional activities and resources to enhance learning are located at the conclusion of each lesson.
- **Student Handouts:** All handouts are located at the end of the lesson. If you prefer, you may elect to display handouts using an LCD projector.
- **Teacher Background Information:** Prior to conducting the lesson, you may wish to read the background information for a thorough understanding of the concepts taught in the activity. Vocabulary Definitions for each lesson may be found in the Teacher Background section.

BACKGROUND INFORMATION FOR TEACHERS: LESSONS 1-4

LESSON 1:
Hot Topics - Exploring Heat & Energy

This lesson interweaves the concepts of energy, heat (thermal energy), the fire triangle and natural resources. It is of primary importance to understand the basic concepts of energy. **Energy** is what enables molecules and atoms to interact, causing chemical reactions. The primary source of energy on our planet is the sun. In order for energy to be used, it must be transferred from one object to another. The three methods of transfer are explained below:

Conduction: This form of energy transfer involves no flow of matter and occurs when solids come in contact with one another. Energy is passed from one molecule through a chain of adjacent molecules, until it reaches all the nearby molecules. For example, if you touch a metal rod exposed to the sun on a hot day, your hand will receive the energy, which has been transferred from the sun, through the rod, to your palm.

Radiation: This form of energy transfer occurs when energy from one molecule travels through space to another. For example, sitting near a space heater, one is able to become warm without touching the heater because the energy is transferred through space.

Convection: This form of energy transfer involves the flow of matter, and occurs when the energy of one energized molecule is transferred directly to another molecule. For example, when warm water flows out of the faucet at home, the pipes are warmed by convection.

Fire and the Fire Triangle:

Fire The word "fire" refers to the natural phenomenon that occurs whenever a combustible fuel comes into contact with oxygen at an extremely high temperature. Fire is the byproduct of a chemical reaction in which fuel stored in a combustible material is converted to a gas. A fire's flame refers to the visual indication of light that occurs once the gas is heated, and is evidence that a fire has taken place.

The Fire Triangle was developed by fire scientists as a simple way of understanding the factors of fire. Each side of the triangle represents one of the three ingredients of fire – (oxygen, heat and fuel) – demonstrating the interdependence of these ingredients in creating and sustaining fire. These ingredients depend on one another to create and sustain fire. Remove any of these three factors from the triangle, and a fire will die.

- Air contains about 21% oxygen, and most fires require at least 16% oxygen content to burn. Oxygen is necessary because it supports the chemical processes that occur during a wildland fire. When fuel burns, it reacts with oxygen from the surrounding air, releasing heat and generating combustion products (e.g., gases, smoke, particles). This process is known as oxidation.
- A heat source is responsible for the initial ignition of wildland fire. **Heat energy** is necessary for **ignition** of a fire, and heat is also needed to maintain the fire and permit it to spread. Heat allows fire to spread by removing the moisture from nearby fuel, warming surrounding air, and preheating the fuel in its path, enabling it to travel with greater ease.
- **Fuel** could be defined as any kind of combustible material, and is characterized by its moisture content, size and shape, quantity, and the arrangement in which it is spread over the landscape. The moisture content of any fuel will determine how easily that fuel will burn.[2]

Vocabulary:

- **Combustion** – The rapid oxidation of fuel in which heat, and usually flame, are produced. Combustion can be divided into four phases: pre-ignition, flaming, smoldering, and glowing. Heat transfers through a material from a region of higher temperature to a region of lower conduction temperature.
- **Fire Triangle** – Instructional aid in which the sides of a triangle are used to represent the three ingredients (oxygen, heat, fuel) necessary for combustion and flame production; removal of any of the three factors causes flame production to cease.
- **Fuel** – Any combustible material, especially petroleum-based products and wildland fuels.
- **Heat Energy** – The net amount of heat that would be given off if fuel burns when it is absolutely dry, noted as BTU per pound of fuel.
- **Ignition Energy** – Quantity of heat or electrical energy that must be absorbed by a substance to ignite and burn.

BACKGROUND INFORMATION FOR TEACHERS: LESSONS 1-4

LESSON 2:
Fire – How Does it Relate to You?

This lesson interweaves the concepts of energy, heat (thermal energy), the fire triangle and natural resources. It is of primary importance to understand the basic concepts of energy. **Energy** is what enables molecules and atoms to interact, causing chemical reactions. The root source of energy on our planet is the sun. In order for energy to be used, it must be transferred from one object to another. The three methods of transfer are explained below:

Impact of Fire
It is also important to understand the impact of fires on the environment, community and economic resources. Fires are naturally occurring, and prior to urban development in the United States, fires would cyclically occur, clearing underbrush from forested areas. With the increase in developed areas, fires have been minimized, which has led to an increase in fuel, or combustible material.

In 2008, fires burned over 1.5 million acres in California, which came at an economic expense of over one billion dollars. Fires devastate communities occupied by humans and wildlife while devouring plants and trees. Fires also pollute the environment by releasing toxins into the air. Burned plants, which at one time controlled erosion, lead to soil runoff, which contaminates rivers and streams.[3]

Additional Information for Teacher Background or Student Questions:

1. What types of forest conditions could lead to a large and intense forest fire that burns out of control (cannot be contained by firefighters)?
   a. **List the forest conditions below.** Overcrowded forest; little spacing between trees; thick brush serves as ladder fuel for fire to move from ground into crowns of trees; crowns/tops of trees are touching, which leads to easy spread of fire from tree to tree; large amounts of fuel on the ground in the form of leaf litter; down branches, logs, etc. This forest would be hard to walk through due to all of the crowded vegetation and woody debris on the forest floor.

   b. **List the consequences of this type of fire.** This fire will get into the crowns of the trees and will be much more difficult and dangerous for firefighters to fight than a ground fire. Large amounts of fuel cause the fire to burn very hot, killing all plants/trees in its path. The heat from high intensity fires also burns up the organic material in the soil and often causes it to become hydrophobic – water beads up and runs off rather than soaking into the soil. This leads to erosion and sedimentation of streams/lakes, etc. Large amounts of smoke will be emitted from this wildfire – emissions will include carbon dioxide, methane, carbon monoxide, nitrogen oxides and sulfur dioxide. This fire could easily endanger nearby communities/homes/people. Animals may be killed and most will need to find new homes as the habitat may not meet their needs for years to come.

2. Imagine a low intensity fire that burns along the forest floor but does not get into the tops/crowns of the larger trees.
   a. **List the forest conditions that would be needed for this type of fire to occur.** There would be spacing between the trees such that most of the crowns are not touching each other. Ladder fuels and ground fuels are minimized. These conditions have been shaped through frequent small, low intensity fires, cutting/thinning of some trees or a combination of both. The overall effect has been to create horizontal and vertical separation of fuels. This forest would be easy to walk through, without large amounts of brush and downed woody material.

   b. **List the consequences of this type of fire.** Due to the low amounts of fuel and ample spacing between trees, this fire is going to burn at a low intensity and will stay on the ground, consuming leaf litter, brush and some small trees. Larger trees will remain unharmed due to thick, protective bark and the fact that the fire will not be able to get up into the crowns because there is little material to serve as fuel ladders. Fire will not burn hot enough to cause the soil to become hydrophobic. Erosion problems are not caused by this fire. Animals leave during the fire but will quickly return as the habitat will still meet their needs and may even improve with more food becoming available as new grasses, foliage, etc. sprout.

3. **List examples of how people might have altered forest conditions in California 500 years ago**.
   Native Americans regularly set fires to minimize accumulation of fuels and reduce risk of large catastrophic wildfires; clear travel routes; increase visibility; create environmental conditions to encourage growth of plants preferred by game animals; reduce pests and collect edible insects; encourage growth of plants that grow in disturbed environments, such as berries, medicinal plants, etc.; create diversity; fight battles with other tribes

a. **List examples of how people alter forest conditions now**. Build homes in or near forests; make campgrounds, trails/recreation areas; harvest trees for wood products; start forest fires as part of a controlled forest management plan; accidentally start forest fires.

b. **What can modern day forest managers do to minimize the negative impacts of forest fires on our environments, economies and communities?** Plan fire safe communities, reduce buildup of fuels in the forest and keep trees from becoming overcrowded through harvest of trees and prescribed/controlled burns.

LESSON 3:
Fire in Our Communities – What Can We Do?

History:
Historically, low-intensity fires were common in California. Most forests burned often and gently, with low flames creeping through grass and pine needles while licking benignly at the base of large trees. Where brush had grown dense or patches of older trees were unusually thick, flames would flare up, leaving in their wake small openings where young trees could flourish. These low-level fires were the norm for thousands of years. About half the fires were ignited by lightning strikes and the rest by native peoples who used fire to improve hunting conditions, create safer living areas, thin oaks to increase acorn crops and other purposes. They kept California's forests open, with a mosaic of patches of trees of different sizes and ages on the landscape. Large, catastrophic fires were rare and forests teemed with wildlife. However, that has changed. Starting in the early 1900s, people began putting out forest fires and altered the natural fire regime. Without low-intensity fires to keep them open, forests began to grow more crowded. Many forests we see today are not natural, but far denser versions of their historic predecessors.

California's Changing Forest Landscape:
In California's mixed-conifer and ponderosa pine forests, 500 or more trees per acre often now stand where less than 70 trees per acre stood historically. In overcrowded forests, trees compete for water, food and sunlight. Without enough nutrients to go around, trees become stressed and susceptible to insect attacks. Insect infestations and tree mortality are reaching epic proportions. Many of California's public lands simply have more trees than the land can sustain, which is causing forest health to suffer. Humans have put out the fires and restricted the timber harvesting that could have thinned these forests. Too many trees is also the reason that catastrophic fires have become more common in recent years. With an abundance of dead, dry trees in forests, fires burn hotter than natural. They can easily blow through, or hurl firebrands (bits of burning trees) over, fuel breaks. That's what happened in South Lake Tahoe in 2007 when the Angora Fire destroyed hundreds of homes. Many forestry experts agree that effective forest management practices must be implemented in order to foster the sustainability of forests and reduce the risk of intense wildfires, while protecting the lives of people living close to forests.[4]

Studies:
Researchers are working to determine the best methods for responsible forest management. One approach is the use of pre-fire fuel treatments to decrease fire severity. Fuel treatments involve the carefully applied practice of removing potential fuel in a given area. A study conducted in the Angora Creek drainage by the US Forest Service's Dr. Hugh D. Safford, David A. Schmidt and Chris H. Carlson, found that fuel treatments "significantly moderated fire behavior and fire effects to the forest". An additional report by the Forest Service showed that this approach helped fire suppression efforts in and around burned housing tracts. The study also found that fuel treatments improved tree survival rate in a fire. Trees in the untreated area had an approximate 80% mortality rate, while trees in the treated stands had only a 20% mortality rate, thus preserving our natural resource.[5]

Additional research on the 2002 Cone Fire, located in Lassen County, California, tested the effectiveness of different fuel reduction treatments in fire suppression. Two studies were conducted. The treatment groups are as follows:

Study A: Area with high structural diversity
Control – no prescribed fire
Treatment Group – prescribed fire

Study B: Area with low structural diversity
Control – no prescribed fire
Treatment Group – prescribed fire

The results indicated that areas which were thinned (reduction of fuel) and which received a follow-up prescribed fire to reduce surface fuels allowed the wildfire to stay close to the ground and be extinguished safely. The areas which were just thinned, without a prescribed burn, had enough surface fuel to severely burn trees.[6]

Defensible Space:
Defensible Space describes the area between a house and an oncoming wildfire where fuel sources have been modified to prevent the spread of wildfire.

BACKGROUND INFORMATION FOR TEACHERS: LESSONS 1-4

The Three R's of Defensible Space: [7]

1. Removal: Eliminate entire plants, particularly trees and shrubs, from the site. Cut down dead trees and remove flammable shrubs.
2. Reduction: Remove plant parts, such as branches or leaves, to reduce fuel. Prune dead wood from shrubs, remove low branches from trees and mow dead grass.
3. Replacement: Remove flammable vegetation and substitute less flammable plants. Remove dense areas of flammable shrubs and plant an irrigated, well maintained flower bed.

The Three Zones: Steps to Make Them More Fire-safe:

1. Home Ignition Zone: This includes your home plus the area within 10 feet around your entire home. What can you do to make it fire-safe? Clean your rain gutters, get rid of dry brush and grass and clear all flammable materials from your deck. Water your plants, and irrigate grass in this area. Search out and get rid of flammable things outside your home and you will be much safer!
2. Defensible Space Zone: This includes your house plus the area enclosed by 100 feet distance from your home. What can you do to make it fire-safe? Keeping this area green and making sure there is space between trees and plants will increase the chance that firefighters can save your home in the event of a wildfire. Use the Three R's (Remove, Reduce and Replace) to keep this area fire safe!
3. Wildland Fuel Reduction Zone: This refers to the area beyond 100 ft. from your home. What can you do to make it fire-safe? After checking with local fire authorities for any necessary permits for brush clearance or tree removal, remove undergrowth (plants that grow beneath trees) and thin trees that are densely populated. Experts recommend that you should have at least 10 ft. between trees. Managing this area will slow down an approaching wildfire.[8]

Author Reference to Quotes used in Interview Activity:

(Dr. Know R. Forests) "Many forests in California are densely packed with trees of all sizes. Unable to compete for water, sun and nutrients, these trees become more likely to be affected by disease, drought and high intensity wildfires." Han-Sup Han, PhD, *Professor of Forest Operations and Engineering at Humboldt State University* [9]

(Professor McFireman) "By the mid-1930s, the Forest Service adopted the '10 am Policy', which stipulated that fires should be contained by 10:00 the morning after ignition. With no natural thinning agent, forests began to get more crowded and unnatural fuel loads accumulated." Thomas M. Bonnicksen, PhD[10]

(Mr. Tim Bur) "In California, only about one-quarter of the forest growth each year is harvested." Jay O'Laughlin, PhD, *Director of College of Natural Resources Policy Analysis Group at University of Idaho* [11]

(Professor Karen Fore-Earth) "Policies and practices have created enormous fuel loads that cause today's fires to burn hotter and with more severe ecological effects than in the past." Linda Blum, *Habitat Specialist* [12]

(Mrs. Brooke Trout) "Forests that once sustained (grew successfully) 50-80 trees/acres now struggle to support more than 500 trees per acre." Gary Nakamura, *University of California Cooperative Extension Forester* [13]

(Professor Seeing R. Past) "Before European settlers, fires occurred more frequently. Native Americans intentionally set fires to improve resource conditions." Claralynn Nunamaker, *California Registered Professional Forester, Scotland* [14]

(Dr. Reece Orce) "Forests are a valuable resource. They provide wildlife habitat, clean air and water, a place for recreation, renewable wood products and jobs for many people!" (Not a direct quotation.)

Vocabulary:

- **Controlled Burning** – a prescribed fire ignited by management actions to meet specific objectives. A written, approved prescribed fire plan must exist, and NEPA requirements (where applicable) must be met prior to ignition.
- **Defensible Space** – the area that is a minimum of 100 feet from your home. This is the area where you've modified the landscaping to greatly increase the chance that your house will survive a fire.
- **Density (of tree spacing)** – the number of trees per unit area.
- **Forest** – an ecosystem characterized by extensive tree cover.
- **Natural Resource** – a material source of wealth, such as timber, fresh water or a mineral deposit, that occurs in a **natural** state and has economic value.
- **Renewable Resource** – a resource whose supply becomes available for use at different time intervals and in which present use does not diminish future supply. (e.g., timber, trees).
- **Suppression –** the act of putting an end to activities, in this case, fire.
- **Sustainability** – the capacity of forests to maintain their health, productivity, diversity and overall integrity over the long term in the context of human activity and use.
- **Timber** – forest crops and stands containing trees potentially used for lumber.

BACKGROUND INFORMATION FOR TEACHERS: LESSONS 1-4

LESSON 4:
Fire Investigation & Experimentation

This lesson serves as the culminating lesson of three, bringing together the concepts of heat energy and fire in our communities. This section will help you understand the factors that contribute to fire danger, how fuel moisture is used to determine fire danger and the procedure for using the fuel moisture sticks.

Factors that contribute to Fire Danger:

1. Temperature – High temperature leads to low moisture content and greater fire danger.
2. Humidity – Humidity is the moisture in the air. Low humidity leads to greater fire danger because fuels ignite more readily.
3. Wind Speed – One of the most critical factors, high winds add oxygen (a component of the fire triangle) to a fire and raise fire danger.
4. Cloud Cover – Clouds provide shade on land, which lowers fuel temperature and raises humidity, leading to lower fire danger.
5. Slope – A steep slope leads to higher fire danger because flames quickly reach nearby branches. Slope also makes it challenging for firefighters to do their job.
6. Aspect – Aspect refers to the direction the property faces. North facing slopes in California are typically cooler with higher humidity, which decreases fire danger. Southern and western facing slopes are typically hotter and drier, increasing fire danger.
7. Fuel Moisture – Fuel moisture refers to the percentage of moisture in the fuel, such as plants, trees and grasses. Low fuel moisture leads to higher fire danger.[15]

Fuel Moisture:
Fuel moisture refers to the amount of water in a fuel, such as grasses, plants, shrubs and trees. It is expressed as a percentage of the dry weight of that fuel. The fuel moisture content would be zero if the fuel were completely dry. If a fuel has less than thirty percent fuel moisture, it is considered dead fuel and is a significant threat to fire danger. Fuels that are considered alive will often range from 30 to 300% fuel moisture.

When fuel moisture is low, fire danger increases. Fires start and spread quickly. On the other hand, when fuel moisture is high, it is more difficult for fires to start and they spread more slowly. Due to the moisture, heat energy must be used to first evaporate the water before the fuel will ignite. Fuels react to their environment: their moisture decreases when conditions are hot and dry, or their moisture increases when conditions are cool and wet.[16]

Using the Fuel Moisture Stick to Assess Fire Danger:
The fuel moisture stick is a tool commonly used by scientists and firefighters to assess the level of fire danger in a specific area. It is important to weigh the fuel moisture stick(s) prior to placing outside, to determine the initial dry weight. A "duff bed" of coniferous needles, leaves or a burlap sack is prepared in the desired area, approximately two inches thick and three feet in diameter. The purpose of the duff bed is to protect the fuel moisture stick from being splashed with mud, which can alter the data.

Once the duff bed is prepared, brackets are placed approximately sixteen inches apart to suspend the fuel moisture stick above the duff bed. The fuel moisture stick is suspended from the brackets horizontally, approximately ten inches above the ground. The fuel stick must remain outdoors, undisturbed in the environment for several days, to allow its moisture content to come into equilibrium with the ambient environment.

After several days, the fuel moisture stick is weighed on a scale. The weight is recorded as the final weight or weight after environmental acclimatization. This weight will reflect the amount of moisture in the environment. The initial weight is subtracted from the final weight, and the difference is divided by the initial dry weight to determine the percent fuel moisture in the environment.

Example: If the initial dry weight of the fuel moisture stick(s) was 100g, and your final weight was 115g

115g – 100g = 15g
15g/100g = 0.15 x 100 = 15% fuel moisture

Vocabulary Words

- **Aspect** – the direction the property faces
- **Crowning** – when a fire advances from tree top to tree top.
- **Duff bed** – the term used to describe a foundation of leaves, coniferous needles or a burlap sack prepared to protect the fuel moisture sticks from contamination.
- **Firebrands** – any burning material, such as leaves, wood and glowing charcoal or sparks that could start a forest fire.
- **Fuel moisture** – the percentage of moisture in the fuel, such as plants, trees and grasses. Low fuel moisture leads to higher fire danger.

BACKGROUND INFORMATION FOR TEACHERS: LESSONS 1-4

- **Ignition** – to begin burning.
- **Ladder Fuels** – firefighting term for live or dead vegetation that allows a fire to climb from the forest floor to the tree canopy.
- **Relative humidity** – the amount of water vapor in the air, expressed as a percentage of the maximum amount that the air could hold at the given temperature.
- **Slope** – to direct at a slant or inclination; incline from the horizontal or vertical.
- **Spotting** – fire set outside the perimeter of the main fire by firebrands.
- **Topography** – the detailed mapping or charting of the features of a relatively small area, district or locality.

Endnotes:

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3 Bischel, D.A. (Winter 2009). Wildfire Blazes Across Political Boundaries. *California Forests,* 13(1), 5.

4 Bonnicksen, T. (2008). *Protecting Communities and Saving Forests: Solving the Wildfire Crisis Through Restoration Forestry.* The Forest Foundation.

5 (2009, June 30). News Release: *Completed Fuel Treatments in Angora Creek Worked as Designed.* USDA Forest Service, Pacific Southwest Region.

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8 *A Homeowner's Guide to Firewise Landscaping in Nevada County*. Fire Safe Council of Nevada County, Retrieved from www.FireSafeCouncilNevCo.com

9 Han, H. (2009). Energy to Burn. *California Forests*, 13(1), 8.

10 Bonnicksen, T. (2008). *Protecting Communities and Saving Forests: Solving the Wildfire Crisis Through Restoration Forestry.* The Forest Foundation.

11 O'Laughlin, J. (2009). Active Forest Conservation Beats Passive Preservation. *California Forests,* 13(1), 10.

12 Blum, L. (2009). Coming Together to Sustain Forests. *California Forests,* 13(1), 13.

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15 Browning, Tom. Battalion Chief, Grass Valley City Fire Department. Personal Interview. 23 September 2009.

16 National Oceanic and Atmospheric Administration. Retrieved from www.wrh.noaa.gov/sew/fire/olm/fuelmoisture.htm

Exploring Heat & Energy

Lesson Plan 1 of 4

Conceptually Based Learner Outcomes:

1. The fire triangle illustrates the relationship between the three basic elements needed to establish fire: oxygen (O_2), combustible fuel, and heat to start and continue combustion. These three elements combined, lead to fuel ignition and combustion.
2. Heat moves in a predictable flow from warmer objects to cooler objects until all objects are the same temperature. *(6th Grade California Science Standard 3.0)*
3. When fuel is consumed, most of the energy released becomes heat energy. *(6th Grade California Science Standard 3.b)*

Overview:

In this lesson students explore the characteristics of heat energy. Students are introduced to the fire triangle and how each component is necessary for combustion. Students discover that heat is released as a result of fuel consumption and friction. Students also investigate how heat moves from warmer to cooler objects.

Prep Time: 10 minutes

Activity Time: 1 Hour

Space Requirements:

This activity is to be done in a classroom. Space should be arranged in two areas of the room, providing enough space for half of the students to gather at each location, work in pairs, and move freely to complete the group challenges "Heat Movement" and "Peanut Fuel."

Vocabulary:

Heat Energy, Fire Triangle, Ignition, Combustion, Fuel
Vocabulary definitions are found in the section titled, *Background Information for Teachers: Lessons 1-4*

Materials:

_____ Prepared "Challenge Cards" for group leaders (See "Student Handouts" at end of this activity)
_____ Clock with second hand
_____ Chalk /Dry erase board or large 3'x4' paper share-sheets
_____ Chalk/Dry erase markers or water-based marking pens
_____ Candle, matches and tall glass
_____ Peanuts
_____ Thermometer (metric) optional
_____ Equipment to mount peanuts (tongs or test tube stand with test tube of water)
_____ Cold object
_____ Fire extinguisher
_____ "Wildfires in California" PowerPoint (optional)
_____ LCD Projector (optional)

**Materials can be obtained inexpensively by bringing objects from home or modifying available classroom resources. "Wildfires in California" PowerPoint available at www.calforestfoundation.org > Teachers & Standards > Online Materials.*

Strategies to Increase Universal Access:

1. Conceptual Student Dictionary: For each concept or major standard area addressed in class, have students create a personal dictionary of new terms related to this concept. Provide an opportunity for anonymous collection of new terms from students, and work with students to define relevant terms. *(English Language Learners, Below Grade Level)*
2. Peer Tutoring: Carefully craft collaborative working groups so that English language learners are paired with a peer who will help them be successful in the group challenge. *(English Language Learners, Below Grade Level)*

Connect and Engage: **5 mins**

1. Immediately engage students in the lesson through this **"Friction Challenge".** Students team up in threes. One student acts as the "Judge" and two students act as the "Competitors". The Competitors rub their own hands together for 15 continuous seconds. Then they immediately place one of their hands on the Judge's forearm to see which Competitor created the most heat. Have students quickly rotate roles so that all students can serve as "Competitors."
2. Process this activity quickly as an introduction to today's lesson. Use the following as a guide for processing: What happened in this challenge? *(hands got warm)* What was generated/made? *(heat)* The friction of our hands rubbing together caused heat. Can you think of another example of when friction, or two objects moving together, can create heat? *(Native American fire-starting methods, engine parts, etc.)*
3. Preview: Heat is essential to life! Even famous TV wilderness men like Bear Grylls and Survivorman use heat to live in the wild. Today we will explore the exciting concept of heat!

Students' Preconceptions: **5 mins**

1. Students brainstorm their understanding of heat, heat movement and the fire triangle. Pose the following questions to students: What do you know about heat? How does

BEGINNING THOUGHTS ON HEAT AND THE FIRE TRIANGLE

heat move? What are the three legs of the fire triangle? What happens when one leg of the fire triangle is removed?

2. Create a collaborative class list on the board or share-sheet by gathering information from students in response to the prompt and display on the board in the front of the class. Label this "Beginning Thoughts on Heat and the Fire Triangle."

Exploration: **10 mins**

1. Teacher Demonstration of Fire Triangle: Draw and label a picture of the fire triangle on the board. Ask the students to match the three components of the fire triangle to your demonstration materials: the candle *(fuel)*, matches *(heat)*, and glass *(invisible oxygen molecules)*. Ask the students to predict what will happen if you place the glass upside down over the lighted candle. *(The fire will consume all the oxygen molecules trapped inside the glass and thus eliminate one leg of the fire triangle, causing the fire to go out.)*

2. Complete the demonstration as students observe. Bring a student volunteer forward and have him/her place a hand near the surface of the glass. Ask the student to describe to the class what he or she feels. *(Heat)* Ask the students to describe what happens to the energy being released by the burning fuel in the candle. How do you know? *(Most of the energy released becomes heat energy, which we can feel with our skin.)*

***Safety Precaution:** Ask your principal if you can use matches in your classroom. Be careful of hot wax that may be formed by the burning candle. Do not allow students to access the matches unless you have your principal's pre-approval. Consider conducting the demonstration in a pie pan filled with water for added safety.

Optional: Use "Wildfires in California" PowerPoint to imbed technology in this lesson.

Conceptual Student Dictionary **20 mins**

3. Engage students with an investigation on the properties of heat. Divide the class into two working groups (Group A and Group B). Group A will move to one side of the room to observe the "Peanut Fuel" demonstration, and Group B will move to the opposite side of the room to complete the "Heat Movement" challenge. Select a group leader from each to read the challenge card presented at the location. At the completion of the challenge, students will rotate to the opposite station.

Peer Tutoring

a. "PeanutFuel" demonstration: The teacher will demonstrate how peanuts, when ignited, create heat. In this demonstration, a peanut serves as the fuel, which is consumed. As it is consumed, the energy released becomes heat energy. This demonstration can be modified depending upon the lab equipment available.

When fuel is consumed, most of the energy released becomes heat energy.

i. The simplest form is to hold a peanut with tongs, or poke a paperclip through a peanut and mount on a stand. Have students hypothesize what will happen when a match is held beneath the peanut. Demonstrate the result by igniting the peanut.

ii. If lab equipment is available, mount a peanut on a ring stand with a test tube clamp, below a secured test tube of water. If you have a thermometer, record the temperature of the water in the test tube. Have students hypothesize what will happen when a match is held beneath the peanut. What will happen to the water if the peanut is ignited? *(The water will be heated.)* This is a great demonstration to show how the energy released from the peanut is primarily in the form of heat energy.

iii. (optional) For enrichment, students can observe how exactly one calorie of heat is transferred from the peanut to the water if the demonstration uses precisely one milliliter of water, and the temperature increase is exactly one degree centigrade.

***Safety Precaution:** Make sure all clothing, hair and other flammable objects are away from the demonstration. Assure proper ventilation and have water readily available to extinguish flame. Avoid direct contact with objects that may burn the skin.

a. "Heat Movement" challenge: Students come in contact with a cold object such as an ice cube, frozen water bottle or cold aluminum baseball bat.

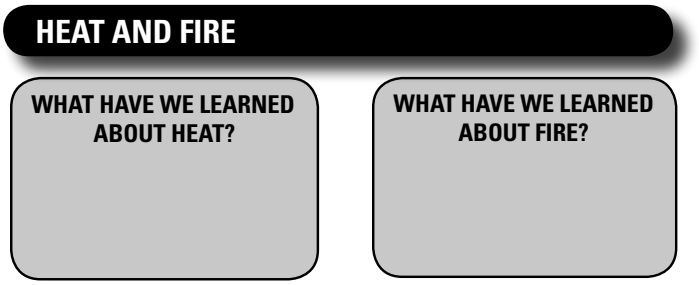
Heat moves in a predictable flow from warmer objects to cooler objects until all objects are the same temperature.

b. Students place their hands on the cold object and remain in contact for thirty seconds. What happenes to the temperature of the object over time? Does your hand continue to sense the movement of heat after the cooler object is the same temperature as the warmer object? Explain. Students record responses in their journals.

*Safety Precaution: Make sure the cold object being used cannot injure students or cause a slipping hazard (melting ice).

Challenge Preconceptions:

1. Bring students back together and process the students' observations of "Heat and the Fire Triangle," "Peanut Fuel," and "Heat Movement." Ask students to describe how heat was produced. What was used to create heat? Which direction did heat move? Create a chart on a board or large paper share-sheet entitled "Heat and Fire". Elicit responses from students. Capture observations under: "What we have learned about heat" and compare to initial student thoughts. Ask students to apply what they learned in the demonstration and classroom activities to determine which of the "Beginning Thoughts on Heat" are not accurate. Highlight the statements that were factually correct.



2. Refer students to adopted science textbook chapter on heat for further instructional materials.

Application/Homework: **5 mins**

1. Have students identify objects in the classroom or at home that conduct heat and would serve as fuel in a fire. Ask:
   a. How could heat be transferred in this object?
   b. What "fuel" is being consumed?
   c. How is this object beneficial to humans? In nature?
   d. What fire safety precautions must I take around this object to keep it from catching on fire?

*Assessment Opportunity: Students complete a "Ticket out the Door" by writing responses to the above questions on a piece of scratch paper prior to leaving class. Students hand this to the teacher when exiting as a "Ticket out the Door".

Enrichment Activities:

1. Have students create an aerial map of the interior of their home, and identify at least three heat sources in each room.
2. Allow students to use their creative methods as they create a children's book about heat and fire. Encourage students to use all of the concepts they learned to create a book which could be shared in a local elementary classroom. The book should include a title, cover, table of contents, information and illustrations.

Safety Precautions:

1. Ask your principal if you can use matches in your classroom. Be careful of hot wax that may be formed by the burning candle. Do not allow students to access the matches unless you have your principal's pre-approval. Consider conducting the demonstration in a pie pan filled with water for added safety.
2. When using rotational stations in a classroom, make sure there is easy access to all areas in the classroom so that students do not trip on desks, bags or cords.
3. In the "Peanut Fuel" demonstration, make sure all clothing, hair and other flammable objects are away from the demonstration. Assure proper ventilation and have water and a fire extinguisher readily available to extinguish flames. Avoid direct contact with objects that may burn the skin.
4. In the "Heat Movement" challenge, take precautions to make sure the cold object being used cannot injure students or cause a slipping hazard (melting ice).

[1] Doherty, Paul. "Burn a Peanut," 2000. Retrieved from www.exo.net/~pauld/activities/food/burnapeanut.html

Student Handouts:
Group Leader Challenge Cards – Cut on dotted line and hand one challenge card to each group leader.

Peanut Fuel: What Happens When Fuel is Consumed?
Group Leader Challenge Card

Group Leader: Your task is to read this card out loud to your group before beginning the challenge! If you have any questions, ask your teacher.

Read Out Loud:

1. Welcome to the Peanut Fuel demonstration. In a moment our teacher will demonstrate what happens when fuel is consumed.
2. What does fuel mean? (*Fuel is an energy source. Food provides nourishment for humans and is our source of energy. Fuel for a fire is a combustible material that keeps the fire going. Examples are wood, coal, gasoline, etc.)*
3. Let's make a group hypothesis. What do you think will happen when the teacher places a match below the peanut? (Listen to student ideas.)
4. Now our teacher will demonstrate what happens when fuel, in this case a peanut, is consumed. Watch carefully!

   The teacher will conduct the "Peanut Fuel" demonstration.

   a) What did you notice?
   b) Was our hypothesis correct?
   c) What happens when fuel is consumed? (Energy is released as heat energy.)

Heat Movement
Group Leader Challenge Card

Group Leader: Your task is to read this card out loud to your group before beginning the challenge! If you have any questions, ask your teacher.

Read Out Loud: Welcome to the Heat Movement challenge. When I say "begin," your task is to place one hand on this cold object. Keep your hand there for 30 seconds. Begin!

After students have held the cold object, read the next part:

Take out your journals and respond to these questions:

(a) What did you notice? (b) How does heat move? (c) Does it continue to move after the cooler object is the same temperature as the warmer object?

Let your teacher know when your group has completed the challenge.

Fire – How Does it Relate to You?

Lesson Plan 2 of 4

Conceptually Based Learner Outcomes:

1. The fire triangle illustrates the relationship between the three basic ingredients needed to establish fire: oxygen (O_2), combustible fuel, and heat to start and continue combustion. These three elements combined lead to fuel ignition and combustion.
2. Heat moves in a predictable flow from warmer objects to cooler objects until all objects are the same temperature. *(6th Grade California Science Standard 3.0)*
3. When fuel is consumed, most of the energy released becomes heat energy. *(6th Grade California Science Standard 3.b)*
4. Fire is a natural component of our forests, however decades of fire suppression and an encroaching wild-land urban interface has led to an increase in the frequency and intensity of large, uncontrollable wildfires. Uncontrollable wildfires cause air and water pollution, may destroy human and wildlife habitat, and are expensive to manage.

Overview:

In collaborative working groups, students will apply their knowledge of the fire triangle and of heat to a wildland fire scenario. Using before and after photos, students will assess the impact of fire on natural resources, economic resources and wildlife.

Prep Time: 10 minutes

Activity Time: 1 Hour

Space Requirements: This activity is to be done in a classroom. An additional space requirement for assessment of fire impact is not necessary.

Vocabulary:

Heat Energy, Fire Triangle, Ignition, Combustion, Fuel
Vocabulary definitions are found in the section titled, *Background Information for Teachers: Lessons 1-4*

Materials:

_____ Chalk /Dry erase board or large 3'x4' paper share-sheets
_____ Chalk/Dry erase markers or water-based marking pens
_____ Student Response Sheet, 1 per student (See "Student Handouts" at end of this activity)
_____ LCD Projector (optional)

Strategies to Increase Universal Access:

1. Peer Tutoring: Carefully craft collaborative working groups so that English language learners are paired with a peer who will help them be successful in the group challenge. *(English Language Learners, Below Grade Level)*
2. Culture Studies: If utilizing Enrichment Activity 3, encourage students to research a fire from the country with which they identify themselves. Use this as a class learning opportunity to explore other cultures and draw on the previous knowledge of English language learners. *(English Language Learners)*
3. Advanced Research: Create a map of California and indicate the location of current or recent fires. Hypothesize the potential impact on California resources. *(Advanced Learners)*

Connect and Engage: **5 mins**

1. Popcorn Review: Have students recall information learned in lesson 1. Engage students in a rapid "Popcorn Review" where students jump up one at a time and share one concept they recall from the previous lesson. As that student sits down, a second may jump up to share another concept until all major concepts are reviewed.
2. Preview: In Lesson 1, we learned the three ingredients to the fire triangle and how each element is necessary for combustion and maintenance of fire. We also discovered that fuel consumption and friction cause heat to be released, and that heat moves from warmer to cooler objects. Today we will put that knowledge to use in a real-life scenario, as we investigate the impact fire has on the environment.

Students' Preconceptions: **5 mins**

1. Brainstorm with the class and list ways in which fire is beneficial and harmful. (e.g., Fire can cause certain seeds to germinate, reduce competing vegetation, kill diseases and insects, release smoke, burn homes, endanger lives, alter wildlife habitat and provide warmth.) Students capture ideas in their journals prior to sharing.

BEGINNING THOUGHTS ON FIRE

2. Use the "popcorn" method to share positive and negative impacts of fire. For this method, one student will "pop" up quickly and share one idea. As soon as that student sits down, a second student will "pop" up to share an additional idea. Continue until all ideas are shared. Capture ideas on the board or a share-sheet.
3. Ask students what type of fuel would be found in the forest. (Live trees, downed trees or limbs, brush, grass, etc.)

Exploration: **35 mins**

1. Students are given the handout, "Forensic Fire Scene Investigator." Students work in "Forensic Teams" of 3-4, assuming the role of investigators. Collaborative groups investigate the pictures of Forest Area 1 (before fire) and Forest Area 2 (before fire), which are located on page 1 of the student handout.

Peer Tutoring

2. Students respond to the guiding questions on page 1 of the student handout, as they make their prediction of the impact made by a forest fire in this area. Students are challenged to list as many impacts as possible.

Connecting Concepts: Fire can cause certain seeds to germinate, reduce competing vegetation, kill diseases and insects, release smoke, burn homes, endanger lives, alter wildlife habitat and provide warmth.

3. After completing thorough predictions, students turn to page 2 of the student handout. On page 2, students investigate images of Forest Area 1 (after fire) and Forest Area 2 (after fire). Students respond to guiding questions.

Enhance the learning experience by including props such as a microphone, reporter's hat, glasses, etc.

4. Reporting Live: This is a fun and lively event in which students are encouraged to get into character as an "Investigative Reporter" and share a live broadcast! Each group selects 1 student to serve as an Investigative Reporter to present the information their group predicted, and the final conclusions their group came to after reviewing the "after fire" images. Each group should have an opportunity for their selected Investigative Reporter to share.

   *Assessment Opportunity: Collect and grade student handouts.
   *Assessment Opportunity: Students grade other individuals in their collaborative group using the Group Scorecard provided.

Challenge Preconceptions: **10 mins**

1. Compile new realizations on the Heat and Fire chart under "What we have learned about fire".
2. Ask students to apply what they learned from the "Reporting Live" presentations to determine which of the "Beginning Thoughts" are not accurate. Highlight the statements that were factually correct.

Application/Homework: **5 mins**

Students write a one page report about the impact of fires on the environment, natural resources, wildlife and economic resources. Students need to show that they understand how forest vegetation conditions affect the intensity and consequences of forest fires. Give students a copy of the Student Response Page provided.

*Assessment Opportunity: Collect reports and grade students using the rubric provided.

 Advanced Research

Enrichment Activities:

1. Introduce the concepts of conduction, radiation and convection with these kinesthetic activities! Students stand in line and pass a tennis ball down the line, as in a bucket brigade, to show conduction. Students throw the tennis ball across the room to another student to demonstrate radiation. Convection is demonstrated by having students make a line and link hands. They will feel the heat from the other students' hands.
2. Instruct students to become "Investigative Reporters" at home. What impact would be made if a fire went through their home and community? Students respond to this question at home with regard to their home environment.
3. To improve research and technology skills, have students research a significant historical fire and create a multimedia (PowerPoint, Video, etc.) presentation to share their findings.

Safety Precautions:

When using collaborative working groups, make sure there is ample room for students to work and easy access to all areas in the classroom so that students do not trip on desks, bags or cords.

Name: _____

Date: _____

Individual Written Report Rubric: The Impact of Fire on the Environment, Natural Resources, Wildlife and Economic Resources

To receive full credit, your written report must be_____ 1 page, _____typed, _____12 point font, and include:

How the fire impacted the environment and natural resources in both Forest Area 1 and 2:

_____ Air _____ Water _____ Soil _____ Trees/plants

How the fire impacted wildlife in both Forest Area 1 and 2:

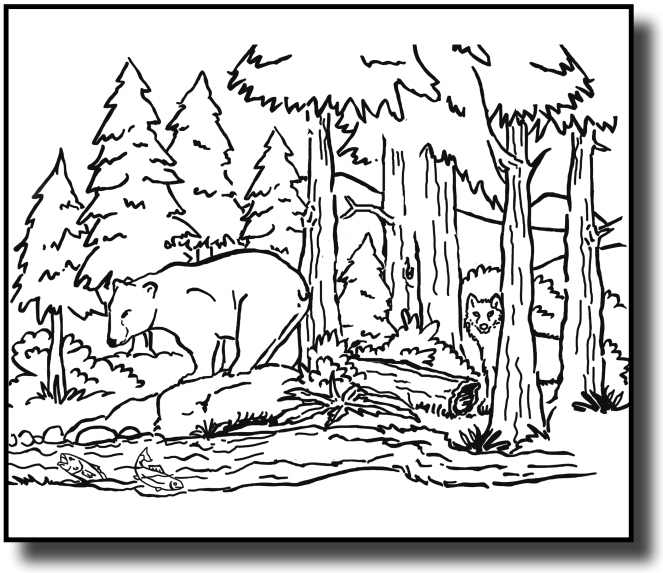
_____ Animals _____ Habitats

_____What fuel is being consumed and how it is turned into heat energy.

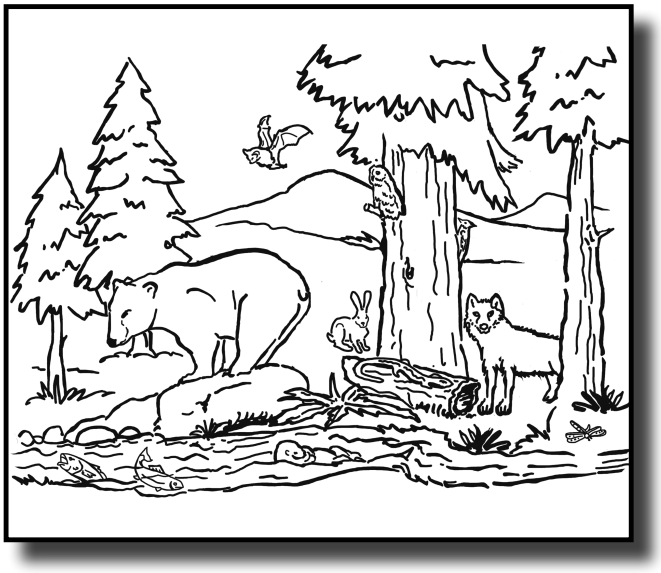
_____ What it took to contain or put out this fire

Name: _____ **Date:**_____

Student Response Sheet: Forensic Fire Scene Investigator!



Forest Area 1 (Before Fire)



Forest Area 2 (Before Fire)

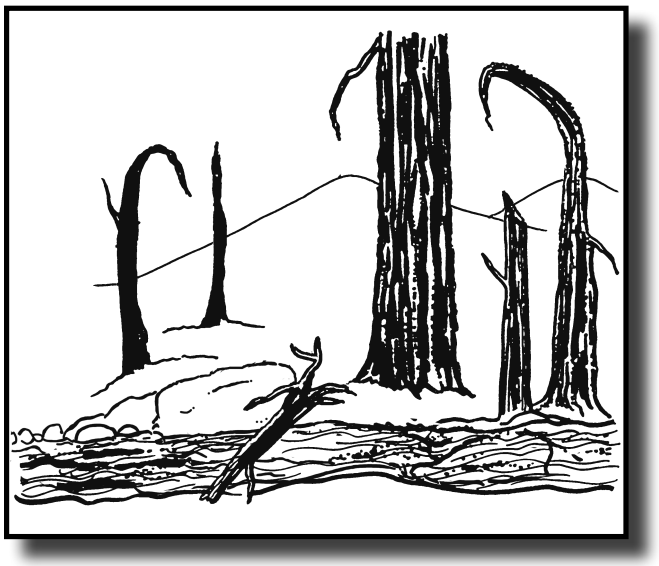
Step 1: Predict

Here's the Scoop - You and your teammates are a group of news reporters specializing in forest fire scene investigations. Write the name of your news group here:_____ (Example – The News Hounds, The Snooper Scoopers, etc.)

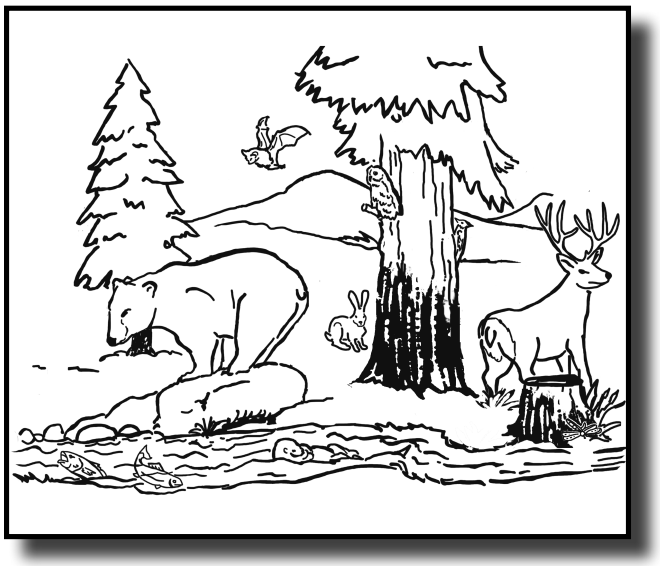
The pictures above show sketches of 2 different forests that you recently visited. You are on the 6 o'clock news and you are giving a detailed description to your viewers. Tell them what you saw in the two areas of the forest and how they were different. What types and amounts of vegetation are there? How would you describe the biodiversity of the area? Explain to your audience how you are predicting fire danger for the two areas. How did you come to this prediction?

Forest Area 1

Forest Area 2



Forest Area 1 (After Fire)



Forest Area 2 (After Fire)

Step 2: Breaking News Update!

Your news team has just visited the aftermath of forest fires in the two areas of forest that you visited last week. Your viewers are anxiously awaiting your report on the fires and it is your job to tell them the facts. What has happened to the air, water, wildlife, soil and vegetation in Forest Area 1? Assess the health of the water, soil, vegetation and wildlife in Forest Area 2. What would you tell your viewers about the biodiversity of both areas after the fires?

Most important, your viewers want to know why the impact of the fires was so different in the two areas. What do you tell them? How could the severity of the fire in Forest Area 1 have been prevented through forest management?

1. How did this fire change the environment and natural resources?

Forest Area 1	Forest Area 2
Air – Water – Soil – Trees/plants –	Air – Water – Soil – Trees/plants –

2. How did this fire affect wildlife?

Forest Area 1	Forest Area 2
Animals – Habitats –	Animals – Habitats –

Forensic Fire Scene Investigator! Sample Answer Key

Here's the Scoop:

Forest Area 1 has a lot of closely spaced trees and brush. Fire danger is very high. If a fire were to start here, the trees and brush will probably be completely burned up because the ladder fuels will allow fire to get into the tops/crowns of trees and spread throughout the forest. Fires that get into the crowns of trees are dangerous for firefighters to fight and are very difficult to control. This fire could easily spread to nearby areas with homes. This fire could threaten human and animal lives. Due to the large amount of fuel, a fire in this forest would be very hard for firefighters to control.

Forest Area 2 has less fuel than Forest Area 1. There is greater space between trees, fewer shrubs and less fuel on the ground in the form of leaves, dead branches and logs. If a fire starts in this forest, it will probably stay on the ground and will not get into the tops/crowns of the large trees. Small trees and brush will get burned up, but the bigger trees will be protected by their thick bark and will survive the fire as it will not be an extremely hot fire due to the low fuel buildup. This fire will be good because it will burn up the fuels that are there, reducing future risk of large, uncontrollable wildfires. It will also kill forest pests and diseases. The fire could open up areas of the forest, improving conditions for wildlife. A fire in this forest may burn out on its own as it runs out of ground fuels or it would be easily contained by firefighters. This forest has a number of different types of plants and animals – biodiversity is high.

Breaking News Update!

Forest Area 1 Post Fire

- Air – *Smoke is emitted into the atmosphere, including large amounts of carbon dioxide.*
- Water – *Root systems of burned vegetation will decay and soil erosion is likely to occur. Soil/sediment washes into the water.*
- Soil – *Hot fire has caused the soil to become hydrophobic, which means that water beads up and runs off rather than soaking into the ground.*
- Trees/plants – *All of the existing trees and plants have been killed by the high intensity of the fire.*
- Animals – *Fast moving, intense wildfire killed animals. Survivors had to escape to another forest area where there will likely be competition from animals already living there.*
- Habitats – *Habitats have been drastically altered. In time, pioneer species will begin to repopulate the area and the cycle of forest succession will continue.*

Forest Area 2 Post Fire

- Air – *Some smoke and carbon dioxide were emitted into the atmosphere, although at lower levels than in Forest Area 1.*
- Water – *This fire had very little impact on water, as it didn't burn up all vegetation in the forest, and leaf litter and roots are still in place to keep soil from washing into the water.*
- Soil – *This fire reduced some of the leaf litter covering the soil, which can be a good thing for improving seed beds for the growth of new trees and other plants.*
- Trees/plants – *The fire killed many of the shrubs and smaller trees. This is beneficial because it reduces competition and allows the surviving trees to have more space – water, sun and nutrients.*
- Animals – *Most animals were able to escape the fire, although some may have died.*
- Habitats – *The habitat was slightly altered. The fire removed fuel buildup and opened up the forest, which will make it easier for some animals to move through and will increase new growth of grasses and shrubs that animals like deer, rodents and birds feed on.*

Class Discussion Questions for Forest Area 1 and 2:

1. What other human made or natural resources might be impacted? *Homes, businesses, forest jobs, campgrounds, recreation areas and human health.*

2. What was the "fuel" being consumed that turns into heat energy? *Trees, shrubs, leaf litter on forest floor, dead branches, logs.*

3. Describe how the impact of the fire in Forest Area 1 is different from the impact in Forest Area 2. *Impacts in Forest Area 1 were much more serious – killing all the trees, burning the soil and causing erosion into the streams. The fire in Forest Area 2 did not burn as hot and did not get into the crowns. Therefore, only smaller trees and shrubs were killed. Soil did not erode into the water.*

4. Why was the impact different in the two forest types? *Forest Area 1 had high levels of fuel and overcrowded trees. Forest Area 2 had widely spaced trees and less fuel buildup, which kept the fire from getting into crowns of trees.*

5. Examine the aftermath of the fire in Forest Area 1. What did it take to put out or contain this fire? *This fire was very dangerous for firefighters to fight because it was in the crowns of the trees. Firefighters probably had a difficult time containing it, and had to bring in air tankers and helicopters to drop fire retardant on the fire. A large number of firefighters and heavy equipment was needed to fight this fire. This was extremely expensive.*

Fire in Our Communities – What Can We Do?

Lesson Plan 3 of 4

Conceptually Based Learner Outcomes:

1. Forest structure has changed in California since European settlers first arrived.[1] Decades of fire suppression have disrupted the natural fire cycle. Forests on much of our public lands have become overcrowded, leading to increased fire danger.
2. Healthy forests are a result of balancing responsible timber harvesting and controlled burning practices. Sustainable forest management protects natural and human-made resources by decreasing wildfire danger.
3. Timber is a natural, renewable resource. (6th Grade California Science Standard 6.b)
4. Creating defensible space around homes will lead to a fire safe community.

Overview:
In this lesson, students will develop and test a hypothesis related to forestry, review the fire triangle, and determine that fuel is the one leg of the triangle that can be controlled. Students explore the concept of defensible space and apply this fire prevention strategy to their home and community.

Prep Time: 10 minutes

Activity Time: 1.5 hours

Space Requirements: The beginning of this activity will be done within the classroom. Students will be taken outside or to a gym where a large area of open space is available for the defensible space activity.

Vocabulary: Timber, Defensible Space, Suppression, Sustainable Harvesting, Controlled Burning, Forest, Natural Resource, Renewable Resource, Tree Density/Spacing
Vocabulary definitions are found in the section titled, *Background Information for Teachers: Lessons 1-4*

Materials:

_____ Chalk/Dry erase board or large 3' x 4' paper share-sheet
_____ Chalk/Dry erase markers or water-based marking pens
_____ Copies of Interview Cards, 1 card cut out per student (See "Students Handouts" at the end of this activity)
_____ Copies of Interview Response Sheets, 1 per student (See "Students Handouts" at the end of this activity)
_____ Copies of Defensible Space Handout, 1 per student (See "Students Handouts")
_____ Why 100 Feet Flyer and Homeowner's Checklist downloadable from: *http://www.fire.ca.gov/communications/communications_firesafety_100feet.php*
_____ Small model house (*Materials can be obtained inexpensively by using a small shoe box, a cardboard cut-out of a house, or other small object in the classroom.)*
_____ 3"x 5" index cards

Strategies to Increase Universal Access:

1. Graphic Organizer: Create a graphic organizer when reviewing concepts from the previous lesson and introducing new ideas. Graphic organizer may be in the form of a table, with columns for concepts, and illustrated to anchor the concept(s). Use bullets on key points. *(English Language Learners, Below Grade Level)*
2. Total Physical Response (TPR): TPR was developed by Dr. James Asher to help in second language acquisition. Students respond to commands that require physical movement, such as in the anchoring activity with the Three R's of Defensible Space. Provide students the opportunity to listen to commands and physically respond without having to verbally respond. *(English Language Learners)*
3. Interest Centers: Set up interest centers in non-disruptive areas of the class where students can study, in greater depth or breadth, an interesting issue related to the class topic after they have completed class work. Information at these centers may include related texts, Internet sites or additional background information. *(Advanced Learners)*

Connect and Engage: **5 mins**

1. Students "Brain Dump" all information they recall from the previous lesson with regard to heat, heat movement, fire and the fire triangle. To complete the "Brain Dump," students place their pencil on a blank sheet in their journal. At the teacher's command, students dump as many ideas out of their head as they can without stopping their pencil. When they are thinking of a new concept to write, students make tiny circles with their pencil until the idea comes to them. Continue without stopping for sixty seconds. Share recollections from the previous lesson and clarify questions.

 Graphic Organizer

2. Preview: In the last two lessons we learned that heat moves in a predictable flow from warmer objects to cooler objects and that friction leads to heat. We were introduced to the fire triangle and investigated the impact of fire on the environment. Today we will discover fascinating information about forestry and what you can do to protect your home and community from a fire.

Student's Preconceptions: **5 mins**

1. Ask students, "In what way has America's natural and human-built environment changed since European settlers first arrived?" Ask the students to develop a hypothesis with regard to whether there are more or less trees in the United States today than when European settlers first arrived. Guide students as they set up the framework for their hypothesis: "It is hypothesized that there are more/less trees today than when European settlers first arrived." Capture ideas on the board or a share-sheet entitled "Changes to America's Natural and Human-built Environment," as students share.

CHANGES TO AMERICA'S NATURAL AND HUMAN-BUILT ENVIRONMENT

HOW CAN OUR HOMES AND COMMUNITIES BE PROTECTED FROM WILDFIRES?

2. Students share ideas about how we can protect our homes and communities from wildfire. Capture shared thoughts on the board or share-sheet.

Exploration: **30 mins**

1. Students test their hypotheses through a series of mock interviews.
   a. Prepare students for mock interviews. Ask students the following questions: What is the purpose of an interview? *(To gather information.)* Think of some people who conduct interviews. *(News reporters, investigators, bosses, etc.)*

Fire Suppression: The act of controlling and limiting fires through firefighting practices.

   b. Distribute "Interview Cards" and Student Response Sheets to each student. ***Interview cards should be cut apart so that each student only receives information about one person.*** Inform students they are taking on the identity of an important researcher, and instruct them to carefully read their card without showing anyone else.

   c. Distribute "Interview Response Sheets" to each student. Students will first find their mock name on the Interview Response Sheet. In the box with their character's name they will rewrite, in their own words, what the statement on their card means.

   d. Explain the process. After making notes for their own character, students will stand up and move around the room interviewing other individuals. Students capture important information from others until they have met the six (6) other people needed to fill their response sheet. Clarify student questions prior to moving forward. You may elect to bring two students forward to model this process before proceeding.

2. Bring students back together and transition into a discussion of the fire triangle and defensible space (Please see *Background Information for Teachers.)*

20 mins

3. Given the fact that there are more trees today than in the past there is more fuel, therefore fuel control is very important. Students recall the fire triangle and the demonstration where oxygen was removed, causing the fire to extinguish. Ask students if it is possible to remove oxygen in a wilderness setting. *(no)* Draw the fire triangle on the board and ask students, "What *can* we control?" Take a straw poll as students raise their hands to vote for one leg of the fire triangle that can be controlled. *(Fuel)* In the next activity students will explore methods for controlling fuel.

Note: This is a *highly kinesthetic activity,* intended for students to be moving around and sharing ideas, with no student writing for this portion. Before starting the following Defensible Space activity, show students pictures that give examples of homes without defensible space. These pictures may be seen by logging onto *www.calforestfoundation.org > Students & Teachers > Online Material.* After discussing the pictures, lead your students outside or to a large open indoor space for the following activity.

a. Gather students in a circle and set a model house (shoebox, milk carton, etc.) in the middle of the circle.

b. Students brainstorm out loud fuel (flammable material) which would likely be around a home. (wood, shrubs, boxes, out buildings, trees, etc.) As students brainstorm, write each suggested fuel item on an index card and hand one card to each student. Students hold card up or attach to clothing so others can read it as you place the students in close proximity to the model house. Continue until all students have a card. (You are likely to have multiple students with the card "trees" or "shrubs.")

c. Ask students what we must do to protect this home from fire danger. As students share ideas, demonstrate by moving students (thinning) away from the home.

d. Introduce students to the "Three R's of Defensible Space[2]." As each "R" word is introduced, students create a body movement to anchor the concept in their mind. For example, students may make a shoveling movement for the word "Remove" and will make that motion in unison every time the word is said.

The Three R's of Defensible Space

Remove – dead and dying grass, shrubs and trees.

Reduce – the density of vegetation (fuel) and ladder fuels, those fuels extending from the ground to the tree canopies.

Replace – hazardous vegetation with less flammable, irrigated landscape vegetation including lawn, or other low growing groundcovers and flowering plants.

e. Guide students back to the classroom.

15 mins

4. Allow students to review *"100' Defensible Space, Make Your Home Fire Safe"* supplemental resource sheet. You may decide to copy this handout for students or project using an LCD projector. Refer to the images online referenced above in step 3. As a class, briefly discuss the drastic difference between the area surrounding the home in this illustration and the area surrounding the home in the photo of the house that did not plan for defensible space. Provide each student a copy of the "Defensible Space" student response sheet. Students are to use the information from the supplemental resource sheet to complete the questions on the student response sheet.

10 mins

Challenge Preconceptions:

1. Review orally with the class each of the "Beginning Thoughts" posed at the beginning of class. Ask the students to compare and contrast the information gathered from the "Interview Cards" and the discussion on defensible space with the statements on the "Beginning Thoughts" sheet. Direct the students to re-write any statements that are not accurate and capture their revisions in their journals.

   * Assessment Opportunity: Journal entries can be assessed informally by walking through the class and casually reading, or formally if collected at the conclusion of the class.

2. Invite students to share out loud their new explanations. Highlight information that was accurate and determine which of the "Beginning Thoughts" were not accurate.

3. Guide students as they accept or reject their proposed hypothesis regarding the population of trees today in comparison to the population when the nation was first settled. Note to teachers: Ultimately students should recognize that changes in forest structure and human populations are important factors to be considered in preventing catastrophic wildfires in our forests and our communities. More information is available in the section, *Background Information for Teachers.*

Interest Centers

Application/Homework: **5 mins**

1. Students create a map of their home, identifying the sources of fuel surrounding the home. Students develop a plan of action for creating defensible space in each of the three zones. (Home Ignition, Defensible Space and Wildland Fuel Reduction Zones) Students are encouraged to work with parents or guardians to take measurements around the house and agree on the steps they think should be taken in each of the three zones to protect their home.
2. Optional: Students and their parents/guardians share their defensible space action plan with their local fire authorities for review and approval.

   * Assessment Opportunity: Evaluate student maps to ensure that they include provisions for fire prevention in each of the three zones. Students living in an urban or suburban area may have to move beyond their immediate community to address the Wildland Fuel Reduction Zone.

Enrichment Activities:

1. Identify a local Fire Safe Council or create one if non-existent.
2. Host a Fire Safe Council meeting at your school.
3. Plan a community clean up day to reduce fuel.
4. Sponsor a wood chipper to come through your community.
5. Produce educational material on fire-safe practices using word processing skills for distribution to your community.
6. Draft a letter to the editor of your local newspaper about the importance of creating defensible space to prevent wildfires. Include the thesis or purpose, explain the situation, follow an organizational pattern, and offer persuasive evidence to validate your argument.
7. Describe tactics employed in advertising to sway the viewer's thinking and provide examples. Develop an advertisement stressing the importance of creating defensible space around your home and your community.
8. Make plans for a neighbor to fire safe their home. Help them do so as part of a community service event.
9. Have students visit nearby forests with their family to assess whether it is fire safe. Have students describe the potential impact if this forest is near a community.
10. If one acre of forest historically supported growth of an average of 60 trees per acre, and today has an average of 500 trees per acre, how many more trees per acre are there today? *(440 more trees/ acre)* Based on this information, how many trees would there be on ten acres today? *(5,000 trees)* How many on 100 acres? *(50,000 trees)* Determine the percent increase over time of trees per acre. *(440/60 = 7.33 x 100 = 733%)*
11. Have students make landscape models of their homes, yards and/or communities in order to visualize defensible space.
12. Share a19 minute video on creating defensible space found at www.fs.fed.us/rm/publications/ titles/videos/wildfire.html
13. Get students involved with this interactive model and discuss burn severity in the various situations. www.fs.fed.us/rm/fire_game/lessons/tour.html

Safety Precautions:

1. Prior to taking students outside to demonstrate defensible space, make sure to walk the area to determine the best route, ensure the area is free of hazards, and make sure there is enough space for students to move freely.

Student Handouts: Interview Cards:

- Copy cards so that there are enough individual cards for each student to have only one.
- Cut each character statement out and distribute one to each student. Students should not see the other character statements.

"Many forests in California are densely packed with trees of all sizes. Unable to compete for water, sun and nutrients, these trees become more likely to be affected by disease, drought and high intensity wildfires."

Dr. Know R. Forests

"By the mid-1930s, the Forest Service adopted the '10 am Policy' which says that fires should be contained by 10:00 in the morning after they start. With no way for forests to be thinned naturally, they began to get more crowded. This means more fuel to burn!"

Professor McFireman

"In California, only about one-quarter of the forest growth each year is harvested."

Mr. Tim Bur

"Policies and practices have created enormous fuel loads that cause today's fires to burn hotter and with more severe ecological effects than in the past."

Professor Karen Fore-Earth

"Forests that once sustained (grew successfully) 50-80 trees per acres now struggle to support more than 500 trees per acre."

Mrs. Brooke Trout

"Before European settlers, fires occurred more frequently. Native Americans intentionally set fires to improve resource conditions."

Professor Seeing R. Past

"Forests are a valuable resource. They provide wildlife habitat, clean air and water, a place for recreation, renewable wood products and jobs for many people!"

Dr. Reece Orce

Name: _____ Date: _____

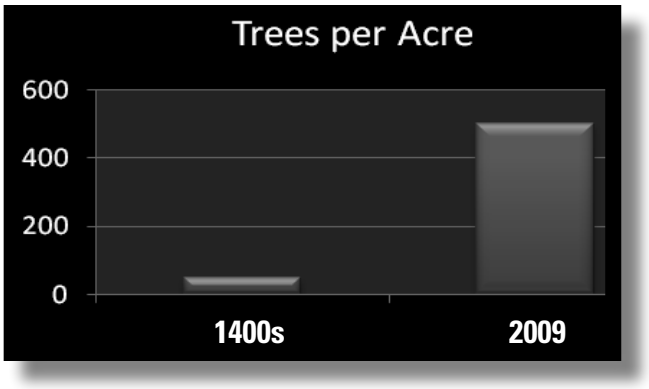
Interview Response Sheet

Interview the following knowledgeable people and take notes on the information they share in each box.

Dr. Know R. Forests
Professor McFireman
Mr. Tim Bur
Professor Karen Fore-Earth
Mrs. Brooke Trout
Professor Seeing R. Past
Dr. Reece Orce

Conclusion:

1. What conclusions can be drawn from these interviews? Should you accept or reject your hypothesis? Write a summary paragraph to explain.



2. What further steps could you take to investigate this issue?

Name: _____ Date: _____

Defensible Space Student Response Sheet

"Defensible Space" refers to space around your home that will help defend it from a fire. Think about the area around your home. What will catch on fire? It is important to manage these flammable items so they do not become fuel to a fire. Think of your house as the center of a target, and as you move away from your home you reach different zones. Check out the information below to see what you can do in each zone, to keep your house fire safe!

Home Ignition Zone:

Where is it?

What can you do?

Defensible Space Zone:

Where is it?

What can you do?

Wildland Fuel Reduction Zone:

Where is it?

What can you do?

Defensible Space, Sample Answer Key

"Defensible Space" is the phrase that refers to space around your home that will help defend it from a fire. Think about the area around your home. What will catch on fire? It is important to manage these flammable items so they do not become fuel to a fire. Think of your house as the center of a target, and as you move away from your home you reach different zones. Check out the information below to see what you can do in each zone, to keep your house fire safe!

Home Ignition Zone

Where is it?

The area occupied by your house plus 10 feet distance around your entire home

What can you do?

Clean your rain gutters, get rid of dry brush and grass, and clear all flammable materials from your deck. Water your plants, and irrigate grass in this area. Search out and get rid of flammable things outside your home and you will be much safer!

Defensible Space Zone

Where is it?

The area occupied by your house, plus 100 feet distance around your entire home

What can you do?

Keep this area green and make sure there is space between trees and plants to increase the chance that firefighters can save your home in the event of a wildfire. Use the Three R's (Remove, Reduce and Replace) to keep this area fire safe!

Wildland Fuel Reduction Zone

Where is it?

Beyond 100 feet distance from your entire home

What can you do?

After checking with local fire authorities for any necessary permits for brush clearance or tree removal, remove undergrowth (plants that grow beneath trees) and thin trees that are densely populated. Experts say that you should have at least 10 ft between trees. Managing this area will slow down an approaching wildfire.

Endnotes:

1. Bischel, D.A. (Winter 2009). Wildfire Blazes Across Political Boundaries. *California Forests,* 13(1), 5.
2. *A Homeowner's Guide to Firewise Landscaping in Nevada County.* Fire Safe Council of Nevada County, Retrieved from www.FireSafeCouncilNevCo.com
3. Nunamaker, C., De Lasaux, M., & Nakamura, G. (2007). *Wildfire and Fuel Management*. ANR University of California, Wildfire and Fuel Management, 8245, 1.
4. *A Homeowner's Guide to Firewise Landscaping in Nevada County.* Fire Safe Council of Nevada County, Retrieved from www.FireSafeCouncilNevCo.com
5. *A Homeowner's Guide to Firewise Landscaping in Nevada County.* Fire Safe Council of Nevada County, Retrieved from www.FireSafeCouncilNevCo.com

Fire Investigation and Experimentation

Lesson 4 of 4

Conceptually Based Learner Outcomes:

1. Fire danger ratings are determined by factors such as humidity, wind speed, slope, aspect (the direction the slope faces) and fuel moisture.
2. Fuel moisture refers to the percentage of moisture present in the surrounding fuels (trees, leaves, grasses, etc.)
3. High fuel moisture levels reduce fire danger. Low fuel moisture levels increase fire danger.
4. Fuel moisture sticks are used to determine the percent fuel moisture in the surrounding environment and assess relative fire danger. *(6th Grade California Science Standard 7.b)*

Overview:
In Part 1, students will explore factors that determine fire danger. Students will observe the effect fuel moisture content has on fire and will be introduced to fuel moisture indicator sticks used to assess the relative fire danger in a given area. Part 2 will be held three to five days later, at which time students collect the fuel moisture sticks, which have come into moisture equilibrium with the environment. Data from the fuel moisture sticks and local weather conditions will guide students in issuing community precautions for fire prevention.

Prep Time: 30 minutes

Activity Time: 2 hours
Pacing for Part 1 – Lab Set Up (1 Hour)

Part 2 should be taught 3-5 days after Part 1
Pacing for Part 2 – Data Collection (1 Hour)

Space Requirements: Part 1 will be held in the classroom with no specific space requirements. Space outside will be required for Part 2. Select an area, ideally surrounded by trees, which will not be disturbed by other students or foot traffic. The space should be large enough to set up the fuel moisture test (3 ft radius), and allow the students to comfortably gather around the data collection site (20 ft. radius). After data collection, space will be required in the classroom where students can weigh the fuel moisture sticks using balances or scales set on a level surface.

Vocabulary: Fuel Moisture, Relative Humidity, Slope, Aspect, "Duff Bed", Ladder Fuels, Topography, Ignition, Spotting, Firebrands, Crown Fires, Ten Hour Fuels
Vocabulary definitions are found in the section titled, *Background Information for Teachers: Lessons 1-4*

Materials:

_____ Sticky notes/Post-its (1 per student)
_____ Chalk/dry erase board or large 3'x4' paper share-sheets
_____ Chalk/dry erase markers or water-based marking pens
_____ "Contributing Factors to Fire Danger" cards (See "Student Handouts" at the end of this activity.)
_____ Masking tape
_____ Green (high moisture content) leaf and dry (low moisture content) leaf
_____ Matches
_____ Water bucket/tray
_____ Tongs
_____ Fuel Moisture Content Lab Student Response Sheet (1 per student) (See "Student Handouts" at the end of this activity.)
_____ Forest Foundation Traveling Kit (fuel moisture sticks, stand, burlap sack or needles/leaves) **Check out from The Forest Foundation by calling toll free: 1-866-241-TREE.** *Purchasing information also available in teacher background section.*
_____ Clean gloves for handling fuel moisture sticks
_____ Internet access
_____ Triple beam balance or electronic scale
_____ "Fire Severity Related to Fuel Moisture Content" reference sheet
_____ What is the National Fire Danger Rating System? *http://www.fs.fed.us/r4/sawtooth/fire/nfdrs.shtm*

Strategies to Increase Universal Access:

1. Cohesion Links: Cohesion links provide a structure or scaffold for understanding terms in context, while connecting them to previous knowledge. In part 1, when students preview the background information on the Fuel Moisture Content Lab response sheet, have students read out loud one sentence at a time. Capture sentences on the board or display using a projector. Underline new words and have students identify other words that could replace these words to provide similar meaning. Use arrows to reflect a relationship between words in a sentence. *(English Language Learners, Below Grade Level)*
2. Sorting Activity: When conducting the "Initial Thoughts Parking Lot" at the conclusion of part 1, physically sort the parked cars into groups of accurate and inaccurate statements. Of the accurate statements, sort cars by topic or theme. *(English Language Learners, Below Grade Level)*
3. Mentorships: If school policy permits, invite a parent volunteer or community member to act as a class mentor during this activity. The mentor should be knowledgeable in the area being studied. Have

advanced learners meet with the class mentor to further discuss the issue, conduct an interview, or explore career options connected to the concept. *(Advanced Learners)*

Part 1 (Procedure for Fuel Moisture and Lab Setup):
In Part 1, students will explore the concept of fuel moisture and how fuel moisture can be used to assess fire danger. Students will identify the factors that contribute to fire danger and will learn that low fuel moisture leads to high fire danger. With the guidance of the teacher, students will set up the fuel moisture stick lab outside, and will collect data in Part 2, 3-5 days later.

Connect and Engage: **5 mins**

1. Students recall information from the previous two lessons through a kinesthetic warm-up. Instruct students to place both hands, palms facing down, approximately 2 inches over their desk. Explain that you will ask a review question, and as soon as a student knows the answer they are to slap one hand on the desk while simultaneously raising the other hand. A student will then be called upon to respond. Suggested review questions include: What are the three components of the fire triangle? *(Oxygen, Fuel, and Heat)* Which component of the fire triangle can we control? *(Fuel)* What happens when fuel is consumed? *(Energy is released as heat)* What does friction create? ***(Heat)*** Which direction does heat move? *(From hot objects to cooler objects)* How are forests different today than when European settlers first arrived? *(Larger population of trees. Smaller, more densely spaced trees.)* What can you do to protect your home from wildfire? *(Create defensible space)*

Students' Preconceptions: **5 mins**

1. Students create a "Parking Lot" to showcase preconceptions. Provide each student a sticky note/ Post-It and instruct them to sketch an outline of their favorite car on the sticky note.

PARKING LOT: BEGINNING THOUGHTS ON FIRE DANGER

2. On the car, students are to respond to the following questions: What outdoor factors cause fire danger to be high in an area? Use your knowledge about the fire triangle to make an educated guess on the definition of "fuel moisture" and how it might affect fire danger.
3. Students "park" their preconceptions sticky note in the "Beginning Thoughts on Fire Danger" parking lot. For example, a student might write on their car, "Fire danger is very high when fuel load is high and fuel moisture is low." The class will revisit the parking lot when preconceptions are challenged at the end of the lesson.

Exploration: **10 mins**

1. (Prior to class, the teacher will have made copies of the "Contributing Factors to Fire Danger" cards and have taped them under student chairs.) Inform students that the room is full of knowledgeable individuals, who are actually sitting on the clues to determining fire danger. Have students raise both hands. When you say the words "Find them!" students are to quickly look beneath their chair and race to the front of the room if they find a factor of fire danger. Congratulate students who find the cards and have them take the card back to their seat.

"When fuel moisture is high, fires ignite poorly, or not at all because heat energy is required to drive water out of a plant before it can burn. When fuel moisture is low, fires start easily and will spread rapidly." www.noaa.gov

2. Have each student with a card share their card out loud, one at a time. Briefly explain each factor as students share the card they found. Students are to capture notes in their journals.
   a. Relative Humidity – Is the ratio of the amount of water in the air at a given temperature to the maximum amount it could hold at that temperature; expressed as a percentage. Low relative humidity leads to greater fire danger because fuels are drier and ignite more readily.
   b. Wind Speed – Is the speed of the wind. It is one of the most critical factors, high winds add oxygen (a component of the fire triangle) to a fire and raises fire danger.
   c. Slope – A steep slope leads to higher fire danger because flames pre-heat the fuel ahead as they move uphill, and quickly reach nearby branches. Slope also makes it challenging for firefighters to do their job.
   d. Aspect – Aspect refers to the direction the slope faces. North facing slopes in California are typically cooler with higher humidity, which decreases fire danger. Southern and western facing slopes are typically hotter and drier, increasing fire danger.
   e. Fuel Moisture – Fuel moisture refers to the percentage of moisture in the fuel, such as plants, trees and grasses. Low fuel moisture leads to higher fire danger.

5 mins

3. Students observe a teacher-led demonstration in which a green (high moisture content) leaf and a dry (low moisture content) leaf are held with tongs and ignited. Prior to the demonstration, have students predict how fuel moisture in this scenario will affect fire danger. Place a flame to each leaf to show how quickly or slowly these two sources of fuel burn. If you have an Elmo Camera or other video projector, use it here to make your demonstration even bigger!

   *Safety Precaution: Ask your principal if you can use matches in your classroom. Do not allow students to access the matches unless you have your principal's pre-approval. Consider conducting the experiment over a bucket or tray of water, so that fire can be quickly suppressed. If smoke detectors are sensitive, this demonstration may be done outside over a paved area that is wind-protected and free from flammable material.

20 mins

4. Students each receive a copy of the "Fuel Moisture Content Lab Student Response Sheet." Direct students to read the background information and underline the unfamiliar words. Connect and clarify main ideas by having students identify the relationships of the words to other sources and related topics. Ask one or two students to summarize how fuel moisture sticks are used.

Cohesion Links

5. Inform students that today they will be setting up the fuel moisture sticks in what will be called "The Standard Fire-Weather Station." The moisture sticks will be left, untouched, in that area for 3-5 days, at which point the class will collect data and evaluate the fire danger.
6. Show students the contents of the Forest Foundation Traveling Kit (Fuel moisture sticks, stand, burlap sack or needles/leaves) and refer students to the diagram on their lab sheet.

If finding a secure location to leave the moisture sticks on your campus is a challenge, try these ideas:

- Place moisture sticks on the roof
- Secure moisture sticks in a locked bike/locker area
- Select students to take moisture sticks home for data collection

7. Prior to moving outside, have a volunteer student weigh the fuel moisture stick(s) to determine initial dry weight. Students will record this weight on their lab sheet. Fuel moisture sticks should be handled with clean gloves to avoid getting dirt or oil from hands on the sticks.
8. Lead students outside to an area you have pre-selected as "The Standard Fire-Weather Station."
   a. Have students carefully prepare the "Duff Bed" using leaves, needles or the burlap sack. The duff bed should be at least 5.1 cm (2 inches) thick. This will prevent any mud from splashing on the moisture stick and altering data.

Empower! Divide the class into working lab groups. For each group, identify the following: **Materials Manager** (in charge of materials) **Chief Scientist** (keeps students on track with lab procedures), **Sanitation Engineer** (ensures all materials are properly cared for and stored), **Recorder/Reporter** (captures notes and shares updates).

   b. Select additional students to assemble the bracket-stand 16 inches apart and place the fuel moisture sticks horizontally, approximately 10 inches above the duff bed. The brackets should be arranged so the fuel moisture sticks will be placed lengthwise in a north/south direction.
   c. Remind students of the importance of not touching the sticks prior to when data is collected, so that data is not skewed.*Safety Precaution: Carefully walk through the selected siteprior to bringing students. Evaluate the area for any potential dangers such as holes, thorn-barring bushes, poison oak, tripping hazards and other threats. Select a site that is free from disruption and tampering.
   d. Guide students back in the classroom to complete Part 1. You will revisit the fuel moisture sticks in 3 to 5 days.

Challenge Preconceptions: **5 mins**

1. Review the students' observations from the activities, demonstration, and lab setup today. Ask students to recall the factors that determine fire danger. What is fuel moisture content? How does fuel moisture content affect fire danger? Elicit responses from students. Capture observations on a share sheet or chalk/dry erase board under "What we have learned about Fire Danger" and compare to initial student thoughts. Ask students to apply what they learned to determine which of the "Beginning Thoughts" are not accurate. Move and segregate the "cars" in the parking lot based on which were factually accurate, and those which were not.

WHAT WE HAVE LEARNED ABOUT FIRE DANGER:

FACTORS

FUEL MOISTURE

EFFECT

Sorting Activity

2. Direct the students to select one inaccurate statement and re-word it to make it accurate. Ask a few of the students to share their corrected fire danger statements. Ask for a show of hands if they agree with the corrected statement.

Application/Homework: **5 mins**

1. On the Fuel Moisture Content Lab response sheet, have students write a paragraph summarizing the major concepts they have learned about components of fire danger, fuel moisture, and fuel moisture sticks.

   *Assessment Opportunity: Students complete the summary paragraph in class or for homework. Collect paragraphs and evaluate for thorough discussion on each of the areas mentioned above.

   *Assessment Opportunity: At the conclusion of this session, have students turn to a partner and share three important things they learned in class related to fire danger, fuel moisture, and fuel moisture sticks. Move throughout the room listening to students, conducting an informal assessment of student comprehension and retention.

Part 2 (Procedure for Fuel Moisture Stick Lab Data Collection):

In Part 1 of this lesson, students identified the contributing factors to fire danger, and discovered the importance of fuel moisture evaluation. Students set up the fuel moisture stick lab to secure data for the surrounding environment. In Part 2, held 3-5 days after Part 1, students will collect and evaluate data related to fuel moisture.

Recall Information: **5 mins**

1. Challenge students to recall information from Part 1. Have students silently think of three things they learned during Part 1. When they have three things in mind, they are to give the thumbs-up sign on their desk. Wait until most students show the sign. Call on several students to share, until all major concepts from Part 1 have been expressed.

Exploration: **50 mins**

1. Have students review the data collection process on the Fuel Moisture Content Lab student response sheets. Clarify any questions and lead students outside to the class's "Standard Fire-Weather Station." Collect fuel moisture sticks and all material. Return to class.
2. In collaborative working groups of four to five, students will weigh the fuel moisture sticks using a triple beam balance or digital scale and record data on the Fuel Moisture Content Lab student response sheet. Handle the fuel moisture sticks with clean gloves.
3. Back at their desks, students will complete the response sheet, using the "Fire Severity Related to Fuel Moisture

Calculating Fuel Moisture: Place the fuel moisture sticks on the scale and record their initial weight in grams. After 3-5 days of exposure, re-weigh the sticks and record their final weight. Subtract the initial weight from the final weight. Divide this difference by the initial weight and multiply by 100 to express the fuel moisture content as a percent of initial weight.

Note: Initial weight is the starting weight before placing fuel moisture stick outside. Final weight is ending weight after fuel moisture stick has sat outside for several days.

[(Final Weight – Initial Weight)/ Initial Weight] x 100 = % Fuel Moisture Content

Ex: If the initial weight of the sticks is 102g, and the final weight after acclimating to the environment the experiment is 115g

[(115 – 102)/102] x 100 = 13% Fuel Moisture

Content" reference sheet to determine the level of fire danger based on the information collected.
4. Take data from each group to determine a class average for the weight of the fuel sticks and the relative percent moisture content.
   *Assessment opportunity: Collect lab sheets and grade for accuracy and thorough responses to follow-up questions.

 Mentorships

5 mins 

Application/Homework:
1. Direct students to access data on local temperature, humidity, wind speed and other environmental factors on lab day. Students can access this data at www.noaa.gov. Instruct students to compile this information with the fuel moisture percentage determined to create a thorough analysis of the local fire danger. Students are to write a brief report including the specific data, specific community wide precautions that should be taken to prevent fires, and their rationale for the fire danger level selected.
2. Provide an artistic opportunity to apply knowledge as students create a poem, song or rap about fuel moisture content and fire danger concepts.

Enrichment Activities:
1. Direct students to log onto The Forest Foundation Website at www.calforestfoundation.org to upload data collected and compare with other schools that have done the same throughout California.
2. After collecting fuel moisture data from different schools in California, create a bar graph showing the level of fire danger in different California locations. Explain the fire danger ranking selected and what factors might influence this ranking. (6th Grade Science Standard 7.c)
3. Repeat the fuel moisture content lab using the moisture sticks in different areas of the school or community. Calculate the average reading to determine the general fire danger level for the area.
4. Evaluate fuel moisture content multiple times throughout the year. Construct a graph showing the percent fuel moisture content over time.
5. Demonstrate persuasive artistic abilities by creating regular fire awareness campaign material in the community. Select a student each month to design a poster showing the fire danger level for the community. Students will convey their opinion on fire safety with detailed evidence and with visual or media displays that use appropriate technology.
6. Invite a member from Cal Fire, the local fire department or local fire prevention unit to speak at the school about fire prevention during high fire danger seasons.

Safety Precautions:
1. Ask your principal if you can use matches in your classroom. Do not allow students to access the matches unless you have your principal's pre-approval. Consider conducting the experiment over a bucket or tray of water, so that fire can be quickly suppressed. If smoke detectors are sensitive, this demonstration may be done outside over a paved area that is wind-protected and free from flammable material.
2. Carefully walk through the selected outdoor site prior to bringing students outside for the lab. Evaluate area for any potential dangers such as holes, thorn-bearing plants, poison oak, tripping hazards and other threats. Select a site that is free from disruption and tampering.

Name: _____ **Date:** _____

Student Response Sheet: Fuel Moisture Content Lab

Background Information

Fuel moisture refers to the amount of moisture (water) present in fuel, such as grass, plants, shrubs and trees. High fuel moisture content causes fire to burn slowly, if at all. Low fuel moisture content means that the fuel is drier, and that the fire danger is increased.

Fuel moisture sticks are used by scientists and firefighters to determine the fire danger in a specific area. Here is how they work. A special fuel moisture indicator stick of a known initial weight is placed outside where it is exposed to the weather. The stick is left outside, undisturbed for several days, before it is brought in and weighed. Any added weight is in the form of moisture and is a result of **humidity**. The moisture stick indicates how much moisture is in the surrounding fuel. By weighing and calculating the percentage of moisture, it is possible to determine the fire danger level in the area.

Part 1: Preparing the Fuel Moisture Content Lab[2]

Date _____ Time_____
Location _____ Season _____ Weather_____

1. Weigh the fuel moisture stick(s) prior to going outside. Record the weight in grams below:

   Initial Weight of Fuel Moisture Stick(s): _____(g)

If you are using multiple sets of moisture sticks, check out the easy to use table at the end of this lab for data collection!

2. Select an area outside, preferably surrounded by fuel such as trees or plants, which will be undisturbed for several days.
3. Create a **"Duff Bed"** to protect the fuel moisture sticks from splashing mud, which can change the data. Use leaves or coniferous needles to create a ground cover, at least 5.1 cm (2 inches) deep, in an area approximately 100 cm by 100 cm. If leaves or needles are not available, a burlap sack can be used.
4. Place two brackets 40.6 cm (16 inches) apart over the Duff Bed to support the moisture sticks.
5. Suspend the moisture sticks horizontally, approximately 25.4 cm (10 inches) above the ground, using the brackets. This area will now be called the class's "Standard Fire-Weather Station."
6. Leave the Standard Fire-Weather Station undisturbed for 3-5 days.

Part 1 Summary Paragraph: Using complete sentences, write a paragraph on the back of this paper that summarizes the purpose of this lab and important information you have learned regarding factors that contribute to fuel moisture and fire danger.

Part 2: Fuel Moisture Stick Lab Data Collection

Date_____Time_____ Location _____
Season _____ Weather_____

1. Carefully bring the fuel sticks back to the classroom, and clean up all materials from the Standard Fire-Weather Station. (If fuel moisture sticks are not weighed right away, seal in an airtight bag to prevent the moisture stick from losing or gaining moisture in between collection and weighing.)

2. Using a triple beam balance or electronic scale, weigh the fuel moisture stick(s). Record your final weight in grams below.

   Final Fuel Moisture Stick Weight = _____g

3. Take the final fuel moisture stick weight and subtract the initial weight. Divide this number by the initial fuel moisture stick weight. Now multiply by 100

   Final Weight ____g - Initial Weight ____g = _____g Weight of Moisture

   Weight of Moisture _____g / Initial Weight _____g = _____ x 100 = _____% Fuel Moisture

   Example: If the initial dry weight of the fuel moisture stick(s) was 102g, and your final weight was 115g
   115g – 102g = 13g 13g/102g = 0.13 x 100 = 13% fuel moisture

4. Use the "Fire Severity Related to Fuel Moisture Content" reference sheet to determine the level of fire danger. Clearly state the fire danger level below and explain why you selected this danger level.

5. What other factors might influence fire danger level?

6. Use your knowledge about our local environment to decide if these other factors will make the fire danger higher or lower. Explain using complete sentences.

Data Table: Data Collected using Multiple Locations

Use this chart to organize data if you are placing fuel moisture sticks in multiple locations.

Location	A	B	C	D	E
	Initial Dry Weight (g)	**Final Weight (g)**	**Moisture (g)** **B-A = C**	**Moisture (g)/ Initial (g)** **C/A = D**	**% Fuel Moisture** **D X 100 = %**
Ex: School Garden	*102g*	*115g*	*115g -102g = 13g*	*13g/102g = 0.127g*	*0.127g x 100 = 13% Fuel Moisture*

Fuel Moisture Content Lab Sample *Answer Key*:

Student Background Information
Fuel moisture refers to the amount of moisture (water) present in fuel, such as grass, plants, shrubs and trees. High fuel moisture content causes fire to burn slowly, if at all. Low fuel moisture content means that the fuel is drier, and the fire danger is higher.

Fuel moisture sticks are used by scientists and firefighters to determine the fire danger in a specific area. Here is how they work. A special fuel moisture indicator stick of a known dry weight (usually 100g) is placed outside where it is exposed to the weather. The stick is left outside, undisturbed for several days, before it is brought in and weighed. Any added weight is in the form of moisture and is a result of **humidity**. The moisture stick should indicate how much moisture is in the surrounding fuel. By weighing and calculating the percentage of moisture, it is possible to determine the fire danger level in the area.

Part 1: Preparing for the Fuel Moisture Content Lab[3]

Date: *November 2, 2009* Time: *9:30 am*
Location *Behind cafeteria at school* Season: *Fall* Weather: *Cool, clear, windy*

1. Weigh the fuel moisture stick(s) prior to going outside. Record the weight in grams below:

   Initial Weight of Fuel Moisture Stick(s): *102*g *(*Sample weight for example only)*

   If you are using multiple sets of moisture sticks, check out the easy to use table at the end of this lab for data collection!

2. Select an area outside, preferably surrounded by fuel such as trees or plants, which will be undisturbed for several days.
3. Create a **"Duff Bed"** to protect the fuel moisture sticks from splashing mud, which can change the data. Use leaves or coniferous needles to create a ground cover, at least 5.1 cm (2 inches) deep, in an area approximately 100 cm by 100 cm. If leaves or needles are not available, a burlap sack can be used.
4. Place two brackets 40.6 cm (16 inches) apart over the Duff Bed to support the moisture sticks.
5. Suspend the moisture sticks horizontally, approximately 25.4 cm (10 inches) above the ground, using the brackets. This area will now be called the class's "Standard Fire-Weather Station."
6. Leave the Standard Fire-Weather Station undisturbed for 3-5 days.

Part 1 Summary Paragraph: Using complete sentences, write a paragraph summarizing the purpose of this lab and important information you have learned regarding factors that contribute to fuel moisture and fire danger.

The purpose of this lab is to test the fuel moisture in our area. We will leave the fuel stick outside for 3-5 days, so that it will absorb moisture from the environment. When we collect our data, we will be able to determine the fuel moisture. Fuel moisture is the term that refers to the percentage of moisture (water) in fuel. Fuel can be trees, plants, grass or other items that will burn. When fuel moisture is high, fire danger is low. When fuel moisture is low, fire danger is high. Fire danger is determined by temperature, humidity, wind speed, cloud cover, slope, aspect and fuel moisture. All of these factors play a part in determining how likely it is that a fire will start and continue to burn.

Part 2 – Fuel Moisture Stick Lab Data Collection:

Date: *November 7, 2009* Time: *9:30 am* Location: *Behind cafeteria at school*
Season: *Fall* Weather: *Cool, cloudy*

1. Carefully bring the fuel sticks back to the classroom. Pick up all materials from the Standard Fire-Weather Station and follow your teacher's instructions on what to do with them.
2. Using a triple beam balance or electronic scale, weigh the fuel moisture sticks. Record your weight in grams below.

   Final Fuel Moisture Stick Weight = *115*g *(*Sample weight for example only)*

3. Take the final fuel moisture stick weight and subtract the initial weight. Divide this number by the initial fuel moisture stick weight. Now multiply by 100

   Final Weight *115*g - Initial Weight *102*g = *13*g Weight of Moisture
   Weight of Moisture *13*g / Initial Weight *102*g = *0.13* x 100 = *13* % Fuel Moisture
   Additional example: If the initial dry weight *of the fuel moisture stick(s) was 105g, and your final weight was 125g*
   125g – 105g = 20g 20g/105g = 0.19 x 100 = 19% fuel moisture

4. Use the "Fire Severity Related to Fuel Moisture Content" reference sheet to determine the level of fire danger. Clearly state the fire danger level below and explain why you selected this danger level.
   The fuel moisture level for our environment was 8%. According to the chart, this is a high ignition hazard.
5. What other factors might influence fire danger level?
   *The temperature, humidity, wind speed, cloud cover, slope and aspect could influence fire danger level. (*Example Only)*
6. Use your knowledge about our local environment to decide if these other factors will make the fire danger higher or lower. Explain using complete sentences.
   *It is cloudy today, which would make the fire danger lower. The outdoor temperature is cool and humidity is high, which also makes the fire danger lower. We are on a south facing slope which makes the fire danger higher. The slope is gradual, which does not increase the fire danger very much. (*Example Only)*

Fire Severity Related to Fuel Moisture Content

Relative Humidity %	Fuel Moisture %	Relative ease of chance ignition and general burning conditions
> 60 (high humidity)	> 20	Very little ignition; some spotting may occur with winds above 9 mph
45-60	15-19	Low ignition hazard – campfires become dangerous; glowing brands cause ignition when relative humidity is less than 50%
30-45	11-14	Medium ignition hazard – matches become dangerous; "easy" burning conditions.
26-40	8-10	High ignition hazard – matches are dangerous; occasional crowning, spotting caused by gusty winds; "moderate" burning conditions.
15-30	5-7	Quick ignition, rapid buildup of fire, extensive crowning; any increase in wind causes increased spotting, crowning, loss of control; fire moves up bark of trees igniting aerial fuels; long distance spotting in pine stands; "dangerous" burning conditions.
< 15 (low humidity)	< 5	All sources of ignition dangerous; aggressive burning, spot fires occur often and spread rapidly, extreme fire behavior probable; "critical" burning conditions.

"Contributing Factors to Fire Danger" Cards
Cut apart each block prior to taping under chairs.

Contributing Factor to Fire Danger **Fuel Moisture**	Contributing Factor to Fire Danger **Relative Humidity**
Contributing Factor to Fire Danger **Wind Speed**	Contributing Factor to Fire Danger **Slope**
Contributing Factor to Fire Danger **Aspect**	

Endnotes:

1 Browning, Tom. Battalion Chief, Grass Valley City Fire Department. Personal Interview. 23 September 2009.
2 Conner, Michael. Owner, Architectural Wood Products. Personal Interview. September 2009.
3 Conner, Michael. Owner, Architectural Wood Products. Personal Interview. September 2009.
4 Adapted from NWCG Fireline Handbook, Appendix B, Fire Behavior, April 2006. B-56

The Forest Foundation – Hot Topics: Wildfires and You

Content Standards for California Public Schools Matrix, Grade 6

Framework for CA Public Schools Standard	Lesson(s) in which standard is taught or reinforced	Standard Description
Grade 6: Science		
Earth Sciences 3	1	Heat moves in a predictable flow from warmer objects to cooler objects until all the objects are at the same temperature.
Earth Sciences 3.b	1,3	Students know that when fuel is consumed, most of the energy released becomes heat energy.
Earth Sciences 3.c	1	Students know heat flows in solids by conduction (which involves no flow of matter) and in fluids by conduction and by convection (which involves flow of matter).
Earth Sciences 6.b	2	Students know different natural energy and material resources, including air, soil, rocks, minerals, petroleum, fresh water, wildlife and forests, and know how to classify them as renewable or nonrenewable.
Investigation and Experimentation 7.a	2	Develop a hypothesis.
Investigation and Experimentation 7.b	3	Select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data and display data.
Investigation and Experimentation 7.c	3	Construct appropriate graphs from data and develop qualitative statements about the relationships between variables.
Investigation and Experimentation 7.d	1	Communicate the steps and results from an investigation in written reports and oral presentations.
Investigation and Experimentation 7.h	1	Identify changes in natural phenomena over time without manipulating the phenomena (e.g., a tree limb, a grove of trees, a stream, a hill slope).
Grade 6: English-Language Arts		
Reading 1.4	3	Monitor expository text for unknown words or words with novel meanings by using word, sentence and paragraph clues to determine meaning.
Reading Comprehension 2.3	3	Connect and clarify main ideas by identifying their relationships to other sources and related topics
Writing Strategies 1.5	2	Compose documents with appropriate formatting by using word-processing skills and principles of design (e.g., margins, tabs, spacing, columns, page orientation).
Writing Applications 2.2	2,3	Write expository compositions (e.g., description, explanation, comparison and contrast, problem and solution): a. State the thesis or purpose. b. Explain the situation. c. Follow an organizational pattern appropriate to

		the type of composition. d. Offer persuasive evidence to validate arguments and conclusions as needed.
Writing Applications 2.3	**1**	**Write research reports: a. Pose relevant questions with a scope narrow enough to be thoroughly covered. b. Support the main idea or ideas with facts, details, examples and explanations from multiple authoritative sources (e.g., speakers, periodicals, online information searches). c. Include a bibliography.**
Written and Oral Language Conventions 1.0	**1, 2,3**	**Students write and speak with a command of standard English conventions appropriate to this grade level.**
Listening and Speaking 1.5	**3**	**Support opinions with detailed evidence and with visual or media displays that use appropriate technology.**
Speaking Applications 2.5	**1**	**Deliver presentations on problems and solutions: a. Theorize on the causes and effects of each problem and establish connections between the defined problem and at least one solution. b. Offer persuasive evidence to validate the definition of the problem and the proposed solutions.**
Grade 6: Visual and Performing Arts		
Music, Creative Expression 2.5	**3**	**Arrange simple pieces for voices or instruments, using traditional sources of sound.**
Visual Arts, Creative Expression 2.1	**1,2,3**	**Use various observational drawing skills to depict a variety of subject matter.**
Visual Arts, Creative Expression 2.3	**2,3**	**Create a drawing, using varying tints, shades and intensities.**
Visual Arts, Connections, Relations, Applications 5.4	**2**	**Describe tactics employed in advertising to sway the viewer's thinking and provide examples.**
Grade 6: Health Education		
Injury Prevention and Safety 1.4.S	**2**	**Examine disaster preparedness plans for the home and school.**
Injury Prevention and Safety 5.1.S	**2,3**	**Use a decision-making process to determine a safe course of action in risky situations.**
Injury Prevention and Safety 6.1.S	**2**	**Develop a personal plan to remain safe and injury-free.**
Grade 6: Math		
Number Sense 1.4	**2,3**	**Calculate given percentages of quantities and solve problems involving discounts at sales, interest earned and tips.**
Number Sense 2.3	**2**	**Solve addition, subtraction, multiplication and division problems, including those arising in concrete situations, that use positive and negative integers and combinations of these operations.**
Algebra and Functions 2.1	**3**	**Convert one unit of measurement to another (e.g., from feet to miles, from centimeters to inches).**
Statistics, Data Analysis, and Probability 3.2	**3**	**Use data to estimate the probability of future events (e.g., batting averages or number of accidents per mile driven).**
Mathematical Reasoning 1.1	**3**	**Analyze problems by identifying relationships, distinguishing**

		relevant from irrelevant information, identifying missing information, sequencing and prioritizing information, and observing patterns.
Mathematical Reasoning 1.2	**3**	**Formulate and justify mathematical conjectures based on a general description of the mathematical question or problem posed.**
Mathematical Reasoning 2.3	**2**	**Estimate unknown quantities graphically and solve for them by using logical reasoning and arithmetic and algebraic techniques.**

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