



High School Physical Science People in Fire's Homeland



INTRODUCTION

Good morning/afternoon. My name is _____
 _____, and I work for the _____ National
 Forest.

LESSON

(Note: This lesson was adapted from “Chapter 8. People in Fire’s Homeland” from “FireWorks Curriculum: Featuring Ponderosa, Lodgepole, and Whitebark Pine Forests,” http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf.)

Fire is quite at home in the forests of the West. And, the plants and animals of these forests are quite at home with fire. The people who lived in these forests prior to 1800 were also at home with fire, but things have changed. People have built permanent homes in the midst of forests and along their edges. Thousands of people live in valleys that fill with smoke during wildland fires. People need to be informed about fire for their own safety and to help make wise choices about managing wildlands.

Today, we are going to be doing some real-world activities related to wildland fire. First, we are going to watch a short video (12 minutes) and go over an informational booklet that fire managers have developed. Your assignment while watching the video and reading the booklet will be to describe the organization of the video and to think about scientific information and viewpoints being presented. Specifically, I want each of you to pull out a piece of paper and make a brief outline of the organization of the video while you watch it. Any questions?



FOREST SERVICE MESSAGES

- A-1:** Fire has a natural role in the ecosystem.
- A-3:** Leaving nature alone has consequences, risks and trade-offs.
- A-5:** The study of the science of fire and its behavior is important.
- B:** People are part of nature, and their actions have effects on the land.
- C:** The Forest Service seeks to improve overall forest health and lessen the risk of high intensity, destructive wildland fires by working to bring the forests closer to historic, ecological conditions.
- C-1:** Prior to European settlement, Southwestern ponderosa pine forests had far fewer trees than today and had frequent, low-intensity surface fires.
- C-4:** Because of unnaturally dense conditions, our forests are at risk for destructive wildland fires, insect infestations and diseases.

ACADEMIC STANDARDS



Arizona Standards

LANGUAGE ARTS

- LS-P2:** Deliver an impromptu speech that is organized, addresses a particular subject and is tailored to the audience
- R-P1:** Apply reading strategies such as extracting, summarizing, clarifying, and interpreting information; predicting events and extending the ideas presented; relating new information to prior knowledge; supporting assertions with evidence; and making useful connections to other topics to comprehend works of literature and documents
- P0 1:** Extract critical details or elements of literature
- P0 2:** Summarize the main points
- P0 3:** Make predictions based on evidence presented
- P0 4:** Extend ideas presented in the text
- P0 5:** Connect prior knowledge to information available

SOCIAL STUDIES

- 3SS-P4:** Analyze the interactions between human activities and the natural world in different regions, including changes in the meaning, use, distribution, and importance of natural resources, with emphasis on:
 - P0 2:** How humans perceive, react to, and prepare for natural



Fires are a natural part of Southwestern forest ecosystems. More and more people are choosing to build their homes in areas where fires have burned naturally for hundreds of years. With the decision to move to these areas comes risks and obligations.

(View the videotape “Managing Wildland Fire – a Matter of Choice,” which will take about 12 minutes.)

After viewing, ask the class to describe the organization of the video. Ask a few of the students to share their outlines of the video’s organization with the class. Then, put the following outline on the board:

I. Ask questions

- A. Can forests thrive with fire?
- B. Can people and property be protected?
- C. How much smoke is too much?

II. Suggest answers or solutions, at least in part

- A. Forests can thrive with fire.
- B. People and property can be protected
- C. Living with Smoke

(Note that each question is paired with an answer.)

Pick a question-and-answer pair. Ask the class to discuss the video’s treatment of that question and answer. (This part of the lesson can be done with the whole class, in small groups, or as a writing assignment.)

- Does the information presented seem to be based on valid science? If you can’t tell, how might you find out? (Some answers might include asking an expert that you trust, looking up more information in books and scientific articles, and doing experiments that test some of the ideas presented in the videotape. Also, the Internet might provide interesting information – how might they judge its validity?)
- What viewpoint is presented, and what techniques are used to present it?
- Do you agree or disagree with the viewpoint? Can you explain why? Can you suggest information or ideas to add to a discussion of the issue?

hazards

- PO 3:** How changes in the natural environment can increase or diminish its capacity to support human activity
- PO 6:** Policies and programs for resource use and management, including the trade-off between environmental quality and economic growth in the twentieth century

SCIENCE

- 1SC-P1:** Propose solutions to practical and theoretical problems by synthesizing and evaluating information gained from scientific investigations
- PO 1:** Evaluate scientific information for relevance to a given problem
- PO 2:** Propose solutions to a problem, based on information gained from scientific investigations
- 1SC-P2:** Compare observations of the real world to observations of a constructed model (e.g., an aquarium, a terrarium, a volcano)
- PO 1:** Assess the capability of a model to represent a “real world” scenario
- 1SC-P6:** Identify and refine a researchable question, conduct the experiment, collect and analyze data, share and discuss findings
- PO 1:** Construct a researchable question
- PO 2:** Employ a research design that incorporates a scientific method to carry out an experiment
- PO 3:** Analyze experimental data
- PO 4:** Communicate experimental findings to others
- 2SC-P6:** Analyze evidence that supports past and current scientific theories about a specific topic
- PO 1:** Distinguish between evidence which supports a given scientific theory (e.g., model of the atom, plate tectonics, natural selection) and evidence which does not support the theory
- 3SC-P1:** Apply scientific thought processes and procedures to personal and social issues
- PO 1:** Apply scientific thought processes of skepticism, empiricism, objectivity and logic to seek a solution to personal and social issues
- PO 2:** Apply a scientific method to the solution of personal and social issues
- 3SC-P4:** Identify and describe the basic processes of the natural ecosystems and how these processes affect, and are affected by, humans
- PO 1:** Describe the basic processes of the natural ecosystems (e.g., water cycle, nutrient cycles)
- PO 2:** Explain how these processes affect, and are affected by, humans
- 5SC-P3:** Identify, measure, calculate, and analyze qualitative and quantitative relationships associated with energy forms and energy transfer or transformation (e.g.,

(Additional exercise if there is extra time: If you could add one more thought to the videotape, what would it be? Write a script for your 2-minute addition to the video. Explain what part of the video you would use it in, and describe the video footage you would like to include with it.)

Ask the students if they think the issues in the videotape are important for their geographic area, and have them explain why or why not. Ask them if they think students in larger, metropolitan areas such as Phoenix would answer differently.

ACTIVITY

(This activity is taken from “Activity 3-4. The Fire Triangle in Wildlands” of “FireWorks Curriculum: Featuring Ponderosa, Lodgepole, and Whitebark Pine Forests,” http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf.)

Now that you’ve learned some of the issues associated with fire management, we are going to do an activity to demonstrate some principles of fire behavior.

I think we are fortunate to live in an area that has a varied landscape. There are mountains, valleys, canyons, steep land, flat land, and more. You name it, and we’ve got it. However, when a wildland fire starts, this same diversity of landscapes and topography can lead to some very interesting fire behavior. That is what we are about to witness, albeit in a controlled environment.

1. Break up the class into four student teams. Explain to them that what they are about to do is similar to research done by chemists and physicists, and that results from research like this are used by foresters, firefighters, range managers, wildlife biologists, and ecologists.
2. Explain that each team will set up different experiments, but the whole class will observe every fire. Yes, I did say “fire,” so let’s go over some safety issues.
3. Review safety procedures in the laboratory; ask teacher to provide guidelines.
4. Give each student team a matchstick forest model (drilled square of masonite, 2 bolts, 1 nut-and-washer set, 1 nail) and 50-100 matches.



changes in temperature, velocity, potential energy, kinetic energy, conduction, convection, radiation)

PO 1: Identify qualitative and quantitative relationships associated with energy (e.g., heat, mechanical, electrical)

PO 2: Measure quantitative (e.g., heat, mechanical, electrical) relationships associated with energy

SSC-P4: Observe, measure and calculate quantities to demonstrate conservation of matter and energy in chemical changes (e.g., acid base, precipitation, heat)

PO 4: Quantify the energy changes in chemical reactions

SSC-P5: Describe and predict chemical reactions (including combustion and simple chemical reactions) and physical interaction of matter (including velocity, force, work and power), using words or symbolic equations

PO 2: Predict the products of a chemical reaction using types of reactions (e.g., synthesis, decomposition, replacement, combustion)

PO 3: Describe physical interactions through use of word equations or formulae



New Mexico Standards

LANGUAGE ARTS

Strand: Reading and Listening for Comprehension

Content Standard I: Students will apply strategies and skills to comprehend information that is read, heard, and viewed.

9-12 Benchmark I-B: Synthesize and evaluate information to solve problems across the curriculum

Grade 9 Performance Standards

1. Use a variety of techniques for researching topics including:
 - cross-referencing while gathering information
 - summarizing dialogue
 - using news sources (e.g., newspapers, magazines, TV, radio, videotapes, Internet, email, government publications, microfiche, other library resources)

Grade 10 Performance Standards

3. Use multiple resources to gather information to evaluate problems, examine cause and effect relationships, and answer research questions to inform an audience.

Grade 11 Performance Standards

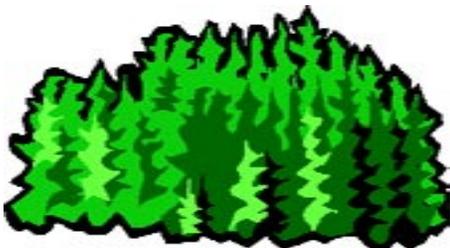
1. Conduct research using data from in-depth field studies.
2. Synthesize information from multiple research studies to draw conclusions that go beyond those found in any of the individual studies.

Have students insert a match in every hole of the matchstick forest model, tips pointing up.



5. Set these “matchstick forests” in burning trays on a heat-resistant surface. If you don’t have laboratory facilities, you might use a trash-can lid filled with sand. Have the first “forest” be level; to the second and third, attach a short bolt so the slope is about 20 degrees. To the fourth, attach the long bolt so the slope is about 40 degrees. Have a spray bottle and fire extinguisher nearby.
6. Explain to the students that the individual matches represent trees that have flammable crowns, like the conifers (ponderosas, Douglas firs, pinyons) found in local forests. Tell them that in this demonstration they will observe how slope and tree density affect fire spread through tree crowns. Before lighting the matches, ask students for their guess (hypothesis) about how the fires will differ.
7. Have one team light the match tips along one edge of the flat “forest” and observe fire behavior (everyone observe). Then have another team light the match tips along the edge of a medium-slope forest and observe. Then have another team light the bottom row of matches on the other medium-slope forest and observe. Finally, have another team light the bottom row of matches on the steep-slope and observe. Ask for descriptions of what the students observe and interpretations in terms of the Fire Triangle. (Heat travels upward, so the matches and trees uphill from a fire receive more heat than those below and are easier to ignite. The fire pre-heats the trees above – you might want to draw a simple drawing on the chalkboard showing this.) Ask students to answer Questions 1-3 on Student Page 5.

8. Have the students remove whatever remains of the matches from each board. They can use the nail in the kit to poke the burned matches out, if necessary.



Grade 12 Performance Standards

1. Identify and defend research questions and topics that will be important in the future.
2. Use a variety of resources to gather information to critically analyze texts to gain meaning, develop thematic connections, and synthesize ideas.
3. Demonstrate increasing sophistication in the selection and use of resources to define issues and use argument effectively.

9-12 Benchmark I-C: Demonstrate critical thinking skills to evaluate information and solve problems.

Grade 9 Performance Standards

2. Support informed opinions by providing relevant and convincing reasons, using various types of evidence, language, and organizational structure, and demonstrating an awareness of possible questions, concerns, or counter-arguments.

Grade 10 Performance Standards

1. Examine controversial issues by:
 - sharing and evaluating personal response
 - researching and summarizing data
 - developing a framework in which to discuss the issue (creating the context)
 - compiling personal responses and researched data to organize the argument
 - presenting data in various forms (e.g., graph, essay, speech, video)

Grade 11 Performance Standards

1. Use language persuasively in addressing a particular issue by:
 - finding and interpreting information effectively
 - establishing and defending a particular perspective
 - responding respectfully to viewpoints and biases

Grade 12 Performance Standards

1. Research, define, and present issues of public concern by:
 - specifying the nature of an issue, including claims made and the reasoning that supports those claims
 - organizing and delivering a presentation that specifies reasons for the claim and makes a clear stance on the issue.

Strand: Writing and Speaking for Expression

Content Standard II: Students will communicate effectively through speaking and writing.

9-12 Benchmark II-A: Communicate information in a coherent and persuasive manner using verbal and non-verbal language.

9. Now, explain that the arrangement of “trees” in the matchstick forests studied so far resembles the arrangement in lodgepole pine/subalpine fir forests



and in the Southwestern ponderosa pine forests we see today that are much more dense than they used to be. Show Class Page 2 on the overhead projector (or just hand out a copy to each team). This table describes the number and arrangement of trees in ponderosa pine/Douglas-fir forests and whitebark pine/subalpine fir forests. (Note: This shows a healthy number and arrangement. Today’s Southwestern ponderosa pine forests have many more trees and are not in a healthy condition.) Ask students to set up matchstick forests resembling these two forest types – using the long bolts to make “steep” forests. Ask how they expect fire behavior to differ.

10. Light these matchstick forests, one at a time, and discuss observations while having students record them on Student Page 5, lines 4 and 5. Also have them complete line 6.
11. Now, ask the students to compare the model forests used in this experiment to real forests. What are the similarities? What are the differences? How would they expect wildland fires to differ from matchstick forest fires? Explain that real wildland fires are much more complicated than model fires. With the models we have been using, we are dealing only with how slope, tree density and arrangement can affect fire behavior. In a real wildland fire, many other factors come into play. Wind has a tremendous effect on fire. Other things that affect fire behavior include the amount of fuels on the ground, fuel moisture, humidity, local terrain features (canyons, draws, etc.), time of day, fire’s ability to create its own weather, aspect (mention that south-facing slopes are usually warmer and drier and thus burn hotter), and the list goes on and on.

(Note to presenter: If while doing this program you notice that time is getting short, you may have to skip some subjects. If you do, cover the topics that you feel are the most important to your objective.)

Grade 9 Performance Standards

1. Evaluate personal effectiveness in group discussions and make corrections as necessary.
2. Ask questions to broaden and enrich discussions.
3. Express an informed opinion that clearly states a personal view, is logical and coherent, and engages the reader’s interest.
4. Support an informed opinion by using appropriate language, reason, and organizational structure for the audience and purpose.

Grade 10 Performance Standards

2. Make well-informed and well-organized formal presentations with a clear main point, adjusting the message, wording, and delivery to the particular audience and context.

Grade 11 Performance Standards

1. Use language persuasively in addressing a particular issue by:
 - finding and interpreting information effectively
 - recognizing propaganda as a purposeful technique
 - establishing and defending a point of view
 - responding respectfully to viewpoints and biases

Grade 12 Performance Standards

1. Develop oral formal presentations using clear enunciation, gestures, tone, vocabulary, and organization appropriate for a particular audience.
2. Make explicit use of various techniques for effective presentations (e.g., voice, inflection, tempo, gestures).

9-12 Benchmarks II-C: Demonstrate competence in the skills and strategies of the writing process to inform and persuade.

Grade 9 Performance Standards

3. Compose written arguments that develop and support informed opinions by:
 - stating a progression of ideas
 - selecting appropriate style, tone, and use of language for a particular effect
 - describing and analyzing personal, social, historical, or cultural influences
 - presenting rhetorical strategies to support the proposal
4. Analyze the origins and meanings of common, learned, and foreign words used frequently in written English.

Grade 10 Performance Standards

1. Write to stimulate the emotions of the reader.
2. Clearly articulate a position through the use of a thesis statement, anticipate and deal with counter-arguments, and develop arguments using

CLOSING

I hope that you have learned about some of the complexities of fire today – both in terms of fire management and fire behavior.

HANDOUT

- Student Page 5
- Class Page 2

SUPPLIES

- “Activity 8-1. A Matter of Choice” trunk from FireWorks Curriculum
 - ⊙ Trunk is from “Activity 8-1. A Matter of Choice” from “FireWorks Curriculum: Featuring Ponderosa, Lodgepole, and Whitebark Pine Forests,” http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf.)
- Trunk includes:
 - ⊙ “Managing Wildland Fire – a Matter of Choice” videotape (12 minutes)
 - ⊙ “Managing Wildland Fire” booklets (one per student)
- Television
- VCR
- Wooden matches (lots)
- “Activity 3-4. The Fire Triangle in Wildlands” trunk from FireWorks Curriculum
 - ⊙ Trunk is from “Activity 3-4. The Fire Triangle in Wildlands” from “FireWorks Curriculum: Featuring Ponderosa, Lodgepole, and Whitebark Pine Forests,” http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf.)
- Trunk includes:
 - ⊙ Matchstick forest kits (4) (could use clay instead of masonite)
 - ⊙ Fire extinguisher
 - ⊙ Burning trays
 - ⊙ Spray bottles with water (2)
- Copies of Student Page 5 (one per team)
- Copies of Class Page 2 (one per team)
- Trash can lids (4)
- Sand
- Long-handled lighter

a variety of methods such as:

- examples and details
- commonly accepted beliefs
- expert opinions
- quotations and citations
- cause and effect
- comparison and contrast reasoning

Grade 11 Performance Standards

1. Use argument to:
 - interpret researched information
 - establish and defend a point of view
 - address concerns of the opposition
 - use techniques (e.g., rhetorical devices, parallelism, hypothetical situation, irony, concrete images)
 - develop a sense of completion
2. Synthesize and organize information from a variety of sources in order to inform and persuade an audience.

Grade 12 Performance Standards

3. Analyze own work for:
 - consistency of facts, ideas, tone, voice
 - development of argument or plot
 - clarity and conciseness

SOCIAL STUDIES

Strand: History

Content Standard I : Students are able to identify important people and events in order to analyze significant patterns, relationships, themes, ideas, beliefs, and turning points in New Mexico, United States, and world history in order to understand the complexity of the human experience.

9-12 Benchmark I-A—New Mexico: Analyze how people and events of New Mexico have influenced United States and world history since statehood.

Grade 9-12 Performance Standards

5. Explain how New Mexico history represents a framework of knowledge and skills within which to understand the complexity of the human experience, to include:
 - explain connections made between the past and the present and their impact.

Strand: Geography

Content Standard II: Students understand how physical, natural, and cultural processes influence where people live, the ways in which people live, and how societies interact with one another and their environments.

9-12 Benchmark II-A: Analyze and evaluate the characteristics and purposes of geographic tools, knowledge, skills, and perspectives, and apply them to

explain the past, present, and future in terms of patterns, events, and issues.

Grade 9-12 Performance Standards

1. Evaluate and select appropriate geographic representations to analyze and explain natural and man-made issues and problems.
2. Understand the vocabulary and concepts of spatial interaction, including an analysis of population distributions and settlements patterns.

9-12 Benchmark II-B: Analyze natural and man-made characteristics of worldwide locales; describe regions, their interrelationships, and patterns of change.

Grade 9-12 Performance Standards

1. Analyze the interrelationships among natural and human processes that shape the geographic connections and characteristics of regions, including connections among economic development, urbanization, population growth, and environmental change.
2. Analyze how the character and meaning of a place is related to its economic, social, and cultural characteristics, and why diverse groups in society view places and regions differently.
3. Analyze and evaluate changes in regions and recognize the patterns and causes of those changes (e.g., mining, tourism).

9-12 Benchmark II-C: Analyze the impact of people, places, and natural environments upon the past and present in terms of our ability to plan for the future.

Grade 9-12 Performance Standards

1. Compare and contrast how different viewpoints influence policy regarding the use and management of natural resources.

9-12 Benchmark II-D: Analyze how physical processes shape the Earth's surface patterns and biosystems.

Grade 9-12 Performance Standards

1. Analyze how the Earth's physical processes are dynamic and interactive.
2. Analyze the importance of ecosystems in understanding environments.
3. Explain and analyze how water is a scarce resource in New Mexico, both in quantity and quality.

9-12 Benchmark II-E: Analyze and evaluate how economic, political, cultural, and social processes interact to shape patterns of human populations, and their interdependence, cooperation, and conflict.

Grade 9-12 Performance Standards

1. Analyze the factors influencing economic activities (e.g., mining, ranching, agriculture, tribal gaming, tourism, high tech) that have resulted in New Mexico's population growth.
3. Analyze the interrelationships among settlement,

migration, population-distribution patterns, landforms, and climates in developing and developed countries.

4. Analyze how cooperation and conflict are involved in shaping the distribution of political, social and economic factors in New Mexico, United States, and throughout the world (e.g., land grants, border issues, United States territories, Israel and the Middle East, the former Soviet Union, and Sub-Saharan Africa).
5. Analyze how cultures shape characteristics of a region.
6. Analyze how differing points of view and self-interest play a role in conflict over territory and resources (e.g., impact of culture, politics, strategic locations, resources).

9-12 Benchmark II-F: Analyze and evaluate the effects of human and natural interactions in terms of changes in the meaning, use, distribution, and importance of resources in order to predict our global capacity to support human activity.

Grade 9-12 Performance Standards

1. Compare the ways man-made and natural processes modify the environment and how these modifications impact resource allocations.
2. Analyze how environmental changes bring about and impact resources.

SCIENCE

Strand I: Scientific Thinking and Practice

Standard I: Understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.

9-12 Benchmark I: Use accepted scientific methods to collect, analyze, and interpret data and observations and to design and conduct scientific investigations and communicate results.

Grade 9-12 Performance Standards

1. Describe the essential components of an investigation, including appropriate methodologies, proper equipment, and safety precautions.
2. Design and conduct scientific investigations that include:
 - testable hypotheses
 - controls and variables
 - methods to collect, analyze, and interpret data
 - results that address hypotheses being investigated
 - predictions based on results
 - re-evaluation of hypotheses and additional experimentation as necessary

- error analysis.
4. Convey results of investigations using scientific concepts, methodologies, and expressions, including:
 - clear, logical, and concise communication
 - reasoned arguments.
 5. Understand how scientific theories are used to explain and predict natural phenomena (e.g., plate tectonics, ocean currents, structure of atom).

9-12 Benchmark II: Understand that scientific processes produce scientific knowledge that is continually evaluated, validated, revised, or rejected.

Grade 9-12 Performance Standards

1. Understand how scientific processes produce valid, reliable results, including:
 - consistency of explanations with data and observations
 - openness to peer review
 - full disclosure and examination of assumptions
 - testability of hypotheses
 - repeatability of experiments and reproducibility of results.
3. Understand how new data and observations can result in new scientific knowledge.
6. Examine the scientific processes and logic used in investigations of past events (e.g., using data from crime scenes, fossils), investigations that can be planned in advance but are only done once (e.g., expensive or time-consuming experiments such as medical clinical trials), and investigations of phenomena that can be repeated easily and frequently.

9-12 Benchmark III: Use mathematical concepts, principles, and expressions to analyze data, develop models, understand patterns and relationships, evaluate findings, and draw conclusions.

Grade 9-12 Performance Standards

1. Create multiple displays of data to analyze and explain the relationships in scientific investigations.
2. Use mathematical models to describe, explain, and predict natural phenomena.
3. Use technologies to quantify relationships in scientific hypotheses (e.g., calculators, computer spreadsheets and databases, graphing software, simulations, modeling).
4. Identify and apply measurement techniques and consider possible effects of measurement errors.

Strand II: The Content of Science

Standard I (Physical Science): Understand the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy.

9-12 Benchmark I: Understand the properties, underlying

structure, and reactions of matter.

Grade 9-12 Performance Standards

Properties of Matter

1. Classify matter in a variety of ways (e.g., element, compound, mixture; solid, liquid, gas; acidic, basic, neutral).
2. Identify, measure, and use a variety of physical and chemical properties (e.g., electrical conductivity, density, viscosity, chemical reactivity, pH, melting point).

Chemical Reactions

12. Know that chemical reactions involve the rearrangement of atoms, and that they occur on many timescales (e.g., picoseconds to millennia).
13. Understand types of chemical reactions (e.g., synthesis, decomposition, combustion, redox, neutralization) and identify them as exothermic or endothermic.
15. Describe how the rate of chemical reactions depends on many factors that include temperature, concentration, and the presence of catalysts.

9-12 Benchmark II: Understand the transformation and transmission of energy and how energy and matter interact.

Grade 9-12 Performance Standards

Energy Transformation and Transfer

1. Identify different forms of energy, including kinetic, gravitational (potential), chemical, thermal, nuclear, and electromagnetic.
2. Explain how thermal energy (heat) consists of the random motion and vibrations of atoms and molecules and is measured by temperature.
4. Understand how heat can be transferred by conduction, convection, and radiation, and how heat conduction differs in conductors and insulators.
5. Explain how heat flows in terms of the transfer of vibrational motion of atoms and molecules from hotter to colder regions.
6. Understand that the ability of energy to do something useful (work) tends to decrease (and never increases) as energy is converted from one form to another.

Strand II: The Content of Science

Standard II (Life Science): Understand the properties, structures, and processes of living things and the interdependence of living things and their environments.

9-12 Benchmark I: Understand how the survival of species depends on biodiversity and on complex interactions, including the cycling of matter and the flow of energy.

Grade 9-12 Performance Standards

Ecosystems

1. Know that an ecosystem is complex and may exhibit

fluctuations around a steady state or may evolve over time.

3. Understand and describe how available resources limit the amount of life an ecosystem can support (e.g., energy, water, oxygen, nutrients).
4. Critically analyze how humans modify and change ecosystems (e.g., harvesting, pollution, population growth, technology).

Energy Flow in the Environment

5. Explain how matter and energy flow through biological systems (e.g., organisms, communities, ecosystems), and how the total amount of matter and energy is conserved but some energy is always released as heat to the environment.

Strand II: The Content of Science

Standard III (Earth and Space Science): Understand the structure of Earth, the solar system, and the universe, the interconnections among them, and the processes and interactions of Earth’s systems.

9-12 Benchmark II: Examine the scientific theories of the origin, structure, energy, and evolution of Earth and its atmosphere, and their interconnections.

Grade 9-12 Performance Standards

Characteristics and Evolution of Earth

4. Understand the changes in Earth’s past and the investigative methods used to determine geologic time, including:
 - rock sequences, relative dating, fossil correlation, and radiometric dating
 - geologic time scales, historic changes in life forms, and the evidence for absolute ages (e.g., radiometric methods, tree rings, paleomagnetism).
5. Explain plate tectonic theory and understand the evidence that supports it.

Strand III: Science and Society

Standard I: Understand how scientific discoveries, inventions, practices, and knowledge influence, and are influenced by, individuals and societies.

9-12 Benchmark I: Examine and analyze how scientific discoveries and their applications affect the world, and explain how societies influence scientific investigations and applications

Grade 9-12 Performance Standards

Science and Society

9. Describe how scientific knowledge helps decision makers with local, national, and global challenges (e.g., Waste Isolation Pilot Project [WIPP], mining, drought, population growth, alternative energy, climate change).
10. Describe major historical changes in scientific

- perspectives (e.g., atomic theory, germs, cosmology, relativity, plate tectonics, evolution) and the experimental observations that triggered them.
12. Explain how societies can change ecosystems and how these changes can be reversible or irreversible.

**FOREST SERVICE CONSERVATION
EDUCATION LEARNER GUIDELINES**

Program title: People in Fire’s Homeland
Target audience: High School Physical Science
Primary topic: Many factors affect how a fire burns.

Length of program: 1 hour

Setting: indoors

Guidelines addressed are referenced here:

9-adult
I. Questioning and Analysis Skills
A1, A2, A3, B1, C1, D2, D3, E3, F1, F2, F3, G1, G2, G3, G4
II. Knowledge of Environmental Processes and Systems
1. A1, B1
2. C2, D2, D3
3.
4. A1, A3, B3, B4, C4, E1
III. Skills for Understanding and Addressing Environmental Issues
1. A1, A4, B3, B4, C1, D1
2. A1, A4, B1
IV. Personal and Civic Responsibility
C2, D3, D4

Student Page 5

Names: _____

The Fire Triangle in Wildlands

In this demonstration, you watch fires on three slopes—flat, medium, and steep. Answer questions 1-3 using the demonstration fires as examples.		
1	How does the steepness of a hillside affect a fire's spread?	
2	How well do fires burn downhill?	
3	How does slope affect fire spread? Use the Fire Triangle to explain.	
Now you will burn two more "matchstick forests" to explore how the arrangement of trees affects fire spread. Answer the questions below.		
	Description of matchstick forest	How well did this arrangement resist crown fire?
4	Ponderosa pine/Douglas-fir forest 100 years ago (5 large trees in area where lodgepole pine might have 50 trees)	
5	Whitebark pine/subalpine fir forest (13 trees, growing in clusters of 2-5 trees, in area where lodgepole pine might have 50 trees)	
6	Use the Fire Triangle to explain.	

Class Page 2

Arranging Trees in the Forest 100 Years Ago

Three kinds of forest, three arrangements of trees

What kind of forest?	How many trees in a matchstick model?	How are the trees arranged?
Lodgepole pine/subalpine fir	49	Trees are dense and quite evenly spaced.
Ponderosa pine/Douglas-fir	5	Trees occur singly, occasionally in pairs.
Whitebark pine/subalpine fir	13	Trees occur in clusters of 2 to 5.