



Specific Heat Capacity and Moisture Content

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Name _____

Directions: Read and study the information below to learn how the amount of moisture in fuel affects its ability to catch fire and burn.

Remember: Three things must be present for fire—**fuel, oxygen** and **heat**. There are many types of fuel, including sticks, twigs, branches and leaves. Even though all of these fuels usually will burn, they must be heated to a certain temperature to ignite. This is called the **ignition, or kindling, temperature**. If the fuel is damp or wet, the ignition temperature is higher. If the fuel is dry, the ignition temperature is lower and the fuel will ignite and burn much more easily. Let's investigate why.

Temperature measures the motion of the atoms and molecules that make up a substance. The greater the temperature, the faster the atoms and molecules are moving. If these tiny particles move fast enough in a fuel, and oxygen is present, ignition will occur. It takes energy to speed up the particles of a fuel; energy can come from any source of heat, such as friction. A match will flame up when rubbed against the striking strip because the friction adds enough heat to raise the temperature of the match head to its ignition temperature. Match heads are made of chemicals with a low ignition temperature.

Besides having different ignition temperatures, different substances have different heat-absorbing abilities. Metals absorb heat easily from their surroundings. The ability to absorb heat is called **specific heat capacity**. Often, specific heat capacity is expressed as how many calories of heat are needed to raise the temperature of 1 gram of the substance 1 degree Celsius.

Specific Heat Capacities of Common Materials

Name of Material	Specific Heat Capacity (calories/gram x degree Celsius)
Copper	.093
Glass	.200
Aluminum	.215
Air (average)	.239
Dry wood (average)	.430
Human body (average)	.829
Strawberries	.929
Water	1.00

Source: Monachos Mechanical Co.: "Specific Heat of Various Materials." Accessed April 20, 2004, at http://www.monachos.gr/en/resources/Thermo/specific_heat.asp.





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Some items in the table are not easily ignitable, for example, copper. Although it absorbs heat readily, its ignition temperature is extremely high. On the other hand, dry wood increases in temperature much more slowly than copper; but, its low ignition temperature makes it a good fuel.

As you can see from the chart, water has a very high specific heat; that is, it takes a lot of energy to change the temperature of water. This is good for two reasons: (1) water's high specific heat makes it a good tool for putting out fires because it takes heat away from what is burning; and (2) living systems, for example the human body, are slow to change temperature because they contain a lot of water. This helps protect living things from wide swings in temperature.

Dry air warms and cools quickly; hence deserts and arid lands have wide swings in temperature from day to night. Humid areas change temperature much more slowly and do not heat up as fast in the day nor cool as fast at night.

What does this mean for fuels? If fuels have a lot of moisture, as in fresh twigs and branches, more heat is needed to raise the temperature to the ignition point. Moist fuels are hard to ignite. However, if fuels are dry, like dead branches or wood used in construction, less heat is needed to raise the temperature and reach the ignition temperature. Dry fuels ignite much more easily.





Adaptations to Wildland Fires

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Name _____

Directions: Fire is usually thought of as destructive, but in many ecosystems fire is a natural factor. In fact, fire is necessary for the health of the ecosystem. Many plants have adapted so they can survive wildland fires, while others need fire for their renewal. Below is a list of terms that indicate some types of plant adaptations. Place each of the terms in the chart next to its proper description. Then, to complete the chart, research to find more examples of plants for each adaptation.

Terms: avoiders, evaders, resisters, endurers, invaders

These plants have adapted to fire by becoming:	Description	Examples
1.	These species come in immediately after a fire, succeeding because of a large production of short-lived, wind-disseminated seeds that spread quickly over a large area of the burned forest. They are shade-intolerant and usually flower or fruit abundantly.	Fireweed
2.	These species store their seeds to protect them from high temperatures during a fire and then germinate rapidly. They include shade-intolerant annuals that come back early but are short-lived in the forest; and shade-tolerant perennials that store seeds for long periods and persist in succession communities long after the fire ends.	Blue-flowered Ceanothus
3.	These species are not adapted to fire. They arrive late in succession and are most likely found in areas where fire cycles are longest.	Hemlock
4.	At maturity, these species have a relatively thick bark that can withstand ground fires, and since they “self-prune” and get rid of peripheral foliage, there is no ladder fuel to increase the chance of crown fires.	Ponderosa pine
5.	After a fire, these species sprout from below ground organs—stem bases, rhizomes, root crowns, roots—that are usually spared by a fire.	Oak





Fire-safe Materials

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Name _____

Directions: Using fire-safe construction and landscape materials reduces the risk of property damage from wildland fire. These materials often cost more, so it is important to make cost-to-benefit comparisons. Research to complete the chart below to help in your comparisons. The first row is completed for you as an example.

Structural component	Material	Fire resistance	Cost	Notes
Roofs	Metal, tile or fiberglass	High	High	Heavy, but long lasting
	Asphalt shingles with tar paper			
	Wood or cedar shakes			
Gutters	Metal			
	Wood			
	Plastic			
Outside walls	Stone, brick or metal			
	Wood			
	Vinyl			
Landscaping materials	Gravel, pavement or stone			
	Green grass, shrubs or flowers			
	Wood chips			

Source: National Institute of Standards and Technology—Building and Fire Research Laboratory. Accessed May 29, 2007, at <http://www.bfrl.nist.gov/>.





Time to Evacuate! What Do We Need?

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Name _____

Directions: Analyze each item on the list below to determine its importance to a safe and efficient evacuation. Write your ideas for each on the worksheet. Then, use the information to create a simple flier to help people prepare for a possible evacuation.

Battery-powered radio

Suitcase

Family papers

Sturdy shoes and clothing





Time to Evacuate! What Do We Need?

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Emergency supplies kit

Map of the community, marked with the evacuation route your family will follow to gain access to the community evacuation route

Signs pointing out the evacuation route

Family/friend network of phone numbers



Visit the American Red Cross Web site at www.redcross.org/disaster/masters

TIME TO EVACUATE! WHAT DO WE NEED?
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Time to Evacuate! What Do We Need?

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Full tank of gasoline

Buses equipped for riders with handicaps

Flashlights and batteries

Police officers stationed at intersections along the evacuation route





What Does Fire Do to the Ecosystem?

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Name _____

Directions: After a fire, the ecology of the burned area will change. Although fire is a natural and necessary component of many ecosystems, officials with the USDA Forest Service form teams of scientists to assess the damage and prevent additional damage. Read about these teams and what they do below.

BAER (pronounced *BEAR*), or Burned Area Emergency Response, teams are formed after major fires to assess damage and implement rehabilitation plans to prevent loss of life and property and reduce further damage to natural resources. In a nutshell, they survey and implement a plan to accomplish erosion control.

BAER teams are composed of highly skilled wildlife biologists, archaeologists, soil scientists, landscape architects, geologists, ecologists, engineers, foresters, botanists and specialists from other disciplines from all over the nation.

During a fire, some or all of the ground cover (called “duff,” which is made up of needles, decomposed wood and leaves) will be burned away, exposing the soil to the direct impact of rain. In addition, and depending on the severity of the fire (“high” being the worst, see the following page), the soil itself may become somewhat hydrophobic, that is, it will repel water, rather than absorb it. These conditions can set the stage for soil erosion when rain occurs.

Also, keep in mind that a forest fire typically does not burn at the same intensity everywhere. The intensity depends on terrain and fuels. Generally, high-intensity burned areas have priority for treatment, as they tend to be more hydrophobic, have the least duff, and have the greatest potential for erosion.





What Does Fire Do to the Ecosystem?

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Burn severity can be classified as follows:

- **Low**—The trees may be dead or alive; needles may be green or brown and still in place. The duff has not been totally consumed.
- **Moderate**—The duff is completely consumed but is mixed with unburned areas. The area has “patchy” ground cover.
- **High**—The duff is completely consumed over a large area. Smaller branches are completely consumed.

TREATMENTS

The goal of BAER is to keep the soil in place, or as much in place as possible.

To accomplish this, certain treatments are applied:

- **Mulching** is the application by hand of weed-free straw to parts of the burned area to replace ground cover that has been lost.
- **Log-erosion** barriers are dead trees cut and placed on the contour of a hill to collect soil and slow water movement.
- **Wattles** are a biodegradable plastic mesh filled with weed-free straw. They are placed on the contour of a hill and function in much the same way as log-erosion barriers.
- **Aerial seeding** is the application of seeds (called cereal grains) by airplane or helicopter. These seeds will germinate quickly. They help to provide ground cover and their roots help to hold soil in place in burned areas. The plants from these seeds are a type that will not live more than a year or two, so they will not compete with native plants as they return to the area.
- **Scarification** is the plowing or disking of strips along the contour. The purpose is to break up the hydrophobic layer of soil so that water can absorb as it flows down the hill. The scarified areas may also be planted.

Source: Hayman Fire & BAER Information—After the Fire. Accessed April 12, 2004, at http://www.fs.fed.us/r2/psicc/hayres/after_fire.htm.





When Wildland Fires Happen, Part 1

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Unexpected emergencies, such as wildland fires that destroy residential areas, may cause you to question a number of things you have always believed about your own safety, and the safety of your family and friends. When we are young, we are taught that, if we are good, good things will happen to us. Sometimes, we see things that make us wonder about this and cause us to doubt what we have been taught.

The following can't answer all of your questions, but it will let you know that it is normal to ask why and how awful things happen.

After the fire, I'm wondering if what I'm feeling is normal. Do other people feel the same way?

There are a number of common reactions following a disaster like a wildland fire.

These can include:

- Sadness, including crying more easily or wanting to cry
- Anger
- Fear
- Guilt because you are okay and others are not
- Trouble falling asleep or staying asleep, or having nightmares
- Changes in appetite—eating too much or not being hungry
- Problems in school and having a hard time concentrating
- Feelings of being helpless

- Wanting to be alone more often than usual, or not wanting to be alone at all
- Moodiness and irritability

These are all normal feelings. They may even go away for a while and come back again when something makes you think of the disaster. That's to be expected. If you have ever been involved in another type of disaster such as an earthquake, tornado, or flood, you may find yourself remembering that disaster and feeling the same emotions you felt then.

You may find that loud noises startle you more easily, or that smells or the sight of objects associated with the disaster can cause a reaction. Don't be surprised at these reactions. They will occur less often and disappear in time. You may also be having some physical problems that come from being upset. These could include:

- Stomachaches
- Headaches
- Increased allergies
- Rashes
- Colds and flu-like symptoms





When Wildland Fires Happen, Part 2

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When will I feel better?

When the fire is less and less in your thoughts and you are not reminded of it, the feelings and reactions will fade, especially as you get back to your usual routine and focus your attention on other things. It doesn't mean that you care less, just that you have put your feelings about this disaster in their own special place. As this happens, you will find that your physical problems diminish.

Everyone feels stress in different ways, so don't compare yourself with your friends and family members, or judge their reactions or lack of reactions.

What can I do?

- Avoid media coverage of the fire. Repeatedly seeing pictures of the disaster and hearing about how frightening it was can seriously slow your ability to get over the stress of the disaster.
- **Talk it out!** Talk about feelings and thoughts with somebody you trust, such as your parents or another relative, a school counselor, or a spiritual leader. Talking makes it easier to work through what happened and deal with the pain and fear.

- Ask for help when you need it. If you find that your feelings are still as strong and you are still having nightmares or physical problems in four to six weeks, you should ask your parents to find someone else you can talk to who will help you sort through your feelings.
- Listen to other people.
- Be especially kind to others. Reassure yourself that there is kindness and caring in the world. Offer your assistance to someone who needs help.
- Spend time with your family.
- Return to your usual routine.
- Sit under a tree or look at a brook, lake, river, or ocean.
- Remind yourself of other times when you were afraid. Remember that you were able to deal with that fear and that it doesn't last forever.
- Do something that could help others—take a first aid or CPR class.

