



Thermodynamics

The Heat Plume of a Fire



Script for the Slideshow

Slide 1 - Today we will go over some important concepts dealing with thermodynamics, the field of physical science dealing with the movement or flow of heat energy and its relationship with other forms of energy and work. [Click](#)

Slide 2 - *These guidelines are included on the student worksheet.* Since this is the first activity with fire, we will discuss safe laboratory procedures. This safety checklist is a great source of basic fire safety information. Take a moment to read each of the safety considerations. *Monitor students to see when they have finished reading through the poster in the slideshow or on their worksheets.* We will now take a quiz over this material to ensure that you understand each of the points and the importance of appropriate behavior and personal protective equipment (PPE). Record your answers to the six questions in the appropriate space in the “Safety Quiz Responses” table. *When all students are ready, continue to the first question.* [Click](#)

Slide 3 - *Monitor to see when all students have answered the question.* What is the correct answer? “*b) Cotton*” is the correct answer. [Click to highlight the answer](#) Let’s take a look at number two. [Click](#)

Slide 4 - *Monitor to see when all students have answered the question.* What is the correct answer? “*a) Closed-toe shoes*” is the correct answer. [Click to highlight the answer](#) Let’s try number three. [Click](#)

Slide 5 - Monitor to see when all students have answered the question.

What is the correct answer? *“a) Should be tied back” is the correct answer.*

[Click to highlight the answer](#) Let's move on to number four. [Click](#)

Slide 6 - Monitor to see when all students have answered the question.

What is the correct answer? *“YES” is the correct answer.* [Click to highlight](#)

[the answer](#) Now it's time for number five. [Click](#)

Slide 7 - Monitor to see when all students have answered the question.

What is the correct answer? *“YES” is the correct answer.* [Click to highlight](#)

[the answer](#) Now let's answer the final question. [Click](#)

Slide 8 - Monitor to see when all students have answered the question.

What is the correct answer? *“TRUE” is the correct answer.* [Click to highlight](#)

[the answer](#) Since we are now familiar with fire laboratory safety considerations, we are ready for the first activity. [Click](#)

Slide 9 - Who can tell me one of the mechanisms that transfers heat?

Convection, Conduction, and Radiation. Any other ways that heat can move? Okay, let's go over the three mechanisms of heat transfer in some detail. On your worksheet, draw a diagram that depicts heat being transferred by each mechanism. [Click](#) *Read the statement for convection.*

Heat can be transferred by hot fluids as they “expand” into the cooler fluids surrounding them. Hot gases/liquids are less dense than cooler fluids, so hot gases/liquids rise and are replaced by “falling” cooler fluids. For gases in air, Earth's atmosphere usually becomes “thinner” (less dense) as you go up in altitude, so “up” has less resistance to the expanding gases than “sideways” or “down.” Therefore, hot air generally rises. [Click](#) Here are a few examples of the convection mechanism you may already be familiar with: a hot air balloon; [Click](#) smoke or steam going up through a chimney; and [Click](#) coastal breezes. [Click](#)

Slide 10 - *Read the definition for conduction.* In fire, conduction enables heat to move from an object's outside to its inside and to move between objects that are touching. **Click** As the molecules that make up the metal rod near the candle flame absorb heat energy, their vibrational motion increases which is shown by an increase in the metal rod's temperature. This increased motional energy is transferred to neighboring molecules and, thus, the metal rod heats up along its entire length. The hand holding the metal rod will soon sense the increase in temperature. **Click**

Slide 11 - *Read the definition for radiation.* Why is radiation an important transfer mechanism for life on Earth? *It allows energy from the Sun to reach Earth.* **Click** How can our bodies detect the radiant energy reaching us from the Sun? *Light, sunburn, warmth, etc.* Besides the vacuum of space, what else can radiant energy pass through? *Radiant energy can be absorbed, reflected, and/or transmitted. Any transparent material (air, water, glass) will allow at least some of the original radiation incident upon it to pass through. Opaque materials can only reflect or absorb radiant energy.* **Click**

Slide 12 - *Read the slide.* On the worksheet, you will find guidelines for completing the activity. Let's take a look at the different roles those in your group will need to perform. **Click**

Slide 13 - The observer will use her/his hand to detect how far from the burning match she/he can detect a change in temperature. This is the edge of the heat plume. Always start your observation from at least 30 centimeters out from the burning match and bring it in toward the flame until you detect a temperature change. This is the outer edge of the heat plume. ***The point is to detect heat, not to determine how much heat you can tolerate!*** Check a ruler so you know how big 3 centimeters is. **Never** bring your hand closer than 3 cm (approximately 1 inch) to a burning match. **Never** place your hand directly under a burning match, in case the tip should fall off; instead, place your hand slightly off to the side. **Click**

Slide 14 - When the observer has detected heat, measure the distance from the flame to the observer's hand. Use a ruler, but do not place it close to or in the flame. If the observer does not detect heat from the match at the 3-centimeter distance, record the 3-centimeter point as your measurement. [Click](#)

Slide 15 - The other member roles listed on this slide could be performed by the same person. The observer should not begin moving her/his hand toward the flame until the stove lighter has been extinguished and, thus, the match is the only source of heat. [Click](#)

Slide 16 - At each station, there is a laminated graph sheet that looks like this. Before you can finish the activity, you must make a diagram reflecting your data on this sheet. You must get the instructor's initials on the student worksheet before moving on to answer questions. Be prepared to explain your group's heat plume using the three heat transfer mechanisms. When you have finished the activity, be sure to clean up your group's station appropriately; the laboratory station should be in exactly the same condition as it was when your group began the activity. Be sure all matches are out before they are disposed of; there is no smoke and no heat being released. Use the metal bucket in the activity area for match disposal. If in doubt, use the station's spray bottle to wet the matches before putting them in the metal bucket.

STOP!

The next slide shows the heat plume of a match pointed downward. This might be good to show after students have finished. [Click](#)

Slide 17 - *This slide could be used for discussion after students have completed the activity.* This slide shows infrared images of a match pointed downward before ignition, during combustion, and after combustion. Can

you identify evidence of all three heat transfer mechanisms?

The End