H02-1: The Fire Triangle: Heat & Fuel

Type: Teacher Key

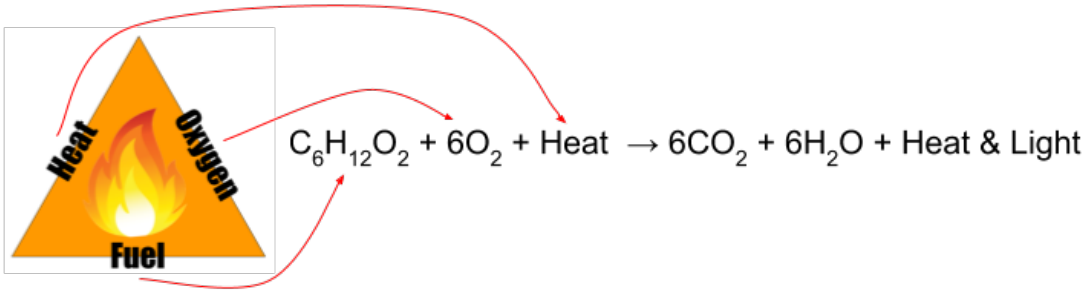
Name: KEY	Class/Period:	Date:

Presentation

Define "conceptual model."

Conceptual Model	In science, a simplified representation of a concept or of concepts related to a phenomenon. Often depicted as diagrams, conceptual models show processes or describe the relationships between concepts or factors essential to a phenomenon.

Make a diagram of the fire triangle. Students will be prompted during the slideshow presentation to write out the chemical equation for combustion and, then, to relate the combustion equation with the fire triangle.



Combustion is a chemical change because the combinations of atoms in the "reactants" are changed to give different arrangements of the same atoms as "products."

Complete the table below by listing the three components of the fire triangle in the first column. Give an example of each factor in the second column.

Table 1: The Three Components of the Fire Triangle

Heat	Lightning; sparks; match; lighter; driptorch
Fuel	Fossil fuels; vegetative biomass (wood, grass, etc.)
Oxygen	Oxygen gas, O_2, found in the atmosphere/air

Laboratory Procedure

Organize your team. Change jobs if you repeat the experiment. For a team of 4:

- The **Observer** should light the matches.
- The **Timer** should measure the duration of burning (in seconds).
- The **Measurer** should measure the length of flames.
- The **Recorder** should record data.

Complete the experiment by following the "Procedures" on the back of this sheet.

Procedures:

1. Be sure the "tree model" experimental setup matches the demonstration setup or the example in the image. Be sure that the tree model stand is on a metal tray.
2. Clamp a wooden match pointing **downward** in the alligator clip.
3. When the **Timer** and **Measurer** are ready, the **Observer** should use the stove lighter to ignite the downward-pointing match. Then have the **Recorder** record the group's measurements and observations in **Table 2** below.

4. Wearing gloves, remove the burnt match and place it on your group's metal tray. Clamp another downward-pointing match in the alligator clip and repeat step 4.
5. Now, with a match pointing upward, complete two more trials.
6. Complete the data table and, then, answer the questions at the bottom of the page.
7. When you have finished the activity, be sure to clean up your group's station appropriately;. e 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.

Table 2: Flame Length and Burn Time

Sample measurements have been included. Measurements could have a wide range of values.

	Match pointing:	Upward	Downward
Flame Length (cm)	Trial 1	5	15
	Trial 2	4	18

	Average	4.5	16.5
Match Burn Time (s)	Trial 1	15	25
	Trial 2	12	16
	Average	13.5	20.5
Use the fire triangle to explain why the upward-pointing matches went out.	Not enough heat.	Heat rising doesn't allow for fuel below to burn.	Usually fuel remains; unburned matchstick.
Use the fire triangle to explain why the downward-pointing matches went out.	Ran out of fuel.	Matchstick completely burned.	Plenty of rising heat for ignition.
Explain similarities or differences in flame length between upward- and downward-pointing matches.	Upward-pointing matches have longer flame length.	The rate of fuel combustion is greater.	More energy being released per unit time.
Explain similarities or differences in "burn time" between upward- and downward-pointing matches.	If matches completely consumed, upward-pointing matches have shorter burn times.	Burn times may be similar depending on how much the matches are combusted.	Upward-pointing matches may have a shorter burn time if the match is not completely consumed.

Additional Notes:

- Lack of oxygen or "running out" of oxygen is not a correct explanation for this activity. Enough O_2 is present in the laboratory's air for combustion to continue if there is sufficient fuel and a source of heat.

- The downward-pointing matches probably burned almost completely. The fire went out mainly because it ran out of fuel. If a tiny stub of unburned wood remained in the alligator clip, it didn't burn because the clip absorbed much of the heat and limited the oxygen that could get to the fuel.

- The upward-pointing match probably went out before it burned completely, so it could not have been limited by fuel. Students may guess that it was limited by oxygen. You can respond to this by asking if they have any indication that the air around them is

short of oxygen – were they having trouble breathing? The explanation lies in the relationship between heat and fuel. Most of the heat was moving up, away from the fuel, as they learned in the heat plume activity. If any heat was going down, it was not sufficient to keep the wood burning.