

Activities

Activity 1: Combustion and Extinguishers

Part 1: How a Candle Works

Here are some simple facts to know about candles and how they work. The wick, which is usually made of soft material, is naturally **absorbent** and has a strong **capillary action**, meaning it soaks up or absorbs liquid effectively. This absorbency is important – the wick needs to absorb liquid wax and move it upward while the candle is burning.

Candles are often made of paraffin wax, which comes from crude oil. Optionally, find an old candle from around your house and light it. (Don't use the candle from your kit.) The ignition source (your match) burns the wick, which starts to melt the wax in and near the wick. The wick absorbs the liquid wax and pulls it upward. The heat of the flame evaporates the wax, which then burns. It is the wax's vapor, not the liquid wax, that burns. When you are done observing the candle, blow it out.

NOTE: The white smoke you see when you put the candle out is the vapor condensing. Paraffin wax melts at about 55(degrees)C or 131(degrees)F, and vaporization occurs at approximately 224(degrees)C or 435(degrees)F.

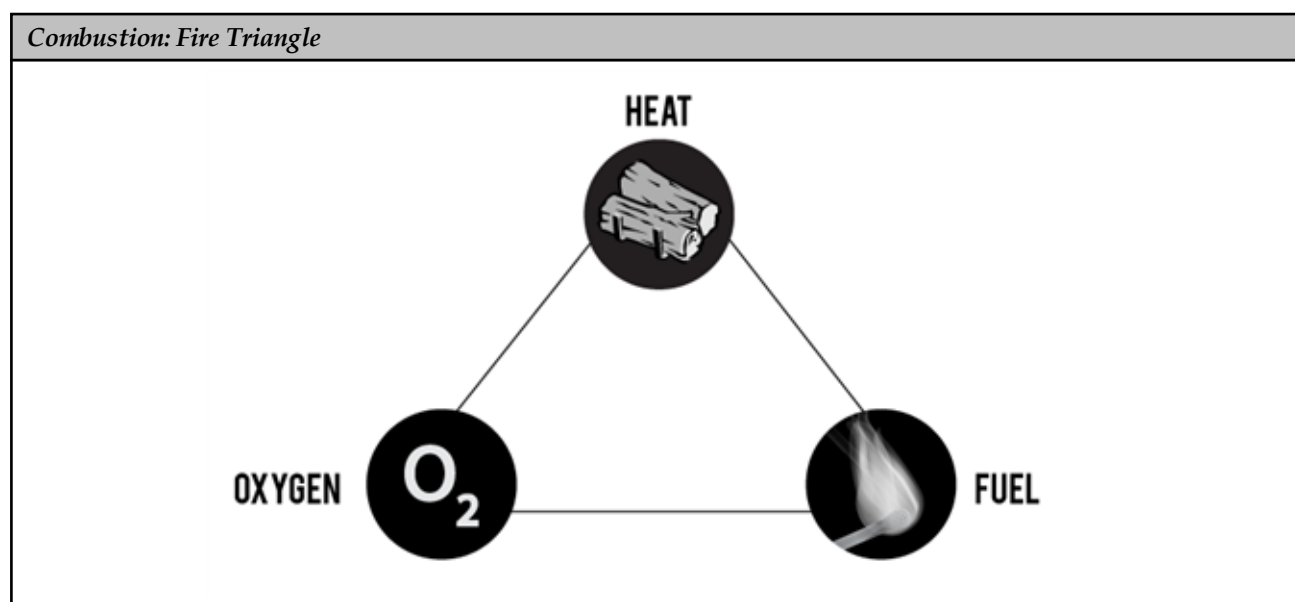
Here is the chemical equation for the combustion of paraffin wax:



Notice that the number of each element remains the same on both sides of the equation:

- 52 hydrogen atoms
- 76 oxygen atoms
- 25 carbon atoms

Combustion reactions in general require three things: oxygen, heat, and fuel. These three create what is called the fire triangle. If one of the three components of the fire triangle is removed, combustion stops.



The goal of the next two activities is to show you the importance of the three components working together. In the activities, you will limit oxygen or limit heat and see what the effect is. Note that you will be working with combustion using a very controlled flame.

CAUTION: This activity involves the use of fire. Follow all directions carefully. Adult supervision is recommended. Do NOT use the thermometer to measure the heat of the flame.

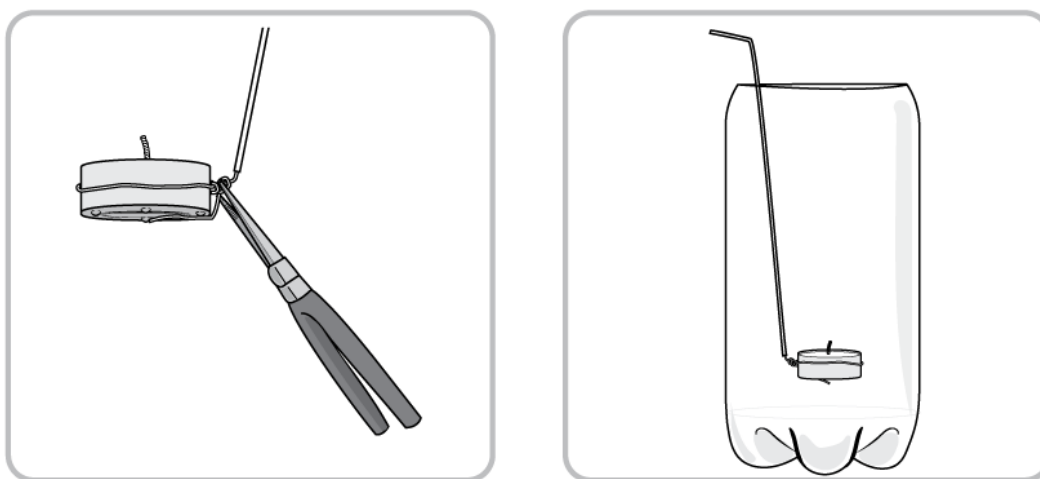
Part 2: Simple Fire Extinguisher

In this part of the activity, you will combine varying amounts of vinegar and baking soda in a 2-liter bottle and then lower a candle into the bottle to see what happens. You will need a partner to help you. When you combine vinegar and baking soda, a basic chemical reaction occurs (represented by the following equation).



Before you begin, gather your materials: empty 2-liter bottle (or old pitcher of similar size), copper wire, pliers, scissors, vinegar, baking soda, measuring cups and spoons, candle, matches or lighter, thermometer, marker, and ruler. Be sure that the vinegar and baking soda are room temperature (that they have not been stored in a refrigerator or other cold area). NOTE: There are 4 different trials in this part of the activity. You can either prepare 4 different empty two-liter bottles (one for each trial), or use one bottle and thoroughly clean and rinse the bottle with lukewarm water between trials.

Follow these steps, using the following illustration as a guide:



1. Cut off the top of an empty two-liter bottle (or use an old pitcher). The hole should be large enough to be able to lower the candle.
2. Wrap the bare wire around the candle and use pliers to twist it well, making sure that the wire is secure and not sliding (refer to the illustration). Bend any excess bare wire under the candle for extra support. Be sure that plenty of wire is available above the candle. You can bend some of it to act as a handle. Practice using the wire to lower the candle into the empty bottle. (Note that if your wire is insulated, you will need 6" or more of the wire to be bare. Strip the wire as needed.)
3. Measure the temperature of the vinegar and record it on the "Combustion and Extinguishers" activity page under "Room Temperature." You can include the same reading for all 4 trials.
4. Combine 1 tsp. vinegar and 1 tsp. baking soda in the bottom of the bottle.
5. The mixture will bubble. Let the bubbling continue until it stops.
6. Insert the thermometer into the baking soda and vinegar mixture; record this reading in the "Temperature of Mixture" column of the table.
7. Have a parent or partner hold the candle and wire steady while you light the candle. Firmly grasp a spot on the wire safely away from the flame. If your wire is not insulated, you may want to use pliers to hold it in case it gets hot. Slowly and carefully lower the candle into the bottle.

8. Observe what happens. At what height did the flame on the candle go out? Make a mark using a marker on the outside of the bottle to mark when the flame stops burning. (NOTE: You will want to slowly lower the candle until the flame goes out. Carbon dioxide gas causes the candle to go out.) Remove the candle from the bottle.
9. Measure the height of the mark starting from the base of the bottle. Record the measurement in the "Observation" column.
10. If you are using the same bottle for each trial, thoroughly clean and rinse the bottle before starting the next trial.
11. Repeat Steps 4-10 for Trials #2, 3, and 4. Each trial involves a different amount of vinegar and baking soda. Consult the activity sheet for amounts. **NOTE:** Trials 3 and 4 will most likely overflow the bottle. Be sure to combine the vinegar and baking soda outside or over a sink! You can set the bottle back on the counter when the mixture has finished bubbling.
12. Answer the questions at the bottom of the activity page. Remember these important facts: carbon dioxide is heavier than oxygen; when oxygen and carbon dioxide are in a container, carbon dioxide will settle to the bottom and push oxygen upward, basically removing oxygen from the bottom of the bottle.

Part 3: Mesh Screen Fire Extinguisher

Remember that if any of the three items required for combustion is removed, the fire will go out. As you saw in Part 2, removal of fuel oxygen will put the fire out. In this part of the activity you will remove the third component of the fire triangle — heat. A common way to do this is to use water, which removes heat through changes in state from a liquid to a gas (boiling and steam), also known as evaporation. Think about what happens when you have been sweating and a breeze is blowing — you cool down as your sweat evaporates. This is the same idea with water. Another way to remove heat is to distribute the heat so that the candle wick does not burn. When you distribute heat, you are spreading it over a wide area, which serves to lower the temperature. Think about what happens when you put something hot into water. Evaporation occurs, but the heat is also distributed throughout the water, cooling the object. The same happens when you place a wire mesh on a flame — it distributes the heat and lowers the temperature. Follow the directions to see what happens.

For this part of the activity, you will need a candle, matches or lighter, and a wire mesh screen or metal strainer. Follow these steps:

1. Light the candle. (If you are using the tea candle from Part 2, be sure to remove the wire before lighting.)
2. Hold a wire mesh screen it over the top of the candle. (Be careful not to get your hands near the flame.)
3. Observe what happens.

Combustion and Extinguishers



Trial #	Vinegar Amount	Baking Soda Amount	Room Temperature	Temperature of Mixture	Observation (height of mark)
1	1 teaspoon	1 teaspoon			
2	1 tablespoon	1 tablespoon			
3	3¼ cup	¼ cup			
4	4½ cup	½ cup			

Questions to Consider

What happened to the flame in the bottle?

What do you think will eventually happen to the carbon dioxide in the bottle?

What would happen if you tried this experiment again thirty minutes later?

What part of the flame triangle does each of the following represent?

Candle wax: _____

Air outside the container: _____

The match that lit the candle: _____

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CAUTION: This activity involves the use of fire, so your child should exercise caution. Parental supervision and assistance is required.

For the table, your child should see the temperature of the vinegar and baking soda mixture decrease in comparison to room temperature. The height of the mark for where the candle goes out should be moving higher on the bottle as the amounts of both reactants are increased. This number will vary based on the size of the bottle.

Answer Key:

- *What happened to the flame in the bottle?*
Carbon dioxide forced the oxygen in the bottle upward. Once this occurred, the flame would go out when it was placed in the area occupied by carbon dioxide.
- *What do you think will eventually happen to the carbon dioxide in the bottle?*
Diffusion will disperse the carbon dioxide as long as the bottle remains open.
- *What would happen if you tried this experiment again thirty minutes later?*
Once the carbon dioxide diffuses (mixes with the air outside the bottle), the amount of oxygen in the bottom of the bottle will increase, making it possible for the flame to burn further down in the bottle.
- *What part of the flame triangle does each of the following represent?*
 - *Candle wax:* fuel
 - *Air outside the container:* oxygen
 - *The match that lit the candle:* the heat source that lit the candle