Candle Lab

Lesson 1 of 2

Grade Level: 9-12
Subject(s): Chemistry
Prep Time: < 10 minutes
Activity Duration: 50-minute class period
Materials Category: Special requirements

National Education Standards				
Science	Mathematics	Technology		Geography
		ISTE	ITEA	
3b, 3c				

Objective:

To investigate the process of combustion, and to explain the process of burning in chemical terms.

Materials:

- Long, tapered candle
- Matches
- 3” x 5” index card
- Beaker
- Flask
- Wire
- Wooden splint
- Clay or play dough
- Safety goggles

Related Link(s):

Microgravity — A Teacher’s Guide — EG-1997-08-110-HQ
http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/Microgravity/Microgravity.Teachers.Guide.pdf

Candle Flames in Microgravity, Glenn Research Center, Cleveland, Ohio
http://liftoff.msfc.nasa.gov/sites/ExternSite.asp?url=http://microgravity.nasa.gov/Combustion.html

Candle Lab

Teacher Sheets

Pre-lesson Instructions

Review lab safety with students.

Background

This activity is a great way to start students thinking about and describing events in chemical terms. Encourage students to explain how and why a process is occurring. It is also a good time to review laboratory safety.

Candles are useful for illustrating the complicated physical and chemical processes that take place during combustion. Combustion is a rapid oxidation accompanied by release of energy in the form of heat and light. Candles are often taken for granted, but they have been the object of scientific study for hundreds of years. Michael Faraday, the famous, 19th-century English scientist who discovered many principles of electricity, wrote that "there is no more open door by which you can enter into the study of natural philosophy [science] than by considering the phenomena of a candle."

Guidelines

1. Read the 9-12 NASAexplores article, “Preventing Fires On The Launch Pad,” and discuss the preventive measures taken to eliminate the risk of fire on the launch pad.
2. Divide students into groups of three to four.
3. Ask students to point out the location of the fire extinguisher, emergency shower, and fire blanket. Ask a student to explain how they are both used.
4. Remind students to tie back long hair, and push loose, long sleeves upward on their arms.

Discussion / Wrap-up

Answers to questions.

1. Heat, carbon dioxide, wax vapor, liquid wax
2. Fuel, heat, oxygen
3. Answers will vary.

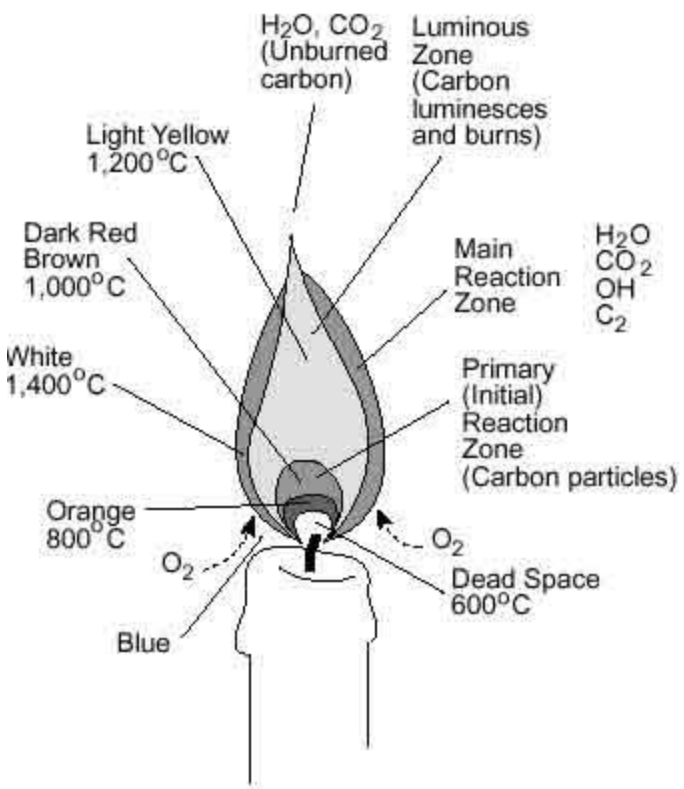
Chemical description of a burning candle

Twenty five percent of the energy created by combustion is given off as heat. A small portion of the radiant heat from the candle flame feeds back into the candle and melts the wax to fuel the flame. The candle flame surface itself is the place where fuel (wax vapor) and oxygen mix and burn at high temperatures, radiating heat and light. Heat from the flame is conducted down the wick and melts the wax at the wick base. The liquid wax rises up the wick because of capillary action. As the liquid wax nears the flame, the

flame's heat causes it to vaporize and combine with oxygen. The vapors are drawn into the flame where they ignite. The heat produced melts more wax, and so on. Carbon dioxide and water is produced and forms and reforms many carbon rich particles (soot). The soot is drawn up into the top part of the flame where increased temperature causes the carbon to luminesce and burn. Fresh oxygen from the surrounding air is drawn into the flame primarily because of convection currents that are created by the released heat. Hot gases produced during burning are less dense than the cooler surrounding air. They rise upward, and, in doing so, draw the surrounding air, which contains fresh oxygen, into the flame. Solid particles of soot that form in the region between the wick and flame are also carried upward by the convection currents. They ignite and form the bright yellow tip of the flame. The upward flow of hot gases causes the flame to stretch out in a teardrop shape.

The wax is actually a complex mix of various long molecules that all have a chain of carbon atoms as a "backbone." Many hydrogen atoms are attached to the carbon atoms .

Draw the picture below on the board, or make an overhead transparency. Discuss the emissions, reaction zones, and the different temperatures.



Candle Flame Reaction Zones, Emissions, and Temperature

- Complete combustion activities in Microgravity — A Teacher's Guide — EG-1997-08-110-HQ
  http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/Microgravity/Microgravity.Teachers.Guide.pdf

Candle Lab

Student Sheet(s)

Objective

To investigate the process of combustion, and to explain the process of burning in chemical terms.

Materials

- Long, tapered candle
- Matches
- 3” x 5” index card
- Beaker
- Flask
- Wire
- Wooden splint
- Clay or play dough
- Safety goggles

Prelab Questions

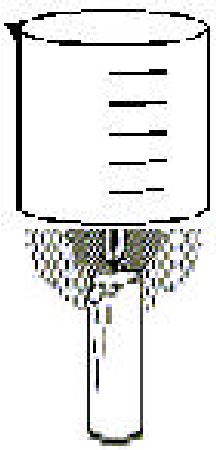
a) What does a burning candle produce?
b) How does a candle work?

Procedure

After each step, write a detailed description of your observations.

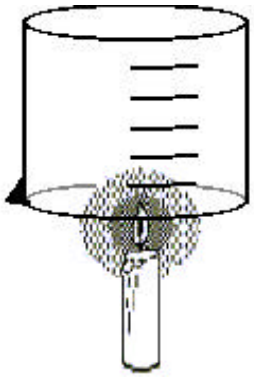
Step 1

a) Place a candle upright in a ball of play dough or clay.
b) Light the candle, lower a clean, dry 250-ml beaker (right side up) into the candle flame, and hold it there for a moment. The candle flame should just touch the bottom of the beaker.
c) Write observations.



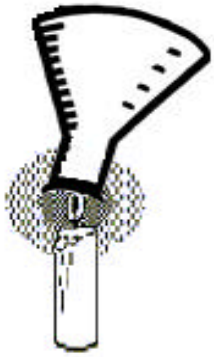
Step 2

a) Hold a clean, dry 400-ml beaker upside down over the burning candle.
b) Locate the flame just inside the mouth of the beaker so that it will continue to burn.
c) Hold the beaker at this height for a few seconds, and note the appearance of the material, which collects on the sides of the beaker.



Step 3

a) Hold a clean, 125-ml flack upside down so that the mouth is just above the candle flame.
b) Hold it in this position for 30 seconds or more, then place it upright on the table. CAUTION: the neck of the flask will be very hot!
c) Add enough limewater to just cover the bottom of the flask.
d) Add approximately the same amount of limewater to a second flask, which will be used as a control.
e) Swirl the solution in each flask (at the same time) until a change occurs in one of the flasks.

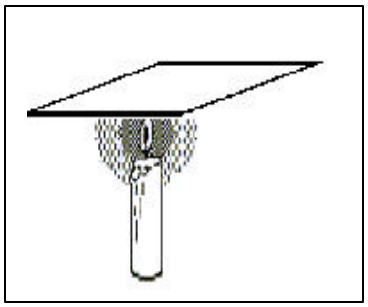


Step 4

a) Fill a small glass vial 1/8 full of limewater solution.
b) Use a clean straw to blow your breath into the limewater solution.
c) Describe observation.

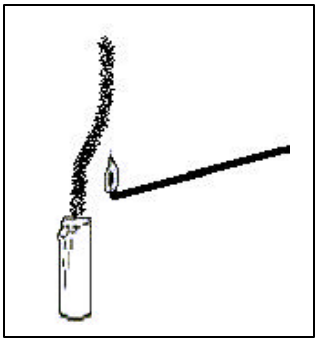
Step 5

a) Light your candle, and allow it to burn for 1 minute.
b) Quickly lower a white 3” x 5” index card (held horizontally) down into the candle flame.
c) Hold the card in this position until the upper side of the card begins to scorch, but not until it catches on fire. Hold it steady.
d) If it does catch on fire, place the burning index card in a beaker, and try again with a new card.
e) Note the scorch pattern on top of the card.



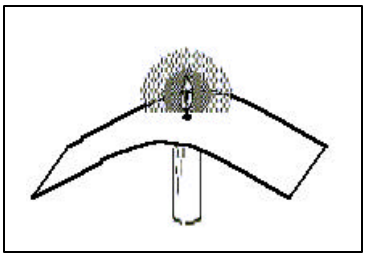
Step 6

a) Light a candle, and allow it to burn for 1 minute.
b) Hold a wood splint in the candle flame until it catches on fire, then hold the burning splint away from the candle.
c) Blow out the candle with a short puff of breath and immediately hold the burning splint about ¼ inch from the candle wick in what appears to be smoke rising from the candle.
d) If there is no apparent result, try again.



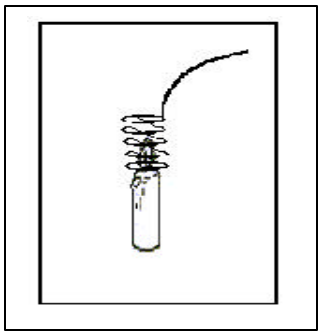
Step 7

a) Burn your candle for 1 minute.
b) Blow out the candle.
c) Obtain a strip of aluminum foil, and punch a small hole in it with a pencil point.
d) Adjust the aluminum foil strip so that it will slip over the wick but will curve just above the body of the candle without touching it.
e) Light the wick, and note the results.
f) Relight the wick if necessary.



Step 8

a) Light your candle, and allow it burn for 1 minute.
b) Take a piece of copper wire, and coil it around your pencil.
c) Leave about 3 inches of wire uncoiled at one end; this will be the end you hold.
d) Remove the coiled wire from the pencil.
e) Holding the straight end of the wire, lower the coil around the wick and flame of your candle.
f) Lift the coil up and down, and observe the results.



Questions:

1. Name four things a burning candle produces.
2. List at least two things that are required for a candle to burn.
3. State three lab rules.