Candle Flames

Lesson 1 of 2

Grade Level: 5-8
Subject(s): Physical Science, Mathematics
Prep Time: 10-30 minutes
Activity Duration: One class period
Materials Category: Special requirements

National Education Standards				
Science	Mathematics	Technology		Geography
		ISTE	ITEA	
2a, 3a, 3c	14a, 14b, 14c			

Objective: To investigate the effect of gravity on the burning rate of candles.

Materials:

- Birthday candles (two per group)
- Matches
- Balance beam scale (0.1 gm or greater sensitivity)
- Clock with second hand or stopwatch
- Wire cutter/pliers
- Wire (florist or craft)
- 20-cm square of aluminum foil
- Eye protection

Related Links:

New Science: A New Flame
http://kids.msfc.nasa.gov/News/2000/News-Flames.asp

Candle Flames

Teacher Sheets

Pre-lesson Instructions

- This activity can serve as an introduction to the candle drop activity in lesson two.
- The wire used in this activity is a lightweight wire like that used by florists and in craftwork. **Do not use wire with plastic insulation due to the flame of the candle tipped at an angle of 70 degrees may reach the wire and begin burning the insulation.**
- Since students will be working in groups and using fire, make certain you go over lab safety rules.
- Be sure all materials are either centrally located or already distributed to the groups.

Background

Combustion studies in microgravity are important to spacecraft safety. Unlike house fires on Earth, you cannot run outside of a Space Station and wait for the fire department to arrive. Fires have to be extinguished quickly and safely. To do this, it is essential to understand how fires are ignited in microgravity and how they spread. The goal is to prevent fires.

Candles are useful for illustrating the complicated physical and chemical processes that take place during combustion. 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 rises up the wick because of capillary action. As the liquid nears the flame, the flame's heat causes it to vaporize. The vapors are drawn into the flame where they ignite. The heat produced melts more wax, and so on.

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, containing 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.

Guidelines

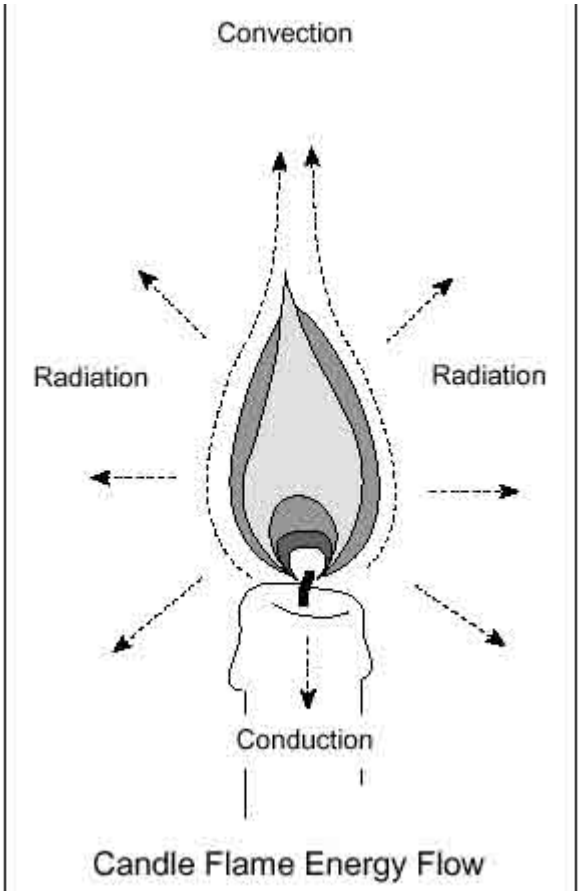
1. Read the 5-8 NASAexplores article,"Fire Prevention In Space," and discuss students' knowledge of fire and fire prevention.
2. Make a list of terms that can be used to describe flame shape, size, color, and brightness.
3. Review skills for writing a hypothesis before the groups begin. They will have to write hypotheses to explain the differences observed in the burning of the two candles. The hypotheses should relate to gravity-induced effects.
   In the case of candle 2, the wax of the candle is above the flame. Convection currents (a gravity-driven phenomenon) deliver lots of heat to the candle, which causes more rapid melting than occurs with candle 1. Much of that wax quickly drips off the candle (gravity pulls the wax off), so more wick is exposed, and the candle burns faster.
4. Each group will need two wires about 20 centimeters long.
5. Precut the aluminum foil into 20-centimeter squares.
6. One square is needed for each group.
7. Provide each group with one set of Student Sheets.

Discussion / Wrap-up

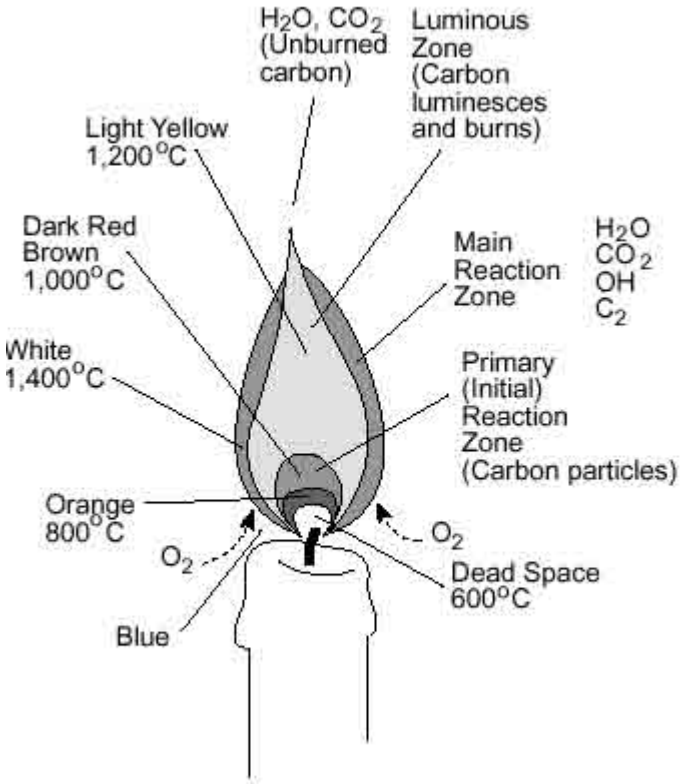
- Discuss the students' observations of the candle burning and their hypotheses.
- Collect the Student Sheets for teacher assessment.

Extensions

- Repeat this experiment with the candles inside a large sealed jar. Let the candles burn to completion. Record the time it takes each candle to burn. Determine how and why the burning rate changed.
- Burn two candles close together. Record the burning rate, and weigh the candles. Is the burning rate faster or slower than each candle alone? Why?



Candle Flame Energy Flow



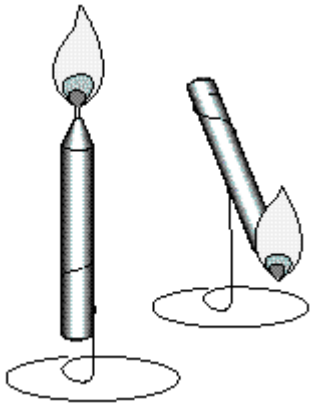
Candle Flame Reaction Zones, Emissions, and Temperature

Candle Flames

Student Sheets

Procedure

1. Make a wire stand for each candle so that it looks like the picture below.
2. Candle 1 should be in an upright, 90° angle. Candle 2's wick should be tilted toward the ground with the candle bottom at about a 70° angle from the base.



Candle 1 Candle 2

3. Weigh each candle by standing it on a balance beam scale, and record its weight in grams on the chart on the next page.
4. Put on eye protection.
5. Place candle 1 on the aluminum square. Light the candle, and let it burn for 1 minute. While it is burning, observe what is happening, and write your observations below.

6. Draw a picture of the candle flame.

7. Weigh candle 1 again, and record its mass in the chart.

8. Place candle 2 on the aluminum square. Light the candle, and let it burn for 1 minute. While it is burning, observe what is happening, and write your observations below.

9. Draw a picture of the candle flame for candle 2.

10. Weigh candle 2 again, and record its mass in the table.
11. Calculate the difference in mass for each candle, and enter your answers in the table.

Candle Mass Table

	Candle 1	Candle 2
Before burning mass		
After burning mass		
Difference		

12. Summarize your observations below.

13. Write a hypothesis for how you think a candle will burn in microgravity.