

Activity 11

Candle Drop

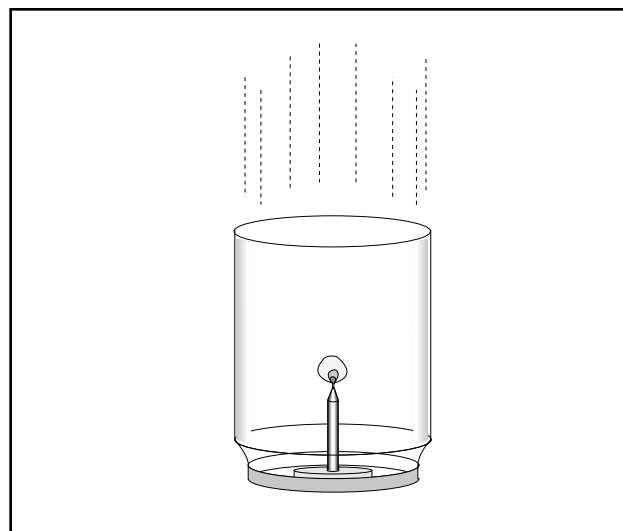
OBJECTIVE:

To observe candle flame properties in free fall.

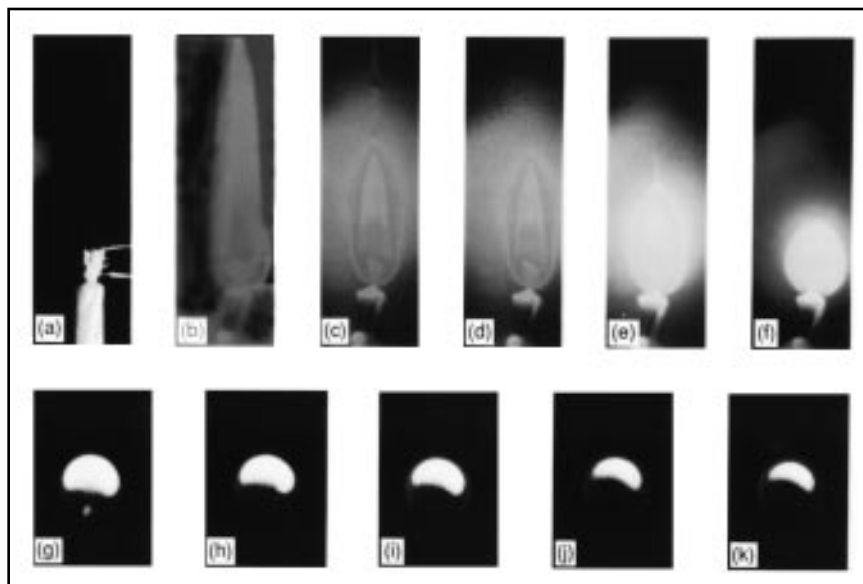
BACKGROUND:

Drop tower and Space Shuttle experiments have provided scientists valuable insights on the dynamics and chemistry of combustion. In both research environments, a flammable material is ignited by a hot wire, and the combustion process is recorded by movie cameras and other data collection devices.

The sequence of pictures beginning at the bottom of this page illustrates a combustion experiment conducted at the NASA Lewis Research Center 150 Meter Drop



Tower. These pictures of a candle flame were recorded during a 5-second drop tower test. An electrically-heated wire was used to ignite the candle and then withdrawn one second into the drop. As the pictures illus-



trates, the flame stabilizes quickly, and its shape appears to be constant throughout the remainder of the drop.

Microgravity tests performed on the Space Shuttle furthered this research by determining the survivability of a candle flame. If the oxygen does not diffuse rapidly enough to the flame front, the flame temperature will diminish. Consequently, the heat feedback to and vaporization of the candle wax will be reduced. If the flame temperature and these other processes fall below critical values, the candle flame will be extinguished. Candles on board the first United States Microgravity Laboratory, launched in June 1992, burned from 45 seconds to longer than 60 seconds.

MATERIALS NEEDED:

Clear plastic jar and lid (2 liter volume)*
Wood block
Screws
Birthday-size candles
Matches
Drill and bit
Video camera and monitor (optional)

* Empty large plastic peanut butter jar can be used.

PROCEDURE:

- Step 1.** Cut a small wood block to fit inside the lid of the jar. Attach the block to the jar lid with screws from the top.
- Step 2.** Drill a hole in the center of the block to serve as a candle-holder.
- Step 3.** Insert a candle into the hole. Darken the room. With the lid on the bottom, light the candle and quickly screw the plastic jar over the candle.

Step 4. Observe the shape, brightness, and color of the candle flame. If the oxygen inside the jar is depleted before the observations are completed, remove the jar and flush out the foul air. Relight the candle and seal the jar again.

Step 5. Raise the jar towards the ceiling of the room. Drop the jar with the lit candle to the floor. Position a student near the floor to catch the jar.

Step 6. As the candle drops, observe the shape, brightness, and color of the candle flame. Because the action takes place very quickly, perform several drops to complete the observation process.

QUESTIONS:

1. Did the candle flame change shape during the drop? If so, what new form did the flame take and why?
2. Did the brightness of the candle flame change? If it did change, why?
3. Did the candle flame go out? If the flame did go out, when did it go out and why?
4. Were the observations consistent from drop to drop?

FOR FURTHER RESEARCH:

1. If videotape equipment is available, videotape the candle flame during the drop. Use the pause control during the playback to examine the flame shape.
2. If a balcony is available, drop the jar from a greater distance than is possible in a classroom. Does the candle continue to burn through the entire drop? For longer drops, it is recommended that a catch basin be used to catch the jar. Fill up a large box or a plastic trash can with styrofoam packing material or loosely crumpled newspaper.