

## Boiling Water at Reduced Temperatures

### Purpose

To demonstrate that boiling is a function of vapor pressure and not temperature.

### Materials

1 liter round bottom boiling flask	clamp for round bottom
ice (in a ziplock bag)	Optional:
stopper to fit flask	thermometer
ring stand	1 hole stopper to fit flask
asbestos glove	

### Procedure

1. Half fill the flask with tap water.
2. Clamp the flask to a ring stand.
3. Heat the water until boiling and the vapor fills the flask.
4. Remove the heat source, and firmly insert the rubber stopper.
5. Invert the flask assembly carefully.
6. Place the ziplock bag with the ice water on the top of the flask. This will cool the gas within the flask.

### Additional Information

1. Do not allow temperature to drop below 10 C. It may implode at such a low pressure.
2. Do not use anything but a round bottom flask.
3. Condensing the water vapor reduces the pressure inside the flask. Thus, boiling will occur below the “normal” boiling point.
4. A vacuum pump can also be used effectively to demonstrate the same effect. See the Marshmallow Man demonstration for details on this variation.
5. Variation: Before the demonstration insert a thermometer through the one hole stopper. When sealing the flask, use this assembly. Take temperature readings of the boiling water as you cool the inverted flask.

### Questions for the Students

1. What is boiling? How can you tell the water is boiling?

2. What is the pressure in the flask:
  - a. before heating?
  - b. while heating?
  - c. immediately after stoppering?
  - d. while cooling with ice?

**Reference**

ICE Demonstration Workshop, University of Arizona, 1985.