BOILING POINT

GEOTHERMAL ENERGY

BRENT CUMMINGS

Time Frame:	Standards:
1 hour	8-9.PS.1.2.1 Use observations and data as evidence on which to base scientific explanations. (648.02a) 8-9.PS.1.6.1 Identify questions and concepts that guide scientific investigations. (649.01a)

Objectives:

Students will record observations, differentiate between observations and inferences, and answer questions using the scientific method.

Students will identify the relationship between pressure and the boiling point of a liquid.

Background Information:

This activity is meant to demonstrate the relationship between pressure and the boiling point of a liquid. The activity can be used to show how water found underground can be heated to temperatures higher than 212° F.

A simple definition of boiling point can be found below.

> "The point at which heat added to a liquid is no longer used to increase temperature but instead to form gas from the liquid. Formally, the boiling point temperature is reached when a liquid's vapor pressure equals external pressure. Boiling points thus decrease with altitude. Water may be boiled at room temperature by decreasing the pressure around it.
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> The boiling point of a substance is the temperature at which it can change its state from a liquid to a gas throughout the bulk of the liquid at a given pressure. A liquid may change to a gas at temperatures below the boiling point through the process of evaporation. Any change of state from a liquid to a gas at boiling point is considered vaporization. Boiling on the other hand is a bulk process, so at the boiling point molecules anywhere in the liquid may be vaporized, resulting in the formation of vapor bubbles.
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> A somewhat clearer (and perhaps more useful) definition of boiling point is "the temperature at which the vapor pressure of the liquid equals the pressure of the surroundings." Hot liquid will boil as it rises through the bulk liquid if the pressure of the environment drops to the vapor pressure of the liquid at its temperature (StateUniversity, 2009)."

Safety Precautions:

This lab has several areas where safety must be taken into consideration.

- Practice this demonstration before doing it in front of your class.
- Always point the stopped end of the flask in a safe direction away from people.
- Make sure that the flask has cooled sufficiently before placing ice on it. If the flask is too hot it may shatter when ice is applied.
- Use hot pads when handling the hot flask.

Materials:

Hot plate
500 mL Florence flask
Rubber stopper
ring stand
iron ring
water
ice
Hot pads

Procedure:

This activity can take place in the lab or the classroom, but easy access to a sink is useful.

Place a 500 mL Florence flask with ~ 200 mL of water in it on a hot plate.

Ask the students to make observations about what is happening. Have them record them in their notebooks.

When the water starts to boil, have the students record what is happening in their notebooks. Discuss with the students (have them think, pair, share) the temperature that the water is at right now. Why? How do they know? (212 degrees F, 100 C) Record the temps on the board.

When there is steam coming out the top of the flask (having pushed the air out), place a rubber stopper in the top of the flask and seal firmly. IMMEDIATELY (using hot pad holders) remove the flask from the hot plate. Invert the flask (taking care to not point the stopper at anybody) and place it in the iron ring with the stoppered-opening facing down.

Record observations

Allow the water to stop boiling in the flask.

Talk about what is happening to the temperature of the water as it is sitting in the flask. (It is going down). Compare it to a cup of hot cocoa cooling, etc.

Record observations

Take ice from the cooler and rub it generously on the top of the flask (above the water). The water inside the flask will start to boil again. The more ice that is rubbed on the top of the flask, the more violently the water will boil.

Record observations

"Is the ice heating up the water?" The students should know that the ice is NOT heating the water. So what IS causing the water to boil?

Record possible inferences or hypotheses.

Discuss the difference between observations (Using senses to tell WHAT is happening) and inference (Using the information from the observations to try to answer WHY or HOW it is happening)

Discuss lab safety procedures, including the flask opening never being pointed at anybody.

Conclusions: Discuss how water can boil using ice. The drop in pressure in the flask allows the water to boil at lower temperatures (even room temperature). Lowering the pressure in the flask drops the atmospheric pressure below that of the vapor pressure of the water and the water boils. The boiling releases water vapor into the flask to increase the pressure once again (Ofstedal, 2009).

How might the boiling point of water trapped under ground be affected? What would happen to the water as if it was pumped to the surface and the pressure was reduced? Is energy released through this process? How might we use that energy to our benefit? Explain to the students that the energy which is released can be converted into electrical energy by turning a turbine.

Assessment:

Have the students write a one-page paper about observations and inferences. They will discuss observations they made about the boiling water and they will make inferences about why it worked. They can use their text books, internet, etc. as sources of information (Ofstedal, 2009).

Additional Content:

None

References:

Activity adapted from:
Ofstedal, Brit (2009, Feruary 25). Boiling water with ice: Effect of pressure on the boiling point of water. Retrieved July 21, 2009, from Minnesota Science Teachers Education Project Web site: http://serc.carleton.edu/sp/mnstep/activities/20129.html

(2009). StateUniversity.com. Retrieved July 21, 2009, from boiling point - Saturation temperature and pressure, Intermolecular interactions Web site: http://encyclopedia.stateuniversity.com/pages/3036/boiling-point.html