

Boiling point as a matter of geography

Developers: Relly Shore

Institute: The Weizmann Institute of Science

Country: Israel

Subject: Chemistry Times

Grade level: 10-12 graders

Curriculum content: steaming, boiling, evaporation, evaporating material, gas laws, and fume pressure.

Kind of activity: Inquiry laboratory

Anticipated time: 2 lessons of 90 minutes each + 1 lesson of 45 minutes.

Task description

The subject of this inquiry-laboratory activity is the possibility to boil water in a temperature that is different from 100⁰C. This phenomenon is connected to many situations that the students meet at real life, like: pressure cooker, different cooking time on high mountains, using pressure suits by pilots and astronauts etc. The inquiry laboratory activity gives the students the opportunity to explore their own questions and to experience all the stages of scientific inquiry.

General Instructions:

Note: Protective glasses and gloves must be worn!

- Read all the instructions well before beginning the experiment.
- Check that you have all the necessary equipment and materials at your disposal in order to conduct the experiment.

Equipment and materials:

1000 ml round flask

tripod or stand + a ring

about 400 ml of distilled water

cork

Bunsen burner
matches
boiling stones
towel
ceramic screen
large (2 liter) beaker with
water and ice cubes

Stage A: The Course of the Experiment

Pay attention to:

- Follow the instructions for carrying out Stage A.
 - Record as many observations as possible.
 - Have all members of the group participate in carrying out the various tasks.
 - Use correct and precise scientific language throughout the process.
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- Add water in the vessel up to 1/4 of its volume and add 3-4 boiling stones.
 - Heat the vessel until the water boils.
 - Turn off the burner.
 - Close the vessel with the cork. Be careful: the vessel is very hot! Make use of the towel.
 - Wait until the boiling stops.
 - Use the towel to hold the vessel and be careful - the vessel is very hot.
 - Cool the vessel by one of the two following possibilities:

One cooling possibility:

- Cool the vessel carefully by means of a fine stream of cold water from the faucet.

Another cooling possibility:

- Hold the vessel carefully using the towel and make sure that it is corked well.
- Place the vessel at an angle, horizontally or turned over on the ring or on the tripod. Make sure that there is no one standing opposite the cork!
- Carefully place a rag soaked in cold water on the vessel.

Stage B: The Steps of the Inquiry

1. Formulate 5 varied, relevant questions that arose following the observations made.
- Choose one of these questions that you want to investigate.

- Formulate this question clearly as an inquiry question and if possible, as a link between two variables.
 - Formulate clearly an hypothesis for the question you chose to investigate.
 - Give reasons for your hypothesis based on correct, relevant scientific knowledge.
2. Plan an experiment that will check the validity of your hypothesis.
- Detail all the stages of the experiment, including the control stage.
 - List the equipment and materials needed on a equipment request form.
 - Consult with the teacher and, if necessary, make changes.
 - Submit the list of equipment and materials to the laboratory technician.
3. Get the teacher's approval for your proposed experiment.
- Carry out the experiment that you proposed after receiving your teacher's approval.
 - Present the observations and the results in an organized manner (table, diagram, graph, etc.).
 - Analyze and Explain/ the results.
 - Draw as many conclusions as possible based on all the results of the experiments and give reasons.
 - Check the connection between the inquiry question and the results.
4. In the summarizing group discussion:
- Express your opinion about all stages of the inquiry (limitations, precision, etc.).
 - If necessary, point out the desirable changes in the inquiry process.
 - List additional questions that arose following the whole process.
 - Prepare the summary of your group's inquiry experiment for presentation before the class.
5. In the summarizing class discussion:
- Relate to the experiment considering the reports of all the other work groups.
6. Ensure that the report is well organized, aesthetic, and readable.

An additional/ version of the experiment

- Add the water to the vessel to $\frac{1}{4}$ of its volume and add 3-4 boiling stones.
- Heat the vessel to the boiling-point of the water.
- Turn off the Bunsen burner.
- Close the vessel with the cork in which there a thermometer. Be careful: the vessel is very hot! Use the towel.
- Record the temperature
- Wait until the boiling stops.
- Record the temperature.

- Hold the vessel using the towel and be careful - the vessel is very hot!
- Cool the vessel carefully by means of a fine stream of cold water from the faucet.
- Record the temperature every 20 seconds during the cooling time.
- Try to list many and varied observations.