Experimenting with Boiling Water

Challenge

Have a look at this video clip of a mud pool in Iceland.

1. What do you observe in the mud pool?
2. Try to explain what you are seeing.

What will we investigate?

We will observe the change in **temperature** as water is warmed up to boiling.
We will follow the **physical changes** as the water changes state from a **liquid** to a **gas**

Equipment and Materials

- einstein™Tablet+ or einstein™Labmate+™ paired with a tablet
- Temperature sensor (-40 to 140 °C)
- 250 mL beaker
- Tap water
- Lab stand
- Clamp
- Ruler
- Hot plate or other heat source

Note: This experiment uses a hot plate or other heat source and should be done by an adult.

Experimental Setup

1. Turn on the einstein™Tablet+ or einstein™Labmate+™ paired with a tablet.
2. Tap the MiLAB ( ) icon to open the application.
3. Set up the Temperature sensor to make measurements as shown in the table below.

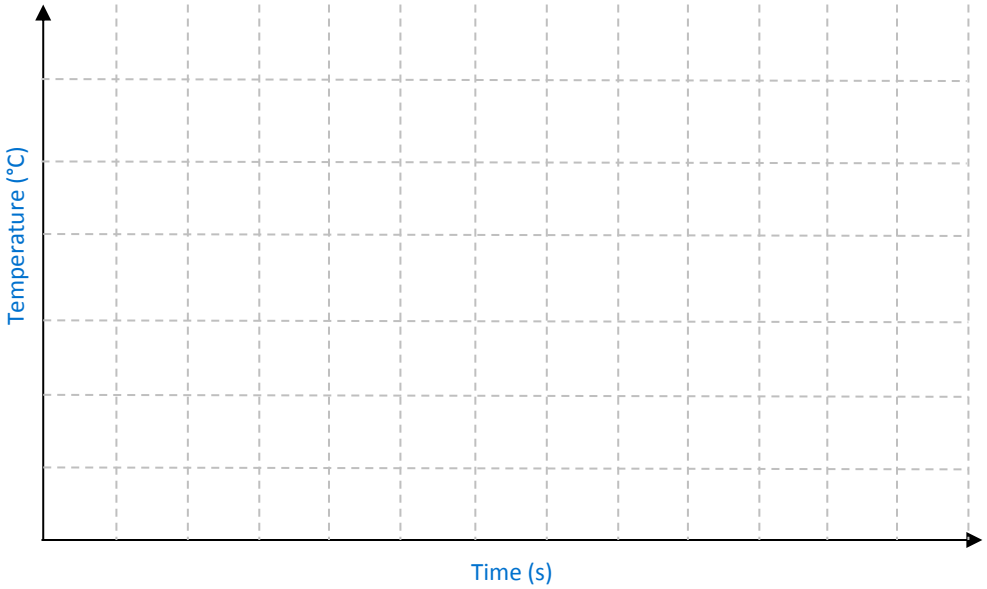
Sensor Setup

Tap the **Setup** cog ( ) and use the table below to set up the measurement parameters:

Sensor:	Temperature (-40 to 140 °C)
Rate:	1 / sec
Duration:	6 minutes

Before You Begin

1. What do you expect to happen as you add heat to the water?
2. Do you expect the temperature to go up, down or remain the same?
3. Sketch the graph of temperature vs time which you expect to observe.



Experimental Procedure

1. Connect the Temperature sensor to your einstein™-enabled device.
2. Select the external Temperature sensor (-40 to 140 °C).
3. Fill the beaker with tap water up to the 50 mL mark.
4. Put the Temperature sensor in the water and clamp it so that it is not touching the beaker.
5. Use the ruler to measure the height of the water in the beaker.
6. Tap **Run** ( ) to begin collecting data.
7. Observe the changes in the beaker of water as it is heated.
8. Observe the graph of the temperature of the water in the beaker vs time.
9. Tap **Save** ( ) to save your data.
10. Measure the height of the water in the beaker again at the end of the experiment, after the water has cooled.

Understanding the Measurements

1. Give a title to the graph.
2. What label should you give to the *y*-axis?

3. What are the units of the y-axis?
4. What label should you give to the x-axis?
5. What are the units of the x-axis?
6. What was the lowest temperature that you measured?
7. At what point during the experiment did you measure the lowest temperature?
8. What was the highest temperature that you measured?
9. At what point during the experiment did you measure the highest temperature?
10. At what temperature did the water begin to boil?
11. Did the height of the water in the beaker change from the beginning of the experiment to the end?
12. Using data from your graph, fill in the table below:

Observations of Warming Water

	State of Matter (circle one)	Temperature (°C)	Height of the Water (cm)
At the beginning of the experiment	Liquid Gas Liquid and Gas		
At the end of the experiment	Liquid Gas Liquid and Gas		

Understanding the Experiment

Have a look at your table of results and use it to give an explanation of the boiling process.

In Depth Learning

1. How much did the temperature change from the beginning of the experiment until the end?
2. Describe the temperature change that you observed.
3. At what temperature did the water change to gas?
4. What can we learn about the vaporization process? Complete the following statements:
   - **During vaporization**: Adding heat causes a change of state in the water from _____to _____
   - **Boiling point**: The temperature at which the water changed from _____ to

_____ was _____.

5. Compare your results to the predictions you made before the experiment.

Using What You Learned

Give examples of vaporization that you observe in everyday life.

Understanding the Science

Most matter can be found in one of three states: **solid** (for example, ice or iron), **liquid**, (for example, water or oil) and **gas** (for example, steam or oxygen). The state of matter describes the physical state. A change of state can be caused by a change in temperature. The change of state from solid to liquid is called **melting**. The change of state from liquid to solid is called **freezing**. The change of state from liquid to gas is called **vaporization**. The change of state from gas to liquid is called **condensation**.