Experiment HT-2
Latent heat

Chemistry

Objectives

- Understand the three classical phases of matter, phase changes, and heating and cooling curves.
- Discover why temperatures remain constant when a liquid is boiling or freezing.
- Learn about Latent Heat.

Modules and Sensors

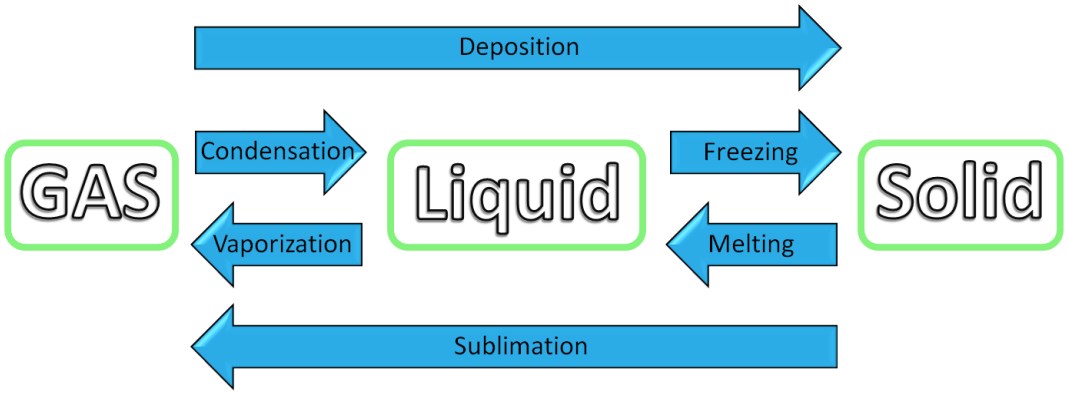
- NeuLog application software and a computer platform
- BLT-202 Bluetooth module or USB-200 USB module
- NUL-203 Temperature logger sensor

Equipment and Accessories

▪ Electric kettle	1
▪ 250mL plastic bottle	1

Introduction

The three classical phases of matter are solid, liquid and gas. Gas particles are well-separated whereas liquid particles are closer together. Solid particles are tightly packed, and are structurally rigid. The following figure describes the different types of phase changes:



A heating or a cooling curve shows the change in temperature of a sample as it is heated or cooled. Sloped regions correspond to temperature changes in one of the different states. Flat regions (constant temperature) correspond to phase changes (this will be discussed further on).

In this experiment we shall learn why temperatures are constant when liquid is boiling or freezing and about Latent Heat.

Procedure

Boiling experiment setup

1. Connect the temperature logger sensor to the BLT module (or use the USB module instead).

2. Put the temperature probe into an electric kettle with three glasses of tap water in it.

3. Turn on the BLT module by pressing the button on the module panel.

> **Note:**
>
> The following application functions are explained briefly. It is recommended to practice the NeuLog application functions (as described in the user manual) beforehand.

4. Run the NeuLog application and check that the temperature sensor is identified.

Settings

5. Click on the **Run Experiment** icon  and set the:

   Experiment duration to: **2 minutes**
   Sampling rate to: **5 per second**

Testing and measurements

6. Click on the **Record** icon  to send the setup parameters to the sensors and to start the measurement.

7. Turn on the electric kettle.

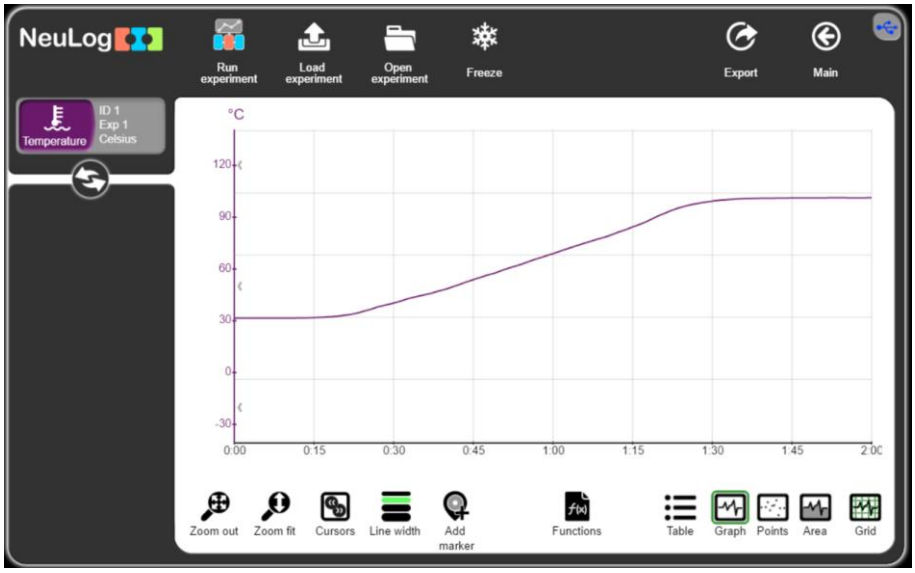
8. Click on the **Arrows** icon  in order to see the sensor's values during the measurement.

9. You can click on the **Zoom fit** icon  during the measurement to observe changes in the graph more clearly.

10. Turn off the electric kettle at the end of the experiment.

11. Click on the **Zoom fit** icon  .

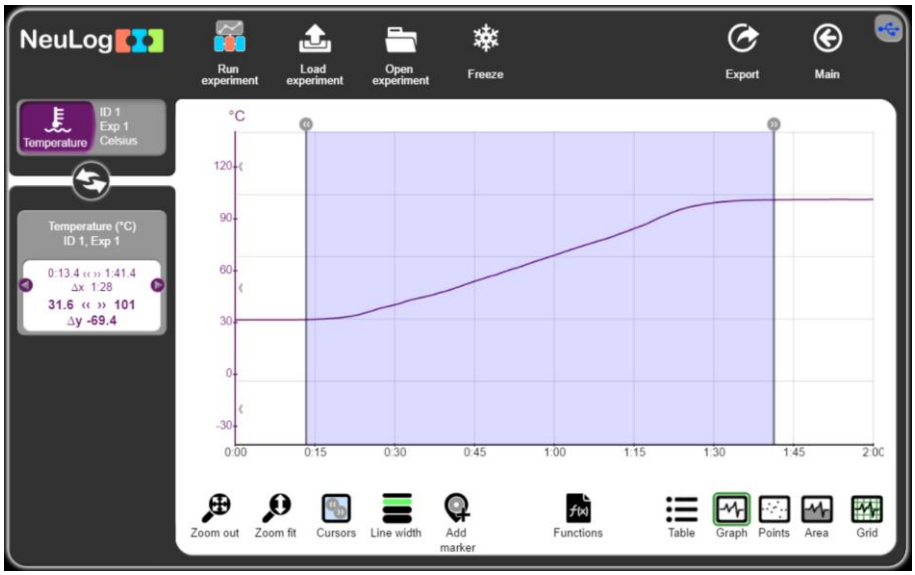
12. Your graph resembles the following:



13. Click on the **Export** icon  , type the name of the experiment and click on the **Save value table (.CSV)** button to save your experiment measurements.

14. Click on the  icon to go back to the graph.

15. Add cursors and move them.



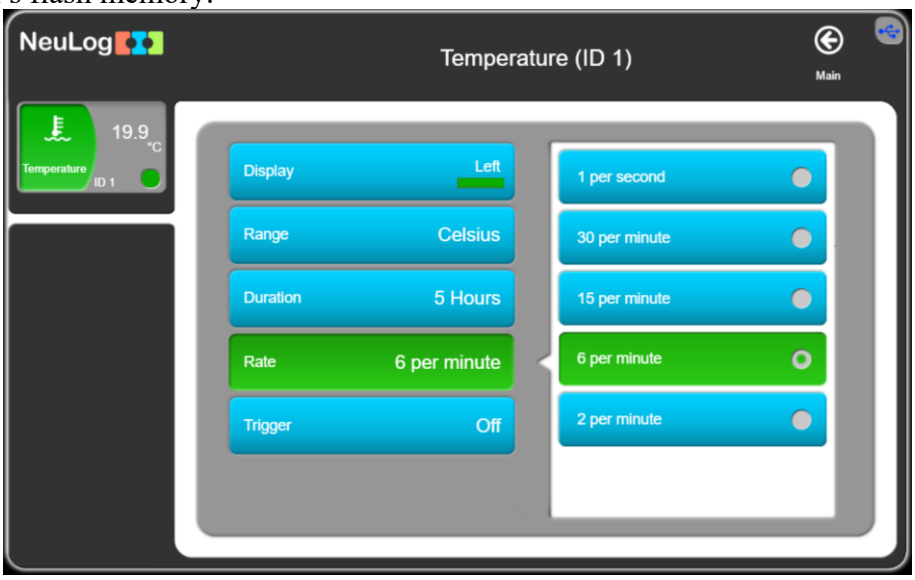
16. The measurement starts at room temperature and stops rising at 100 ºC.

    The reason that the temperature stays at 100ºC is latent heat. Latent heat is the amount of energy absorbed or released by a substance during a change in its physical state (solid, liquid, gas) without a change in temperature. The temperature was constant because heat was absorbed as latent heat of vaporization.

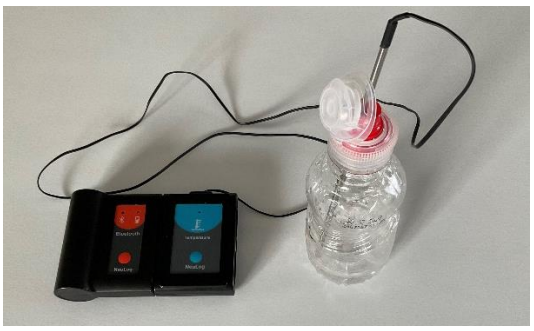
Freezing experiment

17. Return to the Main screen and click on the sensor image for Off-line experiments.

    Set the Duration to 5 hours, with a sampling rate of 6 samples per minute in the sensor's flash memory.



18. Fill a plastic bottle with approximately100 milliliters of water and insert the temperature probe into the bottle.



19. Turn on the BLT module by pressing the button on the module panel.

20. Turn off the BLT module by pressing its orange button for 5 seconds.
    Now the BLT module acts only as a battery module.
    Alternatively, you can connect the sensor to a battery module.

21. Place the bottle with the temperature probe in the freezer but leave the BLT and the temperature modules outside of the refrigerator.

22. Press the Start/Stop button on the sensor panel.
    The sensor LED on the sensor turns on to indicate experiment running.

23. Wait 5 hours or more and then take the bottle and the probe out of the freezer.

24. Turn on the BLT module (or connect the temperature sensor to the USB module) and run the Neulog software.

25. Click on the 'Load experiment' button.
    The opened window shows up to 5 saved experiments in the sensor's flash memory.

26. Click on the orange button and the saved experiment is loaded and displayed.

27. Add cursors and move them.
You can observe that the temperature decreases and remains constant at 0 degrees Celsius.
The temperature continues drop once all the water has turned into ice.

Interesting

28. Return to the main screen and check the temperature.
When the ice starts to melt, and you have ice and water, the temperature should be $0^{o}C$.

29. Add about 3 spoon of salt and shake the bottle well.
What happened to the ice temperature?

Challenge experiments

30. Repeat the boiling experiment with salt water by adding two spoons of salt to approximately 200 milliliters of water (stir the solution well).
What happened to the boiling point temperature?

31. Repeat the freezing experiments with salt water by adding one spoon of salt to approximately 100 milliliters of water (stir the solution well).
What happened to the freezing point temperature?

Summary questions

1. If we close the kettle's cover, will the boiling temperature be higher or lower than 100 °C?

2. Provide examples of liquids with boiling and freezing points different from water.

3. What is the boiling point temperature of salt water:
   a. Above 100ºC.
   b. 100ºC.
   c. Below 100ºC.

4. What is the freezing point temperature of salt water:
   a. Above 0ºC.
   b. 0ºC.
   c. Below 0ºC.

5. What happened to the ice when we added salt?

6. Why do we pour salt on icy roads?