Melting and freezing curve of sodium thiosulphate with measureAPP (Item No.: P1044668)

Curricular Relevance

Area of Expertise: Physics

Education Level: Age 14-16

Topic: Thermal physics

Subtopic: States of matter: Melting, boiling, evaporation

Experiment: Melting and freezing curve of sodium thiosulphate with measureAPP

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	40 Minutes	2 Students

Additional Requirements:

- Apple iPad
- measureApp
- matches or lighter

Experiment Variations:

Keywords:

temperature curve, heat of fusion, undercooles liquid, solidification

Information for teachers

The behaviour of the temperature during melting and then finally solidification of sodium thiosulphate is measured. It can be hereby clearly seen, that heat is required for the melting process: The temperature does not increase until all of the salt has melted.
This heat is liberated again on solidification. This can be particularly clearly seen when the melt is supercooled and suddenly solidifies when a small crystal as nucleation site is thrown in. The temperature hereby again increases to the melting point.

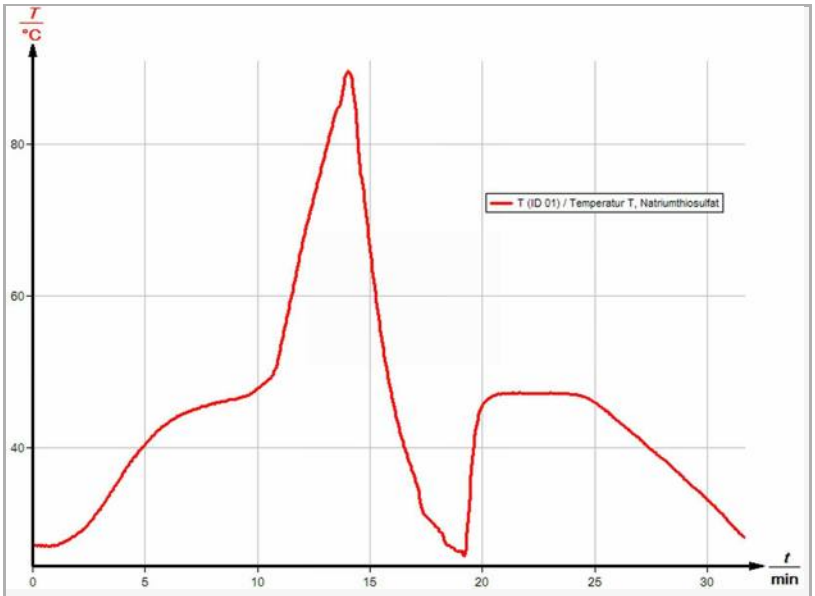

Fig. 1: Theoretical temperature curve of sodium thiosulphate

Notes on set-up and procedure

1. When the thermometer is held tight by the solid in the test tube, it can be freed by heating and so again melting the sodium thiosulphate.
2. The water soluble sodium thiosulphate can be washed down the drain.

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3. Do not move the temperature sensor during measurement of the melting curve, as then the curve would not be smooth – this is the reason for putting it right down to the bottom in the test tube.

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Introduction

Magical heat – What can be observed when a substancemelts and solidifies?

In winter, hand warmers are useful gadgets. If the substance inside is fluid, all you need to do is kink the metal piece and in less than a second your hands can be warm again. Meanwhile, the substance containing sodium thiosulfate grows stiff. But what exactly is happening there? To observe the solidification is part of the experiment you are going to conduct now, by measuring the temperature curves while heating and cooling sodium thiosulfate.

Task

Heat sodium thiosulphate until it melts and let it cool down again. Measure the behaviour of the temperature in dependence on time under uniform heat input or output.

Material

Position No.	Material	Order No.	Quantity
1	Cobra4 Wireless/USB-Link incl. USB cable	12601-10	1
2	Cobra4 Sensor-Unit 2 x Temperature, NiCr-Ni	12641-00	1
3	Immersion probe NiCr-Ni, steel, -50...400 °C	13615-03	1
4	Support base, variable	02001-00	1
5	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	1
6	Boss head	02043-00	1
7	Ring with boss head, i. d. = 10 cm	37701-01	1
8	Universal clamp	37715-00	1
9	Wire gauze with ceramic, 160 x 160 mm	33287-01	1
10	Spoon, with spatula end, 18 cm, plastic	38833-00	1
11	Beaker, low, BORO 3.3, 250 ml	46054-00	1
12	Beaker, low, BORO 3.3, 400 ml	46055-00	1
13	Test tube,200x30 mm,DURAN	36304-01	1
14	Butane burner, Labogaz 206 type	32178-00	1
15	Butane cartridge C206, without valve, 190 g	47535-01	1
16	Sodium thiosulphate pentahydrate, 500 g	30169-50	1
17	Boiling beads, 200 g	36937-20	1

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Set-up and procedure

Set-Up

Fig. 1: Set-up

- Set up the stand as shown in Fig.1.
- Fill the test tube up to a height of about 3 cm with sodium thiosulphate.
- Fill about 150 ml of water in the 250 ml beaker and add a few boiling chips. Place it on the wire gauze.
- Secure the test tube in the universal clamp and lower it into the beaker so that water completely surrounds the sodium thiosulphate.
- Stick the temperature sensor right to the bottom of the test tube.
- Fill 300 ml of cold water into the 400 ml beaker and keep it ready near the rest of the set-up.

Procedure

- Connect the "Wireless/USB-Link" with the Sensor-Unit 2x Temperature and turn on the "Wireless/USB-Link". Attache the immersion probe to the Sensor-Unit.
  Hook up your tablet with the "Wireless/USB-Link" and open the app "measure".
  Select the connected sensor.
- The experiment is conducted with the default settings of the app. You can deselect the second measurement channel since you are only using one immersion probe.

1. Melting

- Start measured value recording in measureApp. Now every second one measured temperature value is detected (sampling rate 1 Hz).
- Light the butane burner and place it beneath the 250 ml beaker.
- Do not move the sensor during heating.
- When the water starts to boil, turn the burner down so far that the water only just keeps boiling.
- Extinguish the burner when the sodium thiosulphate in the test tube is completely melted.

2. Solidifying

- Take the test tube, together with the sensor, from the universal clamp.
- Place the test tube with sensor in the beaker containing cold water.
- When the temperature goes below 35 °C and no crystals have yet been formed, throw a crystal of sodium thiosulphate into the test tube. It might take a moment until something happens, so be patient.
- When the temperature finally again decreases towards the initial temperature, you can end the measurement. Save it, before turing off the measurement unit.

Evaluation

Evaluate the experiment with the report. In the figures below, you can see an examplary temperaturecurve for sodium thiosulphate.

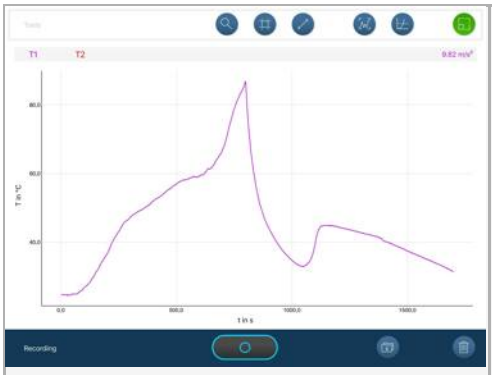


Fig. 2a: Exemplary measurement of the temperature curve of sodium thiosulphate with the app.

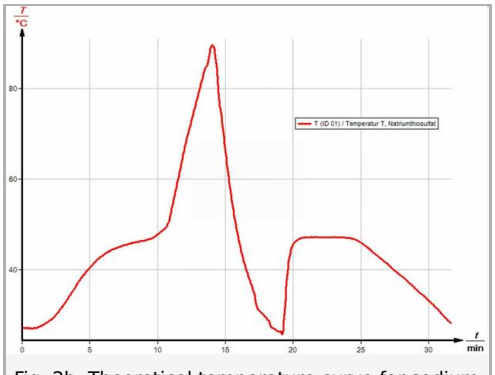
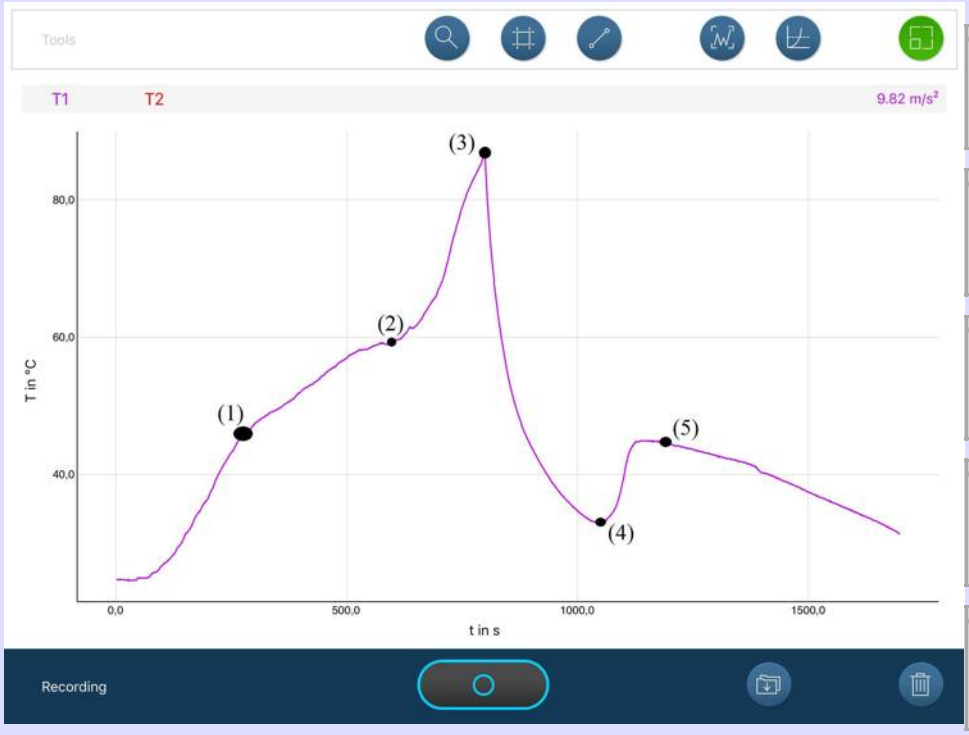


Fig. 2b: Theoretical temperature curve for sodium thiosulphate.

Report: Melting and freezing curve of sodium thiosulphate with measureAPP

Evaluation -Question 1

Your temperature curve should be almost similar to the following. Match the following events to the characteristic points in the curve.



(1)

(2)

(3)

(4)

(5)

The test tube is placed in cold water.

The sodium thiosulphate has completely melted.

The sodium thiosulphate starts to melt.

The sodium thiosulphate has completely crystallized.

The sodium thiosulphate begins to crystallize.

Evaluation - Question 2

Use the "servay" tool to determine the fusion point.

Fusion point: ..... °C (Literature value: 48,5 °C).

Evaluation - Question 3

Why does the temperature hardly increase further until all the salt has melted?

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Evaluation - Question 4

What happened to the amount of heat that was taken up by the test tube from the time melting started to the time it was completed, i.e. when there was no increase in temperature? Where is it now?

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Evaluation - Question 5

Was passiert, wenn ein Kristall in die noch flüssige unterkühlte Schmelze geworfen wird?

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Evaluation - Question 6

The course of the temperature in the graph between (1) and (2) and between (4) and (5) is not exactly a straight line with some measurements. Which measurement errors are responsible for this?

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