Heat of solution (Item No.: P1045200)

Curricular Relevance

Area of Expertise: Physics
Education Level: Age 14-16
Topic: Thermal physics
Subtopic: States of matter: Melting, boiling, evaporation
Experiment: Heat of solution

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	10 Minutes	2 Students

Additional Requirements:

- Sodium thiosulphate pentahydrate, 500 g 30169-50
- Sodium chloride, 250 g 30155-25

Experiment Variations:

- with lab thermometer with stem and universal balance

Keywords:

Task and equipment

Information for teachers

Additional Information

Different quantities of sodium chloride and sodium thiosulfate are dissolved in water. In both cases a temperature decrease is observed.

In a supplementary problem the correlation between dissolved mass and temperature change is studied quantitatively.

Remarks

1. When reading the thermometer, the temperature should be estimated to the nearest 0.5 °C.
2. For the supplementary problem a thermometer with 1/10-degree divisions and a balance are required. A suitable thermometer and balances are on the Material page.

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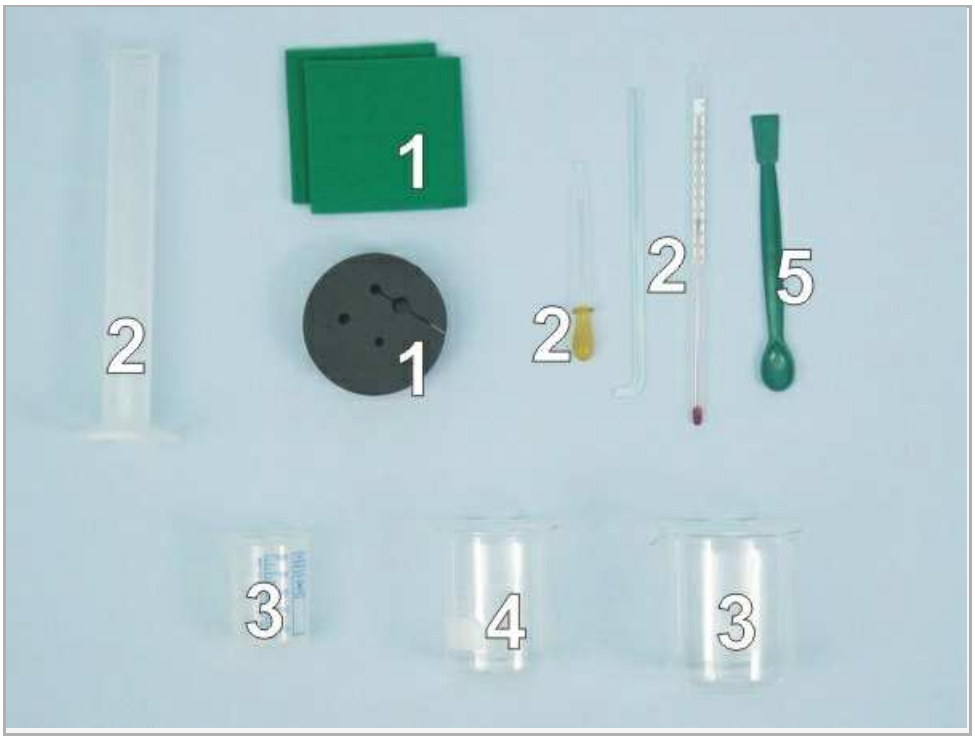
Task and equipment

Task

What happens when salt dissolves in water?

Dissolve different quantities of salt in water and observe the accompanying temperature changes.

Equipment



Position No.	Material	Order No.	Quantity
1	Lid for student calorimeter	04404-01	1
1	Felt sheet, 100 x 100 mm	04404-20	2
2	Agitator rod	04404-10	1
2	Pipette with rubber bulb	64701-00	1
2	Graduated cylinder 100 ml, PP transparent	36629-01	1
2	Students thermometer, -10...+110°C, l = 230 mm	38005-10	1
3	Beaker, low form, plastic, 100 ml	36011-01	1
3	Glass beaker DURAN®, short, 250 ml	36013-00	1
4	Glass beaker DURAN®, short, 400 ml	36014-00	1
5	Spoon,w.spatula end,18 cm,plastic	38833-00	1
	Sodium thiosulphate pentahydrate, 500 g	30169-50	1
	Sodium chloride 250 g	30155-25	1
Additional material:	(for Supplementary Problems only)		
	Lab thermometer with stem 50 mm, +15...+40 °C	38057-00	1
	Universal balance, 3000 g	46009-00	1 or
	Sliding weight balance, 101 g	44012-01	1

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Set-up and procedure

Set-up

Attention!

The temperature should be estimated to the nearest 0.5 °C.

Setup

- Assemble a thermally insulated vessel (calorimeter) using the two glass beakers (250 ml and 400 ml) and two felt sheets.

Fig. 1

Fig. 2

- Insert the thermometer (d = 8 mm) and the agitator rod (d = 5 mm) through the respective holes in the lid.

Fig. 3

Fig. 4

Procedure

The measurements are to be carried out with sodium chloride (table salt) first and then with sodium thiosulfate. First two and then four spoonfuls of salt are to be dissolved each time.

- Pour 100 ml of water into the calorimeter.

Fig. 5

- Measure the initial water temperature ϑ_1 and record its value in Table 1 in the report under sodium chloride in the line labeled "2 spoonfuls".
- Add 2 spoonfuls of sodium chloride to the water.
- Stir until the salt is completely dissolved.
- Read the temperature ϑ_2 and record it in the appropriate column in Table 1.
- Repeat the experiment with 4 spoonfuls of sodium chloride. (Rinse and dry the calorimeter before beginning.)
- Repeat the experiment with 2 and 4 spoonfuls of sodium thiosulfate; record the values in Table 2 (report).

Report: Heat of solution

Result - Table 1

1. Record the temperatures of water without (ϑ_1) and with (ϑ_2) sodium chloride in the table.
2. Calculate the temperature difference $\Delta\vartheta = \vartheta_2 - \vartheta_1$ and record the values in table 1.

	ϑ_1 in °C	ϑ_2 in °C	$\Delta\vartheta$ in °C
2 spoonfuls	1 ±0	1 ±0	1 ±0
4 spoonfuls	1 ±0	1 ±0	1 ±0

Result - Table 2

1. Record the temperatures of water without (ϑ_1) and with (ϑ_2) sodium thiosulfate in the table.
2. Calculate the temperature difference $\Delta\vartheta = \vartheta_2 - \vartheta_1$ and record the values in the table.

	ϑ_1 in °C	ϑ_2 in °C	$\Delta\vartheta$ in °C
2 spoonfuls	1 ±0	1 ±0	1 ±0
4 spoonfuls	1 ±0	1 ±0	1 ±0

Evaluation - Question 1

How does the temperature change when the salts dissolve?

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Evaluation - Question 2

What kind of correlation is there between the dissolved quantity of salt and the temperature change?

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Evaluation - Question 3

Describe the process using the energy concept.

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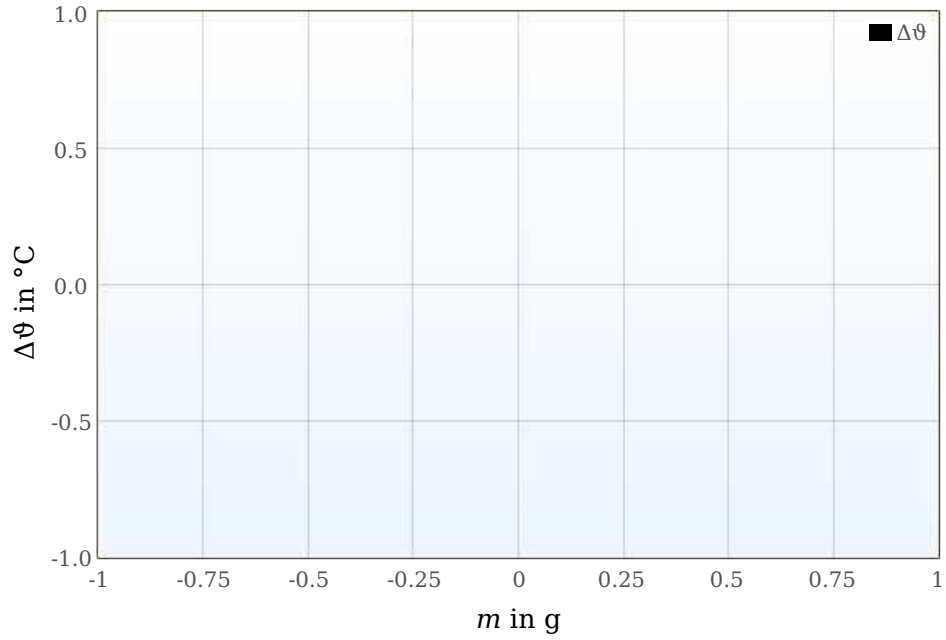
Evaluation - Supplementary problem 1

In an experiment determine the correlation between quantity of dissolved salt and temperature change more exactly.

- The measurements are to be made with sodium thiosulfate.
- The quantities of the salt are to be weighed with a balance.
- The temperatures should be measured with a thermometer whose accuracy is 1/10 °C.
- In each case 100 ml of water is poured into the calorimeter.
- Dissolve the masses of salt *m* given in the table below one after another (rinse and dry the calorimeter before adding new mass of salt); measure the initial temperature ϑ_1 and the final temperature ϑ_2 of the water.
- In each case calculate the temperature difference $\Delta\vartheta = \vartheta_2 - \vartheta_1$ and record its value in the table.

m in g	ϑ_1 in °C	ϑ_2 in °C	$\Delta\vartheta$ in °C
2	1 ±0	1 ±0	1 ±0
4	1 ±0	1 ±0	1 ±0
6	1 ±0	1 ±0	1 ±0
8	1 ±0	1 ±0	1 ±0
10	1 ±0	1 ±0	1 ±0

Number1



Evaluation - Supplementary problem 2

What relation can you observe between Δϑ and *m* in the chart of supplementary problem 1?

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Evaluation - Supplementary problem 3

From the slope of the lines in the diagram calculate the specific heat of solution for sodium thiosulfate

$q = c \cdot m_w \cdot \Delta\vartheta/\Delta m$,

where c = 4.19 J/g°C (specific heat capacity of water) and m_w = 100 g (mass of the water).

Slope of the lines: $\Delta\vartheta/\Delta m$ = ... °C/g.

Specific heat of solution: q = ... J/g.