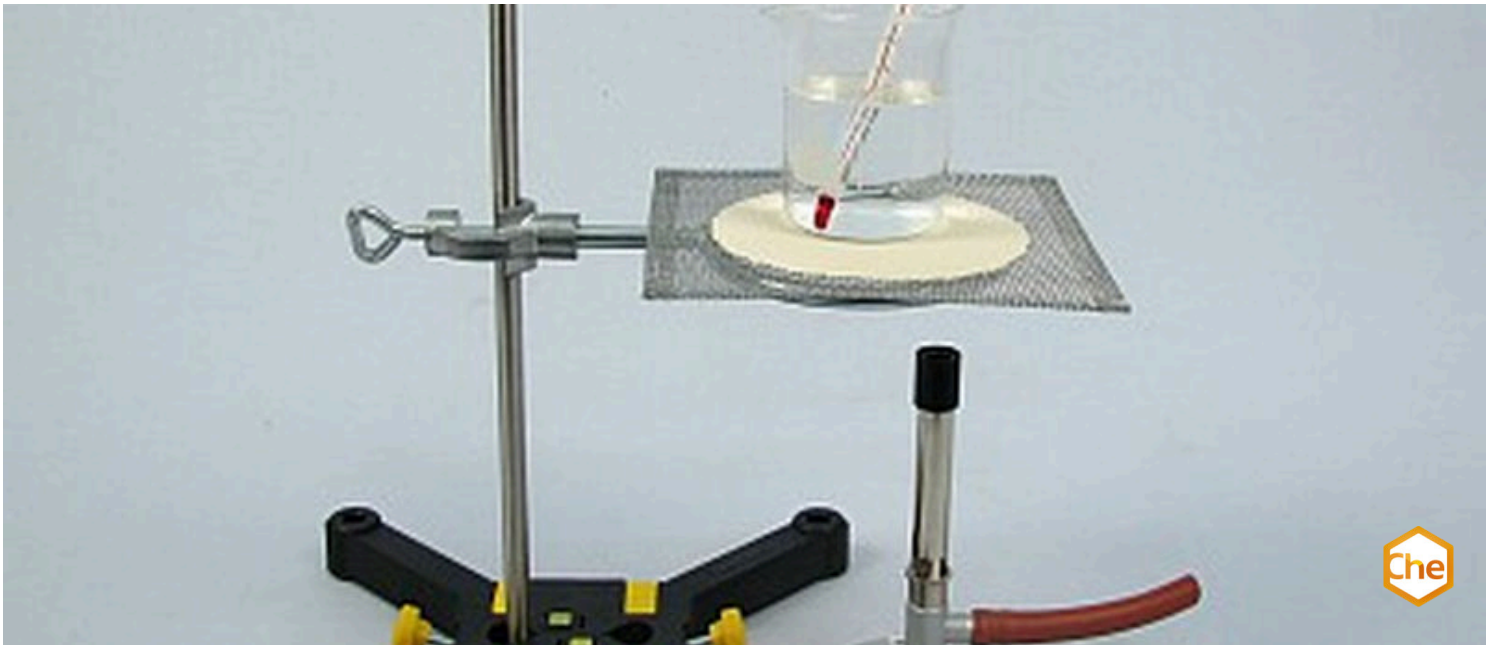
Melting-point lowering and boiling-point elevation



Chemistry > General Chemistry > States of matter, dissolution (kinetic particle theory)

Difficulty level	Group size	Preparation time	Execution time
easy	-	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/5f565807742d0c00034be22b

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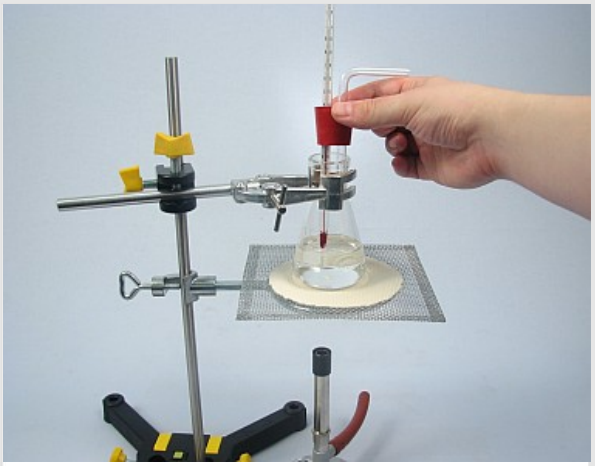
Teacher information

Application



Boiling point determination of a solution

Solutions have a higher boiling point and a lower melting point than pure solvents. The shift in melting and boiling points is due to the interaction between solvent particles and the dissolved substance.

In this experiment the melting and boiling point of aqueous salt solutions is determined by measuring the boiling and melting temperature of pure water with different amounts of salt added.

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Other teacher information (1/2)

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Prior knowledge

- Salts can be dissolved in certain solvents, such as water. In doing so, the water molecules dissolve the original bonds of the crystalline salt molecules.
- Salts consist of anions and cations, which are connected by an ionic bond.

Scientific principle

- By adding salt, the water molecules are prevented from entering the gas phase. This is caused by intermolecular interactions between the solvent particles and the dissolved particles of the respective salt (Raoult's law).
- This means that more particles condense than evaporate, since the dissolved particles do not enter the gas phase.

Other teacher information (2/2)

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Learning objective

- If a salt is added to a solvent and the salt dissolves, the boiling point of the solution (compared to the pure solvent) increases while the freezing point decreases,
- The dissolved salt particles prevent the water molecules from changing to the gas phase by intermolecular attraction. As a result, more energy must be expended for the solution to start boiling.

Tasks

- The melting and boiling points of aqueous salt solutions are determined.
- For this purpose, the boiling point of pure water is measured and then a certain amount of common salt is added.
- After the experiment, the pupils are asked to explain why the roads are gritted with salt in winter.

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Safety instructions

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- When the water is heated, splashes may occur, which can lead to severe burns.
- Use safety goggles !
- Work with caution when handling the gas burner !
- All potential ignition sources must be removed before using the gas burner !
- The general instructions for safe experimentation in science lessons apply to this experiment.
- For H- and P-phrases please consult the safety data sheet of the respective chemical.

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Student Information

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Motivation

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Dangers when driving on a slippery surface.

Black ice and heavy snow storms can cause serious traffic accidents in winter. To prevent this danger, "road salt" is often spread on the black ice or snow layer, which is available in every hardware store.

Even before each heavy snowstorm, people start sprinkling their driveways or other frequently used roads with road salt so that they can still use them after the blizzard has set in. But why do people use road salt for layers of snow and ice?

In this student experiment, the effect of adding a salt on the melting and boiling point of water is investigated.

Tasks

PHYWE

- Determine the melting and boiling point of aqueous salt solutions.
- Write down your observations in general terms and note the measured melting and boiling points in Table 1.
- Formulate the result in general terms in a memoir and then explain the change in boiling and melting points at the atomic level.
- Explain why the roads are gritted with salt in winter.

The process of dissolving a salt in water.

An aqueous saline solution has, compared to water

a lower boiling point

a higher boiling point

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Equipment

Position	Material	Item No.	Quantity
1	Protecting glasses, clear glass	39316-00	1
2	Rubber gloves, size M (8), one pair	39323-00	1
3	Support base, variable	02001-00	1
4	Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	1
5	Spatula, powder, steel, l=150mm	47560-00	1
6	Ring with boss head, i. d. = 10 cm	37701-01	1
7	Wire gauze with ceramic, 160 x 160 mm	33287-01	1
8	Glass rod, boro 3.3, l=200mm, d=5mm	40485-03	1
9	Beaker, 150ml, low-form	46060-00	1
10	Students thermometer,-10...+110°C, l = 180 mm	38005-02	1
11	Beaker, 100 ml, plastic (PP)	36081-00	1
12	Butane burner with cartridge, 220 g	32180-00	1
13	Sodium chloride 250 g	30155-25	1

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Set-up (1/2)

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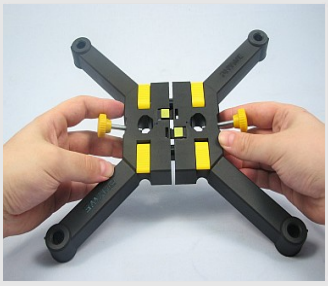
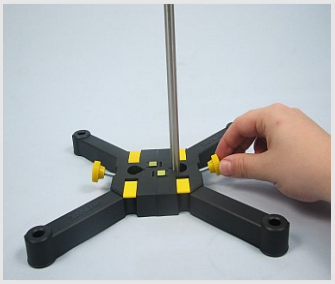
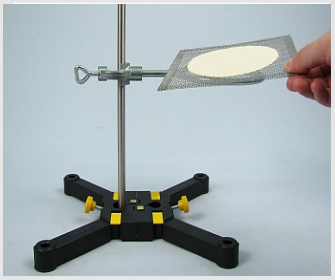
- Assemble the tripod from the tripod base and the tripod rod as shown in the upper left and upper right.
- Attach the tripod ring to the tripod rod (fig. bottom left) and place the wire netting on it (fig. bottom right).
- Finally, check the tripod for strength and stability.
- Only set up the tripod on level surfaces.







Set-up (2/2)

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- Fill the beaker with 50 ml water (upper left illustration).
- Place the beaker on the wire net.
- Make sure that the beaker is firmly positioned on the wire net.
- Handle the gas burner with care and remove all potential ignition sources before using the gas burner !

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Procedure (1/2)

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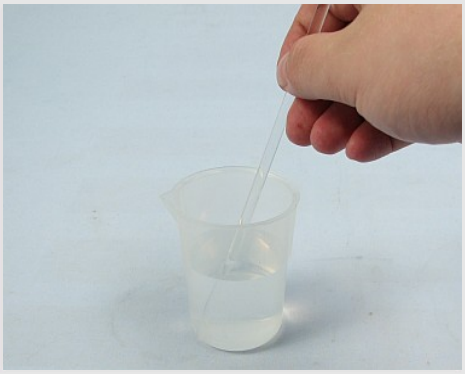
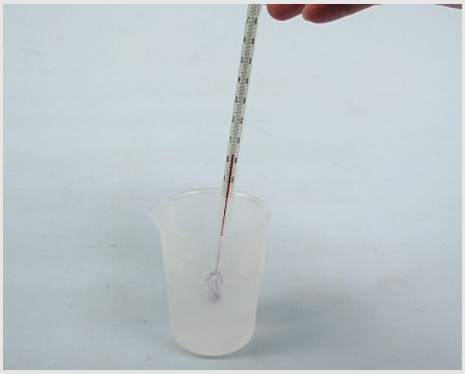
Add five spatulas of common salt to the ice water (fig. left), stir a little with the glass rod (fig. center) and after a two-minute wait measure the temperature of the ice water again (fig. right).

Add another 5 spatulas of common salt to the ice water, measure the temperature as above and enter the values in the table in the protocol.





Procedure (2/2)

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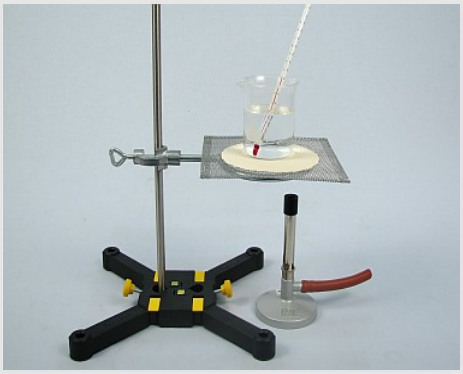
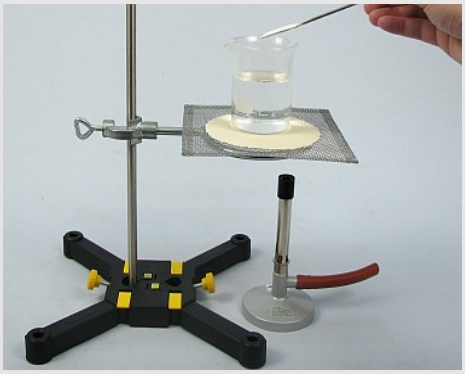
Measure the temperature of the water brought to the boil (left figure). Then add two spatulas of table salt (centered illustration) and stir with the glass rod (right illustration).

Measure the temperature as soon as the water starts boiling again. Then add two more spatulas of table salt and measure the boiling temperature again after stirring.





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Report

Task 1

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Write down your observations in general form !

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Task 2

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Measured melting temperatures

Experiment	temperature measured
plain water	
single addition of common salt	
Repeat addition of common salt	

Task 3

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Measured boiling temperatures

Experiment	Temperature measured
plain water	
single addition of common salt	
Repeat addition of common salt	

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Task 4

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Conventional table salt in a salt shaker

Complete the cloze !

After the addition of common salt in water, this [ ] quickly and completely. The measurements showed that the melting point of the water was [ ] and the boiling point was [ ]. Consequently, [ ] is needed to transfer the water molecules from the liquid to the [ ] phase.

Check

Task 5

PHYWE

The melting point of a solution is therefore lower than that of the corresponding solution because

- the dissolved particles release thermal energy and cause the ice to melt.
- the dissolved particles cause the solvent particles to join together to form a crystal

The boiling point of a solution is therefore higher than that of the corresponding solution because

- ○ more particles condense than evaporate, since the dissolved particles do not enter the gas phase
- ○ more energy must be expended to dissolve the salts in the solvent.

Check

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Task 6

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Explain why the roads are gritted with salt in winter.

Slide	Score / Total
Slide 8: Sodium chloride in water	0/1
Slide 18: Table salt in water	0/5
Slide 19: Multiple tasks	0/2

Total amount 0 / 8

Solutions | Repeat | Exporting text

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