Solubility of salts in water - Comparison with the solubility of gases in water (Item No.: P7154900)

Curricular Relevance

Area of Expertise: Chemie
Education Level: Klasse 7-10
Topic: Anorganische Chemie
Subtopic: Wasser
Experiment: Löslichkeit von Salzen in Wasser - Vergleich mit der Löslichkeit von Gasen in Wasser

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	20 Minutes	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

Solubility, water, gases, material property

Task and equipment

Information for teachers

Learning objectives

- In contrast to gases, the higher the temperature of the water, the better salts dissolve in it.
- By supercooling them, metastable supersaturated salt solutions can be prepared which exhibit a higher salt concentration than that corresponding to the thermodynamic equilibrium quantity at a given temperature.

Notes on set-up and preparation

Preparation
The salts to be used should be pulverised as finely as possible in a mortar before the experiment, because they then dissolve considerably more rapidly.
To save time, preweighed portions of the salts can be distributed to the students. If desired, hot water can be prepared (hot-water apparatus or something similar) which is then brought to the experimental temperature by mixing. The students can also work in groups and exchange their results.

Remarks on the students' experiments
The addition of the salt quantities does not take place in exactly weighed-out portions, which is howeveer also not required to achieve the desired educational objective. However, ensure that the portioning is approximately exact so that the quantities of salt used are not larger than stated, as otherwise sediment forms in the first step.
The supersaturated sodium thiosulphate solution must cool in water which is as cold as possible (if necessary add ice), before a seed crystal may be added.


Hazard and Precautionary statements

Potassium nitrate:

H272:	May intensify fire; oxidiser. Kann Brand verstärken; Oxidationsmittel.
P210:	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.

Hazards

- Sodium thiosulphate is hazardous to health. Do not swallow it!
- Heat cautiously; wear protective glasses!

Remarks on the method

Based on this experiment, the principle of "recrystallization" can again be treated. The terms required for this and in Exercise 4 must be given to the students in a class discussion beforehand.

Advanced courses

Experiment 2 is also appropriate for the introduction of the term "Metastability" in the scope of the thermodynamic equilibrium considerations.

Waste disposal

- The crystallised thiosulphate can be used for similar experiments by redissolving it in warm water; recrystallizing it in a large vessel, and collecting it.
- Put all remaining salt solutions in the collection container for acids and alkalis.

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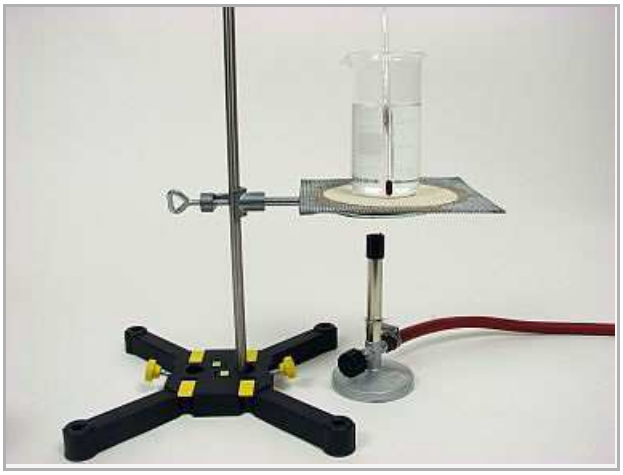
Task and equipment

Task

Which factors determine the solubility of a substance in water?

Prepare saturated solutions at various temperatures and a supersaturated solution.



Equipment

Position No.	Material	Order No.	Quantity
1	Protecting glasses, clear glass	39316-00	1
2	Ring with boss head, i. d. = 10 cm	37701-01	1
3	Wire gauze with ceramic, 160 x 160 mm	33287-01	1
4	Support base, variable	02001-00	1
5	Test tube brush w. wool tip,d25mm	38762-00	1
5	Students thermometer,-10...+110°C, l = 180 mm	38005-02	1
6	Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	1
7	Graduated cylinder, 10 ml, plastic	36636-00	1
8	Wash bottle, 250 ml, plastic	33930-00	1
8	Spatula, powder, steel, l=150mm	47560-00	1
8	Labor pen, waterproof	38711-00	1
9	Beaker, 250 ml, low form, plastic	36013-01	1
10	Test tube rack f. 6 tubes, wood	37685-10	1
10	Test tube, 18x188 mm, 10 pcs	37658-03	(3)
10	Test tube holder, up to d 22mm	38823-00	1
11	Glass beaker DURAN®, short, 250 ml	36013-00	1
11	Rubber stopper, d=22/17 mm, without hole	39255-00	3
12	Glass beaker DURAN®, tall, 250 ml	36004-00	1
13	Watch glass, dia.60 mm	34570-00	3
	Butane burner f.cartridge 270+470	47536-00	1
	Butane catridge CV 300 Plus, 240 g	47538-01	1
	Potassium aluminium sulphate 250g	30018-25	1
	Potassium nitrate 250 g	30106-25	1
	Sodium thiosulphate pentahydrate, 500 g	30169-50	1
Additional material			
	Distilled water		
	Tap water		

Set-up and procedure

Set-up

Hazards

- Sodium thiosulphate is hazardous to health. Do not swallow it!
- Heat cautiously; wear protective glasses!

Set-up

Set up the support stand according to Fig. 1 and Fig. 2. Attach the support ring to the support stand (Fig. 3); place the wire gauze onto the ring (Fig. 4).

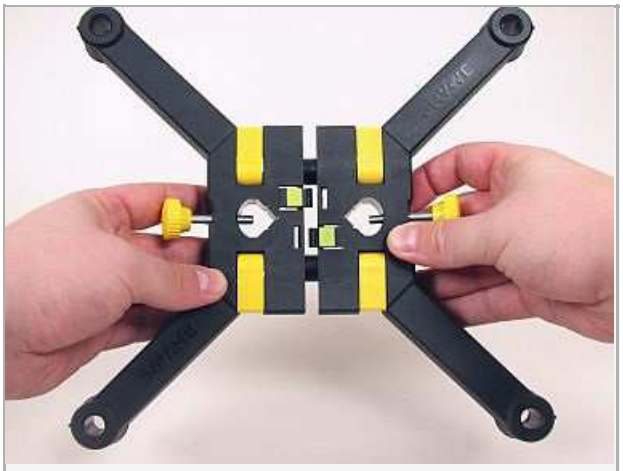


Fig. 1

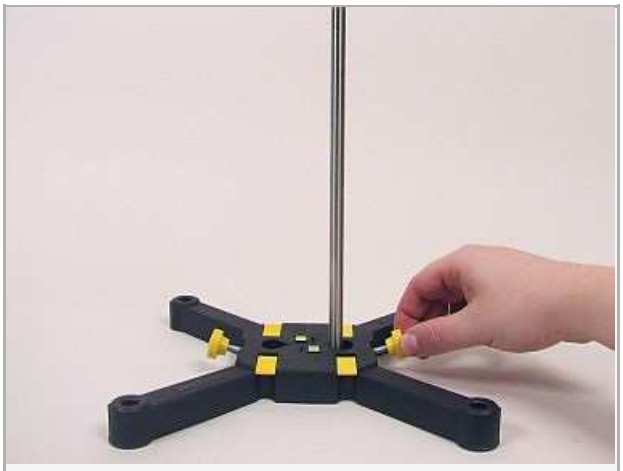


Fig. 2

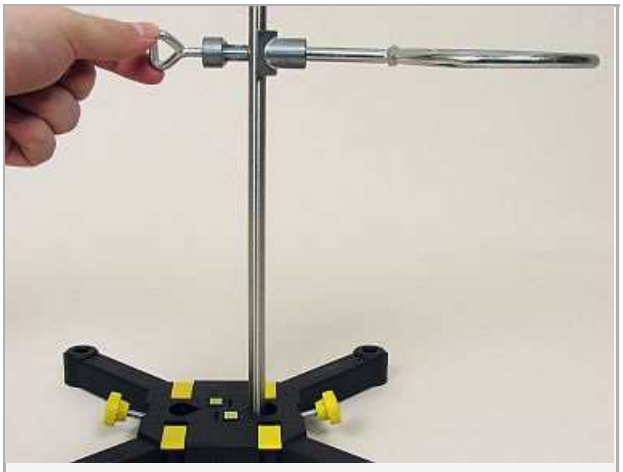


Fig. 3

Fig. 4

Open the balance (Fig. 5) and switch it on (Fig. 6). Place a watch glass onto the balance (Fig. 7). Tare it out to zero (Fig. 8) and put 0.5 g of alum into it with the spatula. Make a mental note of the spatula's filling level for 0.5 g of alum and then fill the porcelain dish with 3 g of alum (Fig. 9). Now proceed in the same manner with 5 g of potassium nitrate (Fig. 10); make a note of the fill quantity for 0.5 g.

Fig. 5

Fig. 6

Fig. 7

Fig. 8

Fig. 9

Fig. 10

Number the test tubes from 1 to 3 and place them in the test tube rack (Fig. 11). Pour 10 ml of distilled water into the test tubes 1 and 2 (Fig. 12).

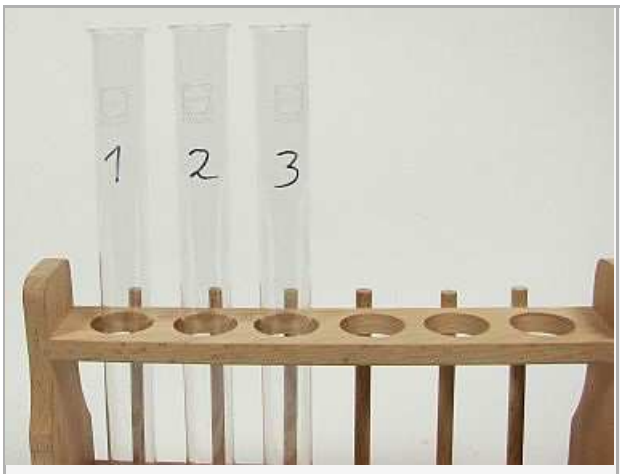


Fig. 11

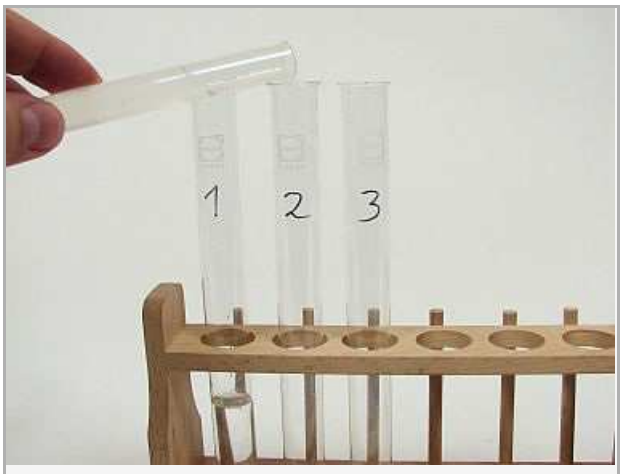


Fig. 12

Fill the three beakers two-thirds full with tap water (Fig. 13). Measure the room temperature of the water (Fig. 14). Heat the water in one beaker on the wire gauze to 30 °C (Fig. 15), the second to 40 °C (Fig. 16). The water in the plastic beaker remains at room temperature. Never use the plastic beaker to heat water with a Bunsen burner!


Fig. 13


Fig. 14


Fig. 15

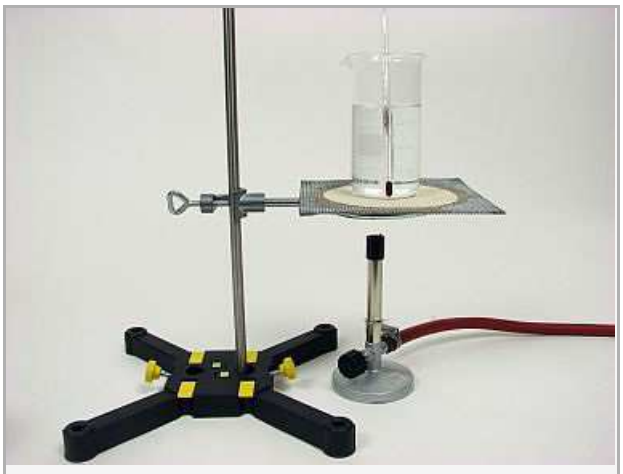


Fig. 16

Procedure

Procedure

Place test tubes 1 and 2 in the beaker containing water at room temperature (Fig. 17). Put 0.5 g of alum in the first test tube and 1 g of potassium nitrate in the second (Fig. 18). Seal the test tubes with the stoppers (Fig. 19) and shake them vigorously until all the salt in both test tubes has dissolved (Fig. 20).

Fig. 17

Fig. 18

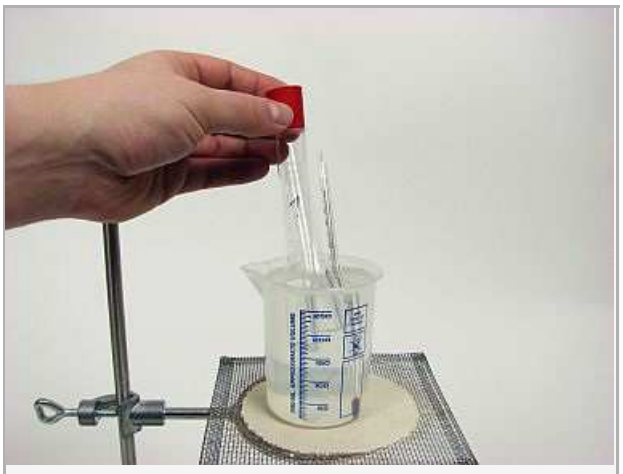


Fig. 19

Fig. 20

Now add salt successively (in portions of 0.5 g each) to the test tubes. Shake them again each time and check whether more salt has dissolved. When a permanent sediment has formed, note the quantities of salt used in Table 1.

Now place the test tubes in the water that has been warmed to 30 °C and wait until the water in the test tube has also warmed up. Check the temperature in the beaker at regular intervals and heat it again if necessary. While doing so, ensure that the experimental temperature is not exceeded. Take the test tubes out of the water after temperature equilibration and shake them. Check whether the sediment has dissolved.

Now add salt in portions as above until sediment has again formed. Note the quantities of salts used. Proceed similarly at an experimental temperature of 40 °C.

Weigh out 6 g of sodium thiosulphate using the watch glass and pour it into test tube 3 (Fig. 21). Add 2 ml of water to it (Fig. 22) and place the test tube in the beaker with warm water (Fig. 23). Heat until all sodium thiosulphate has dissolved (Fig. 24).

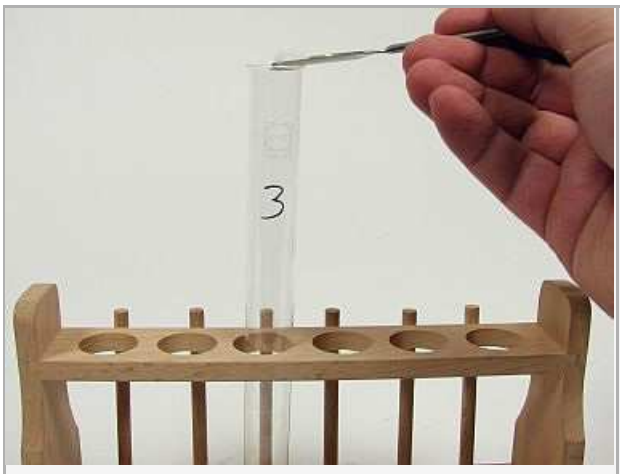


Fig. 21

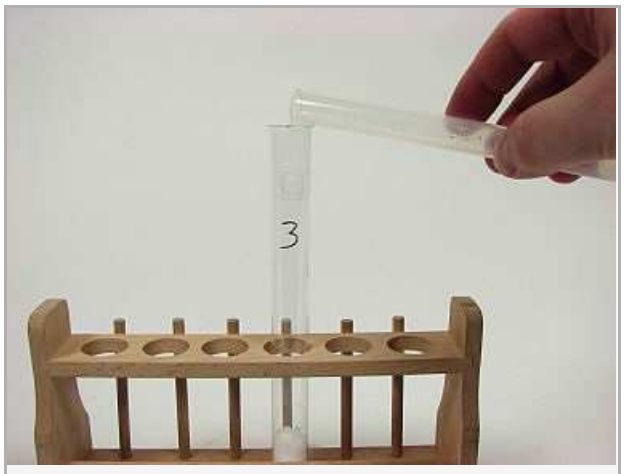


Fig. 22


Fig. 23

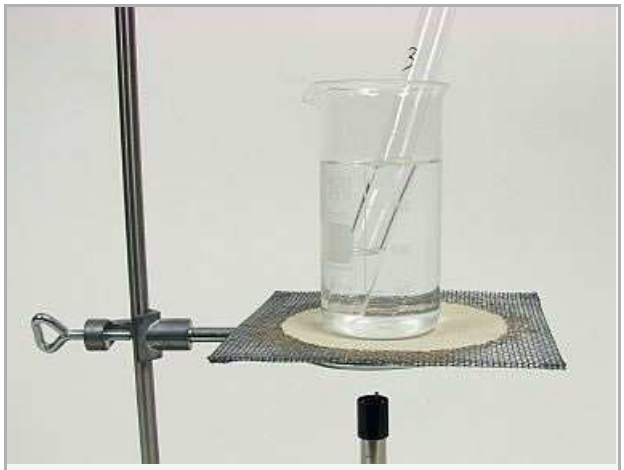


Fig. 24

Now pick up this test tube with the test tube holder (Fig. 25) and place it without shaking in a beaker containing water that is as cold as possible (Fig. 26). After five minutes put one small sodium thiosulphate crystal into the salt solution (Fig. 27) and tap the test tube briefly (Fig. 28).

Fig. 25

Fig. 26

Fig. 27

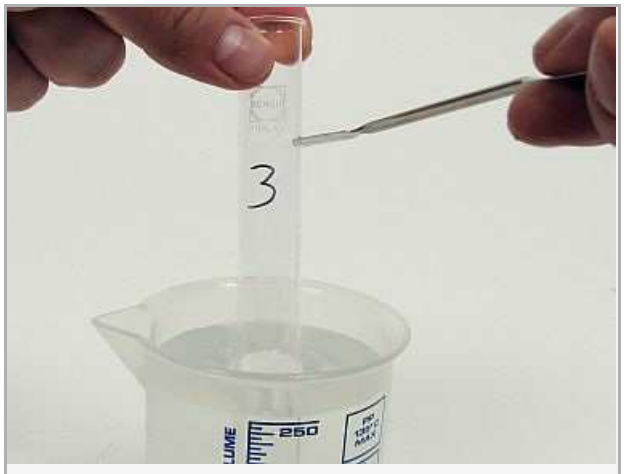


Fig. 28

Waste disposal Entsorgung

- Put all salt solutions in the collection container for acids and alkalis.
- Dissolve the sodium thiosulphate by adding warm water and collect it in a labelled container.

Report: Solubility of salts in water - Comparison with the solubility of gases in water

Result - Observations

Note your observations.

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Result - Table 1

Record the dissolved quantities of the salt in Table 1.

Salt	Quantity of salt (g) at		
	θ = 20 °C	θ = 30 °C	θ = 40 °C
Alum	1 ±0	1 ±0	1 ±0
Potassium nitrate	1 ±0	1 ±0	1 ±0

Evaluation - Question 1

Formulate your conclusions about the first part of the experiment in a concise statement. Compare the solubility of salts in water to that of gases in water. Define the term "saturated solution".

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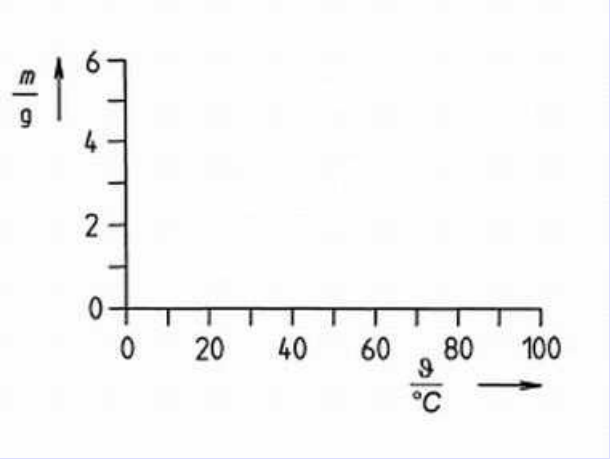
Evaluation - Question 2

Sketch the propable further course of the curve for both salts in the plotted graph.



Evaluation - Question 3

Which factors determine the rapidity of dissolution of salt in water?

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Evaluation - Question 4

Comment on the results of the second part of the experiment.

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Evaluation - Question 5

Based on these results, explain the behaviour of liquid honey if left to stand for a long time. State how the altered honey can be changed back to its original condition.

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