Ammonia - a comparison of a gas and aqueous solution (Item No.: P7158750)

Curricular Relevance

Area of Expertise: Chemie

Education Level: Klasse 7-10

Topic: Anorganische Chemie

Subtopic: Säuren und Basen, Protonenübergänge

Experiment: Ammoniak - Vergleich von Gas und wässriger Lösung

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

Additional Requirements:

Experiment Variations:

Keywords:

ammonia, material property, aqueous solution of ammonia

Task and equipment

Information for teachers

Learning objectives

- Ammonia chloride (and household detergents) and sodium hydroxide form a gas smelling like a horse stable - ammonia.
- Ammonia shows the typical properties of an alkali only in the form of an aqueous solution. Alkalis thus behave in a similar way as acids.

Notes on set-up and procedure

Preparations
In order to save time, concentrated ammonia chloride solution can be prepared before the lesson starts. The dry tubes can be filled and prepared beforehand, too.

Remarks on the students' experiments
This experiment is rather sophisticated as far as the instruments required are concerned. Make sure that the experimental set-up is complete and the electric circuit wired correctly. Let the students carry out a conductivity measurement of distilled water if this has not already been done in the course of the preceding experiment. Stop the experiment immediately after temperature and conductivity have been measured in order to prevent larger quantities of ammonia from escaping into the environment. If there are not enough working places available unter the fume hood, the test with dry litmus paper can be left out and the evolving ammonia can be directly led into the water. In this case the nasal nuisance is reduced to a minimum with the apparatus being closed. The non-colouration should be demonstrated with an apparatus placed under the fume hood. Reuse the experimental set-up for the next experiment.



Hazard and Precautionary statements

Sodium hydroxide:	
H314:	Causes severe skin burns and eye damage.
H290:	May be corrosive to metals.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P309 + P310:	IF exposed or if you feel unwell: Immediately call a POISON CENTER or doctor/physician.
P301 + P330 + P331:	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P501:	Dispose of contents/container to an approved waste disposal facility.
Ammonium chloride:	
H302:	Harmful if swallowed.
H319:	Causes serious eye irritation.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P501:	Dispose of contents/container to an approved waste disposal facility.

Hazards

- Sodium hydroxide is highly corrosive. Do not touch it with bare fingers! Put on protective glasses!
- In the course of the experiment harmful and evil smelling gases are released. The experiment must thus be carried out under the fume hood!
- Use some glycerine to make rubber-glass joints slippery!

Notes

The reason why ammonium chloride is used for this experiment instead of concentrated ammonia solution as it is mostly stated in the literature is that in this way the nasal nuisance can be reduced to a minimum.
Ammonium chloride is decomposed by sodium hydroxide to the following equation:

$NH_4Cl + NaOH \rightarrow NH_3 + H_2O + NaCl$

The ammonium chloride solution must be concentrated since otherwise - due to its good solubility - there is not enough ammonia gas released.

Remarks on the method

Though the experimental set-up is rather complicated, this experiment is suitable as a student experiment. It can also serve for preparing the students for more complicated set-ups in advanced courses. This experiment (ion concept) already allows to work out the Brönstedt definition of an alkali as a proton donator though from the methodical point of view this results in a more immanent way in the course of the experiments on the reactions of metal oxides with water.

Waste disposal

Put the content of the vessels into the collecting tank for acids and alkalis. Reuse the dry tube and its content for the experiment "Solubility of ammonia in water".

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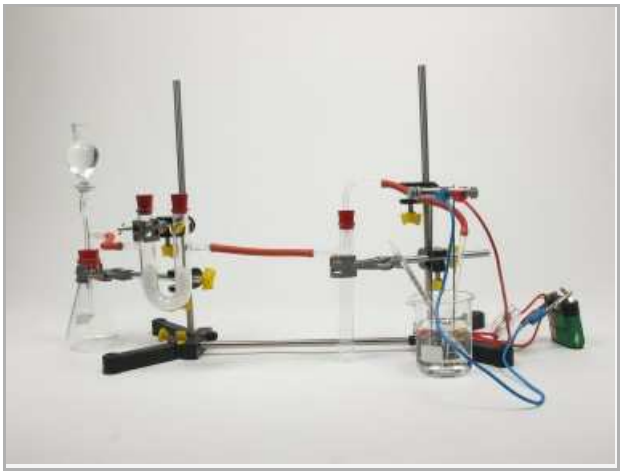
Task and equipment

Task

What are the properties of the alkalis contained in household detergents?

Prepare ammonia on the basic of "salmiac" and study its properties.



Equipment

Position No.	Material	Order No.	Quantity
1	Protecting glasses, clear glass	39316-00	1
2	Wash bottle, 250 ml, plastic	33930-00	1
3	Students thermometer,-10...+110°C, l = 180 mm	38005-02	1
4	Glass rod,boro 3.3,l=200mm, d=5mm	40485-03	1
5	Connecting cord,19A,50cm, blue	07314-04	1
6	Connecting cord,19A,50cm, red	07314-01	2
7	Glass tubes,straight with tip, 10	36701-63	(1)
8	Alligator clips, bare, 10 pcs	07274-03	(2)
9	Lampholder E10, case G1	17049-00	1
10	Erlenmeyer flask, narrow neck, PN 29	36424-00	1
11	Rubber stopper 26/32, 2 holes 7 mm	39258-02	1
12	Glass tube,right-angled, 10 pcs.	36701-52	(2)
13	Flat battery, 4.5 V	07496-01	1
14	Lamp 4 V/0,04 A,E 10	06154-00	1
15	Spatula, powder, steel, l=150mm	47560-00	1
16	Beaker, 100 ml, low form, stackable, plastic	36081-00	1
17	Rubber tubing, i.d. 6 mm	39282-00	1
18	Litmus paper, red, 1 box	30678-02	1
19	U-tube w. 2 lat tubulure PN19	36966-00	1
20	Rubber stopper, d=22/17 mm, without hole	39255-00	2
21	Rubber stopper, d = 22/17 mm, 1 hole	39255-01	2
22	Test tube,180x20 mm,side arm,PN19	36330-00	1
23	Dropping funnel with drip nozzle, 50ml	36912-00	1
24	Glass beaker DURAN®, short, 250 ml	36013-00	1
25	Holder for two electrodes	45284-01	1
26	Support base, variable	02001-00	1
27	Universal clamp	37715-00	3
28	Boss head	02043-00	4
29	Iron rods, flexible, 5 off	45127-00	(2)
30	Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	3
	Ammonium chloride 250 g	30024-25	1
	Glycerol, 250 ml	30084-25	1
	Sodium hydroxide, flakes, 500 g	30157-50	1
	Water, distilled 5 l	31246-81	1
	Phenolphthalein solution, 0.5%, 100 ml	31715-10	1

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Set-up and procedure

Set-up

Hazards

- Sodium hydroxide is highly corrosive. Do not touch it with bare fingers! Put on protective glasses!
- In the course of the experiment harmful and evil smelling gases are released. The experiment must thus be carried out under the fume hood!
- Use some glycerine to make rubber-glass joints slippery!



Set-up

Set up the support stand according to Fig. 1 - Fig. 6.

Fig. 1

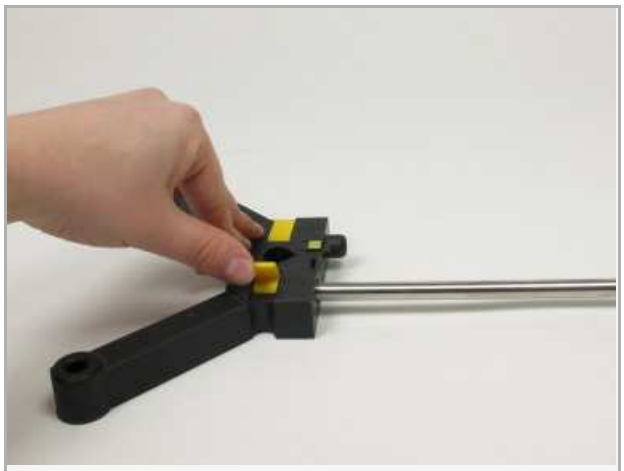

Fig. 2

Fig. 3

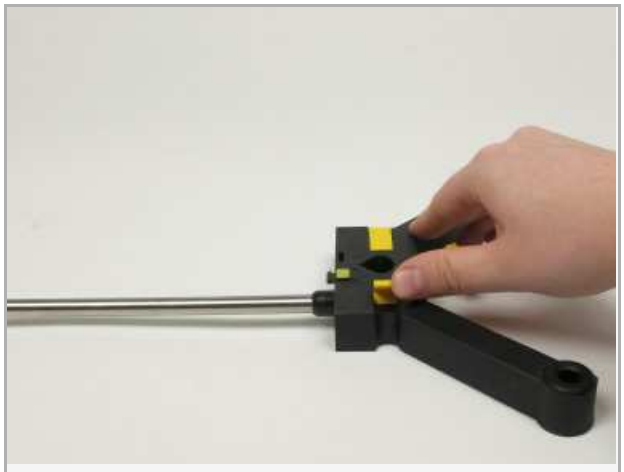

Fig. 4

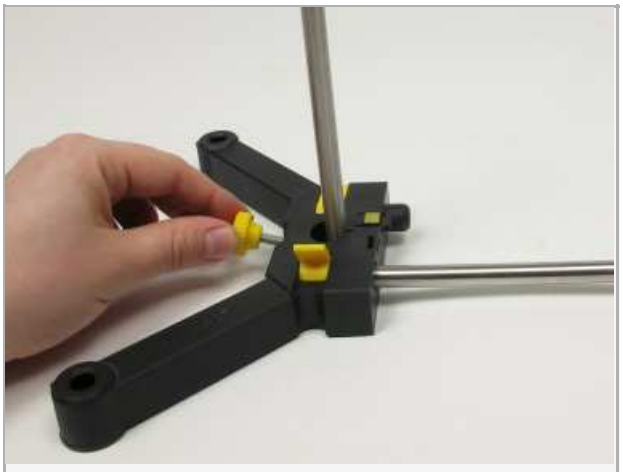

Fig. 5

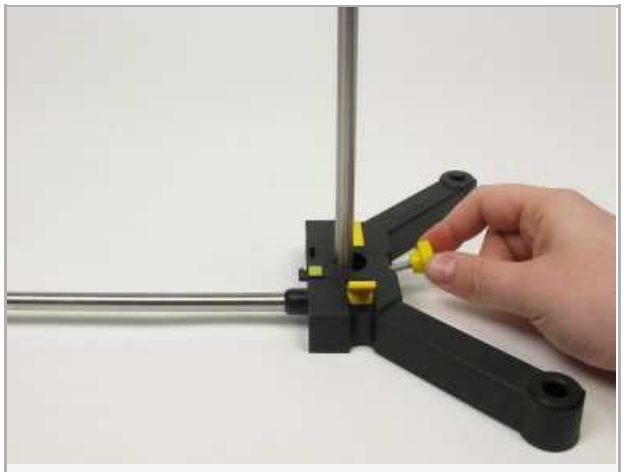

Fig. 6

Attach a bosshead (Fig. 7) and a universal clamp (Fig. 8) to the left support rod and fix the Erlenmeyer flask so that it is placed on the working surface in a stable way.

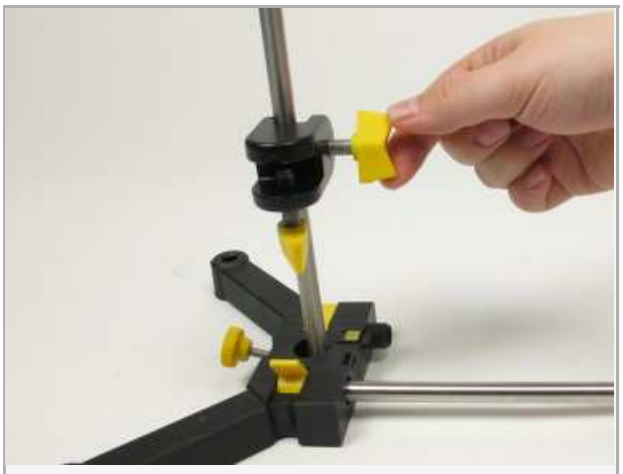

Fig. 7

Fig. 8

Fig. 9

Complete the support system according to Fig. 10 - Fig. 14.

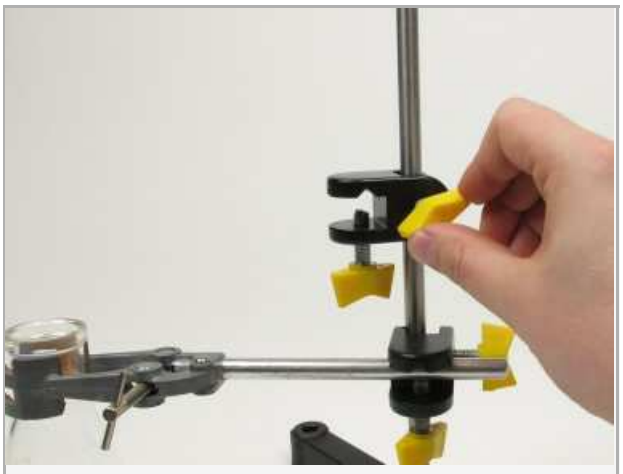
Fig. 10


Fig. 11

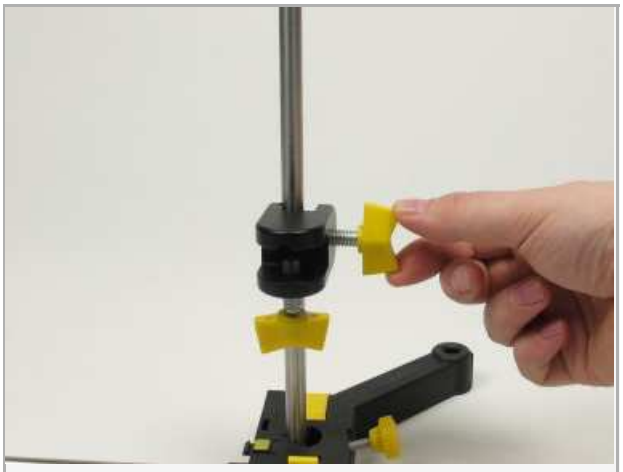
Fig. 12

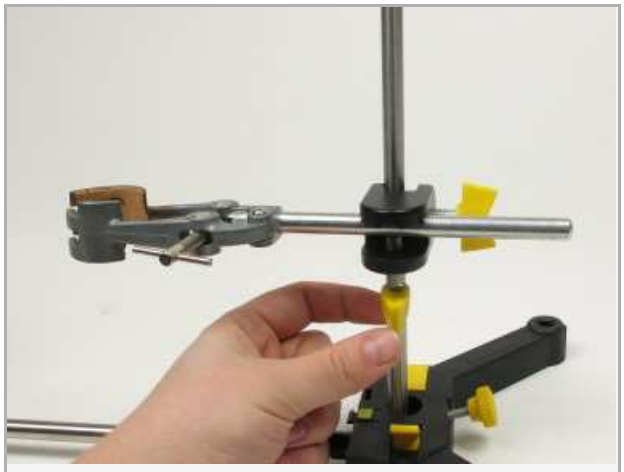
Fig. 13

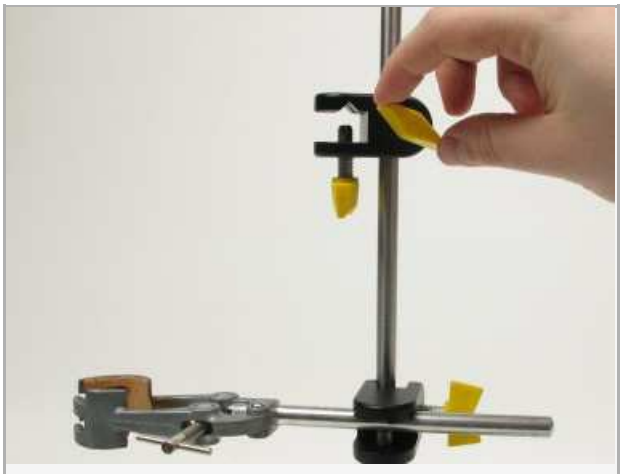
Fig. 14

Fill three spatulas of sodium hydroxide flakes into the flask (Fig. 15).

Fig. 15

Carefully slip the dropping funnel into the rubber stopper with the two holes (Fig. 17) (use some glycerine to make it slippery (Fig. 16)) and the right-angled glass tube into the other hole (Fig. 18). Seal the Erlenmeyer flask by means of this stopper (Fig. 19).

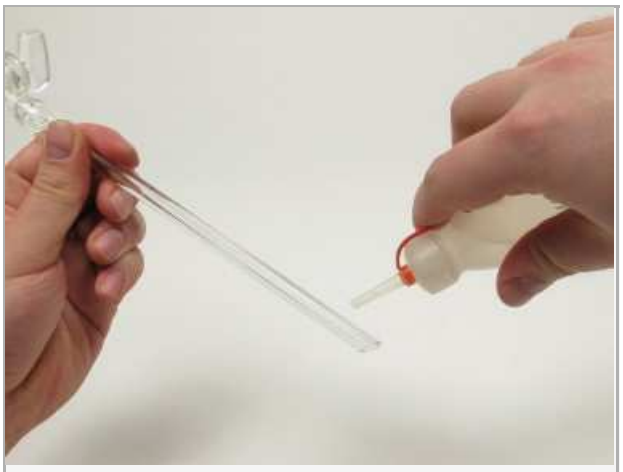

Fig. 16

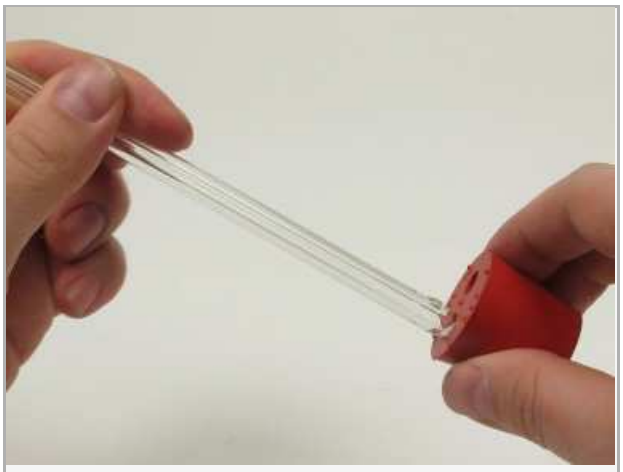

Fig. 17

Fig. 18

Fig. 19

Fill the U-tube with sodium hydroxide pellets until both legs are about half full (Fig. 20) and seal them with the rubber stoppers without holes (Fig. 21). Fix the U-tube into the second clamp (Fig. 22) and use a rubber tubing to connect the side arm of the U-tube with the right-angled glass tube of the Erlenmeyer flask (Fig. 23).

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Fig. 20

Fig. 21

Fig. 22

Fig. 23

Attach a test tube with side arm to the support rod on the right (Fig. 24). Use another rubber tubing to connect the side arm of the test tube with the U-tube (Fig. 25).

Fig. 24

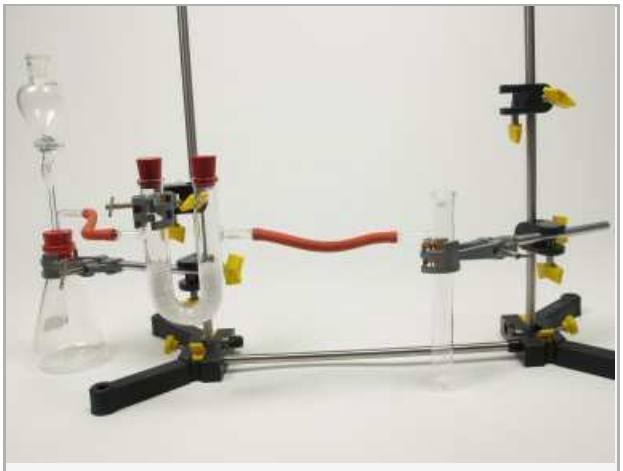

Fig. 25

Slip a right-angled glass tube into a rubber stopper and use this stopper to seal the test tube with side arm. Use another rubber tubing to connect this right-angled glass tube with the glass tube with tip (gas-entry tube) (Fig. 26).

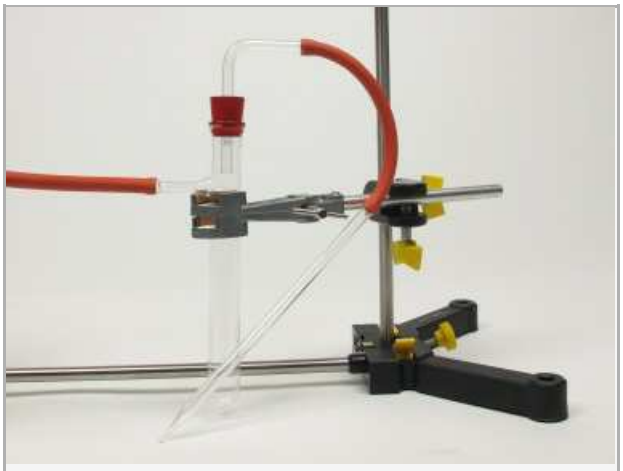

Fig. 26

Fix the two iron tods into the electrode holder and clamp this one into a bosshead in such a way that the iron rods point downwards (Fig. 27).

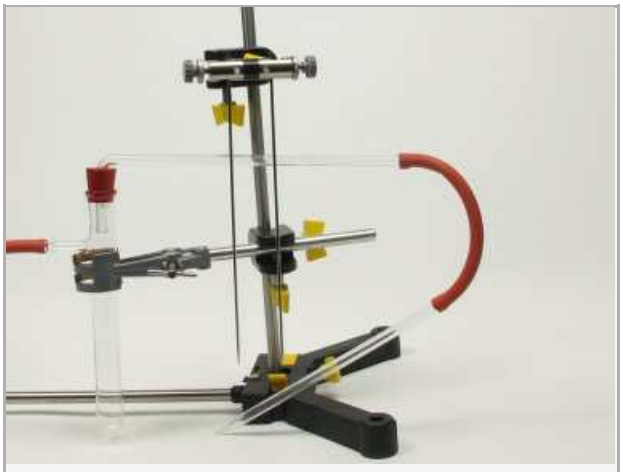

Fig. 27

Insert the plugs of two connecting cords into the free sockets of the electrode holder (Fig. 28 + Fig. 29). Set up the connections between the electrode holder and the battery as well as between the battery and the lampholder by means of some connecting cords and some crocodile clips (Fig. 30). Screw the filament lamp in the lamp holder.

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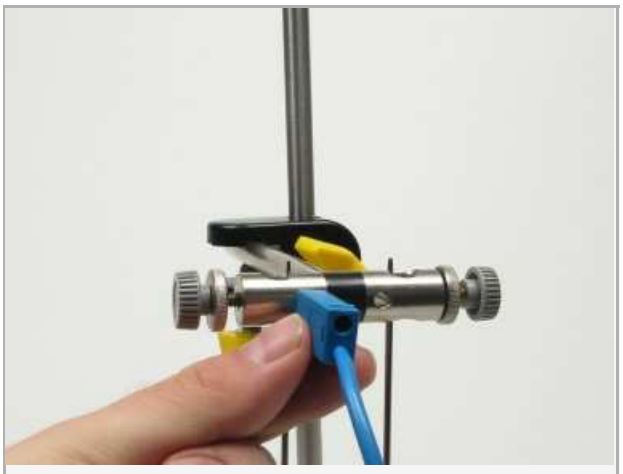

Fig. 28

Fig. 29

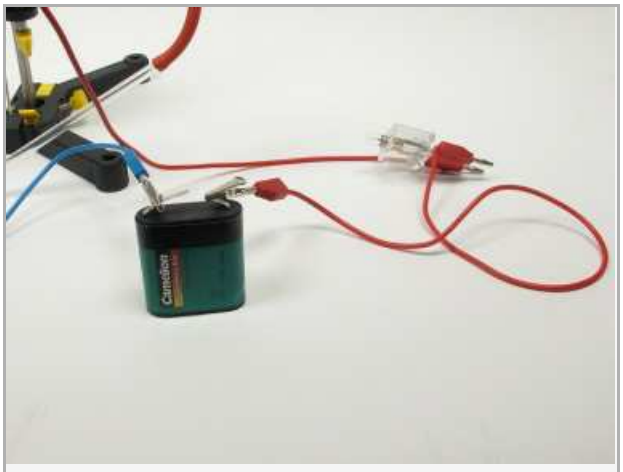

Fig. 30

Fill approximately 100 ml of distilled water into a beaker (Fig. 31) and add some ammonium chloride while stirring everything with a glass rod until the salt no longer dissolves (Fig. 32).

Fig. 31

Fig. 32

Procedure

Fill the ammonium chloride solution into the dropping funnel with the tap being closed (Fig. 33).

Fig. 33

Fill the glass beaker two thirds full with distilled water and place it under the electrode holder (Fig. 34). Lower the electrode holder so that the iron rods are dipped into the distilled water (Fig. 35). Examine the conductivity of the distilled water by means of the filament lamp and the temperature by means of the thermoemter (Fig. 36).

Fig. 34

Fig. 35

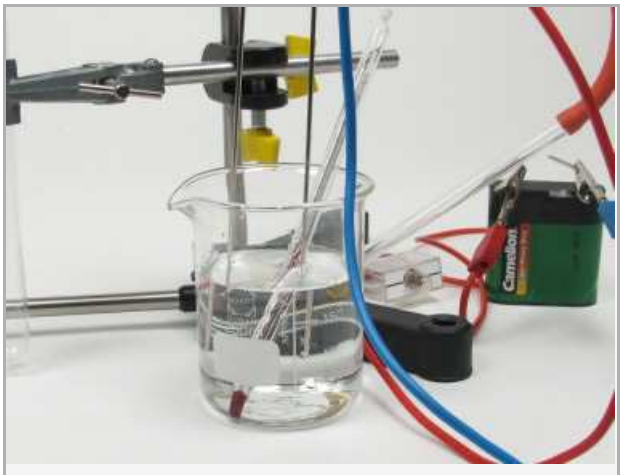

Fig. 36

Open the tap of the dropping funnel to such an extent that the concentrated ammonium chloride solution drops onto the sodium hydroxide (Fig. 37). Hold a piece of humid red litmus paper at the orifice of the gas offtake tube (Fig. 38).
Replace it by a dry peace of litmus paper when the humid one has changed its colour.


Fig. 37

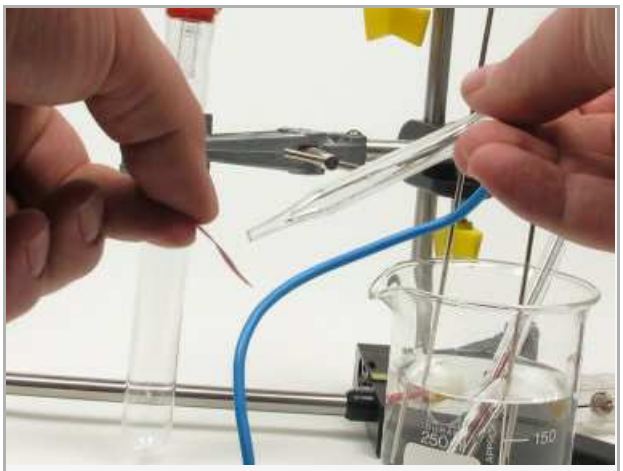
Fig. 38

Plunge the gas-entry tube into the glass beaker filled with distilled water (Fig. 39) and observe the course of temperature with the aid of the thermometer.

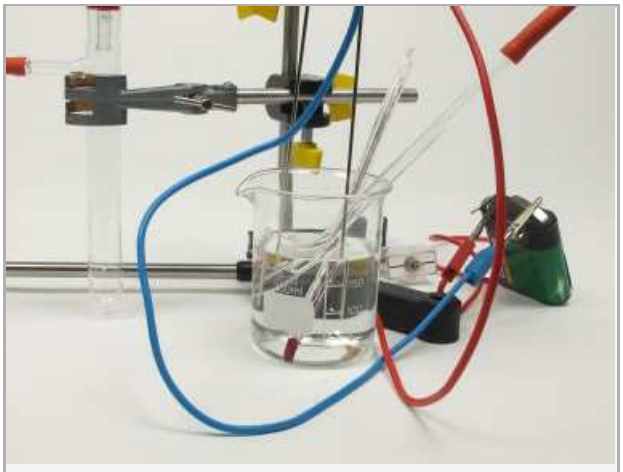
Fig. 39

Examine once more the conductivity of the solution (Fig. 40).

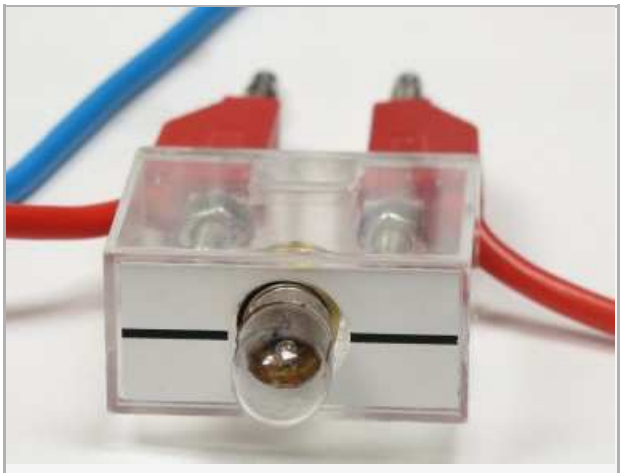
Fig. 40

Waste disposal

- Put the content of the Erlenmeyer flask and of the glass beaker into the collecting tank for acids and alkalis.
- Reuse the dry tube containing the sodium hydroxide pellets again for the next experiment.

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Report: Ammonia - a comparison of a gas and aqueous solution

Result - Observations

Write down your observations in a general form.

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Result - Table 1

Enter the results into Table 1.

	before the evolution of gas		after the evolution of gas	
Litmus paper humid	red	1	blue	1
Litmus paper dry	red	1	red	1
Temperature in °C		1 ±3		1 ±3
Filament lamp on/off	off	1	on	1

Evaluation - Question 1

Draw the conclusions from your observations. How can it be recognised that the alkaline solution obtained in this experiment is the same as the one contained in household detergents?

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Evaluation - Question 2

Which fact determined in conjunction with the acids corresponds to these observations? Apply this fact to the alkalis.

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Evaluation - Question 3

An alkali must be made up of what particles as far as the result of this experiment is concerned?

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