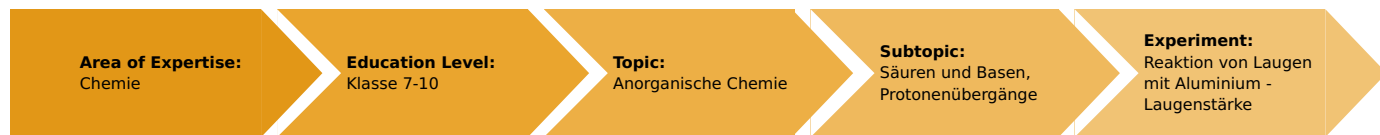


Reaction of alkalis with aluminium - alkali strength

(Item No.: P7159300)

Curricular Relevance



Difficulty



Easy

Preparation Time



10 Minutes

Execution Time



10 Minutes

Recommended Group Size



2 Students

Additional Requirements:

Experiment Variations:

Keywords:

alkalis, alkali strength, material property

Task and equipment

Information for teachers

Learning objectives

- On the basis of their reactivity, alkalis can be divided into strong and weak alkalis.
- Strong alkalis react with aluminium to form aluminates while at the same time hydrogen is released.
- The reactivity of the alkalis can thus be determined with the aid of the reaction time required for dissolving the aluminium.

Notes on set-up and procedure.

Preparations

Prepare concentrated solutions of sodium hydroxide and barium hydroxide before the lesson. Especially the baryta water must be as fresh as possible since it reacts rather rapidly with the carbon dioxide in the air. For this experiment identical concentrations are not necessary.

Remarks on the students' experiments

Make sure that the students handle the concentrated alkaline solutions properly. Keep the wash bottle ready to hand! If there are not enough working places equipped with a fume hood available, it is recommended to carry out the third part of the experiment (ammonia solution) in the form of a demonstration 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 continuously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
 P309 + P310: IF exposed or you feel unwell: Immediately call a POISON CENTER or doctor/physician.
 P301 + P330 + P331: IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.

Barium hydroxide:

- H302: Harmful if swallowed.
 H314: Causes severe skin burns and eye damage.
 H332: Harmful if inhaled.
 P280: Wear protective gloves/protective clothing/eye protection/face protection.
 P301 + P330 + P331: IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
 P305 + P351 + P338: IF IN EYES: Rinse continuously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
 P309 + P310: IF exposed or you feel unwell: Immediately call a POISON CENTER or doctor/physician.

Ammonia solution:

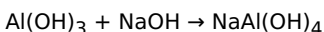
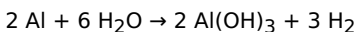
- H335: May cause respiratory irritation.
 H314: Causes severe skin burns and eye damage.
 H400: Very toxic to aquatic life.
 P280: Wear protective gloves/protective clothing/eye protection/face protection.
 P273: Avoid release to the environment.
 P301 + P330 + P331: IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
 P305 + P351 + P338: IF IN EYES: Rinse continuously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
 P309 + P310: IF exposed or you feel unwell: Immediately call a POISON CENTER or doctor/physician.

Hazards

- Concentrated alkaline solutions are highly corrosive. Avoid any skin contact! Put on protective glasses!
- Ammonia solution releases pungent and harmful gases. Do not inhale these gases! The experiment must thus be carried out under the fume hood!

Notes

The reaction of aluminium with alkalis is based on its amphoteric character. Aluminium hydroxide partly has the same properties as an alkali and partly those of an acid. On the one hand it is a Brønsted base (proton acceptor) and on the other hand also a Lewis acid (electron pair acceptor). The reaction of aluminium formally takes place according to the following reaction scheme:



The concept of a base strength applied here does not correspond to the chemical definition as a base dissociation constant (K-value). But since the concentration of the OH⁻ ions determines the reaction time, the experimental results follow the result of a determination of the dissociation constant, if identical or at least similar starting concentrations are maintained.

Remarks on the method

Before the experiment can be carried out it is recommended to treat the reaction of alkaline metals and alkaline-earth metals with water in order to be able to work out the phenomenological similarity with this experiment. The identification of the gas formed as being hydrogen should take place in the form of a demonstration. If the reaction of aluminium with caustic soda solution (if necessary, heat it slightly beforehand) is rather vigorous, the hydrogen evolved can be ignited directly over the liquid surface by means of a burning wood splint.

Waste disposal

Allow the aluminium to react completely. Remove any residues and put the alkaline solutions into the collecting tank for acids and alkalis.

Reaction of alkalis with aluminium - alkali strength

(Item No.: P7159300)

Task and equipment

Task

Are there alkalis that differ in strength?

Study the reaction of several alkalis with aluminium.



Equipment



Position No.	Material	Order No.	Quantity
1	Protecting glasses, clear glass	39316-00	1
2	Porcelain dish, 75ml, d = 80 mm	32516-00	3
3	Tweezers, straight, blunt, 160 mm	64610-02	1
4	Grad. cylinder, high, PP, 50ml	46287-01	2
5	Labor pencil, waterproof	38711-00	1
6	Digital stop watch, 24 h, 1/100 s & 1 s	24025-00	1
7	Petri dish, d 100 mm	64705-00	1
	Aluminium sheet, 0.2mm 50 g	30017-05	1
	Barium hydroxide 250 g	30034-25	1
	Sodium hydroxide, flakes, 500 g	30157-50	1
	Ammonia solution, 25% 1000 ml	30933-70	1
	Water, distilled 5 l	31246-81	1

Set-up and procedure

Set-up

Hazards

- Concentrated alkalis are highly corrosive. Avoid any skin contact! Put on protective glasses!
- Ammonia solution releases pungent and harmful gases. Do not inhale these gases! The experiment must thus be carried out under the fume hood!



Procedure

Use the tweezers to put two identical pieces of aluminium sheet into each of the three evaporating dishes (Fig. 1).



Fig. 1

Fill a graduated cylinder with 40 ml of concentrated caustic soda solution and a second one with 40 ml of concentrated barium hydroxide solution (baryta water) (Fig. 2).



Fig. 2

Fill the content of the two graduated cylinders into separate evaporating dishes (Fig. 3) and trigger the stopwatch (Fig. 4). Clean one of the measuring cylinders and fill it with 40 ml of ammonia solution. Fill the ammonia solution under the fume hood into the third evaporating dish and cover the dish by means of the Petri dish (Fig. 5).



Fig. 3



Fig. 4



Fig. 5

Check the result of this part of the experiment at the end of the lesson and leave the evaporating dish under the fume hood for the next lesson. Enter the reaction time measured into Table 1.

Waste disposal

Put the content of all the evaporating dishes into the collecting tank for acids and alkalis.

Report: Reaction of alkalis with aluminium - alkali strength

Result - Observations

Write down your observations.

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Result - Table 1

Enter the results into Table 1.

Alkali	Reaction	Reaction time in min	
Caustic soda solution	evolution of a gas, aluminium dissolves	1	1 ±1
Baryta water	slow evolution of a gas, aluminium dissolves slowly	1	1 ±2
Ammonia solution	hardly noticeable	1	> 1 day 1

Evaluation - Question 1

What gases could have been formed in the course of this experiment? By means of what test would it be possible to find out what gas has been formed?

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Evaluation - Question 2

Draw the conclusions from the experiment and answer the question given in the title of this experiment.

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Evaluation - Question 3

This experiment reminds you of what other reactions?

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