Properties of the aluminum

In this experiment, students learn about the properties of aluminum in practice.

Chemistry > Inorganic chemistry > Chemistry of metals

Difficulty level	Group size	Preparation time	Execution time
medium	1	10 minutes	20 minutes

This content can also be found online at:

http://localhost:1337/c/61f2a3bd38d14300030c8668

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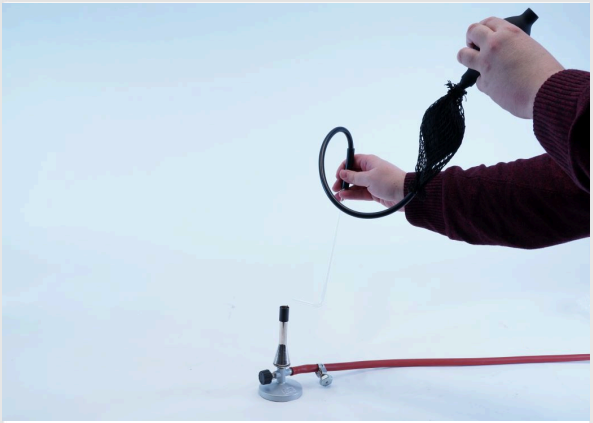
General information

Application



Test setup

In this experiment, the properties of aluminum are investigated.

For this purpose, aluminum powder is ignited, the reaction behavior of aluminum toward hydrochloric acid and the pH value of some aluminum salts are investigated.

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Other information (1/2)

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Prior

Students should already be familiar with the material properties of aluminum in theory.

Principle

Aluminum powder is ignited and the reaction behavior of aluminum toward hydrochloric acid and the pH of some aluminum salts are investigated.

Other information (2/2)

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Learning

In this experiment, students learn about the properties of aluminum in practice.

Tasks

Students ignite aluminum powder and investigate the reaction behavior of aluminum toward hydrochloric acid and the pH of some aluminum salts.

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Safety instructions

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- Safety goggles, gloves and lab coats must be worn during the experiment.
- Concentrated acids are highly corrosive. They destroy skin and textiles. When diluting, first the water, then the acid.
- For the H- and P-phrases please refer to the corresponding safety data sheets.
- The general instructions for safe experimentation in science education apply to this experiment.

Theory

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Aluminum is in the periodic table of elements in category 13: metals. It has the atomic number 13 and the symbol "Al".

We all know the aluminum foil from everyday life. But what properties does this foil actually have?

In addition to its familiar use as foil, however, aluminum is also used in other areas: It is valued for its lightness in the construction of aircraft, cars and railroads. It is also increasingly used in bicycle construction. It also has very good properties in terms of conductivity (electrical and thermal).

In the following experiments, the specific properties of aluminum are examined in more detail.

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Equipment

Position	Equipment	Item no.	Quantity
1	Bunsen stand, 210 x 130 mm, h = 750 mm	37694-00	1
2	Double socket, cross clamp	37697-00	2
3	Tripod clamp, span 80 mm with set screw	37715-01	2
4	Safety shim, 26.5 cm x 36.5 cm, aluminum	39180-01	1
5	Teclub burner with needle valve, for natural gas, DIN version	32171-05	1
6	Safety gas hose, DVGW, running meter	39281-10	1
7	Igniter for natural and liquid gas	38874-00	1
8	Hose clamp for d = 12-20 mm, 1 piece	40995-00	2
9	Rubber blower - double blower-	39287-00	1
10	Glass tubes, rectangu, 230 x 5 10 piece		

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Structure and implementation

Structure and implementation (1/4)

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Experiment 1: Burning aluminum powder

- The experiment is set up as shown in the figure on the right.
- The long leg of a rectangular glass tube is connected to a rubber blower and the short leg is filled with aluminum powder.
- By applying rapid, strong pressure to the rubber blower, the aluminum powder is blown from below into a non-luminous burner flame (burner stands on safety shim).

Test setup

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Structure and implementation (2/4)

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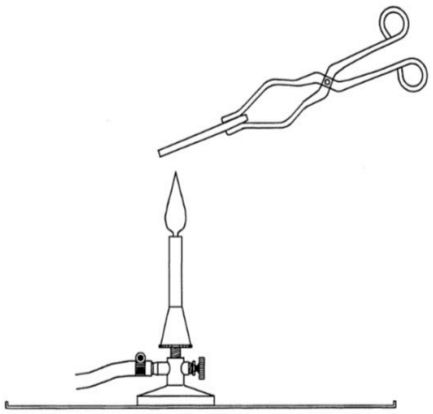
Experiment 2: Melting aluminum sheet

- The experiment is set up as shown in the figure on the right.
- A strip of aluminum sheet is held with the crucible tongs in the non-illuminating burner flame (burner is on safety support plate).
- The drop of molten metal that forms is pierced with an iron rod and the metal is allowed to drip onto the safety shim.



Test setup

Structure and implementation (3/4)

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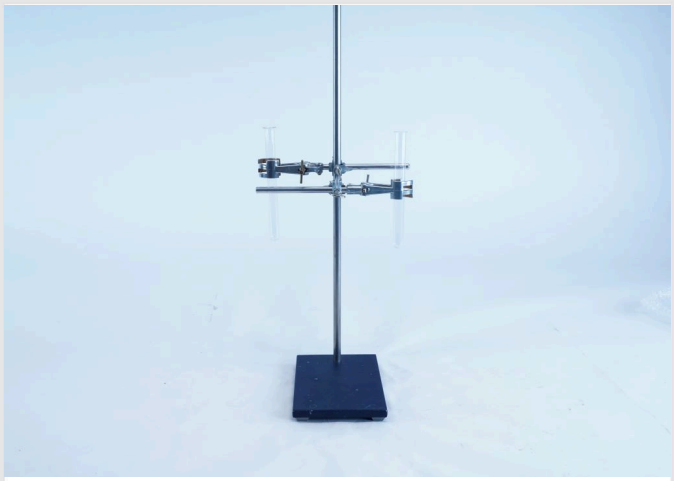
Experiment 3: Reaction with acids

- The experiment is set up as shown in the figure on the right.
- Two large test tubes are held on a stand and filled to a height of about 10 cm with dilute hydrochloric acid (add about 35 ml of concentrated hydrochloric acid to a beaker containing about 175 ml of water).
- Then put a strip of aluminum sheet into one glass and a strip of zinc sheet into the other.



Test setup

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Structure and implementation (4/4)

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Experiment 4: Amphoteric aluminum salts

- The experiment is set up as shown in the figure on the right.
- Dissolve about one spatulaful of aluminum chloride in a beaker containing 100 ml of water, add about 10 g of ammonium chloride to this solution and add ammonia solution to the solution while stirring. The pH value of the solution should not rise above 7 (check with universal indicator paper).
- Half of the solution with the precipitate is poured into a second beaker. Then add hydrochloric acid to one beaker and sodium hydroxide solution to the other in small portions while stirring.

Test setup

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Evaluation

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Evaluation (1/8)

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Observation

Experiment 1: Burning aluminum powder

The aluminum powder burns emitting a flash of light.

Experiment 2: Melting aluminum sheet

The aluminum strip does not ignite in the burner flame. The metal starts to melt, but does not drip as seen with other metals, but collects in a "Haut". After destroying the "skin", the silver-colored metal can flow out.

Experiment 3: Reaction with acid

\The zinc reacts immediately with the hydrochloric acid under hydrogen separation. In the case of aluminum, the reaction starts only after 1 - 2 minutes. It is weak at first, but then becomes increasingly stronger.

Experiment 4: Amphoteric acids

Evaluation (2/8)

PHYWE

Evaluation (1/4)

Experiment 1: Burning aluminum powder

The reaction of aluminum with oxygen takes place with the release of a large amount of heat.

$ {2Al} + {\frac{3}{2}} {O_2} \{Al_2O_3} $

Because the reaction is also very fast, all the energy is released in a very short time. The intensity of the light is so high that it is used in photographic technology. Vacu flash lamps contain a ball of very fine aluminum filaments that are electrically ignited and burn in a flash to form aluminum oxide.

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Evaluation (3/8)

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Evaluation (2/4)

Experiment 2: Melting aluminum sheet

The thin but firm skin consists of aluminum oxide. It forms in air and becomes about 0.0002 mm thick. Since it is very dense, further oxygen cannot penetrate to the metal surface. The metal is thus protected from destruction by oxidation. During melting, the liquid metal collects under this oxide layer and cannot drip off.

Experiment 3: Reaction with acid

The thin oxide layer on the aluminum protects it from the acid for a while. Only when this layer is destroyed (dissolved) does the aluminum react with the hydrochloric acid in accordance with its position in the voltage series, generating hydrogen.

Evaluation (4/8)

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Evaluation (3/4)

Experiment 4: Amphoteric aluminum salts

Aluminum chloride dissolves in water to form a hydrated cation $[Al(H_2O)_6]^{3+}$ which can act as a proton donor. In the process, cations such as $[Al(H_2O)_5(OH)]^{2+}$, $[Al(H_2O)_4(OH)_2]^{+}$ etc. are formed. By adding ammonia, the released protons are trapped until finally the precipitation of the oxide hydrate $[Al(H_2O)_3(OH)_3]$ takes place.

Since ammonium chloride is also present in the solution, the addition of ammonia creates a buffer system NH_4Cl/NH_3 . The pH value required for the quantitative precipitation of the aluminum hydroxide can therefore not be exceeded so quickly by adding the weak base ammonia.

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Evaluation (5/8)

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Evaluation (4/4)

Experiment 4: Amphoteric aluminum salts

Aluminum hydroxide is amphoteric. The freshly precipitated hydroxide dissolves in both acids and bases. In the alkaline medium, aluminates are formed.

$ {[Al(H_2O)_3(OH)_3]} + {OH^-} \longrightarrow {[Al(H_2O)_2(OH)_4]^-} + {H_2O} $

In acidic solutions, the hydrated cation forms again from the precipitated hydroxide.

$ {[Al(H_2O)_3(OH)_3]} + {3H_3O^+} \longrightarrow {[Al(H_2O)_6]^{3+}} + {3H_2O} $

Evaluation (6/8)

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Which statements about experiment 1 (burning aluminum powder) are true?

- [ ] Aluminum powder, like all other metals in powder form, is non-flammable and only slightly flammable.
- [ ] The intensity of the light during the combustion of aluminum powder is so high that it is used in photographic technology.
- [ ] The aluminum powder burns, emitting a flash of light.

Check

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Evaluation (7/8)

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Which statements about experiment 2 (melting aluminum sheet) are true?

- [ ] The aluminum strip ignites in the burner flame.
- [ ] After destroying the "skin", the silver-colored metal can flow out.
- [ ] The metal begins to melt, but does not drip as seen with other metals, but collects in a "skin".
- [ ] None of the answers is correct.

Check

Evaluation (8/8)

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Drag the words into the correct boxes!

Aluminum chloride dissolves in water to form a _____. $[Al(H_2O)_6]^{3+}$ which can act as a _____. Thereby cations like $[Al(H_2O)_5(OH)]^{2+}$, $[Al(H_2O)_4(OH)_2]^{+}$ etc. are formed. By the addition of _____ the released protons are intercepted until then finally the precipitation of the _____. $[Al(H_2O)_3(OH)_3]$ takes place.

proton donor
oxide hydrate
ammonia
hydrated cation

Check

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Slide	Score / Total
Slide 19: Aluminum powder	0/2
Slide 20: Melting aluminum sheet	0/2
Slide 21: Amphoteric aluminum salts	0/4

Total 0 / 8

Solutions Repeat

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