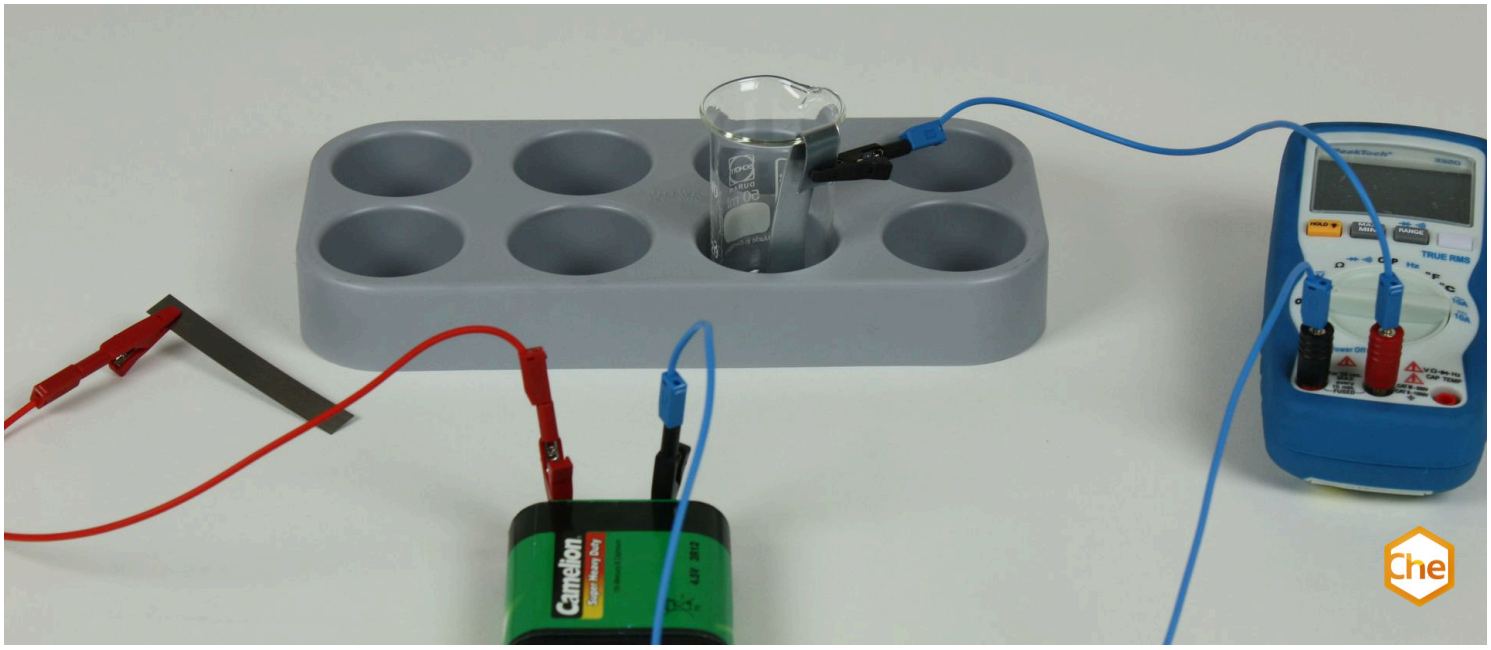
Galvanic zincking



The students are to galvanise a strip of sheet iron by electrochemical means. The protective effect of this galvanisation against corrosion is then demonstrated in a long-term experiment.

Chemistry > Physical chemistry > Electrochemistry > Electrochemical voltage series

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/637524b49eb79c00033f8751

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Teacher information

Application

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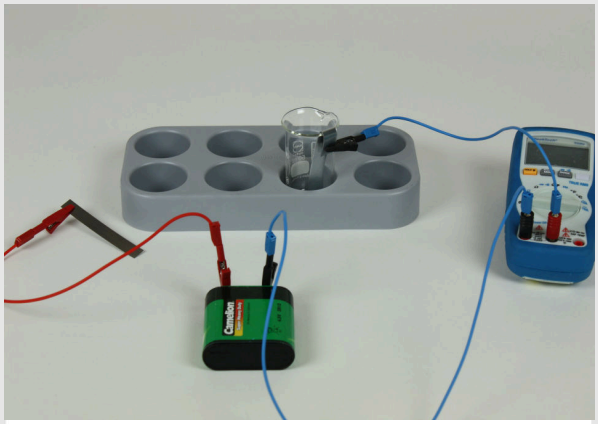

Experimental setup

For the longevity of many ferrous products, corrosion protection is needed to protect the surfaces from oxidation with atmospheric oxygen and water, thus preventing rust formation.

Iron can be protected from corrosion by conductive contact with zinc (local element formation), as zinc and copper form a galvanic element here. The electrons that are released during the oxidation of the less noble zinc are absorbed by the iron and thus the iron is protected from corrosion.

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Other teacher information (1/2)

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Prior knowledge

Students should already know what chemical and physical processes take place during corrosion. They should also know that there are different methods to prevent corrosion.

Principle

Corrosion protection by galvanising is achieved by two different processes:

1. By hot-dip galvanising, in which the iron parts to be galvanised are briefly immersed in a bath of molten zinc. This leaves a closed solid layer of zinc partially alloyed with the iron on the surface.

2. By electroplating, i.e. by a galvanic (or electrochemical) separation of zinc from zinc solutions, in which one hangs the iron parts to be galvanised as cathode.

Other teacher information (2/2)

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Learning objective

The students are to galvanise a strip of sheet iron by electrochemical means. The protective effect of this galvanisation against corrosion is then demonstrated in a long-term experiment.

Tasks

A strip of sheet iron is to be galvanised by electrochemical means. The protective effect of this galvanisation against corrosion will then be demonstrated in a long-term test.

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Safety instructions

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- Wear protective goggles and gloves.
- The galvanising solution has an irritating effect.
- For the H- and P-phrases please refer to the corresponding safety data sheets.
- The general instructions for safe experimentation in science lessons apply to this experiment.

Disposal

Acids and bases are put in the sink after neutralisation (pH 6 to 8), heavy metals and solutions containing heavy metals are disposed of in the canister for heavy metal waste. The solution for galvanising is to be collected after use, as it can be used again and again!

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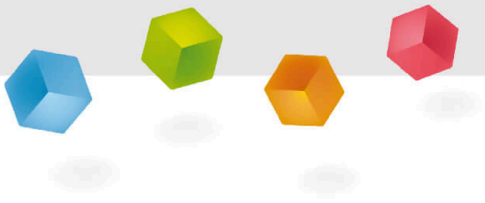

Student information

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Motivation

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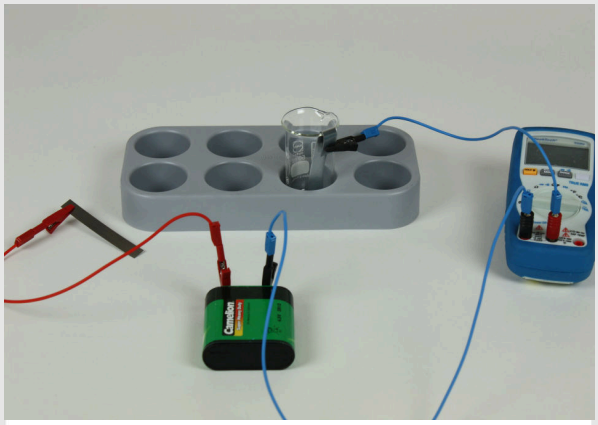

Experimental setup

Surely you have already noticed that many metals that are left outside acquire a reddish-brown patina (green film) and are even downright destroyed over time.

These metal destructions are summarised under the term "corrosion" (lat. corrodo = gnawing, eating away).

But surely you have also noticed the shiny silver garden gates or flagpoles. This "galvanisation" protects iron from corrosion.

Tasks

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Galvanise a strip of sheet iron by electrochemical means.

In a long-term test, you then prove the protective effect of this zinc coating against corrosion.

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Equipment

Position	Material	Item No.	Quantity
1	PHYWE Digital multimeter, 600V AC/DC, 10A AC/DC, 20 MΩ, 200 µF, 20 kHz, −20°C…760°C	07122-00	1
2	Connecting cord, 2 mm-plug, 5A, 500 mm, red	07356-01	1
3	Connecting cord, 2 mm-plug, 5A, 500 mm, blue	07356-04	2
4	Reducing plug 4mm/2mm socket, 2	11620-27	2
5	Alligator clip, insulated, 2 mm socket, 2 pcs.	07275-00	1
6	Set Strip electrode (Al, Fe, Pb, Zn, Cu)	07856-00	2
7	Emery paper, medium	01605-00	1
8	Block with 8 holes, d = 40 mm	37682-00	1
9	Sheet metal strips, 20 pcs	06532-00	1
10	Flat battery, 4.5 V	07496-01	1
11	Zinc sulphate 7-hydr. 250 g	30249-25	1
12	Zinc chloride, dry, 250 g	31983-25	1
13	Sodium sulphate dried 250 g	48344-25	1
14	Sulphuric acid,0.5M 1000 ml	48462-70	1

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Set-up (1/2)

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Preparation of the solution for galvanising:

Dissolve successively in 500 ml of pure water: 125 g of zinc sulphate (7 hydrate), 10 g of zinc chloride, 25 g of sodium sulphate and 5 g of 0.5 M sulphuric acid.

Set-up

Place a beaker in the measuring cell block.

Cut a strip of zinc sheet measuring 10 mm x 80 mm and bend its upper end to an acute angle at a length of about 20 mm.

Hang this zinc sheet as an anode in the beaker (fig. right).

Hang the zinc sheet in the beaker

Set-up (2/2)

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Fill the beaker 2/3 full with the solution for galvanising. In addition to water (as solvent), the solution contains zinc sulphate, zinc chloride, sodium sulphate and some sulphuric acid in a quantity ratio that ensures uniform galvanic zinc deposition.

Sand a strip of iron sheet on all sides with emery cotton wool and wipe it with a paper towel or a round filter without touching it directly with fingers again (It must remain grease-free!).

Hold this strip of sheet iron with an alligator clip and connect it to the negative pole of a DC voltage source. (A variable transformer with a rectifier is best suited for adjusting the voltage and current. However, the experiment also works with a 4.5 V flat battery).

From there, continue the circuit via the measuring instrument (as an ammeter, setting 2000 mA) to the zinc sheet strip.

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Procedure (1/2)

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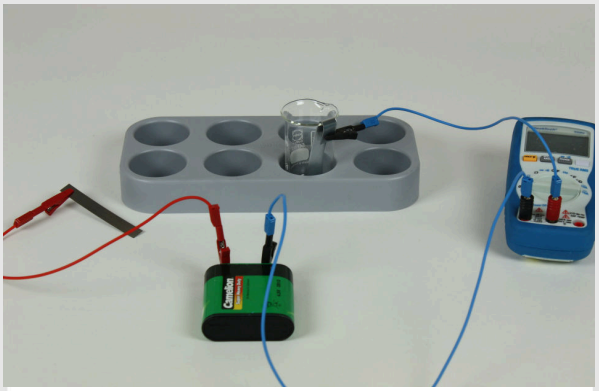
If a variable transformer is used, set the voltage to 2 V.

After switching on the current, immerse the iron sheet in the galvanising solution for a few seconds without touching the zinc sheet (anode).

Then rinse and dry the iron sheet. Make a note of your observations.



Your experimental set-up should look like this

Procedure (2/2)

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Advanced experimental part

Two beakers are filled with fresh tap water.

Place the electroplated sheet iron strip in one of these jars and a sheet iron strip in the other jar, which has been carefully cleaned on the surface with emery cotton wool and degreased.

Leave the iron sheets in the water overnight and note your results the next day.

Structure of the continuative part of the experiment

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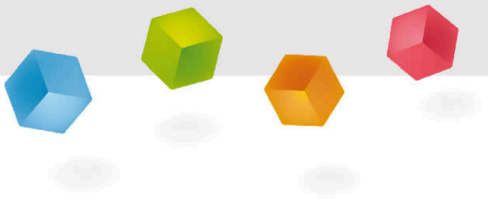

Report

Task 1

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Why is corrosion protection needed for the longevity of many ferrous products?

- ○ To protect the surfaces from reduction with atmospheric oxygen and water and thus prevent rusting.
- ○ To protect the surfaces from oxidation with atmospheric oxygen and water and thus prevent rust formation.
- ○ A legal requirement regulates corrosion protection: these fully have the effect that all ferrous components installed outdoors look the same.

Check

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Task 2

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Which two processes are used in engineering for corrosion protection by galvanising?

- [ ] Hot-dip galvanising in which the iron parts to be galvanised are briefly immersed in a bath of molten zinc. In the process, a closed solid layer of zinc, partially alloyed with the iron, adheres to the surface.
- [ ] Electroplating, i.e. by a galvanic (or electrochemical) separation of zinc from zinc solutions, in which the iron parts to be galvanised are suspended as a cathode.
- [ ] Water bath in which the iron parts to be galvanised are briefly immersed in a bath of water and then sprinkled with zinc powder.

Check

Task 3

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Which procedure is preferred and why?

- ○ As the hot-dip galvanising process consumes much less energy, it is the preferred process today.
- ○ Since the water bath process uses much less zinc per square metre of surface area, it is the preferred process today.
- ○ Since the electroplating process uses much less zinc per square metre of surface, it is the preferred process today.

Check

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Slide	Score / Total
Slide 15: Corrosion protection	0/1
Slide 16: Galvanising process	0/2
Slide 17: Preferred method	0/1

Total 0 / 4

Solutions Repeat

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