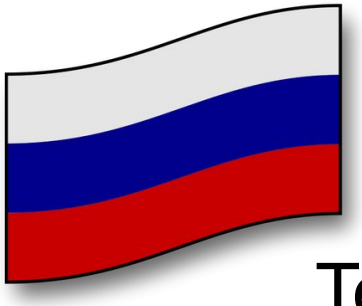
8. Magnet and matchstick

A matchstick is not attracted to a magnet, however the head of a burned matchstick is attracted by a strong magnet. Investigate the reasons and the role of relevant parameters.



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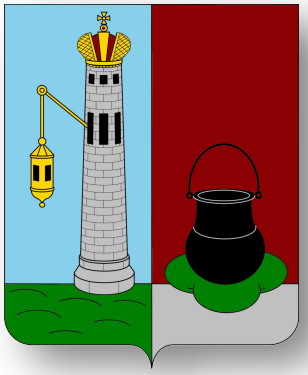


Goal and main points:

The first (trial) experiment. Hypothesis

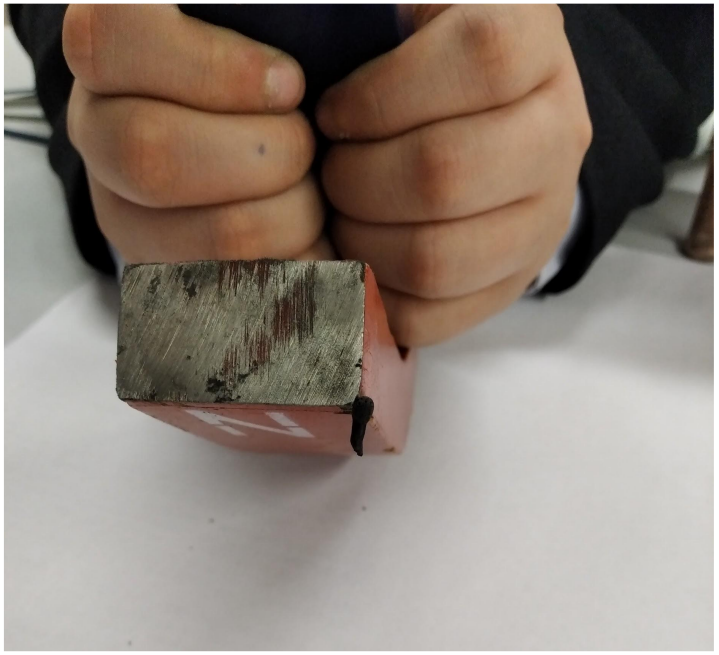
Matchstick composition research.

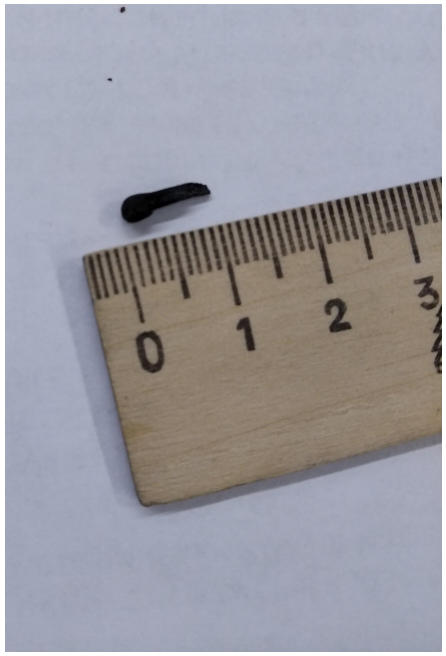
Experimental research.

Conclusion.

Experiment #1

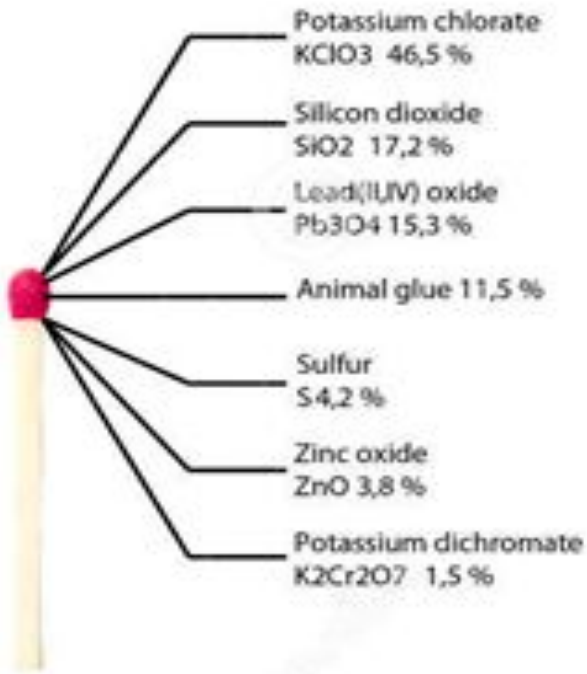
The unburned match was not attracted to the magnet, but the burned match was attracted.
Moreover, we noticed that only the head was attracted, and the rest of the matchstick was not.
Therefore, we need to find out the composition of the match.





The Theory:

The composition of the match:



The red iron $\mathbf{Fe_2O_3}$ containing in the head and giving it its characteristic reddish color, upon combustion, forms another iron oxide - magnetite $\mathbf{Fe_3O_4}$. It is magnetite that is attracted to a strong magnet, and also pulls the rest of the wooden straw behind it.

Conclusion:

matchstick has burned and the ferromagnet has been formed

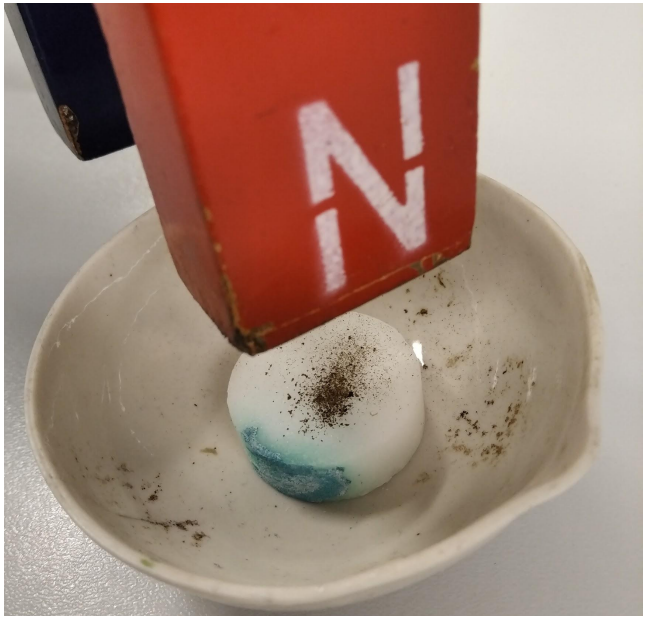
We repeated the experiment without the matchstick.

1) whether the ferric oxide $\mathbf{Fe_2O_3}$ was attracted to magnetic field or not?

2) will it be attracted after strong heating?

Experiment #2

1. Put the Iron oxide (the rust).
2. Iron oxide is not attracted by the magnet.



3. Heavy heating of the Iron oxide (800 **degree**, as a matchstick).

4. After heating the particles of Iron oxide began to attract to the magnet.

Conclusion:

After burning iron oxide turns into magnetite

($\mathbf{Fe_2O_3}$), ($\mathbf{Fe_3O_4}$).

That's why after combustion of the matchstick its head became attracted by the magnet.

Explanation of experiments:

Simple equation for the reaction is:

Iron(III) oxide + carbon → iron + carbon dioxide

So when the matchstick is burnt, it undergoes a chemical reaction, turning the red head (iron oxide and carbon) into iron and carbon dioxide gas.

The iron causes attraction of the matchstick's head to the magnet.

Note: The Iron-containing substance are absent in some matchsticks. For example, the experience with the green-head matches is unsuccessful .

Experiment #3. Hunting matches test

Hypothesis: the head of hunting matchstick is bigger that's why it has bigger combustible substances and prolonging combustion substances (e.g. $\mathbf{Fe_2O_3}$).

Expertise: we attract a burnt out hunting match with a magnet.

What we got: a hunting matchstick is attracted like a regular match.

Conclusion: a hunting match contains the same amount of $\mathbf{Fe_2O_3}$ as an ordinary match, so it is drawn into the magnetic field in the same way as an ordinary one

About The Hunting Matchsticks

Hunting matches have a thicker and longer head, a straw soaked in paraffin. Substances added to the head do not allow it to get wet quickly.

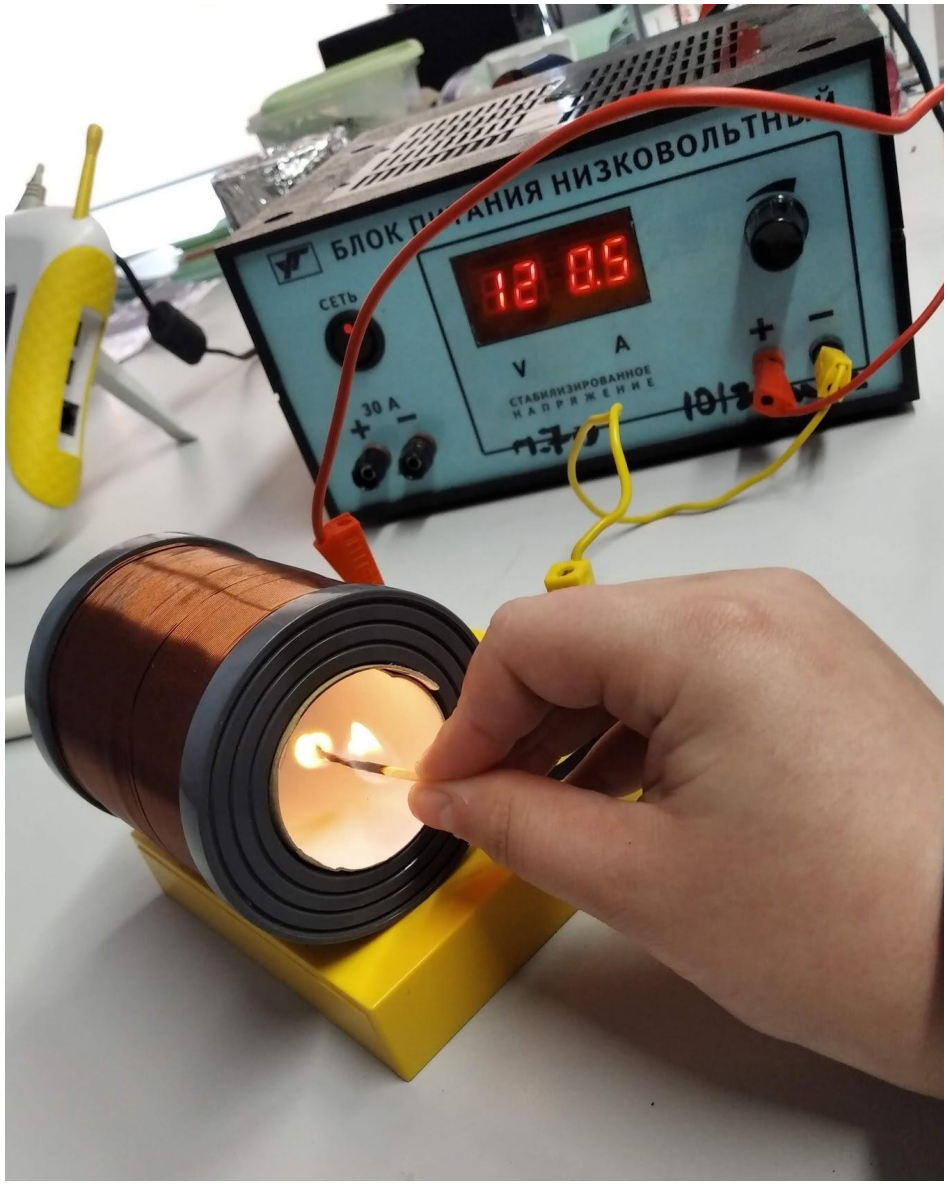
Experiment #3. What if the match burns out directly in a magnetic field?

It's well- known fact that a magnet can lose its magnetic properties being heated. How will the magnetic properties of a match change if it burns in a magnetic field?

Hypothesis: a match that burns out in a magnetic field will change its properties more than a match that burns out of the field.

Experimental conditions: in order not to heat the magnet with the flame of a match, we use an electromagnet (a coil through which an electric current flows).

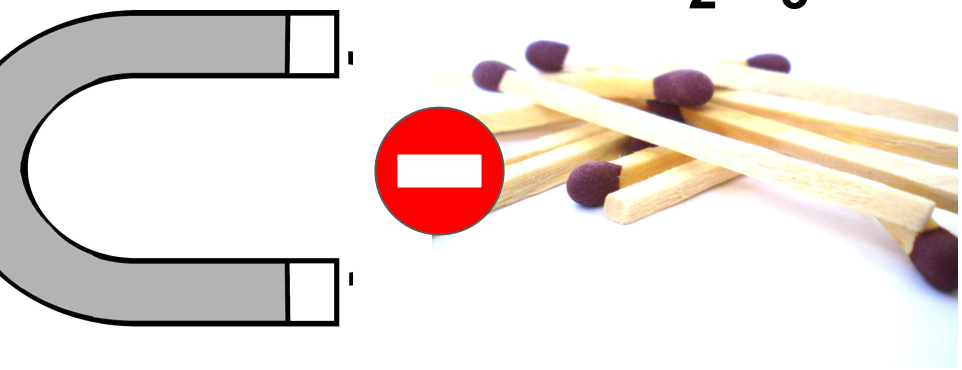
Results and their explanation: a match being burnt into a magnetic field, remains the same properties as the match burnt outside the magnetic field.



Conclusion and resume

1. The head of the match contains iron oxide (**Fe_2O_3**)
When burned, it turns into magnetite.
Magnetite (**Fe_3O_4**) is a ferromagnet that is drawn into a magnetic field. Therefore, the burnt match is attracted to the magnet.

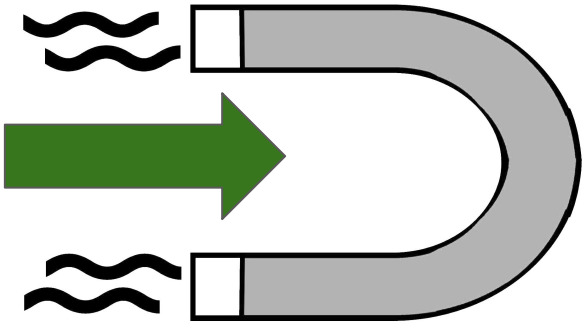
Fe_2O_3



Fe_3O_4

2. Perhaps the experiment with the coil failed because there was a weak current in it - the experiment should be continued with a stronger magnetic field.

3. We also refuted the hypothesis that a big hunting match contains more iron oxide than a regular match.

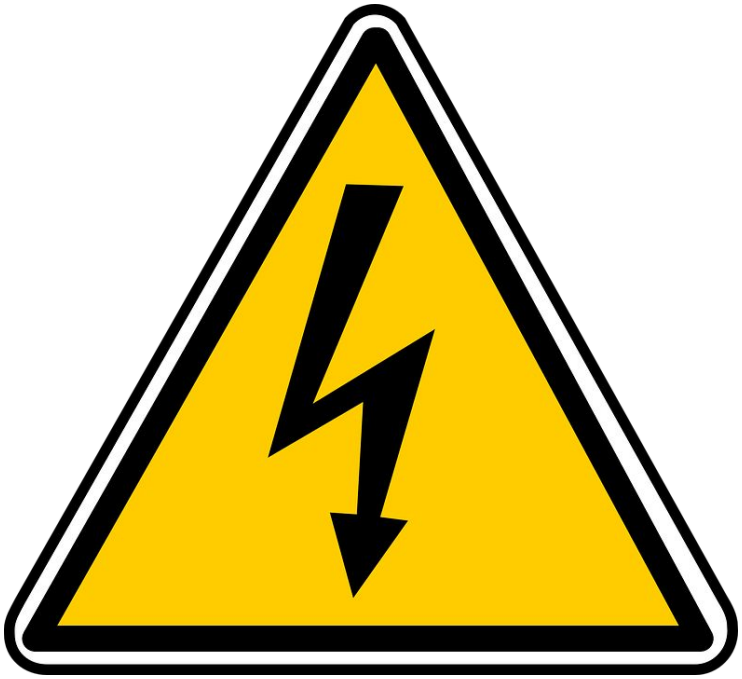


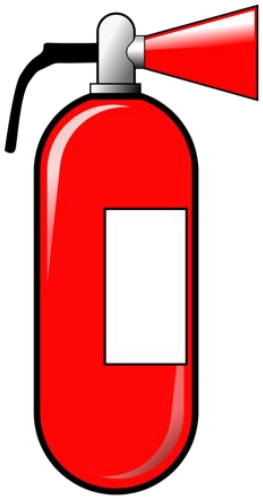
Experimental conditions and safety precautions

All experiments were carried out in a specially equipped room, accompanied by a laboratory assistant.

The maximum voltage on the coil was 12 V. Experiments with electric current were carried out while standing on a dielectric mat.

There was a fire extinguisher and sand near us.





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Magnetic substances: