Problem № 3
«Photography with iron salts»

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The task

Mix 10 parts of ferrous oxalate (25% aqueous solution), 7 parts of concentrated ammonia solution, and 20 parts of saturated solution of oxalic acid to produce a photosensitive iron complex. Prepare separately a 25% solution of potassium ferricyanide. A sheet of paper saturated with a mix of these two solutions can be exposed to light and produce an image. What other iron salts are photosensitive? Produce photographs using various approaches and various iron salts, and investigate the role of relevant parameters.

Hypothesis

if you change the source of radiation, the method of receiving a photo or a solution of light-sensitive salt and its proportion with a solution of red blood salt, we get photographic images of different quality.

Aim of the study

to create photos using different techniques and different iron salts and explore the role of the accompanying parameters.

Objectives

1. To study theoretical material on the research topic, data on various photosensitive salts and methods for creating photographs.
2. To carry out the experiment proposed by the organizers of the tournament.
3. To consider taking photographs using light-sensitive metal compounds.
4. To create prints using light-sensitive compounds.
5. To prove in practice the dependence of photosensitivity on the salts taken and various conditions.
6. To determine which other iron salts are photosensitive.

Theory

Daguerotype and Talbot's calitype– the earliest photographic processes are daguerreotype and calypria. They are based on the light sensitivity of silver iodide.

Theory

Cyanotypia - method of photographic printing depicting the characteristic bright blue color. At the heart of the cyanotype is the ability of trivalent iron under the influence of ultraviolet light to recover to bivalent.

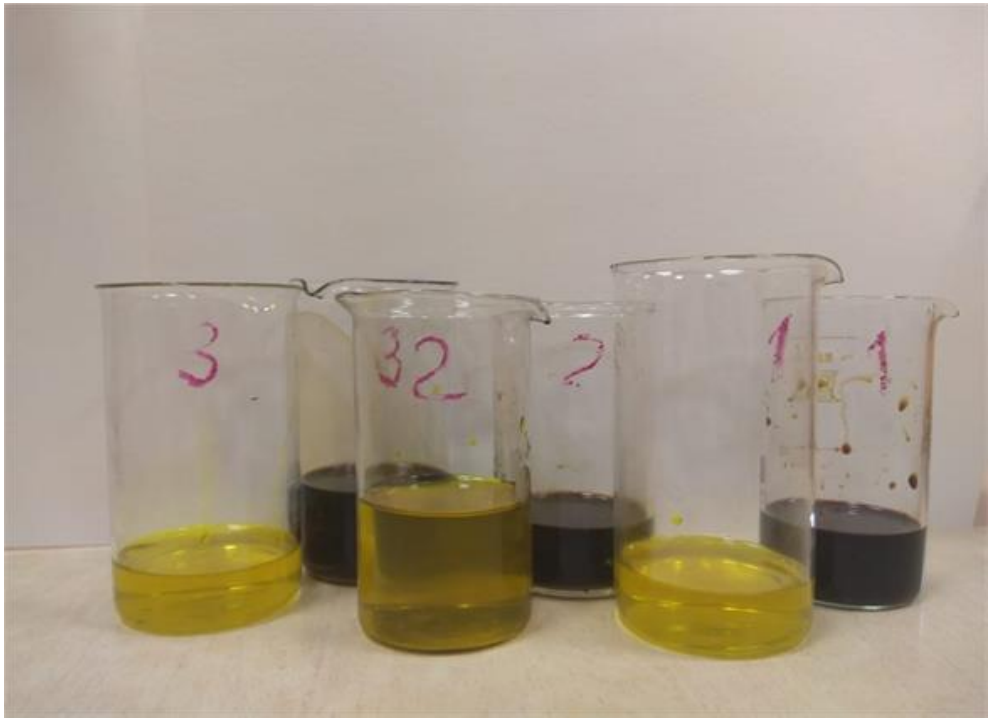
Experimental part

All experiments were conducted on the same method:

1. Making solutions
2. Apply solutions to paper in a dark room
3. Drying sheets
4. Exposure to sheets with solutions on them, within the framework on which the glass is painted with a black pattern.
5. Washing samples to remove salt residues

<u>Experiment 1:</u> Getting pictures with iron citrate in different proportions when irradiated by an ultraviolet lamp.

<u>Equipment and reagents</u>: flasks, a watercolor paper, a brush, a drawing frames, a red lamp, Iron[(III)Lemonmium Green $5FeC_6H5O_7 \times 2$ $(NH_{4)3}C_6H_5O_7 \times$ $(NH_{4)})C_6H_7O_7 \times 2H_2O$, Red Blood Salt or Hexicianoferrate (III) Kali $K_3[Fe(CN)_6]$



Salt solutions in different proportions: 1: 1, 1: 2, 2: 1

<u>Experiment 1:</u> Getting pictures with iron citrate in different proportions when irradiated by an ultraviolet lamp.

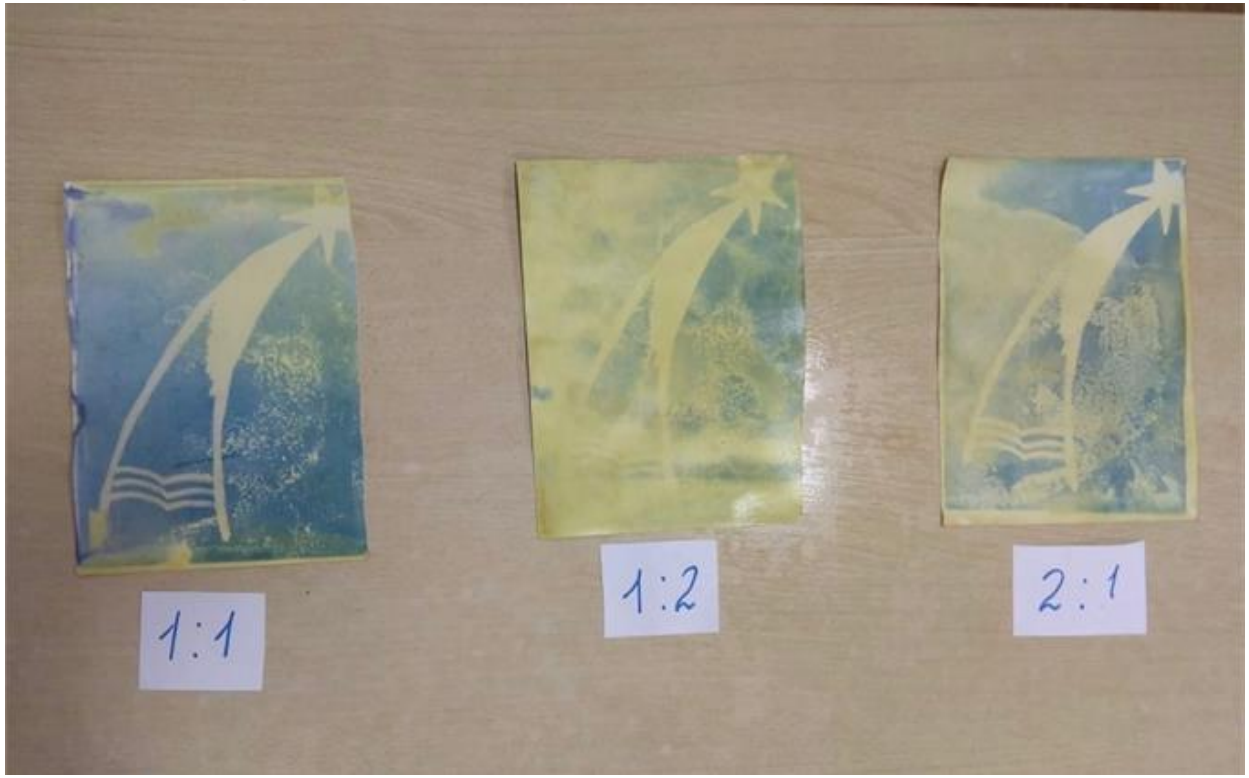
The essence of the process is to transite the iron with a charge of 3+ to Iron with a charge of 2+ $5FeC_6H_5O_7 \times 2(NH_4)_3C_6H_5O_7 \times (NH_4)C_6H_7O_7 \times 2H_2O$ in the light: $Fe^{3+} \rightarrow Fe^{2+}$

Then comes the formation of the Berlin azure:

$$Fe^{2+} + K_3[Fe(CN)_6] \rightarrow 2K^+ + KFe[Fe(CN)_6]$$

<u>Experiment 1:</u> Getting pictures with iron citrate in different proportions when irradiated by an ultraviolet lamp.

After washing in running water, not to continue lighting previously unrradied areas, the samples were dried and put under pressure for disbursing.



The formation of Prussian blue from iron (III) citrate by mixing substances of various proportions under irradiation of an ultraviolet lamp

The highest light sensitivity is observed when reacting with reagents in a ratio of 1:1.

<u>Experiment 2:</u> Getting pictures with iron citrate when Irradiated by different sources of ultraviolet light.

The frame in the ratio of reagents 1: 1 was left in daylight for 3 hours.

When exposed to daylight for about 3 hours, they achieved the clearest image due to the complete transition of the Fe3 + ion to Fe2 + and the formation of Prussian blue.

Formation of Prussian blue from iron (III) oxalate under daylight irradiation.

Formations of Prussian blue from iron (III) citrate when substances are mixed in a 1: 1 ratio under daylight

<u>Experiment 3:</u> Getting images using iron oxalate and comparing the light sensitivity of iron citrate(III)and iron oxalate (II).

<u>Equipment and reagents</u>: flask, watercolor paper, brush, pattern frame, red lamp, iron oxalate ammic complex (III) $(NH_4)_3[Fe(C_2O_4)_3]$, red blood salt or hexacianoferrate (III) kalia K3[Fe(CN)6].

$$(NH_4)_2[Fe(C_2O_4)_2] + K_3[Fe(CN)_6] \rightarrow (NH_4)_2C_2O_4 + K_2C_2O_4 + KFe[Fe(CN)_6]$$

$$2(NH_4)_3[Fe(C_2O_4)_3] \xrightarrow{h\nu} 2(NH_4)_2[Fe(C_2O_4)_2] + (NH_4)_2C_2O_4 + CO_2$$

According to the presented experiments, it can be concluded that the photosensitivity of iron (III) oxalate is better, since the images are brighter, which indicates a greater formation of Prussian blue.

<u>Experiment 3:</u> Getting images using iron oxalate and comparing the light sensitivity of iron citrate(III)and iron oxalate (II).

Formation of Prussian blue from iron (III) oxalate under daylight irradiation.

Formations of Prussian blue from iron (III) citrate when substances are mixed in a 1: 1 ratio under daylight

Experiment 4: Getting pictures with silver salts.

Equipment and reagents: flask, watercolor paper, brush, pattern frame, red lamp, silver nitrate, sodium chloride.

We added to the silver nitrate solution common salt solution until complete precipitation of silver chloride.

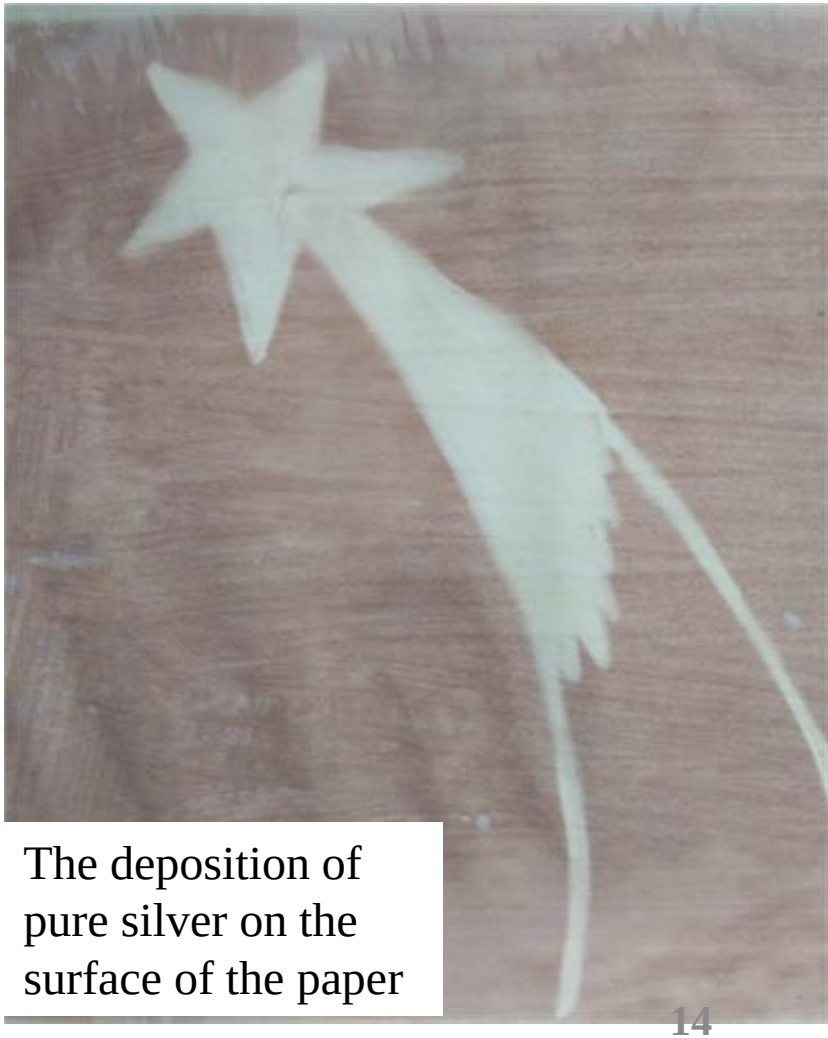
$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$

$2Cl^- + h\nu \rightarrow Cl_2 + 2e$

$2Ag^+ + 2e \rightarrow 2Ag$

Samples obtained to remove residues silver and fasteners washed in sodium thiosulfate, which is with silver forms a complex.

$AgCl + Na_2S_2O_3 = Na[Ag(S_2O_3)] + NaCl$



The deposition of pure silver on the surface of the paper

Conclusions

1. In information sources, there are various light-sensitive metal salts: gold, platinum, silver, iron. The simplest and most inexpensive are the salts of iron and silver, which we used in our experiments.
2. The photosensitivity of iron (III) oxalate is higher than the photosensitivity of iron (III) citrate, which was proven by obtaining brighter images during the experiment.
3. During the experiment, it was also found that prolonged exposure to daylight is more effective for obtaining clear images. Irradiation with an ultraviolet lamp did not lead to the appearance of bright pictures, since the lamp was low-power and the irradiation was carried out for a short time so as not to harm the health of the students.
4. The light sensitivity of silver salts is much higher than that of iron salts. The first signs of a photochemical reaction in daylight appeared in the case of silver chloride within 15 minutes. Signs of the reaction with iron salts appeared much later.

References

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