III IYNT 2015

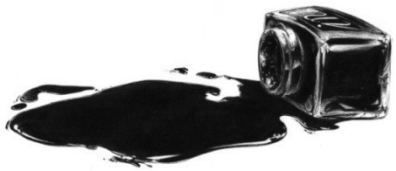
Problem № 6
«Disappearing Inks»

Team *«MG 12»*

Problem:

Suggest ink that vanishes in a while after writing in it. What can influence the time of your ink's disappearance? Can you make the text, written in your ink, appear again?

- **Hypothesis:** if we can choose appropriate coloring materials and conditions we will be able to make inks that can disappear and then appear again.



- **Objective:** To choose suitable materials to make ink that disappears in some time after applying it on a surface and appears again after changing conditions.

Tasks:

- Search for information in various resources
- Conduct experiments using several colouring substances.
- Work out criterions that the vanishing or appearance of inks depends on.
- Conduct experiments using colourants that meet the conditions of the problem .
- Draw conclusions.

1. Ink formula:

Every ink contains the following components:

1) Solvents;

2) Colourants.

2. Detection methods

- thermal
- chemical
- optical

Detection method	Ink formula	Developer
Thermal		
	Apple or onion juice	Temperature
	Milk	Temperature
	Swede	Temperature
	Sulfuric acid	Temperature
Chemical		
	Citric acid	Benzyl orange
	Wax	Calcium carbonate or tooth powder
	Beer or white wine	Paper ash
	Phenolphthalein	Solute of a base
	Starch	Solute of iodine
	Aspirin	Iron salts
Optical		
	Washing powder (solute)	UV light

3. Requirements for inks according to conditions of the problem:

1) moderate drying speed;

2) instability of the colour during long periods of time when stored in ordinary conditions;

3) Possibility of colour restoration .

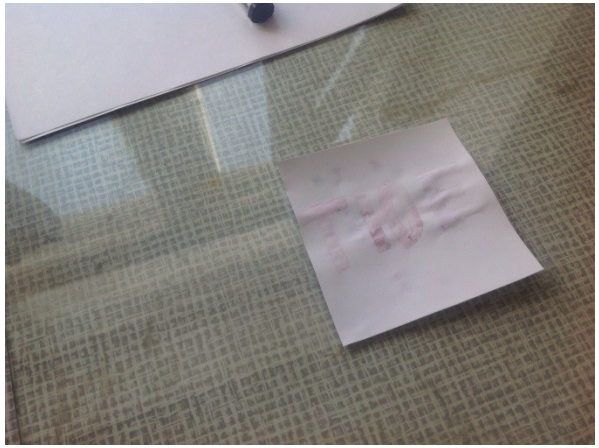
Experiments

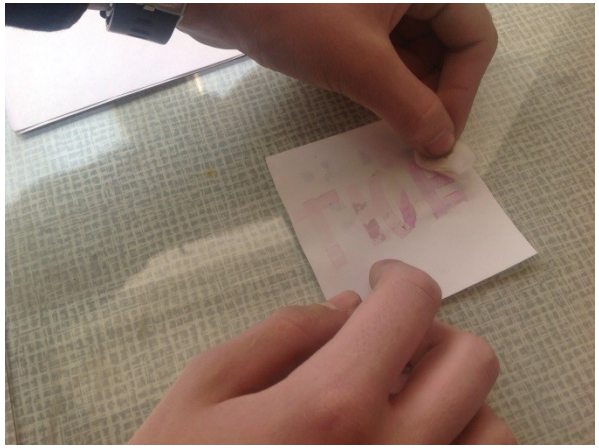
We used

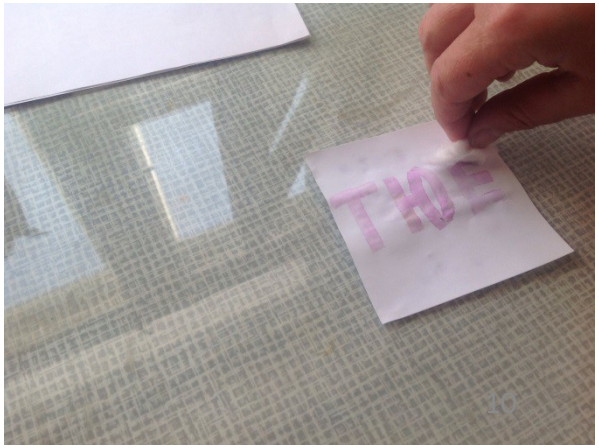
- water as a solvent
- ordinary office paper with density 80 g/m2 as a surface
- various chemical substances as colourants
- heat, chemical reagents as developers

Experiment 1

- Ink's formula: a solute of sodium dioxide coloured with phenolphthalein
- Developer: Any substance which pH is higher than 7
  - $NaOH = Na^{+} + \mathbf{OH}^{-}$
  - $CO_2 + H_2O = H_2CO_3 = \mathbf{H}^{+} + HCO_3^{-}$
  - $Na_2CO_3 = 2Na^{+} + CO_3^{2-}$
  - $CO_3^{2-} + HOH = HCO_3^{-} + \mathbf{OH}^{-}$

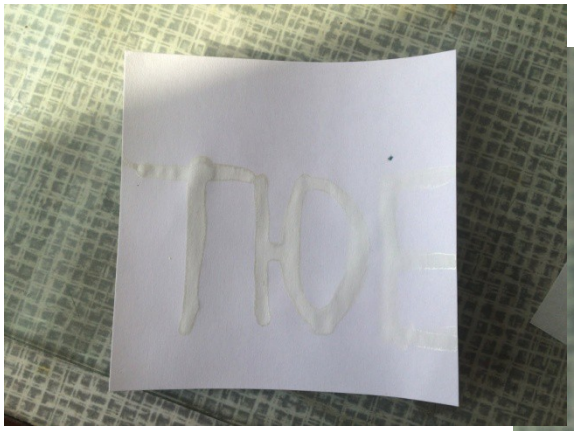


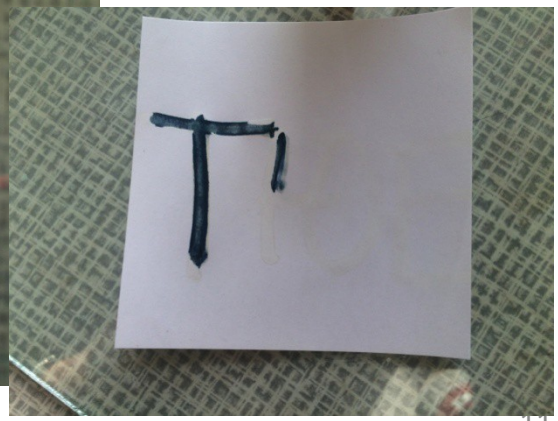




Experiment 2

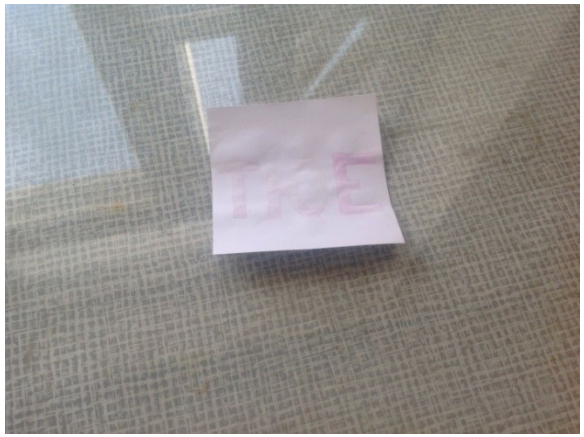
- Ink's formula: $K_4[Fe(CN)_6]$- yellow solute, becomes invisible when dries up. After a contact with iron trichloride its colour turns into blue (berlin blue):
- $K_4[Fe(CN)_6] + FeCl_3 = KFe[Fe(CN)_6] + 3KCl$
- Developer: $FeCl_3$

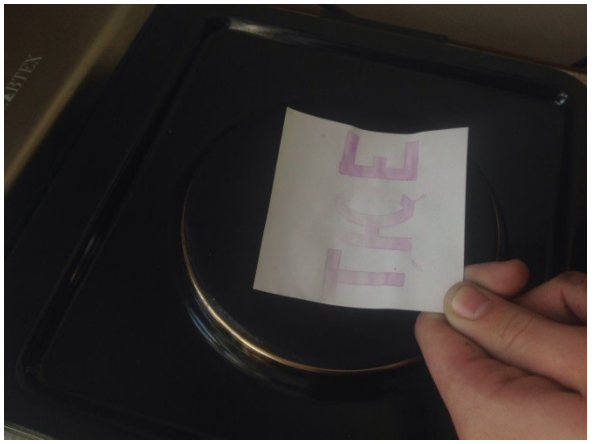




Experiment 3

- Ink's formula: $CoCl_2*6H_2O$ (hexahydrate cobalt dichloride) – pink solute. Loses its colour after it dries up. Turns into monohydrate and becomes pink-purple if heated $CoCl_2*H_2O$:
- $CoCl_2*6H_2O = CoCl_2 *H_2O + 5H_2O$ (vapours)
- Developer: heat





Conclusions:

We can suggest 3 formulas of inks that are not only disappearing but can also appear after changing conditions:

1) A solute of sodium dioxide coloured with phenolphthalein (Developer: Any substance which pH is higher than 7)

2) A solute of yellow Potassium hexacyanoferrate (Developer – a solute of iron trichloride)

3) A solute of hexahydrate cobalt dichloride (Invisible after it dries up, appears if heated, and disappears again if humidified)

Source of information

- https://ru.wikipedia.org/wiki/%D1%E8%EC%EF%E0%F2%E8%F7%E5%F1%EA%E8%E5_%F7%E5%F0%ED%E8%EB%E0
- http://schoolchemistry.by.ru/
- http://chemistry-chemists.com/N3_2012/U3/Co.html
- Krasitskiy V. A. Invisible inks// Chemistry and chemists, №5, 2009.