Project: "Taking up the culprit's trail"

This project was originally developed at the Technical University of Braunschweig.

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In the project “Taking up the culprit’s trail” you take on the role of detectives who examine the scene of a crime. It is your task to find out who the perpetrators are and who is the victim. You start by preparing the scene of a crime for a second group. To support the second group first set up “criminal records” by writing down your names and putting your fingerprints into the column next to the name. One member of the group is the victim, all others are the perpetrators. The perpetrators leave one exhibit each: Two of the perpetrators leave their fingerprints on the sheet of paper called “exhibit fingerprints”. One fingerprint should be made visible by means of graphite powder, the other one with indantrione hydrate. The other two perpetrators leave their names in secret writing at the scene of the crime. One of these perpetrators uses the blue secret writing, the other one the red one. Please use the sheet of paper entitled “exhibit secret writing A” and “exhibit secret writing B” and write your names twice onto the sheet in case the other group makes a mistake during the detection process. The victim leaves a bloodstain at the scene of the crime. It is now your task to seek the bloodstain and find out who left the stain. Right then: who is the victim? On the next pages we will tell you how to take fingerprints, write in invisible writing and find blood stains.

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Information for teachers: How to handle chemicals

When working with chemicals in the laboratory it is necessary to know the safety rules and to comply with them. Even if in class only those chemicals are used which are as risky as cleansing agents it is important to instruct the students and pupils right from the beginning how to use them and to comply with certain safety rules. Thus, right from the beginning responsible handling of chemicals can be trained.
Just as with household chemicals (cleansing agents, detergents, paint, adhesives, hairspray, etc.) receptacles for chemicals are also labelled with orange stickers showing various hazard symbols indicating possible risks. You find detailed explanations in the enclosed copy.
In the student experiments only those chemicals are used which are classified with the symbols Xn (noxious), Xi (irritating), F (flammable) or C (caustic) although any lye labelled with a C (caustic) contains only very low concentrations so that there is no harm to fear.
By complying with the following safety rules any potential hazard to the students can be excluded:

Wear safety glasses and safety gloves during all activities.
At any rate, avoid any contact with your skin, eyes or mucous membrane.
Never eat, drink or smoke inside any laboratory, and, of course, never eat or drink any chemical substance.
Wash off any splash of any chemical substance on your skin immediately with plenty of cold water.
If, in spite of all precautions, any solution gets into your eyes rinse them immediately with a soft water jet. Afterwards go and see a doctor immediately.
In case of accidents or sudden indisposition always contact a doctor.

Of course you have to make sure that no student is playing around splashing substances. The students must be instructed to work as cleanly as possible.

Note:

In contact with skin hydrogen peroxide (H_2O_2) causes white stains which, however, disappear after one or two days. Since this is a slight caustic reaction the skin may burn a bit. However, there is no reason to be worried.

Indantrione hydrate causes violet stains on the skin which also disappear after a few days. Again, there is no reason to be worried

Name:

Make fingerprints visible with graphite powder

Category:
- Chemistry

For age range:
7 years and older

For how many?:
c. 12 children

Where:
Demonstration room

How long: .
c. ¾ hrs.

Aims for the children:
The scientific knowledge of the children is broadened.
The children learn different methods to make fingerprints visible
The children learn new terms, such as graphite powder
Their sense of responsibility and ability to understand rules are enhanced.
: The children are called upon to comply with safety rules.
The children have to handle materials and chemicals responsibly.
Children pass on acquired knowledge to others.

Scientific explanation:

Skin secretes (particularly when perspiring) salts, fats and amino acids as catabolic products of tissue-forming proteins which through contact can be transferred onto objects. Due to the groove-like structure of our fingertips the touch leaves individual prints of these substances on the object which can be made visible by means of specific reagents; for example. the graphite powder settles into the fats, the indantrione hydrate makes amino acids visible. Whenever you touch any object, fat from the fingers is transferred onto it. When covering it with graphite powder the latter settles on to the fat so that the fingerprints become visible. On a dark substrate it is also possible to use a white powder (for example. powdered starch). To make this experiment successful it is advisable to wear a non-powdered disposable glove for some time before taking fingerprints. Thus more fat is transferred onto the object. This method is useful to make visible fingerprints on for example. glass. For paper the method is less suitable.

Preparation/materials:
This experiment mainly serves to familiarize the students with fingerprints and their basic patterns and helps to practise the mapping of unknown fingerprints on each other.

When taking fingerprints it is important not to use too much of the endorsing ink. You have to take a print from the entire fingertip because often all characteristic features are located in the lower part. Otherwise a classification which maps the basic patterns is not possible.
Graphite, 1 brush, 1 roll of scotch tape, 1 glass panel, paper to test, 2 pairs of disposable gloves, non-powdered, safety glasses, overall, magnifying glasses; template of the basic patterns, chart to take the fingerprints on, fingerprint cards.
In addition, one face cloth, one bucket of water, kitchen rolls.

Steps:
1. Talk about the rules.
2. The children leave their fingerprints on the glass panel.
3. Now they cover them with graphite powder, by using the brush.
4. Remove loose graphite powder by gentle tapping of glass panel
5. The children take a piece of scotch tape and take the fingerprint.
6. Then the print is stuck onto the chart. The children work with the magnifying glass to examine the prints and compare them with the basic pattern.

Possible variations:
- - Detect fingerprints with indantrione hydrate

References:
e-mail: p.mischnick@tu-bs.de
webpage: www.agnespockelslabor.de

In details: More detailed information for ex. in: Römpp-Chemie-Lexikon, Hrsg.: J. Falbe, M. Regnitz, 9. Aufl., 1991, Thieme-Verlag, Stuttgart, S. 3004	

<table>
<tr><td colspan="2">Name:

Make fingerprints visible with indantrione hydrate</td><td>Category:
- Chemistry</td></tr>
<tr><td colspan="2">For age range:
7 years and older</td><td>For how many?:
c.. 10 children</td></tr>
<tr><td>Where:
Demonstration room</td><td>How long: .
c. 30 min.</td><td>Preparation/materials:
- Talk about safety rules.
- Talk about how to handle tools and chemicals.
Children and staff put on their overalls, gloves and safety glasses.
Per child: an overall, safety glasses, non-powdered disposable gloves, one small bottle of indantrione hydrate solution (0.2 mg/100 mL in ethanol), paper, a pair of tweezers, for all together a heating plate, a bucket with water, a face cloth, paper towels</td></tr>
<tr><td colspan="2">Aims for the children:
The indantrione hydrate reacts only with the amino acid which was transferred onto the paper by the finger. During the reaction a blue-violet colour develops.
The scientific knowledge of the children is broadened.
The children learn new terms, such as indantrione hydrate and amino acid.
Their sense of responsibility and ability to understand rules are enhanced.
The children are called upon to comply with safety rules. In addition they have to handle chemicals and materials responsibly.</td><td>Steps:
1. Tell the children to leave their fingerprint in the marked field and to cut it out.
2. Now one to two drops of indantrione hydrate are applied onto the fingerprint on the field.
3. Then take up the paper with a pair of tweezers and hold it over the heating plate which has a temperature of up to c. 100 degrees.
4. Now the fingerprint becomes visible in a blue-violet colour.</td></tr>
<tr><td colspan="2" rowspan="2">Scientific explanation:
With the indantrione hydrate method fingerprints can be detected on paper.

When heated up the indantrione hydrate reacts with the amino acid transferred onto the paper by the fingers. During the reaction a blue-violet colour develops.
Before taking a fingerprint it is again advisable to use non-powdered disposable gloves so that the hands start transpiring. This improves the quality of the prints.</td><td>Possible variations:
Make fingerprints visible with graphite powder and ink</td></tr>
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e-mail: p.mischnick@tu-bs.de
webpage: www.agnespockelslabor.de</td></tr>
</table>

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Name:

Taking fingerprints

Category:
- Biology

For age range:
6 years and older

For how many?:
7 children

Where:
Demonstration room

How long:
¾ hrs.

Preparation/materials:
Ink pad, magnifying glasses, copies of the sample cards, paper to try out, fingerprint cards

Aims for the children:
This experiment mainly serves to familiarize the students with fingerprints and their basic patterns and helps to map unknown fingerprints on each other.
Scientific knowledge about fingerprints is imparted.
The children get to know the basic pattern of fingerprints.
The children get to know their own fingerprints and those of others.
The children practise the correct handling of the materials.
The children learn not to use too much stamping ink for the fingerprints.

Steps:
1. All children get paper to practise taking fingerprints.
2. Ask them to print with their right and left finger.
3. After the first tests every child gets a chart on which are marked: RT – right thumb, RI – right index finger, etc. as well as LT – left thumb, LI – left index finger, etc.
4. Now the children can work on their own to leave their fingerprints on the table.
5. Then the children get time to thoroughly examine their own fingerprints with a magnifying glass.
6. Afterwards let them compare their own fingerprints with the four other basic patterns and assign their prints to these patterns.

Scientific explanation:
The fingerprint is for each person a characteristically esteemed patterns of the skin relief, that you win in the fingerprint procedure (Daktyloskopie).

This experiment mainly serves to familiarize the students with fingerprints and their basic patterns and helps to practise the mapping of unknown fingerprints on each other.

Possible variations:
Compare different fingerprints in a card index**.**

References:
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webpage: www.agnespockelslabor.de

Be aware of:
When taking fingerprints it is important not to use too much of the endorsing ink. You have to take a print from the entire fingertip because often all characteristic features are located in the lower part. Otherwise a classification which maps the basic patterns is not possible.

In detail:	

Name:

The blue secret writing

Category:
- Chemistry

For age range:
7 years and older

For how many?:
c. 10 children

Where:
Demonstration room

How long: .
c. ¾ hrs.

Preparation/materials:
50ml yellow potassium ferrocyanide (potassium hexacyanoferrat (III)), 50ml ferric (III) chloride solution, gloves, safety glasses, overall, 1 hairdryer, 2 brushes or cotton bud, white paper for every child

Aims for the children:
The scientific knowledge is broadened.
The children learn that there are different methods how to make writing visible.
The children learn new terms for chemicals.
The children learn the correct handling of the materials.

Steps:
1. The children take a sheet of paper and place it in front of them.
2. Now they take a brush or a cotton bud and dip it into the yellow potassium ferrocyanide. Then they can paint or write something onto the paper.
3. Afterwards the text or picture is dried with the hairdryer.
4. Now the children dip a fresh brush into the ferric (III) chloride solution and brush over the dried paper.
5. What can you observe?

Scientific explanation:
If you use a solution B (potassium hexacyanoferrat II: $K_4[Fe(II)(CN)_6]$, 3 g/100ml) to write something onto the paper and then brush it over with the $FeCl_3$ it results into the following reaction producing a blue-coloured complex (Berlin blue):

$K_4[Fe(II)(CN)_6] + FeCl_3 \rightarrow K[Fe(III)Fe(II)(CN)_6] + 3\ KCl$
pale yellow *yellow* *soluble Berlin blue*

$3\ K[Fe(III)Fe(II)(CN)_6] + FeCl_3 \rightarrow Fe(III)[Fe(III)Fe(II)(CN)_6]_3$
insoluble Berlin blue

The intensive colour results from the simultaneous existence of iron in bivalent and trivalent oxidation number. The transition between the two causes the colour. Since in case of high iron (III) excess the insoluble Berlin blue fails on coloured spots or on those spots on which you have written you get rather clear contours. If you use the solutions in reverse order the blue runs because the soluble form develops. Children may ask whether it does matter in which order you use the solutions.

Possible variations:
- Pink secret writing
- Secret writing with a pencil
- Secret writing with a correction pen
- Secret writing with lemon

Be aware of:
Do not mix up the brushes since otherwise the experiment fails. Talk about the rules related to the handling of chemicals since this chemical substance is low-grade toxic.

References:
e-mail: p.mischnick@tu-bs.de
webpage: www.agnespockelslabor.de

In detail:

Name :

The pink secret writing

Category: Chemistry
- Acids and lye

For age range: 6- 10 years

For how many?: 4-6 children

Where: Demonstration room

How long: c. 20 - 30 minutes

Preparation/materials:
- Mix the chemical.

White paper, brush or cotton bud for the solution, hairdryer.

Aims for the children:
- :Their scientific knowledge is broadened.
- The children learn why the writing becomes visible.
- The children get to know chemicals.

Scientific explanation:

The principle of this secret writing is based on the pH-value of the aqueous sodium carbonate. This is called the "dissociation of water". The acid value of a aqueous solution is determined by the concentration of protons which is influenced by the dissolved substances and indicated as pH-value. A pH-value of 7 characterises a solution in which there are as many protons as hydroxy-ions. This solution is called neutral. Any solutions with a pH-value smaller than 7 are acidic. They contain more protons than hydroxy-ions. Any solution with a pH-value above 7 is alkaline. In those solutions the hydroxy-ions predominate.

The sodium carbonate used here absorbs protons from the water and thus reduces the concentration of protons. As a result the pH-value of this solution goes up.

In basic solution (pH 8.2 - 9.8) phenolphthalein forms an extended π -electron system, which readily absorbs visible light, thus producing the observed colour.

The colouring is based on the enlarged π–electron system, which develops during the donation of electrons, whereby electron transitions in the visible area can easily take place.

Since the donation of protons can only occur in a aqueous medium you have to first apply the ethanol-containing phenolphthalein solution and then, in a second step, the aqueous sodium carbonate solution. Once the phenolphthalein has dissolved in a mix of water and ethanol the colouring occurs with a short delay also in reverse order.

Reaction equation:

$H_2O \rightleftharpoons H^+ + OH^-$

$\mathbf{CO_3^{2-} + H^2O \rightleftharpoons HCO_{3-} + OH}$

Steps:

First the children take a sheet of paper and place it in front of them.

Now they take a clean brush or a cotton bud and dip it into the solution F (phenolphthalein solution) and paint or write something onto the paper. The children have to take care not to apply too much of the liquid. Now the paper is dried with a hairdryer. Once the paper is dry they brush it over with solution G (sodium carbonate solution). Attention: only the paper should be brushed over.

Possible variations: see Blue secret writing

Be aware of:

Sodium carbonate(Na_2 CO3) Xn = low-level noxious

Safety glasses, gloves and overall, wash your hands after the experiments.

References:

e-mail: p.mischnick@tu-bs.de
webpage: www.agnespockelslabor.de

In detail: The principle of this secret writing is based on the fact that colourless phenolphthalein reacts with lye (alkaline solution) in the form of formation of the pink colorant. Therefore, if you write something with a phenolphthalein solution onto a sheet of paper, dry it and treat it afterwards with lye, the writing appears in pink colour.	

Name:

Secret writing with lemon juice

Category: Chemistry
– natural browning

For age range:
3 years and older

For how many?:
Four children

Where:
In a room

How long: ca
30 min

Preparation/materials:
Pour the lemon juice into the bowls.
Brush, lemon juice, onion juice, small bowls, paper, iron

Aims for the children:
The children should recognise that certain acids, such as for example, lemon juice or onion juice become visible on paper when heated up.

Steps:
1. Every child gets a brush and a sheet of paper.
2. Then the children use the vinegar to paint something onto the paper.
3. After the drying process the children carefully iron the painting so that the invisible picture becomes visible.

Scientific explanation:
Lemon juice contains carbohydrates which carbonize when heated up over a candle or on a heating plate expecially under acidic conditions as in the juice.
There are other ingredients that also may form brownish products by dehydration and polymerisation. - It is a very complex combination of reactions.

By doing this on all painted spots a brown colouring becomes visible so that the writing becomes readable. It is important, though, not to heat up the paper to much. Otherwise it carbonizes as well.

Instead of lemon juice you can also use orange juice, grapefruit juice or milk.

Possible variations:
For painting the pictures it is possible to use not only vinegar but also other juice, for example lemon and onion juice.

References:
e-mail: p.mischnick@tu-bs.de
webpage: www.agnespockelslabor.de

Be aware of:
Take care because the iron is very hot.

In detail:	