

# Making invisible ink

The general thaw in East/West relations and substantial government cut-backs in MI6 expenditure has resulted in people on cultural exchanges being used to carry sensitive diplomatic messages.

Development of new techniques using invisible ink have become essential as messengers using other techniques have mysteriously disappeared!

## - Your task

Write a message in invisible ink on plain A4 paper. When dry the paper must be sent to MI6 together with instructions and materials for 'developing' the message. You are permitted 7 sheets of paper. You may send more than one message.

Based on a suggestion by J. Crellin.

## Time

60 minutes.

## Group size

2–4.

## Equipment & materials

Eye protection.

Suggest students are warned in advance to bring an old shirt or a CDT apron to the session.

### General

Cocktail sticks or empty old fountain pens or cotton swabs, beakers, test tubes. Pink paper, white paper.

### Chemicals

Sulfuric acid, nitric acid, lemon juice, white vinegar, cobalt chloride, phenolphthalein indicator solution, sodium hydroxide. Potassium thiocyanate solution, iron(III) chloride solution.

## Health & Safety notes

This is an open-ended problem solving activity, so the guidance given here is necessarily incomplete. Teachers need to be particularly vigilant, and a higher degree of supervision is needed than in activities which have more closed outcomes. Students must be encouraged to take a responsible attitude towards safety, both their own and that of others. In planning an activity students should always include safety as a factor to be considered. Plans should be checked by the teacher before implementing them.

You must always comply with your employer's procedures and in some cases may decide that a particular activity is inappropriate in your situation. Further information on Health and Safety should be obtained from reputable sources such as CLEAPSS [<http://science.cleapss.org.uk/>] in England, Wales and Northern Ireland and, in Scotland, SSERC [<https://www.sserc.org.uk/>].

Care must be taken when developing those inks that require a heat source. (The ink should singe before the paper does.)

Suggested concentrations:

Sulfuric acid, 0.5 M H<sub>2</sub>SO<sub>4</sub>(aq), is of low hazard.

Nitric acid, 0.4 M HNO<sub>3</sub> (aq), is an IRRITANT.

Cobalt(II) chloride-6-water, 0.1 M CoCl<sub>2</sub>.6H<sub>2</sub>O (s), is a carcinogen (by inhalation) mutagen, reproductive toxin, skin/respiratory sensitiser and hazardous to the aquatic environment.

Phenolphthalein indicator (0.1% w/v in 60% v/v ethanol) is flammable. (If in methylated spirits rather than pure ethanol it is also harmful if swallowed and can cause damage to organs)

Sodium hydroxide solution, 0.5 M NaOH (aq), is corrosive to skin and eyes.

Potassium thiocyanate solution, 0.1 M KSCN (aq) is an eye irritant, harmful if swallowed, inhaled or in contact with skin and releases toxic gas in contact with acids.

Iron(III) Chloride, 0.5 M FeCl<sub>3</sub> is CORROSIVE and HARMFUL if swallowed.

Eye protection should be worn.

**Disposal:** Any acid or alkali solutions should be neutralised with a weak acid or alkali (as appropriate) before being washed to waste. Cobalt chloride should be collected for appropriate disposal.

It is the responsibility of the teacher to carry out a suitable risk assessment.

## Curriculum links

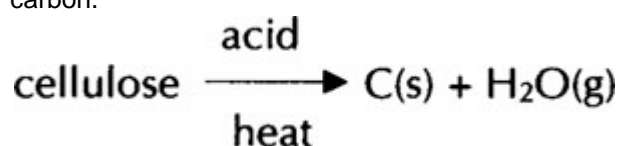
Chemical reactions.

## Possible approaches

Invisible inks consist of chemical solutions that are 'colourless' before developing, but which become visible when (i) heated, (ii) observed under ultra-violet light, or (iii) treated with other chemicals.

Invisible inks that respond to heat:-

1 Acids, eg sulphuric acid, nitric acid, lemon juice, white vinegar (colourless, go black with heat). Lemon juice is a very good magic ink. More concentrated acids are better than very dilute acids. **NB** When hot acid is concentrated, it chars paper by reacting with the cellulose to produce black carbon.



2 Cobalt chloride (dilute cobalt chloride solution is light pink, almost colourless. If it is used as an ink the "invisible" writing goes blue on warming, due to dehydration of the salt. If you then breathe on the paper the writing once more disappears).

To develop the message, slowly pass the paper above a hot light bulb (check that the lamp is safely wired and earthed). Alternatively use a radiator or sunlight.

Invisible inks that require chemical treatment:-Phenolphthalein indicator solution (colourless, goes pink with alkali solution).

Potassium thiocyanate solution (colourless, goes red with iron(III)chloride solution). The Fe(III) ion reacts with the thiocyanate ion (SCN<sup>-</sup>) to produce the red complex, Fe(SCN)<sup>2+</sup>.

## Evaluation of solution

Suggest credit is given for:-

1 The clarity (contrast and resistance to smudging) of the text after developing.

- 2 The extent to which the message can be detected before developing.
- 3 The wit of the message.

## **Extension work**

To find other 'magic' inks.

## **Credits**

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*Health & safety checked May 2018*

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