EXPERIMENT MANUAL

Version 2.0

CHEM C1000

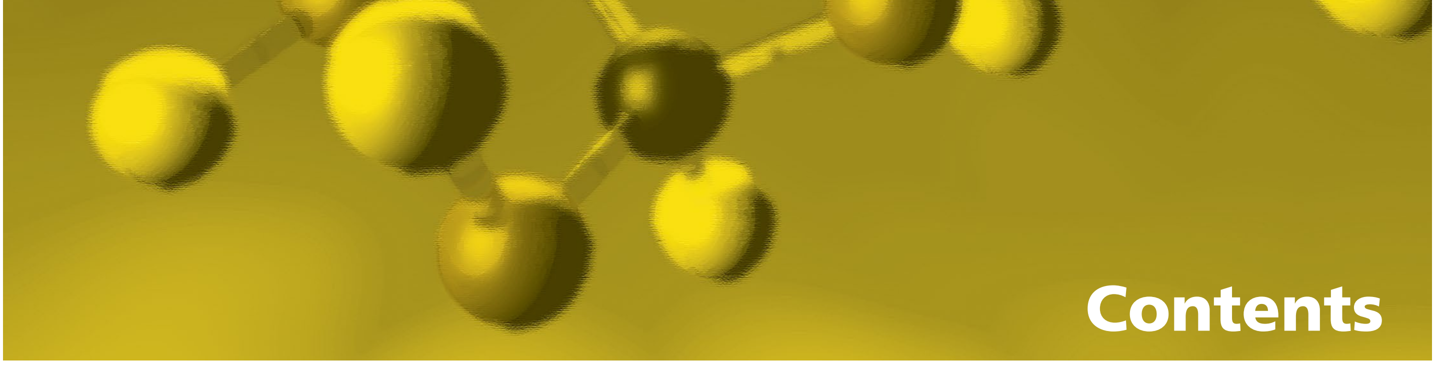
Please observe the safety information, the advice for supervising adults on page 5, the safety rules on page 6, the information about hazardous substances and mixtures (chemicals) on pages 7-8 and their environmentally sound disposal on page 75, the safety for experiments with batteries on page 7, and the first aid information on the inside front cover.

WARNING. Not suitable for children under 10 years. For use under adult supervision. Contains some chemicals which present a hazard to health. Read the instructions before use, follow them and keep them for reference. Do not allow chemicals to come into contact with any part of the body, particularly the mouth and eyes. Keep small children and animals away from experiments. Keep the experimental set out of reach of children under 10 years old. Eye protection for supervising adults is not included.

WARNING — Chemistry Set. This set contains chemicals that may be harmful if misused. Read cautions on individual containers and in manual carefully. Not to be used by children except under adult supervision.

THAMES & KOSMOS

Franckh-Kosmos Verlags-GmbH & Co. KG, Pfizerstr. 5-7, 70184 Stuttgart, Germany | +49 (0) 711 2191-0 | www.kosmos.de
Thames & Kosmos, 301 Friendship St., Providence, RI, 02903, USA | 1-800-587-2872 | www.thamesandkosmos.com
Thames & Kosmos UK Ltd, Goudhurst, Kent, TN17 2QZ, United Kingdom | 01580 212000 | www.thamesandkosmos.co.uk

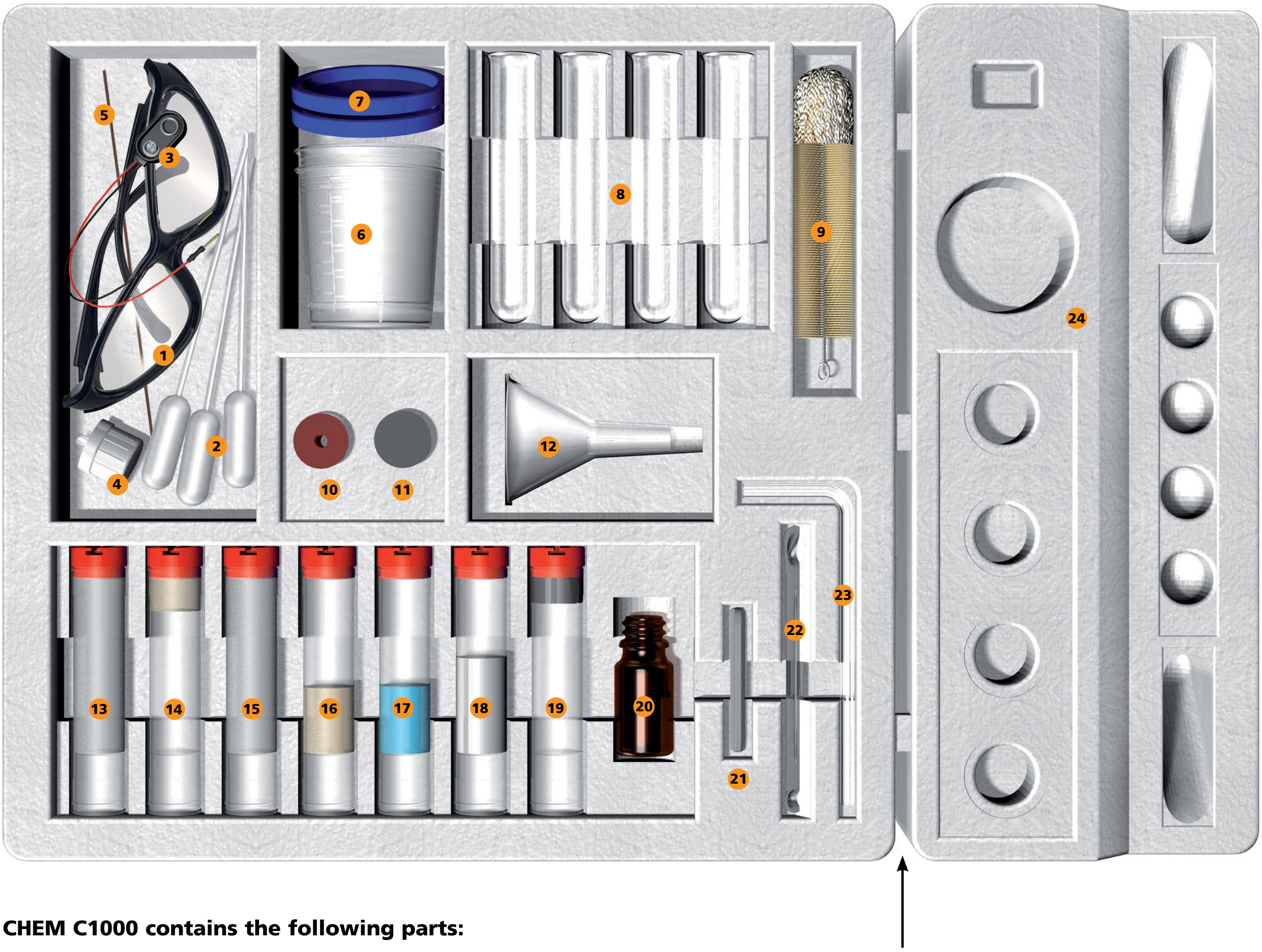


Contents

Introduction and Precautions

The Experiments

Appendix



CHEM C1000 contains the following parts:

No.	Description	Item No.
1	Safety glasses	717019
2	Three dropper pipettes	232134
3	Clip for 9-volt battery	712310
4	Safety cap with dropper insert for litmus bottle	704092
5	Copper wire	000063
6	Two large graduated beakers	087077
7	Two lids for graduated beakers	087087
8	Four test tubes	062118
9	Test tube brush	000036
10	Rubber stopper with hole	071028
11	Rubber stopper without hole	071078
12	Funnel	086228
13	Sodium carbonate, 12g	033412
14	Potassium hexacyanoferrate(II), 4g	033422
15	Calcium hydroxide, 8.5g	033432
16	Ammonium iron(III) sulfate, 5g	033442
17	Copper(II) sulfate, 8g	033242
18	Citric acid, 10g	032132
19	Litmus powder, 1g	771500
20	Small bottle for litmus solution	771501
21	Lid opener	070177
22	Double-headed measuring spoon	035017
23	Angled tube	065378
24	Experiment station (part of the polystyrene insert)	711461
25	Filter paper sheets (not pictured)	702842

The experiment station (for more info, see p. 10) can be divided here using a sharp knife. An adult must do this step.

Please note: The actual design of your experiment station and component storage tray may vary from what is pictured here.

Keep the packaging and instructions, as they contain important information.

Please check whether all of the parts and chemicals listed in the parts list are contained in the kit.

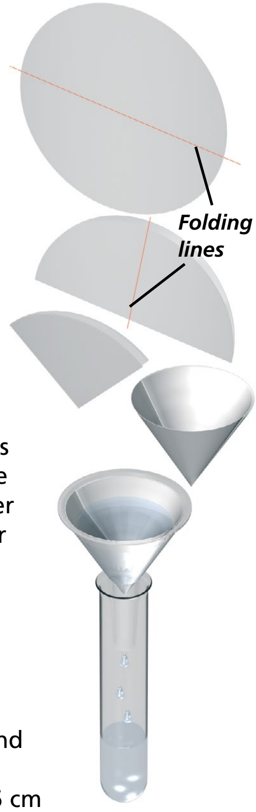
How can individual parts be reordered?
Contact Thames & Kosmos customer service to inquire about an order.

Additional materials required
On page 13, we have made a list of the additional materials required for a number of experiments.

3 Magic blue and secret inks

Round filters and filter bags from which you can trim round filters.

For now, the magic blue is still hidden in the chemical vial labeled "Litmus powder." When you open the vial, you will discover a dark, fine-grained substance inside. To perform experiments with it, you will need to prepare a litmus solution, which lasts one day. You know: sugar and salt dissolve in water so easily that it seems as if it disappears. It's not quite so easy with the litmus powder. First you need to become acquainted with one of the most important laboratory techniques: **filtering**.



Super-sieves in action

You will need the filter paper sheets from your kit for these experiments. If you run out of filter paper sheets, you can always use white coffee filters for filtering: either the round ones or the larger filter bags out of which you can cut round filters (diameter approx. 9 cm). In the experiments, we will call these filters "filter paper."

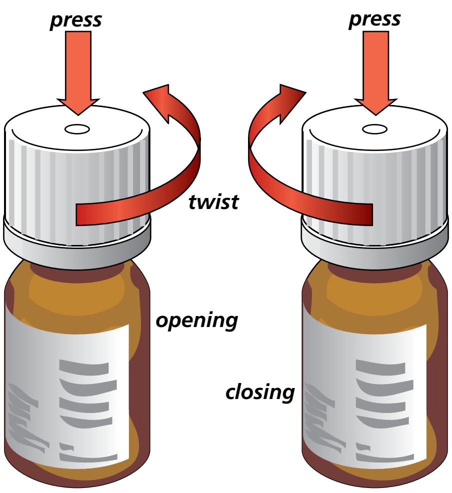
EXPERIMENT 01

Additional material: *Sand*
Fold a round filter paper as shown in the illustration. You will end up with a cone consisting of one layer of filter paper on one side and of three layers on the other. Place the filter cone into the funnel and moisten it with a little water. This will help it stick better to the wall of the funnel. In a sealed test tube, shake some sand with 6 cm of water (remember, keep your thumb on the stopper!) and pour the mixture into the filter cone. The sand remains in the filter and a nearly clear liquid, the filtrate, drips into the test tube below.

The solution prepared from litmus powder is filtered.

What's happening here?

Sand is made of small quartz crystals. The particles are difficult to dissolve or not soluble at all in water and too large to pass through the tiny pores of the filter paper. In contrast, the particles of water and the soluble substances are so small that they overcome the "filter blockade" with no trouble. By using super-fine sieves, you can separate the soluble from the insoluble components of a mixture.



How the safety closure of the vial for the litmus solution works.

EXPERIMENT 02

Preparing the litmus solution. Place 3 cm of water in a test tube and add 3 small spoonfuls of litmus powder to it (level scoop). Close the tube with the stopper, shake vigorously and allow the closed tube to stand for one day somewhere that is out of the reach of young children.

Now set up the funnel and filter for filtering like in the previous experiment. Place the funnel on the vial provided for the litmus solution and pour the deep-blue mixture into the filter. You can dispose of the insoluble leftovers in the trash. If denatured alcohol (careful, fire hazard!) is available, an adult should add a half pipette of it to the vial.

For the following experiments, you will also need ***white writing paper*** and ***barbecue tongs***.

EXPERIMENT 18 Squeeze the juice out of a lemon and use the juice as "ink." The pen or brush should not be too thin. After it's dry, you won't be able to see a trace of this ink, either. To make the ink visible, you will need to heat up the paper a lot without allowing it to go up in flames. Using the barbecue tongs, hold it over (not on!) an electric heating plate. What do you see?

EXPERIMENT 19 Repeat the experiment, this time using household vinegar. Be patient, though — it takes a bit longer for the writing to appear.

EXPERIMENT 20 Preparing onion juice will probably bring you to tears. The strong-smelling ingredients in onions irritate the eyes like tear gas. It's best to prepare the juice using a garlic press. Now you can test out the juice as a secret ink just like in the previous experiments (heat it up well again).

Unlike the Berlin blue ink, these secret inks from the kitchen are made visible by charring (or "carbonization") of the carbon-containing compounds contained in the "inks." As a result, the carbon becomes visible (brown to black coloration).

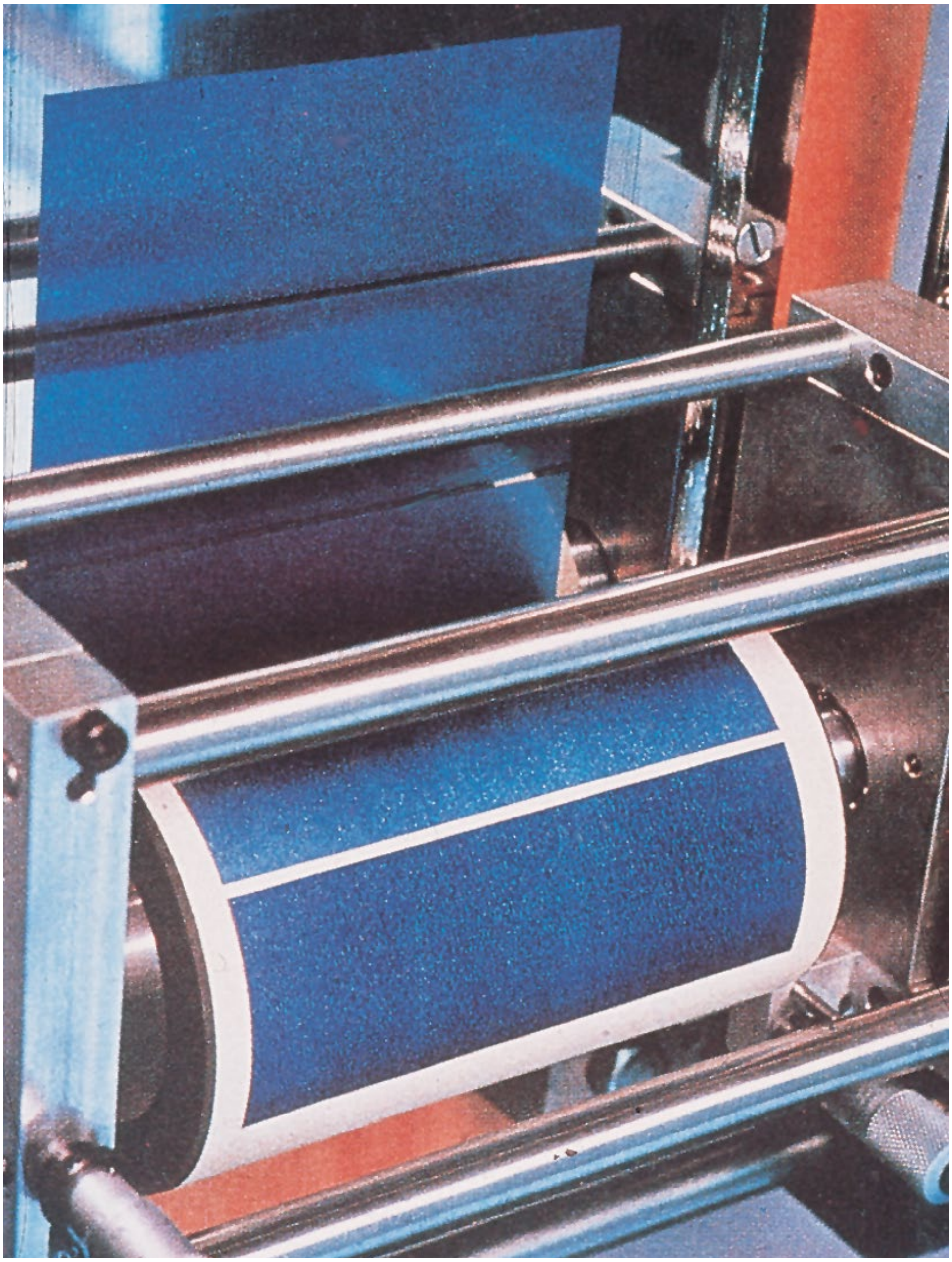
Side Notes

Berlin blue — an accidental discovery

In 1706, a paint manufacturer from Berlin named Diesbach was mixing a scale insect brew (yes, you read that correctly) with alum, iron sulfate, and an "alkali" that had been discovered not long before for making a carmine red paint. The alkali was the stinky animal oil prepared by Johann Conrad Dippel (1673 – 1734) from animal blood. Diesbach was extremely surprised when, instead of the red he wanted, he got a deep blue product.

We now know that "Dippel's oil" (as it was called) contained a number of substances, some of which were very hazardous. Highly toxic cyanide may have been present in it, or yellow blood-lye salt, an old name for the potassium hexacyanoferrate(II) you're using. Which name do you like more? In both cases, Berlin blue can be produced together with iron compounds.

Great success came from this accidental discovery. The merits of the new dye were praised: it was suitable for painting with water or oil or for printing wallpaper, it didn't fade when exposed to light, it was resistant to acid and posed no health hazards (unlike others, for example poisonous paints containing arsenic). In the 19th century, expansive factories for the production of Berlin blue sprung up.



Even after the discovery of a number of new dyes, Berliner blue is still used, especially in the printing industry (photo: Degussa AG, Wolfgang).

Mysteriously appearing blue ring

And finally, a not-so-simple but very impressive experiment.

! For **ammonium iron(III) sulfate** and **potassium hexacyanoferrate(II)**, note the "Hazardous substances and mixtures" information on pp. 7 – 8.

EXPERIMENT 33 Place a square or round filter paper (approx. 7 – 8 cm sides or diameter) onto a sufficiently large screw-top lid turned over. Place 1 drop of ammonium iron(III) sulfate solution (1 spoon tip in 2 cm of water) into the middle of the filter paper. Now allow the spot to grow to 5 – 6 cm diameter by adding saline solution drop by drop. Wait until the saline solution is fully absorbed. Then, in the middle of the spot, place 1 drop of sodium carbonate solution (1 small spoonful in 2 cm of water) and then 1 drop of the potassium hexacyanoferrate(II) solution prepared according to the tip on p. 19. Wait again until the solutions have soaked in. Now add saline solution again drop by drop to the starting point. After the second or third drop, a deep-blue, jagged ring suddenly appears — something like in the illustration.

A reaction on filter paper: Berlin blue ring

What's happening here?

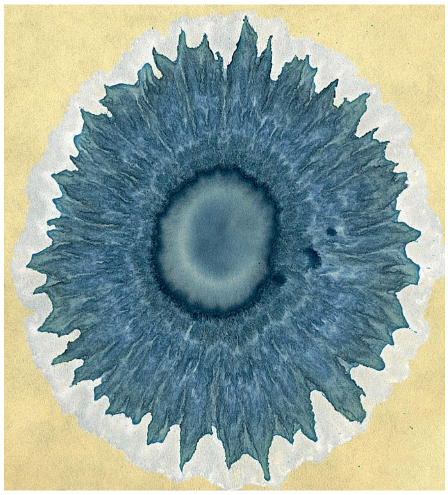
You already know how Berlin blue is formed; and you also know that Berlin blue is broken down by sodium carbonate solution (Experiment 16). While the majority of the ammonium iron(III) sulfate is transported by the saline solution to the "outskirts" of the paper, the rest remaining in the center would produce a distinct blue coloration. That is prevented by the sodium carbonate. Through the addition of saline solution again, the potassium hexacyanoferrate(II) also travels to the outskirts — even farther than the sodium carbonate, in fact. In the area where there is no longer a noteworthy amount of sodium carbonate, there is nothing left to stop the formation of the Berlin blue.

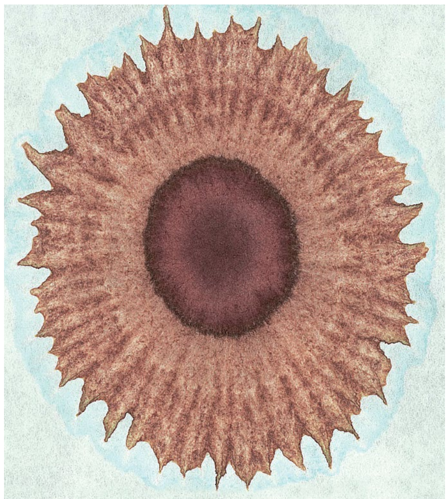
? **Question 10.** This experiment requires a little flair and patience. Sometimes parts of the blue ring fade again, especially if more water or saline solution is dripped on. Why do you think that is?

Side Notes

Pattern images for painters and fabric designers

In the experiments in this chapter, the interplay of colors and shapes has been emphasized, while the physical and chemical processes took a back seat for now. In so doing, you are tracing the footsteps of a man who took a similar approach. The chemist F. F. Runge (1794 – 1867) experimented with dyes and color reactions on filter paper and so became the father of paper chromatography — a technique that only became an integral part of chemical practices much later, during World War II (1939 – 1945). Runge published a book about his "self-grown pictures." He wanted to give drawers, painters, and fabric designers inspiration for their work.





Produced according to the original formula of Friedlieb Ferdinand Runge, the inventor of this painting technique.