Thames & Kosmos®

# CRYSTALS
## ROCKS & MINERALS

SCIENCE EDUCATION SET

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

**Experiment Manual**

# Kit Contents


| No. | Name | Qty. | Item No. |
|---|---|---|---|
| 1. | Potassium hexacyanoferrate (III) | 1 | 770 695 |
| 2. | Citric acid, 10g | 1 | 032 132 |
| 3. | Copper sulfate, 8g | 1 | 033 242 |
| 4. | Potassium aluminum sulfate, 50g | 2 | 771 061 |
| 5. | Gypsum (calcium sulfate), 500g | 1 | 770 800 |
| 6. | Food coloring, blue | 1 | 705 725 |
| 7. | Double-ended measuring spoon | 1 | 035 017 |
| 8. | Lid opener | 1 | 070 177 |
| 9. | Box | 1 | 705 726 |
| 10. | Wooden spatula | 1 | 000 239 |
| 11. | Measuring cup, large | 2 | 087 077 |
| 12. | Lid | 1 | 087 087 |
| 13. | Measuring cup, small | 2 | 061 150 |

| No. | Name | Qty. | Item No. |
|---|---|---|---|
| 14. | Plastic pipette | 2 | 232 134 |
| 15. | Safety goggles | 1 | 052 297 |
| 16. | Bag of rocks: granite, limestone, basalt, marble, pumice | 1 | 772 781 |
| 17. | Bag of minerals: calcite, pyrite, hematite, quartz crystal, bornite, fluorite | 1 | 772 785 |
| 18. | Magnetite | 1 | 772 783 |
| 19. | Soapstone | 1 | 772 784 |
| 20. | Geode mold | 1 | 708 119 |
| 21. | Compass | 1 | 706 355 |
| 22. | Magnifying lens | 1 | 311 137 |
| 23. | Balloon | 2 | 708 265 |
| 24. | Sandpaper | 1 | 700 881 |
| 25. | Die-cut sheet | 1 | 708 120 |
| 26. | Paper sheet/rock cycle | 1 | 708 200 |
| 27. | Wooden stick | 1 | 020 042 |

*Additional Items Needed: two empty glass jelly jars with lids, distilled water, pot of hot water (40-50 °C, 100-120 °F), paper towels, small rock with rough surface, all-purpose glue, clean empty yogurt container, black ink or watercolor paint, scissors, hammer, cup or plate made of light-colored ceramic or porcelain with an unglazed (rough) area, iron nail, steel nail, penknife, copper penny, matches, paper, pencil, tape, yarn, table salt, tea light candle, small cardboard box, sand, food coloring or watercolor paints (red, blue, and yellow), deep dish.*

For example, 100 ml of water at room temperature (20 °C, 68 °F) will dissolve just 12 grams of alum. At 40 °C (104 °F), it will dissolve 25 grams, and at 60 °C (140 °F), 58 grams. A solution that can't dissolve anything further at a certain temperature is called **saturated**.

When the solution cools off — or when the water evaporates, as in the last experiment — it becomes **supersaturated**, and the excess alum separates out in the form of crystals. This cooling method provides crystals very rapidly, although they won't look as pretty as with the evaporation method.

## 03 Experiment

### Crystals of blue

The crystals of blue copper sulfate have a different color from those of alum, and have a really unusual shape as well.


**Copper sulfate**
is hazardous to health and to the environment. See the information on page 6!

**You will need:** copper sulfate, small measuring cup, double measuring spoon, safety goggles, *old glass jelly jar, distilled water.*

### Procedure:

1. Dissolve 16 small spoonfuls of copper sulfate in 10 ml water. Let the solution stand uncovered for a few days in a protected location. It will evaporate and form blue crystals with a characteristic shape.

2. After the crystals have formed, pour the solution into a jelly jar, take out the prettiest crystals with the help of the measuring spoon, and save them in your box.

3. The rest of the solution has to evaporate completely. Return the dry copper sulfate to the vial.

- Fact Sheet -

**COPPER SULFATE**

The blue substance is produced from copper sulfate in large quantities, and serves as a pesticide in wine production and to combat algae in swimming pools — it is a powerful poison to microorganisms. This copper salt is also used to copper coat objects and to clean copper metal.

*Copper sulfate crystal*

### Explanation:

Copper sulfate forms clear blue crystals. They look like someone grabbed a brick by one corner and pulled it lengthwise.

## 04 Experiment

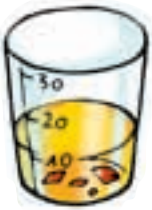
### Blood-red shapes

The third substance for making crystals has the name potassium hexacyanoferrate (III). It's also known by the name Prussian red, which is easier to remember.

**You will need:** potassium hexacyanoferrate (III), small measuring cup, double measuring spoon, safety goggles, *old glass jelly jar, distilled water.*

### Procedure:

1. Dissolve 30 small spoonfuls of potassium hexacyanoferrate (III) in a small measuring cup with 15 ml water. Leave the yellow solution to stand uncovered for a few days in a protected place. It will form deep red crystals.




2. After the crystals have formed, pour the solution into the jelly jar and use the measuring spoon to pull out the prettiest crystal for your box.

3. Let the remaining solution completely evaporate, and return the dry potassium hexacyanoferrate (III) to the vial.

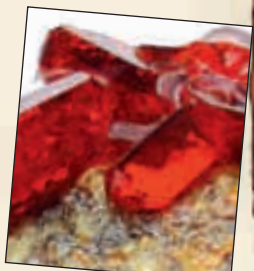
### Explanation:

In fact, potassium hexacyanoferrate (III) does form beautiful, deep-red crystals out of an intensely yellow solution. But be careful: it can stain things.

- Fact Sheet -

**POTASSIUM HEXACYANOFERRATE (III)**

Prussian red has an iron atom in its molecule to thank for its color. It is used, for example, in photography, for the production of architecture blueprints, for wood stains, and as a hardening agent for steel. It is also a very sensitive indicator for iron compounds, a quality that will help you in the next experiment.



*Potassium hexacyanoferrate (III) crystal*

## 05 Experiment

### Artificial mineral layer

In nature, crystals often grow on rocks. Mineral collectors call these mineral layers. You can easily create such layers yourself by letting one of your chemicals crystallize out on a rock.

**You will need:** 2 small measuring cups, copper sulfate, double measuring spoon, safety goggles, *small rock with rough surface, distilled water.*


**Copper sulfate**
is hazardous to health and to the environment. See the information on page 6!

# Treasures Growing in the Shadows

Crystals can form in small or large bubbles in rock. Crystal-filled rocks and hollow spaces of this type are called geodes, which is derived from a Greek word meaning "earthlike." You can make your own geodes, although you will have to follow the instructions carefully if you want your geode to look nice — because the crystals inside will be growing out of your sight.

Agate geode

## 07 Experiment

### The geode takes shape

In nature, geodes are made of solid rock. Yours, on the other hand, will be made of plaster. You will create two halves that you will then glue together. Read the instructions through carefully first, get everything ready, and be speedy while you work, because otherwise the plaster will harden too quickly.

**You will need:** gypsum, wooden spatula, large measuring cup, double measuring spoon, alum seed crystals that you grew, sandpaper, *all-purpose glue, clean empty yogurt container, black ink or watercolor paint.*

**! Caution:**

Gypsum can produce dust — do not inhale it! Do not put the material in your mouth, and do not put it on your hands! Wash hands after use. Before beginning the experiment, read the safety instructions on pages 6 and 7.

**→ Procedure:**

1. Cover your work surface with old newspapers. Pour 75 ml of cold distilled water into the empty yogurt container.

**i Tip:**

If you want the geode to be dark gray on the outside, add a few drops of ink or black watercolor paint to the water.

2. Fill the large measuring cup with gypsum, and mix it with the water; stir thoroughly with the wooden spatula, until there are no more clumps of gypsum.

3. Pour the plaster mixture into the molds.

4. Spread the mixture up along the walls to create a hollow in the middle. This will be easy as long as the mixture is thick and gooey. The walls of the geode shouldn't be too thin, or the geode will break after it hardens. The upper edge in particular has to be at least five millimeters (0.2 in) thick, because you will be setting the other half on it later on.

5. Before the plaster has hardened, sprinkle half of the seed crystals that you already grew into various locations in the hollow area of your geode half, and press them lightly into the plaster. Repeat the process to make the second geode half.

6. Let the geode halves dry for a day, and then carefully remove them from their molds.

7. Smooth the edges of the geode halves with the sandpaper, and check to see how their edges line up by setting them against each other.

You can also rub them against each other until they fit together smoothly without any gaps.

8. Use the double measuring spoon to scrape two small holes in one geode half, spaced about 2 cm (1 in) apart. The hole diameter should be just large enough for the thin pipette tube to fit into it. You will later add the crystal growing solution through these holes.

9. Glue together the two halves with the all-purpose glue, leaving the holes unobstructed. Let the geode dry well. To make the joint between the two halves as unnoticeable as possible, you can smooth it a little more with the sandpaper, or spread a little more plaster on it.

## 08 Experiment

### Filling the geode

**You will need:** homemade geode, alum from Experiment 1, dye powder, double measuring spoon, large measuring cup, small measuring cup, pipette, balloon, safety goggles, *distilled water, scissors, pot with hot water, hammer.*

### Procedure:

1. Cut the balloon near the opening. The hole has to be big enough so that you can pull the balloon over the geode, leaving the top few millimeters with the holes uncovered. The balloon should lie smooth against the sides of the geode.