

The Crystal Clock: Measuring a Change Too Slow to Watch

Investigation question: How fast does a crystal grow when nobody can see it growing, and how long would it take, at that rate, to become a crystal one meter long?

Physical model

Groups of 3

3 sessions

Setup 10 · Activity 135 · Cleanup 10 min

MS-ESS2-2 · practice

MS-ESS2-1 · supports

Name _____ Group _____ Date _____

Your role today

- ☐ **Solution maker:** Measures the alum into the cup, receives the hot water from the teacher, stirs until a few grains stay undissolved, and labels the cup. Never carries hot water.
- ☐ **Measurer:** Each day lifts the cup onto the millimeter grid card (or holds the ruler flat against the cup wall), reads the longest edge of the largest crystal to the nearest 0.5 mm with the hand lens, and counts the crystals, without stirring or tilting the solution.
- ☐ **Recorder and grapher:** Writes each day's value and observation in the table, plots the point on the graph the same day, sketches the largest crystal on the first and last day, and keeps the sheet with the cup.

Safety

- Goggles on whenever solutions are being made, poured or emptied. Alum and Epsom salt solutions are eye irritants.
- No tasting, no sipping, no fingers in the cup. Alum is sold as a food additive but in these amounts can cause stomach upset; Epsom salt is a laxative. Label every cup 'Do not drink'. Wash hands after handling crystals.
- Only the teacher handles hot water: water at 60 to 70 °C is poured by the teacher into cups that are already on a tray at the student station; students never carry a cup of hot solution.
- Carry cooled cups with two hands on a tray; mop any spill at once, since a wet floor with dissolved alum is slippery.
- Do not use thin plastic cups or glass that is not heat-tolerant; hot water can soften or crack them.
- Crystals have sharp edges once removed; handle them by the broad faces, not the points.
- Disposal: small volumes of alum or Epsom salt solution can go down the drain with plenty of running water; crystals go in the trash or home in a bag if your school allows.

Procedure

1. Session 1 (day 1). Put on goggles. Label your cup with your group number, 'Do not drink' and your cooling condition (SLOW or FAST). Weigh or measure about 30 g of alum into the cup and record the mass.

2. Set the cup on the tray. The teacher pours 100 mL of hot water (60 to 70 °C) into it. Stir gently for about two minutes until nearly all the alum dissolves. If every grain disappears, add half a teaspoon more and stir; stop when a few grains stay on the bottom. Record the water temperature the teacher reads.
3. SLOW groups: wrap the cup in the towel and set it inside the box with the lid loosely on. FAST groups: stand the cup in the tray of room-temperature water for the rest of the period, then move it to the open shelf. Do not stir again. Record the time you put it away.
4. Session 2 (day 2 or 3). Without tilting or stirring, lift the cup onto the millimeter grid card. Find the largest crystal. Using the hand lens and the grid or a ruler held flat against the outside of the cup, measure the longest edge of that crystal to the nearest 0.5 mm. Record it as the first measurement, with the date, and count how many crystals you can see.
5. Sketch the largest crystal with its shape and the number of flat faces you can see. Return the cup to its shelf and condition.
6. Every school day after that (five minutes at the start of class), repeat the measurement of the same crystal, count the crystals, note anything new (new crystals, cloudiness, a crust at the surface) and plot the day's point on the graph before you sit down.
7. Session 3 (day 7 or 8). Take the final measurement in the solution. Then pour the solution into the waste container, lift out the largest crystal with the spoon, dry it on a paper towel, measure it directly with the ruler, and (if a scale is available) record its mass. Sketch it next to your first sketch, at the same scale.
8. Calculate your growth rate: (final length minus first length) divided by the number of days between them, in millimeters per day. Then calculate how many days, and how many years, a crystal would need to reach 1,000 mm (one meter) at that rate.
9. Post your group's cooling condition, number of crystals and largest-crystal length on the class table. Answer the analysis questions individually, then compare within the group.

Record your observations

Lab 1 recording sheet: The crystal clock

Session 1: fill in the setup table. Session 2 and every school day after: one line in the daily table and one point on the graph. Session 3: the final line, both sketches, the rate calculation and the questions. Never stir or tilt the cup after day 1.

Safety reminders — Goggles on when solutions are made or emptied. The teacher pours the hot water. Do not taste or touch the solution. Wash hands after handling crystals. Carry cups on the tray with two hands.

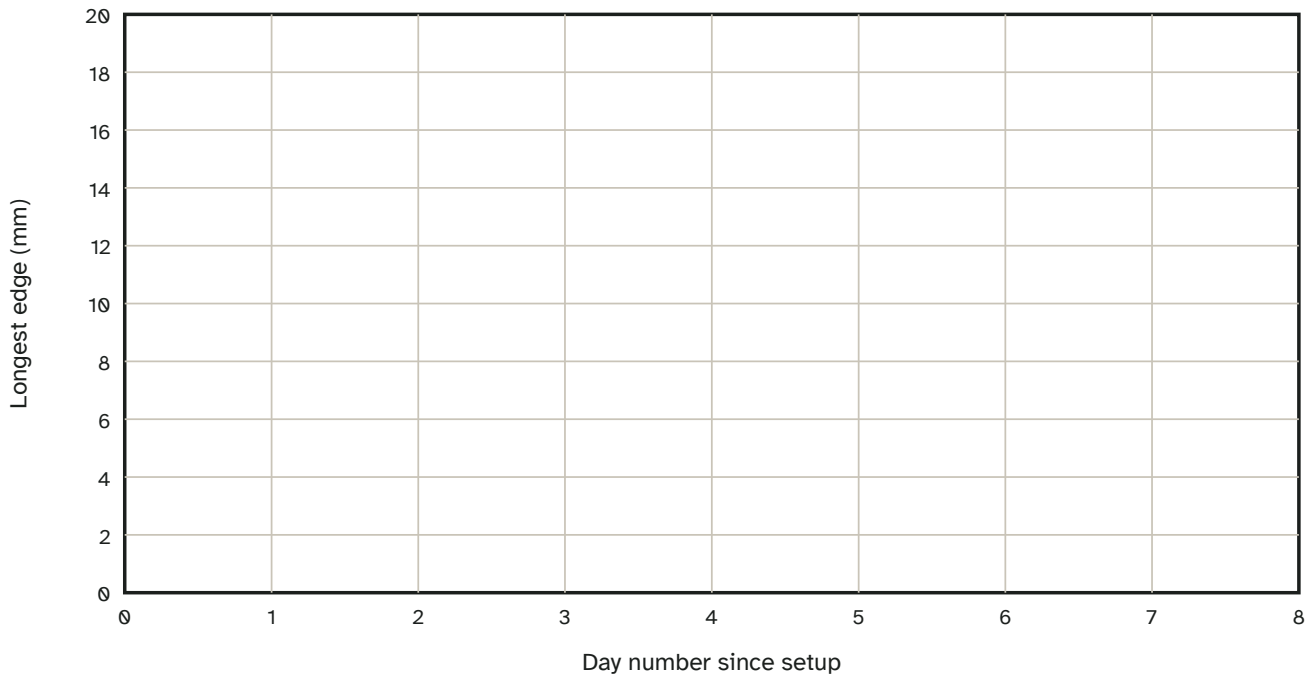
Setup (session 1)

Cooling condition (SLOW or FAST)	Salt used	Mass of salt (g)	Water volume (mL)	Water temperature (°C)	Time put away

Daily measurements of the largest crystal

Day number	Date	Longest edge (mm, to 0.5 mm)	Number of crystals you can see	What else changed (new crystals, crust, cloudiness)
1 (setup, no crystals yet)		0	0	
Final (crystal removed and measured directly)				

Longest edge of the largest crystal over time



-  Sketch the largest crystal on the first measuring day (left) and on the final day (right) at the same scale. Draw a 10 mm scale bar under each sketch, label the number of flat faces you can see, and label any faces that look the same shape on both days.

Rate and extrapolation

First length (mm) and day	Final length (mm) and day	Change in length (mm)	Days between	Rate (mm per day)	Days to reach 1,000 mm	Same time in years

1. During any one class period, could you see your crystal growing? How did you know it was growing anyway?

2. Class results: on average, which cooling condition produced more crystals, and which produced the largest single crystal? Write the class numbers you are using.

Analysis questions

3. Show the calculation of your growth rate in millimeters per day. Then convert it to millimeters per year (multiply by 365).

4. At your rate, how long would a crystal need to reach one meter (1,000 mm)? Show the calculation in days and in years. Then explain one reason the real answer would be longer than your calculation.

5. Describe the shape of your graph. Was the growth rate the same every day? Use two numbers from your table to support your answer, and explain what in the cup could make the rate change.

6. Compare the SLOW and FAST cooling results for the whole class. Explain what the comparison suggests about why some rocks that cool from magma have crystals you can see while others have crystals too small to see.

7. The crystal is a model of Earth processes such as a cave formation growing from drips or a dune growing from gusts. Give one way the model matches those processes and one way it does not.

8. The giant gypsum crystals in the Naica cave in Mexico are up to about 11 m long and are estimated to have grown over roughly 500,000 years. Calculate their average growth rate in millimeters per year and compare it with your crystal's rate per year. About how many times faster did yours grow?
