'Crystallisation' in a pudding dish
Simulating the formation and growth of crystal lattices

Show pupils a well-formed crystal, or display Photograph 1 which shows two large quartz crystals. Explain that the crystal faces are entirely natural and have not been cut. Ask what was needed for such good crystals to form (*enough raw material, in this case silicon dioxide; enough space for the crystals to grow in; enough time for the atomic lattices to form a crystalline structure*).

1. Large quartz crystals (5cm long) which had plenty of time and space in which to grow

Explain that the demonstration will model the **time** factor in the above list.
Take a flat bottomed round dish and a bag of spherical objects of uniform size. These could be ball bearings, glass marbles, polystyrene spheres or sweets, such as Maltesers™. (Before the lesson, find out how many spheres it takes to make a uniform layer on the base of the dish, after it has been shaken gently from side to side for a while). In front of the class, pour these spheres into the empty dish in a haphazard way, so that they lie like those shown in Photograph 2. Then, shake the dish from side to side for a few seconds, until the spheres begin to form a uniform pattern (Photograph 3). Finally, shake the dish for a while longer until all the spheres lie in one plane on the base of the dish and study the pattern so formed (Photograph 4).

Explain that the regular pattern formed by the spheres represents the arrangement of the atoms in a crystal (the crystal lattice). The longer the time available for the spheres to form such a lattice, the bigger and better-formed the crystal will be. So, rocks which have cooled from the molten state very slowly, below ground, will mostly have large, well formed crystals. Rocks which have cooled rapidly, like lavas, will mostly have small, poorly-shaped crystals. Sometimes, when molten rock cools very quickly, the atoms are 'frozen' in place before they have time to form a regular lattice, and the product is a volcanic glass, with no defined crystalline structure at all.

2. Maltesers ™ after being poured randomly into a dish

3. The Maltesers ™ after a little shaking of the dish

4. The Maltesers ™ after a few seconds of shaking

The back up

Title: 'Crystallisation' in a pudding dish

Subtitle: Simulating the formation and growth of crystal lattices

Topic: A teacher-led demonstration of the formation of regular patterns with spherical objects, akin to the way in which crystal lattices may be produced in nature.

Age range of pupils: 14 -18 years

Time needed to complete activity: 5 minutes

Pupil learning outcomes: Pupils can:

- observe the ways in which spherical objects form a variety of patterns, ranging from haphazard to well ordered;
- explain that the regularity of the pattern depends on the time available for it to form;
- relate the model to the formation of crystals with regular atomic structures (crystal lattices);
- relate the model to the cooling rate of igneous rocks and to the sizes of the mineral grains which make them up.

Context: This demonstration can be used in any lesson on the growth of crystals, whether from molten rock (magma) to form igneous rocks, or from cooling aqueous solution, producing vein minerals as in Photograph 1.

Following up the activity:

- The layer of spheres in the dish gives a two-dimensional representation of a lattice. Try adding enough spheres to make a second layer and shaking the dish gently. Watch to see if the spheres in the second layer settle into the 'holes' in the first layer, thus beginning to build up a regular three-dimensional lattice structure.
- (See Photograph Sheet, p 3). Ask pupils to match the photographs of igneous rocks in Photographs 5 to 7 with the pictures of the Maltesers™ in Photographs 2 to 4. [*Photo 1 (random) matches Photo 6 (obsidian); Photo 2 (partial pattern) matches Photo 7 (microgranite); Photo 3 (regular pattern) matches Photo 5 (granite*)].
- Ask pupils to explain the relative sizes of the crystals in the Shap Granite (Photograph 8). (*Two phases of underground crystallisation are represented – the large well-formed feldspar crystals crystallised first, very slowly, with plenty of room to form. The rest of the minerals crystallised later, albeit still slowly when compared to a lava*).

Underlying principles:

- Most igneous rocks and most vein minerals are crystalline.
- Crystals have a definite atomic structure, which defines their external shape and physical properties.
- Defects in the crystal lattice may produce irregularities in the crystal (shown by the slight differences in size and shape of Maltesers™; this is not seen if identically-sized ball bearings are used).
- The availability of raw materials; the amount of space available and the length of time before the rock becomes solid, are all factors controlling the size and shape of the crystals in an igneous rock or mineral vein deposit.

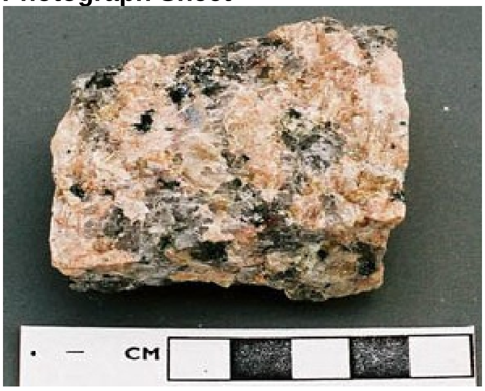
Thinking skill development:
Pupils establish a pattern in the model 'atoms'. Cognitive conflict arises when irregularly shaped 'atoms' upset the pattern. Applying the modelling to real crystals involves bridging skills.

Resource list:

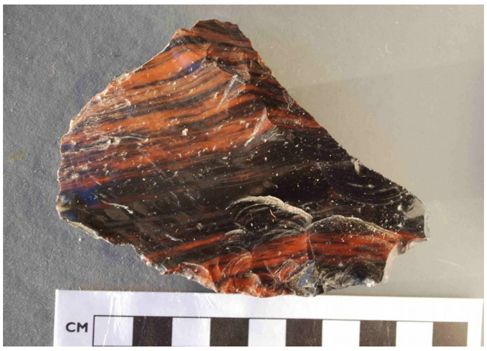
- a shallow dish, as in the photographs
- a bag of spherical objects of uniform size, such as ball bearings, glass marbles, polystyrene spheres or sweets such as Maltesers™

Source: Devised by Peter Kennett of the Earthlearningidea team, from the recollection of a very old educational film, lost in the mists of time!

Photograph Sheet

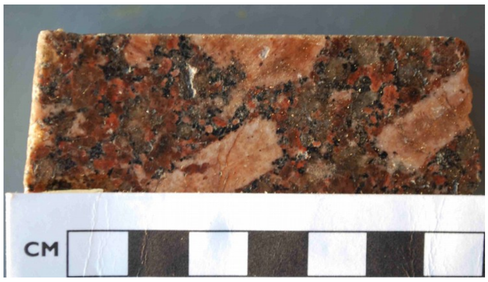


5. Granite – a coarse grained igneous rock, with crystals of three different minerals



6. Obsidian (volcanic glass).

7. Microgranite (a medium grained variety of granite) – a cut and polished surface



8. Granite from Shap Fell, Cumbria, showing very large crystals in a generally coarse-grained groundmass – a cut and polished surface

(*All photographs are by Peter Kennett*)