

Teacher and Technician sheet

In this practical students will:

- Experiment with plaster of Paris, to determine whose teeth (or what tool) left an impression.
- Report on their observations of what happens to the plaster of Paris, throughout the experiment.
- Explaining why plaster of Paris goes through these changes, based on my scientific knowledge and understanding.

Introduction for Teachers:

This session would link into a forensic module. The discussion could start with some input about the nature of the Plaster of Paris, and the chemistry involved. This could start by asking if anyone has broken a limb and had it put into a cast. What did it feel like when the cast was being applied? What was it like to touch?

In *Ancient Mesopotamian Materials and Industries* (OUP 1994) P.R.S. Moorey cites evidence of plaster vessels designed for carrying dry ingredients have been found in excavations of Ur (c3000 BCE.) and Tel Brak (c6000 BCE). They appear to have been used for their fire preventive properties and this was one of the reasons it had been used on walls over the centuries and in Paris in the 17th century, when plaster of Paris was used to coat wooden structures. The Arabs used Plaster as a bandage from around 1000 CE as noted in the *Al-Tasrif*, an Arabic medical encyclopaedia. The use of plaster of Paris in European and American medicine did not begin until the 1800s.

From the Egyptians artists had used plaster of Paris to create sculpture, make decorative items, as a painting surface especially on walls as frescos, to create replicas of famous artworks and to make casts of the heads of the in order to recreate their likenesses. The use of finely ground gypsum plaster to create decorative moulding was popular during the 18th and 19th centuries.

Like chalk and limestone, gypsum is found as a mineral rock. They are calcium compounds. Chalk and limestone are calcium(II) carbonate and gypsum is calcium(II) sulfate. Calcium(II) carbonate is used for sculpturing and calcium(II) sulfate is used for casting. Calcium(II) carbonate is also used to coat the surface of a support like wood or canvas to create a surface for painting on. This surface is known as the ground.

The crystals of calcium(II) sulfate are hydrated which means they have water molecules bound into the crystal. This is known as water of crystallisation.

If gypsum is heated gently some of the water is lost and the crystal becomes a white powder. (It changes from $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ to $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$) If water is added to the cold white powder the water recombines with the calcium(II) sulfate to form hydrated calcium(II) sulfate or plaster of Paris. As this happens the mixture gets hot which chemists call an exothermic chemical reaction. When water is added to the anhydrous calcium(II) sulfate it does not form crystals but a white paste which then sets hard.



Artists still use materials like calcium(II) sulfate for creating casts. Sometimes these are created by making a wax image, then placing plaster of Paris around the wax with two holes in the bottom of the cast. The cast is allowed to set hard. Hot metal can be poured into one of the holes in the cast bottom. The wax melts and the gases and overflow metal can come out of the other hole in the base. Left to cool the metal has filled all of the crevices of the surface in the plaster cast and an exact copy can be created. This is known as the lost wax process and is still used today to make cast objects. Historically the oldest cast materials date back to 4500-3500 BCE.

A research task for pupils could be to look at the use of lost wax casting from around the world.

In the past and in some circumstances today, scenes of crime officers (SOCO) or crime scene investigators (CSI) use plaster of Paris or a resin to take imprints of shoe prints, tyre marks, stab wounds in a body or bite marks left at the scene of a crime. This is because the print itself could be damaged or destroyed. So to preserve it a cast is made of it. Teeth marks can be important clues because they can be matched with dental records and a suspect possibly identified. The pupils will simulate this in the following investigation which could be developed to include a lost wax activity.

Curriculum Range:

This practical is really designed for secondary students but can easily be carried out by upper primary pupils. The aim is to gain some understanding of the way the materials are used to create artefacts. It links with:

- Setting up simple practical enquiries, comparative and fair tests;
- Reporting on findings from enquiries and observations, including oral and written explanations, displays or presentations of results and conclusions;
- Using straightforward scientific evidence to answer questions or to support their findings;
- Build a more systematic understanding of the chemistry of plaster of Paris by exploring the way calcium(II) sulfate can be used to make a different substance with useful properties;
- Ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience;
- Use appropriate techniques, apparatus, and materials during laboratory work, paying attention to health and safety;
- Make and record observations using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements;
- Present observations using appropriate methods;
- Interpret observations and identify patterns using those observations to draw conclusions;
- Present reasoned explanations, including explaining data in relation to predictions and hypotheses;



- Learn about the concept of hydrous and anhydrous materials and how that affects the properties of substances.

Hazard warnings:

Food must not be eaten in the laboratory because of the risk of contamination. Before the students enter the laboratory they should have prepared an apple with a bite in it. The aim is to leave a clear set of teeth marks. This can take a little practice.

Alternatively an indentation could be made with a tool (fork, spatula, spoon, knife, etc.) into an apple or potato and the indentation could then be cast to find the tool that created it. This makes a better cast than teeth on an apple. **Do not raise a dust or inhale any plaster of Paris dust.**

It might be better, with younger pupils to demonstrate the heating of the hydrated calcium(II) sulfate and the way the material changes with the loss of water of crystallisation.

Plaster of Paris can get very hot in contact with moisture, so it is advised that pupils should not put the plaster of Paris directly on their skin.

It should be stressed that pupils must in no circumstances try to make casts of hands or other body parts. The heat generated has in the past lead to severe burns and even amputations!

Equipment:

A

- Eye protection
- Spatula
- Boiling tube
- Bunsen burner
- Clamp stand
- Clamp
- Key or coin
- Evaporating basin
- Piece of cardboard 10 cm x 10 cm
- 10 lumps of Gypsum (calcium sulfate)

B

- Eye protection
- Disposable plastic gloves
- Disposable cup
- Glass rod
- Plaster of Paris



- Apple
- 200 cm³ Water

Technical Notes:

Cover the work bench with newspaper before working with plaster of Paris because it can be messy.

The consistency of the homemade plaster of Paris should be thick, but not too difficult to stir. If you feel the plaster is somewhat runny, add more plaster powder. The opposite is also true - if the plaster is too hard to stir, add more water.

A 3:2 ratio of plaster of Paris to water works well to start with. It will set in about an hour.

Results:

It can sometimes be a little difficult to get a good impression with bite marks on an apple. Better casts can be made using an indentation in a potato or apple, using a fork. (Potatoes could be provided to the students with the indentations already made). The students could be tasked with finding out what tool(s)/utensil(s) caused the indentation. These tools can be identified from the casts made from them.

The plaster of Paris works better if it is slightly thicker rather than runny.

It may take an hour for the casts to set well so the results may not be able to be completed within the lesson time.

Taking the work further:

Pupils should find out about the lost wax process and see if they can devise a method of getting a lost wax impression of the teeth marks.

Compare the wax approach with the Plaster of Paris and evaluate which gives the best impression.

