**ACTIVITY: Investigating clay**

**Activity idea**

In this activity, students investigate some of the properties of clay such as moisture content, shrinkage and strength.

By the end of this activity, students should be able to:

* identify by appearance and texture the clay types kaolin, earthenware and bull clay
* determine the water loss that occurs when clays are firstly dried and then heated in a kiln
* describe how shrinkage in clays occurs
* state some of the changes that occur when clay is fired
* effectively use top-loading balances.

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**Introduction/background**

This activity follows on from the article on [What is clay?](https://www.sciencelearn.org.nz/resources/1771-what-is-clay) The moisture content of different clays is determined after different drying processes and the amount of shrinkage that occurs as a consequence of this is also measured. The dried clays are then tested for strength.

The main purpose of this activity is to demonstrate that high-temperature firing is required to maximise the strength of the final product. High temperatures are needed to drive out excess water that resides within the clay minerals as well as allowing the minerals to fuse together to from a strong, rigid, giant network solid.

The clay types to be investigated include kaolin, earthenware and bull clay.

**What you need**

* 200g lumps of moist, kneadable clay (1 lump each of kaolin, earthenware and bull clay and a further 3 of any one of these types)
* Blunt cutlery knife to cut the clay
* Top-loading balance
* Metal tray
* Oven to heat to 100°C
* Access to a pottery kiln to heat to 900°C (you may need the assistance of the Art Department or a local pottery club)
* Copies of the student worksheet

**What to do**

1. Make sure each student has the necessary materials and equipment and the student worksheet.
2. After step 4 of the student worksheet, discuss the students’ findings and compare the values obtained for each of the clay types. (The common clays that the majority of potters use will shrink between 10–15%. Shrinking clay can ruin a piece of pottery by causing the piece to warp, crack or collapse. Knowing how to work with clay shrinkage is a key component of successful pottery.)
3. After step 11 of the student worksheet, discuss the students’ findings and compare the values obtained for each of the clay samples. Also discuss any differences between different clay types.
4. After the last step of the student worksheet, discuss the students’ findings and compare for each of the clay samples. Also discuss any differences between different clay types.

**Discussion questions**

* Why is it important for potters to thoroughly knead the clay before shaping it and then firing it?
* How can the shrinkage of clay in the drying stage be controlled to limit cracking?
* What are some of the variables a potter needs to be aware of when firing a crafted piece of pottery work?
* What is the difference between earthenware, stoneware and porcelain?
* What is ‘bone china’?

**Extension ideas**

Pottery items are often coated with a glaze and fired a second time. Investigate this process by considering questions such as:

* What are glazes?
* How are they applied?
* What function do they have?
* What sorts of colours do glazes give to pottery items?

**Student worksheet – Investigating clay**

|  |  |
| --- | --- |
| 1. You have been given 3 types of clay – kaolin clay (white), earthenware clay (red/brown) and bull clay (dark grey). Using a small sample of each clay type, roll out slabs that have the dimensions shown in the diagram.
 | 15cm1cm4cm |
| 1. On the top of each rectangular slab, make a 2mm deep scratch exactly 10cm long.
2. Place the slabs in a warm place to dry out completely. This may take several days. Some shrinkage of the clays will occur during this drying phase.
 | 10cm |

1. Measure the length of the scratched line on the dried clay for each sample and calculate the percentage shrinkage for each of the clay types using the table below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SHRINKAGE** | **Kaolin clay** | **Earthenware clay** | **Bull clay** |  |
| Wet length | 10 | 10 | 10 | cm |
| Dry length |  |  |  | cm |
| Shrinkage 100 x (wet length – dry length)/wet length  |  |  |  | % |
| **Conclusion:** |  |  |  |  |

|  |  |
| --- | --- |
| 1. Using any one of the clay types, roll out three slabs that have the dimensions shown in the diagram.
 | 15cm1cm4cm |

1. Determine the mass of each slab by weighing on the top-loading balance, record this in the table below and leave the slabs to air dry over a 3–4 day period.
2. Determine the mass of each of the air-dried slabs and calculate the percentage of water that has been removed by air-drying. Record this in the table below. (Ideally, the percentage calculated should be the same for each slab.)
3. Place samples 2 and 3 in an oven set at 100°C and leave for 24 hours to dry further. Set sample 1 aside in a safe and dry place.
4. After oven-drying, reweigh samples 2 and 3 and calculate the percentage of water further removed by oven drying. Record this in the table below.
5. Place sample 3 in a pottery kiln set at 900°C and leave for 24 hours. Set sample 2 aside in a safe and dry place.
6. After kiln-drying, reweigh sample 3 and calculate the percentage of water further removed by kiln-drying. Record this in the table below

|  |
| --- |
| **Clay type used:** |
| **MOISTURE CONTENT** | **Sample 1** | **Sample 2** | **Sample 3** |  |
| Wet mass |  |  |  | g |
| Air-dried mass  |  |  |  | g |
| Oven-dried mass (100°C) |  |  |  | g |
| Kiln-dried mass (900°C) |  |  |  | g |
| Water removed 100 x (wet mass – dry mass)/wet mass  |  |  |  | % |
|  |  |  |
|  |  |  |
| **Conclusion:** |  |  |  |  |

1. Hold the air-dried slab between both sets of fingers as if breaking off a piece of chocolate from a block. On a scale of 1–5 (1 =very easy, 5 = very hard) assess how easily the slab breaks and circle the appropriate number in the table below. Repeat with the other slabs.

|  |  |
| --- | --- |
| **BRITTLENESS** | very easy to break 🡨**-------------------------------------------------------**🡪 very hard to break |
| Air-dried | 1 | 2 | 3 | 4 | 5 |
| Oven-dried | 1 | 2 | 3 | 4 | 5 |
| Kiln dried | 1 | 2 | 3 | 4 | 5 |
| **Conclusion:** |

1. Look carefully at the texture of the broken pieces. Are there any differences? If so can you explain why? Does the kiln heating affect the texture and apparent strength of the slab? If so, can you explain why?
2. Place a small piece of each of the slabs in a beaker of water. Leave overnight. Remove the slab pieces from the water. Compare the soaked piece with a dry piece. Try to account for any differences you observe.