Unit 1 - Hot stuff

Based on QCA Unit 5D: Changing state (Science Year 5) and Unit 6D: Reversible and irreversible changes (Science Year 6)

The first QCA unit delivers a programme to teach that materials can be classified as different states and can change between states, including the processes of solidification and melting. This unit requires that children become familiar with thermometers and see how they can be used. The second unit looks at changes in materials and how they can produce new materials. This second unit does ask that teachers show the children what happens when water is added to cement. It also mentions that the children need to know that burning/heating material can result in a different material.

The production of cement is an excellent real life example of how raw materials can go through all these changes in state to produce something we use every day in our lives.

- The actual process of cement manufacture is described, highlighting melting and solidification.
- The reaction when water is added to cement is examined, measuring temperature changes during reaction.
- A few fun things to make with cement are suggested (e.g. make your own fossils).
- A fieldtrip to a cement works brings all elements in this unit to life. Each part of the process can be described and changes in state and the effects of heat can be directly experienced!

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W: www.cementindustry.co.uk

Lesson 1 - How to make cement

Learning objectives	• To see the stages involved in cement production. • Identify 'melting' and 'solidification' in the cement making process.
Relevance	To understand that these changes in state can occur in a material that the children use every day.
Vocabulary	Cement Melting Solidification Clinker Concrete Change in state Volcano Irreversible reaction.
Preparation/resources	• Items made from cement (e.g. roof tile, paving slab). • Uses of cement from British Cement Association website (www.cementindustry.co.uk) or other cement manufacturers' websites. • Raw ingredients of cement - limestone, shales, clay or chalk (depends on what your local cement works uses. Ask at works for samples). • BCA website (as above) for the stages involved in cement production. This can be displayed on an interactive whiteboard, or download pictures and laminate to show children. • Cards to show all seven stages of cement making process. • Percussion instruments to help act out stages of cement manufacture. • Worksheet 1 • Worksheet 2

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Lesson 1 - How to make cement

Lesson plan

Introduction

Cement is a material we all use every day (it might be useful to have a few concrete items, or pictures of buildings - see BCA website for examples). An average family uses 1 tonne of cement each year. This is similar to the weight of an average family car. 18 tonnes of cement is needed to build an average house.

Cement is made by heating up rock (show children actual raw ingredients) to huge temperatures - approximately 2000°C (remember water boils at 100°C). At this very high temperature, the rock melts, very like inside a volcano. This molten rock is called Clinker, which is then ground into powder and turned into cement.

Development

Briefly go through the cement manufacture process using the BCA website.

Divide the children into 7 groups. Assign each group one of the stages of cement making and give them a card describing each part of the process.

1 Quarrying

2 Grinding

3 Pre-heater

4 Kiln

5 Cooled

6 Milled

7 Despatch

Ask the children to put together a 3 minute performance of their part of the cement making process. They can include percussion instruments, or ones of their making, to help show what happens in their stage of the process.

Distribute worksheets 1 and 2, ask children to cut out each stage of cement making process on worksheet 1 and place them onto worksheet 2 in the correct order, so that the raw ingredients are turned into cement. Cut out 'melting' and 'solidification' labels from worksheet 1 and place them onto parts of cement making process where these also occur.

Plenary

As whole class, go through the correct order of stages in the cement making process and where melting and solidification occur. Higher attainers, or early finishers, can add caption on each stage to describe what is happening in each stage. Lower attainers can use captions provided.

Paste the stages and labels onto worksheet 2. Another performance of the process would reinforce the sequence of stages in cement manufacture.

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Lesson 1 - Resources

Print this sheet and cut up the squares to give you 7 cards. These cards describe the cement making process.

QUARRYING

1 Limestone is blown up to get the rock out of the ground.

2 The rock is put onto the dumper trucks.

3 The dumpers put the rock into the crusher.

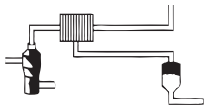
4 The crusher smashes the rock into smaller pieces.

GRINDING

1 The pieces of rock are ground into a powder using a machine called a Mill.

2 The mill has two big discs which spin and rub together.

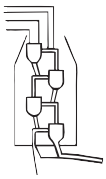
3 The rock is put between the discs which grind the rock into tiny pieces.



PRE-HEATER

1 The rock powder is spun around in hot air.

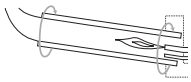
2 The powder must be hot before it can go into the kiln.



KILN

1 The rock powder is heated up inside the kiln.

2 The kiln is a huge cylinder which rotates all the time.



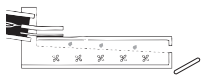
3 The rock is heated up so hot - same temperature that you would find in volcanoes.

4 The rock melts and turns into black round lumps, called clinker.

COOLER

1 The very hot clinker (melted rock) needs to be cooled.

2 It is pushed over lots of fans that make cool air.



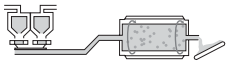
MILLING

1 Another substance called Gypsum is added.

2 Then it is all poured into a cylinder.

3 This cylinder rotates.

4 The cylinder contains small metal balls that smash the rock and gypsum into a fine powder.

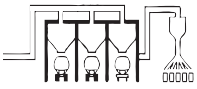


DESPATCH

1 The ground up cement is a fine powder.

2 It can be poured into big lorries.

3 It can be poured into smaller bags to go to DIY shops.



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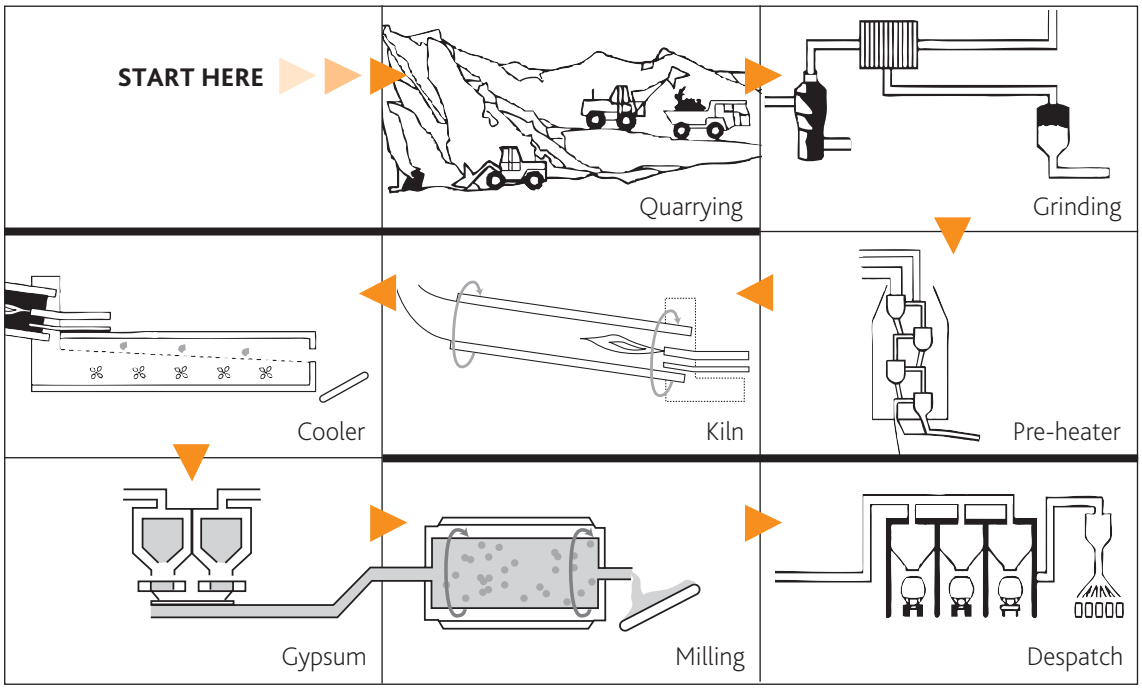
Worksheet 1 - Stages in Cement Making Process



Labels for states

SOLIDIFICATION	MELTING

Labels for process

Raw ingredients are ground into a powder.	Rock is extracted from the quarry.	The raw meal is heated to 2000°C.
The cement powder is stored in silos and then put in bags or loaded into lorries.	Clinker is passed over cool air.	Gypsum is added to the clinker.
The clinker and Gypsum are ground into powdered cement using a mill.	The raw meal is heated by passing it through warm air.	

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Worksheet 2 - The Cement Making Process

STAGES OF PROCESS	DESCRIPTION LABEL	STATE LABEL

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Lesson 2 - Too hot to handle

Learning objectives	• To observe reaction which occurs when water is added to cement. This is an irreversible change. • To use a thermometer to measure a change in temperature. • To develop experimental skills.
Relevance	To observe an irreversible reaction, used for the creation of the children's built environment, from huge sports stadiums to garden patios.
Vocabulary	Reaction Solidification Irreversible Thermometer Temperature °C
Preparation/resources	• Uses of cement can be found on the British Cement Association website www.cementindustry.co.uk • A piece of pipe or paving slab to show what cement can be used for. • Print off COSHH forms from www.lafargecement.co.uk/products. • Bag of quick setting cement (fastest available). • Goggles, gloves and aprons for each person doing experiment. • Covered work surface. • Moulds. • Heat proof container. • Jug of water.

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Lesson 2 - Too hot to handle

Lesson plan

Introduction

Use the piece of concrete to revisit what cement can be used for. Perhaps show parts of the school buildings that demonstrate uses of cement (e.g. roof tiles, floors, mortar, plaster and foundations).

To create all these products, water must be added to cement. There is a strange reaction when water is added to cement. This reaction can sometimes mean that it can be dangerous. We will discover why.

Development

For these experiments, everyone will need to be careful.

I suggest using extra adult help when carrying out these experiments. Although the experiment is not very dangerous, care must be taken. It is best to keep the size of groups small with an adult supervising at all times. These experiments could be carried out in a separate area in the classroom. Small groups of children could be doing these experiments, while the rest of the class does previous lesson, or creating moulds.

Use goggles to prevent getting dust into eyes. Use thick gloves to protect hands. If get cement/concrete on hands it is okay, as long as you wash it off straight away. Use aprons to cover clothing and cover work surface. If children are sensible and have suitable adult supervision, this experiment is very effective, fun and safe.

Look on instructions on your pack of cement product, it will advise you what proportion of cement to water you should use. It will also tell you what amount of time it will take to set.

Have cement dust in a heatproof container and water in a jug. Ask the children for predictions about what will happen when you add water to cement.

Carefully add the water to the cement and then pass container around group of children. Let them hold container. What do they notice (that it gets warm). This heat is generated as cement dissolves. The cement will then turn into hard concrete after a short space of time.

Therefore, one material (cement) has turned into a new material (concrete) with completely different properties.

Is this change reversible? NO

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Lesson 2 - Too hot to handle

Lesson plan (cont'd)

Development (cont'd)

FUN STUFF

1 **Who would like to own their own piece of concrete?**

- Use prepared moulds. You can buy all sorts of shapes in hobby/toy shops
- Use strong plastic moulds used for sand castle building.
- Make fossils using plasticene moulds, made by pressing a fossil into plasticene and then filling the shape with concrete. This is very similar to one of the major processes of fossilisation, but it takes a lot longer in real geological time!
- Make a large batch of concrete for each group of children and pour into each mould. Leave moulds still and allow concrete to harden. Remove mould.

2 **Class Wall**

- Each child could bring in a margarine tub, or use cardboard tubes cut into sections. These make excellent moulds to make concrete bricks.
- Children could use something blunt (e.g. pottery tolls, stick, end of pencil) to sign or decorate their 'brick'. Stack 'bricks' (safely) into a class wall.

3 **Class Walk of Fame**

- Use a tray as a mould (or could make one from wood) for a paving slab.
- Pour in concrete and before it sets, ask all children to gently press hands into concrete and sign, as seen at the Hollywood Walk of Fame. Wash hands straight away.
- Slabs can then be put into school grounds and replaced each year …

Plenary

Did children notice that the concrete got warmer before it set?

Use a digital thermometer attached to a computer (or a normal digital thermometer and read it at regular intervals). Add water to cement again and follow change in temperature.

Put the container in ice and watch temperature change. Is it different? Does it take longer to set? Why might this be a problem to builders in the winter, or in countries with colder climates? It can slow work down because builders need to wait longer for concrete to set. They can sometimes use rapid setting cement which contains extra substances which makes the concrete harden quicker. If you have time, you could compare different cement products – their setting times and temperatures generated.

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Fieldwork 1 – Heating and cooling, melting and solidification . . .

Tour of local Cement Works

Learning objectives	• See cement making process. • Directly experience heat used to melt rock in kiln. • See cooling procedure used to solidify clinker. • See computer temperature control and monitoring throughout process.
Relevance	To see that melting and solidification can be used to create a material that the children use every day. To also see the use of IT to control and monitor temperatures in an industrial process.
Vocabulary	Pre-heater Kiln Cooler Monitor Clinker
Preparation/resources	• Preliminary visit to check that children can get safe access to pre-heater, kiln, cooler and control room.

Lesson plan

Introduction

Explain that the children will be looking at how important melting and solidification is in the production of cement.

Development

Cement works tour with a close look at the pre-heater, kiln and cooler. If possible, visit control room to watch images of the kiln to appreciate just how hot it gets. See if can get any temperature information downloaded to take back to school. These could be added to children's sequence pictures they did in last lesson.

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Fieldwork 2 – Making concrete in action

Tour of construction site

It may be possible to visit a construction site where cement is being used. This would allow the children to look at the cement being used by builders and safety measures that have to be carried out to use this material safely.

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