IRREVERSIBLE CHANGES – chemical reactions

Science background for teachers

VOCABULARY

Reaction, reversible, permanent, irreversible, chemical, iron oxide, rust, corrosion, vinegar, plastic, milk, carbon dioxide, borax, Plaster of Paris

Most changes that cannot be reversed are **chemical reactions** where a new material is formed, and it is not possible or extremely difficult to recover the original materials. Children will experience such changes all the time in their everyday life and in the science activities they do in school, but it is not always obvious that a chemical reaction has taken place. Changes that take place in cooking, some heating, mixing some materials, such as vinegar and bicarbonate of soda, and burning are all chemical reactions. As children experience these activities it is worth discussing this with them as an on-going idea so that they begin to develop and build on the concept.

In a chemical change, the bonds between the particles of the substances are broken and reform in a different arrangement as a new substance. This may require energy taken from the surrounding material, and there is a drop in temperature as happens when lemon juice and bicarbonate of soda are mixed. Very often however, there is energy produced as a result of the reaction and an increase in temperature, as in the reaction between Plaster of Paris and water.

Rusting and the **burning** of a fuel in the presence of oxygen are both chemical reactions known as **oxidation.** Iron, in the presence of water and oxygen, reacts to form iron oxide or rust. Whilst the rust can be rubbed off to reveal the 'good' iron underneath, the top layer has been changed and removed permanently. Since this change is one that children will see happening and causes such a lot of corrosive damage, it is worth investigating the factors that affect it and what may prevent it from happening. Steel rusts because of its iron content. Stainless steel does not because traces of other metals have been added, this prevent the oxidising process which gives rise to the rusting. Galvanised steel or iron is coated in zinc, which also prevents rusting. Old copper coins react with the air and copper oxide forms making them 'dirty' and black. If they are dropped into cola, the strong phosphoric acid in the cola reacts with the copper oxide and cleans the coins.

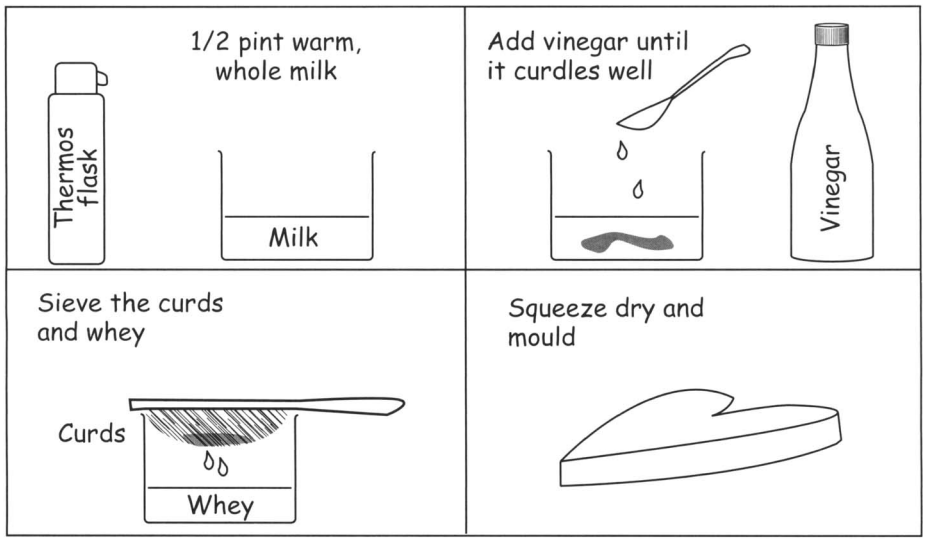
Other chemical changes Mixing materials together often causes a chemical reaction and it is interesting for children to do some examples of these and compare them with mixtures that only change physically. Salt dissolves in water to form a solution, a physical change that can be reversed by causing the water to evaporate leaving salt crystals behind. Alka-Seltzer also dissolves in water to form a solution, but there is also a chemical change and carbon dioxide, a new material is produced. This is a chemical change that cannot be reversed.

SKILLS

- Ability to plan and carry out a fair test.
- Use equipment accurately, with care and work cooperatively.
- Observe carefully and record results.

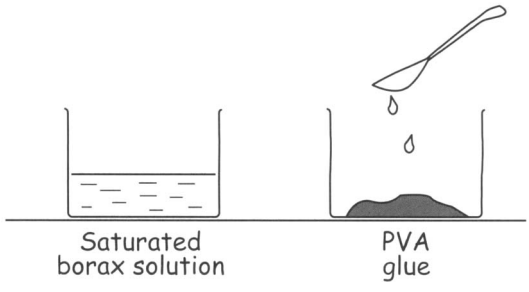
Non-reversible changes result in the formation of a new material that may be useful

Making plastic with milk and vinegar This can be a directed activity or a demonstration. Warm about half a pint of **whole** milk and add about 1 tablespoon of white vinegar to it. The milk immediately curdles. Strain and keep the solid curds and put the plastic on kitchen paper to dry it. You can then handle it, put it in a mould or shape it yourself. This will dry firm overnight if kept in a warm place, become very hard in time and can be painted and varnished. Milk can be kept warm in a thermos flask. The temperature and exact quantities are not critical for this activity.



Making plastic with PVA glue and Borax This will make a similar but translucent plastic. (Borax can be bought very cheaply from a chemist.) Make up a small quantity of saturated borax solution (this is when no more solid will dissolve in the water, there maybe a little borax left in the bottom of the container). Add a teaspoon at a time of this solution to one tablespoon of PVA glue. Mix continuously and the glue will absorb the borax solution. Keep adding and mixing as the PVA changes to a solid that is 'bouncy' and can be handled and moulded. Leave to dry for a few days in the warm, it will go very hard. This is a good group activity, as a small jar of saturated borax solution can be used by a group of six children each with their own spoonful of glue in a container.

Mix the borax solution really well into the PVA glue. Add more until it changes.



Safety!

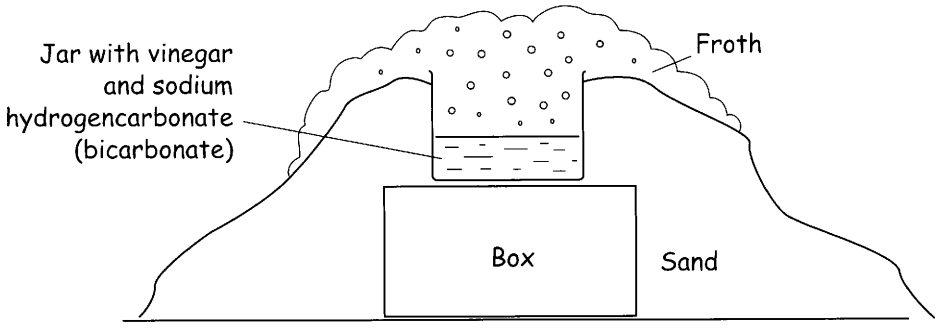
- Care when handling glassware.
- Care with iron filings, they are a potential hazard for eyes.
- Care with sharp objects eg nails.

Making a model with Plaster of Paris and water When water is added to Plaster of Paris there is an exothermic reaction, heat is given off as the plaster is setting and gets really warm as the plaster gets hard. This may take 15 minutes and can be clearly felt or measured by older children with a thermometer, but do not leave the thermometer in it too long or it will get stuck! Make a mould with a card strip, paper clip and rolled out plasticene. Make an impression on the plasticene and grease it lightly with Vaseline. Pour in the mix of water and Plaster of Paris, which should be the consistency of thick cream. Leave this to set.

Making carbon dioxide There are various ways of making this, (refer also to Solids, liquids and gases section). Perhaps the most spectacular is with sodium hydrogencarbonate (bicarbonate) or baking powder and white vinegar, to which you can add food colouring or paint. When the vinegar is added to the baking powder, the reaction is immediate, carbon dioxide is produced and makes a lot of froth. An active volcano can be made by making a mountain using damp sand, and gravel in a tray. The dry powder is put into a small jar or plastic bottle in the centre of the mountain, then the vinegar and red food colouring mixture is dropped onto it. It flows out of the jar as lava!

For a quick, explosive reaction that will blow the lid off a film canister, try half an Alka-Seltzer tablet and water. (See page 58.)

A 'sodium bicarbonate' volcano



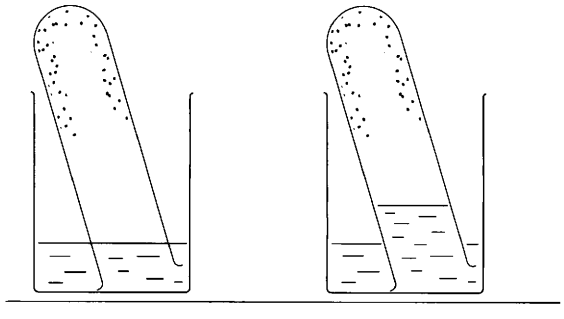
Some irreversible changes are not useful and may be corrosive

Rusting Discuss with the children the general idea of rusting and show them something that has rusted. Discuss where they see it, what they think causes it and the materials that rust.
Referring back to the rusted object you showed eg an iron nail, this material can then be used as a basis to begin the activities on the factors that affect rusting and its prevention. The material they have seen with rust on is then eliminated as a variable. They know that iron rusts so they can go on to find out what conditions make it happen. The rusting process may take several days. If iron filings are used it only takes about an hour because there is a larger surface area. Children could use iron filings and nails to do a comparison of the time it takes.

(a) **Investigate what makes things go rusty?** This can be a simple, directed activity or a planned investigation. If the children are planning the investigation, they need to begin by deciding what factors they think make things go rusty, and setting out to prove it. As a directed activity, there are a variety of ways to carry out this activity but it can simply be by putting a nail in a dish on damp cotton wool and another on dry cotton wool. This shows that rusting takes place in the presence of water and air. Eliminating the air/oxygen completely is difficult. Boiling the water for 5 minutes to force out the air, putting this into a jar with the nail and a layer of oil on the top of the water is often successful. However, a little rust sometimes appears and it is quite difficult to explain this to the children.

(b) **An activity to show that rusting uses up oxygen** This directed activity or demonstration can be used to show that air/oxygen is used up in rusting, and works well. Wet the inside of a test tube and sprinkle in some iron filings, which then stick to the wet tube. Invert the tube into a beaker of water at an angle. As the iron filings rust, oxygen in the tube is used up and water rises up the tube to replace the used oxygen. It begins to work after about an hour and works really well after a day or so. If the tube is marked into five equal sections before beginning the activity it can also be used to show the approximate percentage of oxygen in the air. The water rises about 1/5 of the way up the tube.

Water rises up inside the tube as the iron filings rust.



(c) **Investigate does the type of liquid affect rusting?** As a directed activity, the children can prepare cotton wool soaked in variety of liquids eg distilled water, salty water, sugar water, vinegar, oil and tap water. Each piece of cotton wool is then placed in a dish with an iron nail and they wait to see how much rust forms and how quickly over a period of a week. As an **investigation,** the children plan the liquids they want to try, and the way they want to do the investigation.

(c) Which materials rust? This is a simple, classifying activity which can be directed by the teacher or planned as an **investigation** by the children. As an investigation the children need to decide which materials they are going to test, and how they are going to get them to rust. They will have some ideas about rusting from investigating the factors that affect rusting, this will help them to plan how to get the materials to rust. If it is a teacher-directed activity give the children a selection of small objects made of a variety of materials eg safety pins, paperclips, brass screws, coins, iron filings, steel wool, plastic object, rubber, wood etc. Put these materials in conditions that would induce rusting such as on damp cotton wool in a dish.

Word processing

Note that in warm conditions evaporation will occur and the cotton wool may need 'topping up'.

Object to test	Material	Results after...				
		1 day	2 days	3 days	4 days	5 days
eraser 	rubber					
screw 	brass					
paperclip 	steel					
nail 	iron					
pentop 	plastic					

(d) Investigate ways of preventing rusting Discuss the issues of protecting iron that has to be exposed to air and water and discuss ways in which it might be protected. Get the children to plan their own investigation using any of the ways previously used to rust materials and get them to decide on ways to protect the materials. Any oil or grease based material will help to prevent rusting, they could see which was the best eg Vaseline, model paint, engine grease, cooking oil.

star* Poetry
by Michael Rosen

Concrete Paw

Our friends next door
have moved away.
They put everything
in a van today.

They got in a car
and went.
That's it.
No one's left.

My friend's gone.
Her sister's gone.
Their mum's gone.
Their dog Sniffy's gone.

Everyone's gone.
Nothing left...

...except for
the mark of Sniffy's paw
printed into the concrete
by their front door
where it'll stay
forever more.

Some advice for you if you are thinking of walking across a very old bridge

Don't trust
rust

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