IRREVERSIBLE CHANGES

National Curriculum Science KS2 PoS Sc3: 2a, f
QCA Science Unit 6D: Reversible and irreversible changes
Scottish 5–14 Guidelines Science Changing materials – Level C

HOW TO GATHER THE DATA

Irreversible changes can be a fascinating topic to teach, and children enjoy watching the chemical reactions. Make sure that all the children have a secure understanding of reversible changes such as melting, boiling, evaporating and dissolving (the latter two are quite difficult) before moving on to consider irreversible changes.

You can organise the children into groups to observe and measure the temperature changes occurring in a number of simple chemical reactions: citric acid with baking powder (sodium hydrogen carbonate), which is unusual because the temperature drops; citric acid with sodium carbonate (washing soda); white vinegar with sodium carbonate; plaster of Paris with water; and so on. Safety precautions need to be taken (see the ASE booklet *Be Safe!* or local authority guidelines for sensible advice): the children should wear safety spectacles (and face masks when handling plaster of Paris).

Answers

1. About 5 minutes.
2. It took some time for the reaction between the water and the plaster of Paris to start happening – this is quite a slow reaction.
3. 37°C
4. 17°C
5. It would cool down to room temperature (20°C).
6. At about 5½ minutes.
7. 2°C
8. 11°C
9. Yes, irreversible changes often cause an energy change. They can either release heat so that the temperature rises (as in Investigation 1), or take in heat so that it falls (Investigation 2).
10. The reaction of plaster of Paris with water took about 40 minutes. The reaction of baking powder with citric acid solution took less than 1 minute, so it was much faster than the first reaction.

THE SCIENCE BEHIND THE DATA

This activity provides children with a simple introduction to irreversible chemical reactions, and is an important introduction to the chemical changes they will study in secondary school.

Most chemical reactions are similar to the reaction of plaster of Paris with water: they give out heat (are exothermic). More energy is released when making new chemical bonds in the product than is required to break the existing chemical bonds in the starting materials (the reactants). The excess energy is lost to the surroundings. Where chemical reactions occur quickly, as in the reaction of metals with acids, the mixture often becomes hot. The burning of carbon-based materials (reacting with oxygen under initial conditions of intense heat) releases a lot of energy, which is why we burn fuels to provide heat and drive machines.

Adding acids to the carbonates or hydrogen carbonates of metals produces the gas carbon dioxide. The reaction of sodium hydrogen carbonate with citric acid is unusual in that it absorbs heat from the surroundings (it is endothermic). More energy is required to break the bonds in the reactants than is produced when new bonds are formed in the products (sodium citrate, carbon dioxide and water).

When you are discussing irreversible changes with the children and asking them to make predictions about whether the temperature will rise or fall, it is always important to value both predictions. The children will find out in secondary school that either answer can be right, depending on the reactants.