10. SUSTAINABLE MATERIALS: WHICH METAL?

2–3 HOURS

Children discuss the properties of a range of everyday materials before focusing their attention on different types of metal and their uses. They investigate how metals can corrode when exposed to substances in the environment and that rusting is one type of corrosion. Children are introduced to the properties and uses of precious metals and consider how one company uses these to reduce the amount of dangerous gases emitted by high numbers of vehicles on our roads today.

TYPE OF ENQUIRY

Observing changes over time / Carrying out comparative and fair tests

OBJECTIVES

Give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic (Year 5 Properties and changes of materials)

Explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda (Year 5 Properties and changes of materials)

Planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary (UKS2 Working Scientifically)

SCIENCE VOCABULARY

materials, metal, precious metals, sustainable, corrode, rust, catalytic converter

RESOURCES

per group of 4, unless otherwise stated

Activity 1:

- 1 set of metal discs or testing strips from an educational supplier or a range of objects made from different metals, e.g. steel paper clips, fine steel wool pads, steel washers, copper plated coins, iron nails, aluminium foil
- 4 shallow containers, such as saucers or petri dishes containing water
- Magnet

- Industry sustainability story: Presentation

Activity 2:

- 4 fine steel wool pads
- Resources requested from individual groups might include mild white vinegar or salt
- **Activity Sheet 12:** grid photocopied onto clear acetate sheet
- 4 pairs of disposable non-latex gloves
- 4 shallow containers, such as saucers or petri dishes containing water
- 4 safety glasses (if using acidic solutions)
- Industry sustainability story: **Presentation**
- 4 lab coats or aprons

PRIOR KNOWLEDGE / EXPERIENCE

Children will have compared and grouped materials, focusing on similarities and differences.

ACTIVITY NOTES

Introduction: Start with a game, in which the teacher names an object (e.g. bag) and the children suggest materials from which it could be made. The game is a great way for children to think about how the same object can be made from different material, such as a bag, which can be made out of paper, plastic or fabric, and also how an object can be a composite of materials, such as scissors which can have metal blades and plastic handles.

Progress to focusing on objects made from different types of metals, for example: kitchen foil or drinks cans are commonly made from aluminium, electrical wiring is often made from copper, scissors and cutlery can be made from stainless steel. Ask how many metals the children can name and then discuss why different types of metal are useful for different things.

Presentation Slide 1: Ask children if they think metal is a sustainable material. This means that the availability of metal 'meets our current needs without having a negative effect on the needs of future generations'. Explain that, once manufactured, metal can be recycled and used repeatedly. Many people believe that non-renewable resources used to make metals, like minerals and fossil fuels, are not being used-up because the metal can be used again, and this makes it sustainable. Children discuss whether they agree with this or not.

Presentation Slide 2: Introduce children to the idea of *precious* metals and explain that these are naturally occurring metals of high value. Discuss that many properties of precious metals do not change under different conditions, for example, they can be shaped without losing toughness and, even at very high temperatures, they do not corrode or rust. Because of this, precious metals are often used to make jewellery. Common precious metals are gold, silver and platinum. Encourage children to research and name any other, lesser known, precious metals.

Ask children to consider how the environment can affect some metals, such as the damage caused when metals corrode. Discuss how corroded metals change, often in colour, and become weaker. Explain that rusting is a type of corrosion and think about different examples of some types of metals rusting such as car bodies and exhaust systems, nails, screws, metal gates, etc. Children could carry out a 'rust hunt' around the school, listing the rusting objects and (possibly) what they are made from. This will aid the process of making predictions about which materials may rust, based on their knowledge of everyday objects.

Note: the teacher might wish to check that there are, or even 'plant', rusty things to find prior to the hunt.

MAIN ACTIVITY 1: WHICH METALS RUST?

The original activity and comprehensive background information can be found in Activity 1 of: ***http://www.ciec.org.uk/pdfs/resources/water-for-industry.pdf***

Provide small groups of children with a range of objects made from different metals or commercial test discs/strips (see resources above).

Children could place the metal objects in shallow containers, such as saucers or petri dishes, with just enough water poured in to almost cover each object. Over several days, children should observe carefully which objects start to show signs of rust and which do not. They could use a magnet to identify metal items that contain iron or steel.

Children should observe signs of the reddish-brown iron oxide that we know as rust on objects made from iron or metals that contain iron – such as steel. They should begin to form conclusions that both air and water are needed for this to happen. See **Background Information below**.

MAIN ACTIVITY 2: RUST DETECTIVES

To learn more about the corrosion of iron and how salt affects rusting, visit Activity 6 of: ***http://www.ciec.org.uk/pdfs/resources/pinch-of-salt.pdf***

Once the children have discovered that several metals do corrode over time, and that the term 'rust' is only used for iron and its alloys, such as steel, and that this is due to a reaction with oxygen in the air and water, they should be encouraged to develop further questions about rusting. Examples include:

- Can iron and steel rust where there is little or no water?
- Does pollution in rainwater speed up rust?
- Do the salty roads in winter or salt spray from the sea make cars rust faster?
- Can I prevent iron or steel from rusting?

Children then plan and carry out a test to answer one of these questions. They should choose a good test material from the previous activity (such as fine steel wool pads) and give reasons for this choice. They could compare a control pad with either one dampened with water, one with saltwater or one with a mixture of water and mild white vinegar (acid). They could examine the pads at regular intervals such as each day over the period of a week and take photographs and measurements of changes over time.

One method of measuring the rusting is to hold a centimetre square grid (on an acetate sheet or tracing paper) above each pad and count the number of squares through which rusting is visible. A square grid is provided on **Activity Sheet 12** for this purpose. Children may have other ideas, such as taking a sequence of photographs, or collecting rust that they shake or scrape off their test material or observing colour changes of the liquids in each container.

BACKGROUND INFORMATION

Corrosion is the damage caused to materials such as metal and stone when they react to substances in the environment. Stone statues can be damaged by harmful gases in the air, or when they are transformed and carried in 'acid' rain.

'Rusting' is the term given to the corrosion of metals containing iron, e.g. steel, when in contact with water and air. The metal reacts with the oxygen in the air to form a metal oxide. It is impossible to stop corrosion, but it can be controlled.

Precious metals are unique in many ways. They are relatively non-reactive, so they will not rust or explode when exposed to different substances or high temperatures.

The eight precious metals are gold, silver, platinum, palladium, rhodium, ruthenium, iridium and osmium. Gold and silver are probably the best known for their use as high value currency, silver wear and jewellery.

In recent years, silver has seen an increased demand for industrial uses, mainly photography, photovoltaic (solar) cells and batteries as well as medicine (wound dressings, creams, and as an antibiotic coating on medical devices) and hygiene (clothing additives and colloidal silver in after shaves). Gold is used in electronic components because of its high conductivity and resistance to corrosion. While the use of gold has decreased in dental applications, some new markets such as catalysts and pharmaceutical drugs have emerged.

Small amounts of platinum, palladium and rhodium are used in catalytic converters and electronic devices (only a few grams per car). However, the total volume of car sales is large and increasing, as the global economy continues to improve. With a rising need to reduce pollution by promoting electric vehicles, platinum and palladium may also be needed in hybrid cars.

EXTENSION OR HOME-BASED ACTIVITIES

Discuss with children how it is important to recycle objects made from metal. Recycling is better for our environment as it uses much more energy to extract metals from the ground than it does to recycle them. Metal can be re-melted and reshaped into new products many times. Explain how even rusted metal can be recycled and reused once the oxygen has been removed.

A fun way to see how corrosion can be removed is to investigate what happens to old coins when they are rubbed with acidic substances, such as vinegar, lemon juice or even cola. Children should investigate with different types of coins to see whether some metals corrode more or less than others, for example copper coins can be made shiny again, while silver coins are visually unchanged.

Remind children that our coins do not technically 'rust' as they are not made from iron, however, the metal does corrode over time, and show a dull colour, due to contact with oxygen and water.

QUESTIONS FOR THINKING

- Why do we make so many objects from metal?
- What are precious metals and how are they useful to us?
- Do you agree that metal is a sustainable material? Why do you think this?
- Why is it important to recycle objects made from metal?
- Why do you think steel wool pads are a good test material for rusting?
- Why do we not make expensive jewellery from iron or steel?
- Which material would you choose for a pipeline? Why?
- Why do we paint steel bridges?

SAFETY GUIDANCE

Children should be particularly careful when handling metal objects and fine steel wool because they may have sharp edges or corners. They should protect their eyes from acidic solutions, such as vinegar, by wearing safety glasses and refrain from rubbing their eyes during investigations. They should also protect their clothes with lab coats or appropriate aprons. Encourage children to wear disposable non-latex gloves and wash their hands thoroughly to avoid any skin irritations. After completing the investigations, children should clean up responsibly.

INDUSTRY LINKS AND AMBASSADORS

Ambassadors visiting the classroom could bring samples of metals and metal equipment and talk about how metal is used on site or for important industrial processes. The ambassador can discuss the sustainability of metal in terms of how metal is made, used, reused or recycled on their sites and to give examples where alternative materials to metal are used.

To enable children to explore one company's use of precious metals to solve the problem of dangerous car emissions polluting our atmosphere, teachers and children should follow the slides on the presentation **Sustainable materials: which metal?** and engage in discussion points and activities to develop a further understanding of industrial contexts.

CROSS CURRICULAR LINKS

Mathematics: There is an opportunity to measure and compare the area of rusting / corrosion using grids.

PSHE: to research, discuss and debate topical issues, problems and events that are of concern to them and offer their recommendations to appropriate people; to learn that they have different kinds of responsibilities, rights and duties at home, at school, in the community and towards the environment; to continue to develop the skills to exercise these responsibilities.