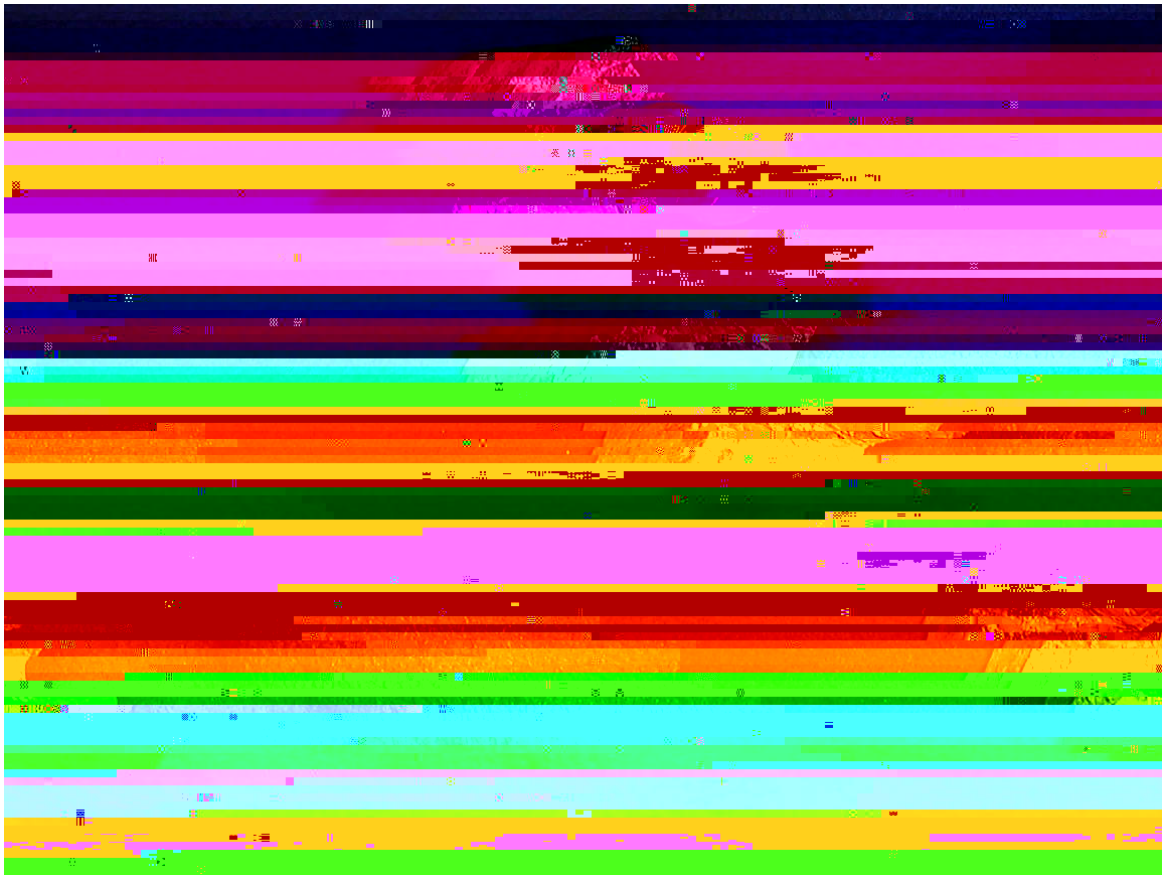


ZINC – A short Science Project for Primary Schools

The Zinc Project

Project summary and suggested tasks.

1) Visit by the presenter – a half day overview with demonstrations and class work on science

2) Read the zinc notes to get a background on zinc.

3) Pick out some parts of the zinc notes to discuss with the class and discuss how they might set up the zinc plate drip experiment (Exp 1). Class sets up the zinc drip plate experiment with acidified tap water.

4) The class is asked to collect 5 soil samples to bring in for testing and asked to try and collect 5 samples of dirt and soil where zinc may have accumulated from dripping off galvanised fences or similar.

5) Testing of soil and dirt samples and the zinc drip plate water.

6) Class is asked to hunt for metals that may be zinc at home and rub a small piece of sandpaper on the item and bag the sandpaper. Each sample should have a written description of what it was rubbed on. Warn them not to rub important objects or damage any surfaces.

7) Test sandpaper rubbings.

8) The class tests a small sample of zinc ore (sphalerite) (exp. 2) by grinding up using a ball bearing on a hard surface.

9) Class sets up the lemon experiment (exp. 3) and leaves it running for one day.

10) Class tests the lemon experiment for zinc. Teacher only uses knife to slice up lemons. Class sets up zinc plating experiment (Exp 4) and observes at 1, 1½ and 24 hours later.

Teacher disposes of all zinc chemicals and test solutions by washing down the sink. The sphalerite(zinc ore) despite being relatively safe should not be left as a class exhibit, it can be thrown away or kept somewhere safe for future use.

All the little pieces of materials, battery holder, wires and the 12 measuring beakers can be kept by your school.

11) Send the results to Steve Conway. email: grace@csteve.fsbusiness.co.uk

12) I'll collate the six schools results and send you a copy back.

ZINC

Sponsored by Royal Society of Chemistry's Specialty Chemicals Sector

Teachers' notes

'Zinc' is a short chemistry project for years 5 & 6 but can be used for larger age range groups too. These notes are to be used as a detailed background for teachers to understand the science and technology of presentation and subsequent class work. The figures and photographs referred to within the notes are separate to enable their use with the class.

A short history.

North Wales has always been a place to mine for metals. The earliest use of metals is obscure in Wales but from other parts of the world there is evidence of people using iron from meteorites and natural copper metal, though both are rare. Natural copper has been found in several Welsh mines and it is likely it was used alongside stone tools. By 3000 years ago copper, found as the natural metal, is likely to have run out and people began mining copper ores. An ore is a substance containing the metal but it is locked up; chemically bound to another element, often oxygen, sulphur or both carbon and oxygen, as in carbonate. Copper ores come in several distinct chemical types. Some are easy to turn into metallic copper and those were sought after early on, while more difficult copper ores were thrown away. Later still, when knowledge improved, the difficult copper ores were mined and turned into copper. This became known as the Bronze Age when tin from Cornwall was added to copper to make the harder mixed metal known as bronze.

The Iron Age followed and by Roman times several metals were in use, particularly lead. Lead always contains a little sil60221(r)2.5788(n)-066653(t)0.874347(a)-3.66838(l)11.539 0 Td [(e)-14.3226(d)9.

What they were after was a less common white, or sometimes canary yellow zinc ore, called smithsonite. At the time it was known as calamine by them but th

Zinc and the human body

We're all familiar with the knowledge that a lack of iron in our body can cause noticeable symptoms, often beginning with tiredness. The very colour of blood is caused by iron as if to remind us of its importance and doctors use this sign as a quick check to assess levels. Zinc gets almost no mention for its role in the body but it is arguably more important than iron. A huge number of chemical processes in our body, our biochemistry, rely on zinc to work properly.

Our bodies extract zinc from our food and normally collect enough for our needs. Unfortunately, in many parts of the world foods are grown on soils deficient in zinc where even the food plants, that also need zinc to grow, struggle to thrive. Red meat is an excellent source of zinc but even livestock needed to get their zinc from plants. These zinc deficient foods cause subtle changes in humans that are often difficult to pin down but can make them more susceptible to disease and they fail to grow and thrive as healthy adults. Britain has good levels of zinc in the soil that transfers to our meat and vegetables. In part Turkey the problem of zinc deficient soils was discovered quite late but zinc was added to fertiliser with dramatic effects on crops and improved health for the population.

As with most things, too much of a good thing can be bad for you. Our body only contains about two grams of zinc, an amount about the size of two peas. Swallowing two grams of zinc would make most of us vomit, feel very sick and produce a fever. It is not wise to drink from zinc-coated containers or mix drinks when they are small or have water that has stood in them for a while.

Zinc as a coating

Galvanising is the coating of zinc onto other metals, almost only iron/steel but sometimes on aluminium. Iron is the world's most commonly used metal but it has a great disadvantage, it rusts. Oxygen and water get together to turn iron into a red oxide that destroys its strength. Fail to maintain a steel bridge and it will be weakened by rust and finally collapse. Salt from the sea spray or winter road gritting speed up rusting enormously. Coating iron with copper, nickel or chromium stops rust by acting as barrier but if small pits or scratches in the coating lead to deep pits of rust.

Zinc has a different action to copper, nickel or chromium when used as a coating. It will be attacked before the iron and even if scratched away the surrounding zinc still protects the iron from severe rusting until finally most of the zinc coating decays away. The process can be clearly seen on corrugated iron roofing sheets, commonly called tin roofs although they have no tin on them. When new they are very reflective with their zinc coating but within a year or two they are dull grey. Depending on the quality of the zinc coating, mainly its thickness, the corrugated roof sheet may last from 10 to 30 years before rust begins to appear as reddish patches amongst the remaining thin grey zinc.

There are two ways of coating zinc onto iron. The oldest method, developed by the French in the 1740s is simply to use an acid on the steel to clean it and then dip it in molten zinc. Today we have baths containing more than a 100 tonnes of molten zinc to dip large objects, as in beams, steel doors, gates and even lampposts. This gives the thickest coatings. A second way that took a century to develop and improve finally came into common use in the 1930s. This used electricity and a cold solution of zinc salts to plate a very thin layer of zinc on iron or steel. It is often used on cars today before they are painted so that a manufacturer can guarantee a rust free period.

Advanced note: Two different metals when touching or one coated on another make a simple battery if wet. Salt allows the electrical current to flow more strongly and cause more rapid corrosion. As a simple class experiment pairs of metals can be left in salty water – held together with a tight elastic band and as a control another set separated but still in the same dish of salty water. Copper and iron make a suitable pair.

Figure 1

Weathering and zinc

Lead has traditionally been the choice for parts of church roofs but zinc is more versatile and safer. It is used for cladding and roofing and can be darkened with an artificial treatment. Examples of zinc-clad buildings in our region include the Ruthin Craft Centre, Theatre Clwyd in Mold and the Colwyn Bay shopping centre.

Zinc metal left out in the rain to weather, very slowly disappears. The acid in the rain, natural and manmade, turns it into zinc ions that flow away invisibly. In large cities the rain is often more acidic and zinc is thinned faster. In clean countryside away from animal farms it will last for much longer. The colour changes from shiny metallic to whitish grey with time as oxygen and carbon dioxide dissolved in water attack the surface. The thin layer slows the loss of zinc but gradually it all dissolves away. Zinc cladding of two millimetres thick will last a lifetime or more but galvanised coatings can be very thin (in some cases deliberately thin) and corrode away quickly by e.g. car exhausts.

Zinc ions in water dripping onto plants below often kill plants if concentrated enough. See photo 17. In this photo zinc from railings along Colwyn Bay seafront have dripped zinc-laden water onto microscopic dark lichens growing on the concrete and killed them. Unfortunately, many dark flat tiny lichens are mistaken for dirt!

The common zinc batteries

Common batteries like the typical AA cell are made from zinc metal, either as a zinc cylinder containing the moist powdered chemicals or as zinc metal powder with the jelly-like chemicals. The zinc gives away two electrons to become a zinc ion and the electrons can be harnessed as a flow of electricity. The common zinc battery turns zinc into zinc ions and effectively gives out electricity. Of course when the zinc metal has all gone the battery is dead but the zinc ions are still inside the case. Until about 30 years ago the battery that used a zinc case was the common battery and it used to leak as the case itself was eaten away. They're still around as the cheap batteries. The more expensive 'alkaline' battery that uses zinc powder inside a steel case is now more popular as it leaks less and lasts longer.

Advanced note: The common batteries all use pairs of materials to generate their power but to avoid complications the other half of the battery contents, a black paste of manganese dioxide with added carbon, can be ignored for primary level. All batteries also need a fluid (an electrolyte) to allow the electricity to flow from the one part to the other. In the cheapest batteries this fluid is an ammonium chloride/zinc chloride solution and this is used to name the battery although it is technically incorrect as both zinc batteries on sale, 'alkaline' and 'zinc chloride' are zinc-manganese dioxide batteries.

Safety note: The cheapest batteries, if opened, contain chemicals that are messy rather than harmful. Alkaline batteries contain a strong alkali that can damage the skin and produce red sore patches if the hands are contaminated.

Zinc die-casting

In every home there will be many zinc die-cast parts. The molten metal is forced into the mould or die and the machine then automatically opens and the part falls or is pushed out. The die closes and more metal is injected for the next identical part. This is a very large industry. Zinc is ideal as it melts at a low temperature compared to iron or copper. Metal toys are nearly pure zinc. Small parts in washing machines and cars are often die cast zinc. Parts of window catches, door handles, door catches, vacuum cleaners and computer printers also frequently are die-cast zinc parts. Its rival, aluminium is much lighter and stronger but is more difficult to cast.

Coins

kills the bacteria and other microscopic creatures detoxifying and eating the waste in the filter bed of the works.

Identifying zinc coated materials

If a spangle effect is visible then it is zinc. If fence wire is pale grey then it is also zinc. Safety fence (crash barrier) is grey from zinc but is often dark from road dirt or even slightly orange from underlying rust. The A55 road shows a series of examples from new to rusty. See photo 15. Buildings covered in zinc are usually a range of greys from light to dark and is often used on vertical faces. Lead, the other common metal on roofs, usually weathers a whitish grey with white streaks in parts, it is rarely used on vertical sheets as it is very weak.

Grey letters on gravestones, often dropping out, are lead or later, 1960s, resin filled.

Grey paints are sometimes used with zinc metal but mixed and these are harder to pick out. They are more common on lamp posts. Grey plastic is common on signs and posts but often shows up by peeling or cracking.

Roofing that is grey and corrugated is likely to be zinc coated and it was very common, particularly on farm buildings, when plastic was rare. See photo 13. It is still used but with high iron prices is less common. In many other countries painted steel roofs, without corrugations but with a zinc coating are very common. In one steel-making town in Poland I saw a house made of steel, the roof, walls and floor

Zinc’s relatives

Zinc has two chemical-relative metals, cadmium and mercury. In many cases, particularly in earlier times industry jumped ahead of chemistry and simply used something new without considering the chemical consequences. In other cases chemists developed a process and from inadequate knowledge at the time a later hazard had to be removed by the work of another group of chemists. Mercury was known to be a toxic metal for many years before laws were brought in to curb its uses. In zinc batteries it was added to improve performance but used batteries ended up in landfill and incinerators releasing their mercury. It was the chemist’s role to find ways to make the batteries work as well without mercury and now most are mercury free thanks to a concerted effort by industrial chemists.

Cadmium is so good at protecting iron against rust, when applied as a coating like zinc, that it would have overtaken zinc in usage. Luckily, it wasn’t as common to find deposits to mine and this kept the price higher. If it was as plentiful as zinc and was mined as much as zinc was in Flintshire much of the county would now have poisoned soil and water. The Japanese people found to their cost that cadmium is toxic when it killed more than 200 and injured many more, until about 50 years ago when it was controlled. Mines allowed cadmium contaminated mining waste to escape into the river water that was used to irrigate the rice fields. The rice picked up high levels of cadmium. For years the people complained of ‘ouch-ouch’, or Japanese ‘itai-itai’, disease, as it was so painful. Work on some of the last fields 6121(a)-3.66653(t)11.14.3252

Experiment 1. The weathering of zinc by rain

Aim: To show that zinc very slowly dissolves in acid rain

Background and methods:

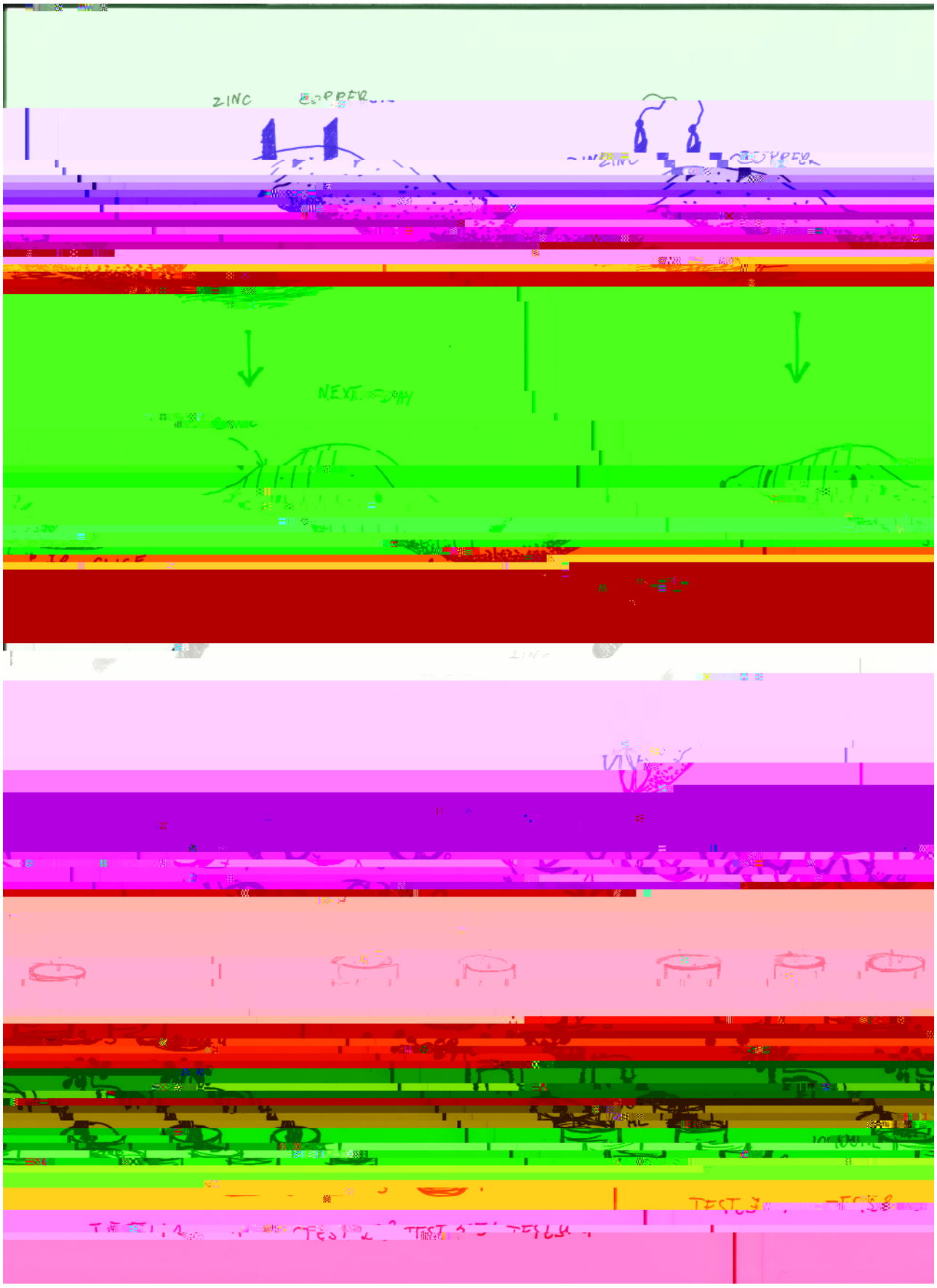
Experiment No. 2 Detecting zinc in zinc ore

How easily does zinc leach from the zinc ore, sphalerite?

Background and methods:

Sphalerite was known as ‘black jack’ to many miners as sphalerite can contain so much iron it looks a

Experiment 3. The lemon experiment


ZINC
NEXT DAY