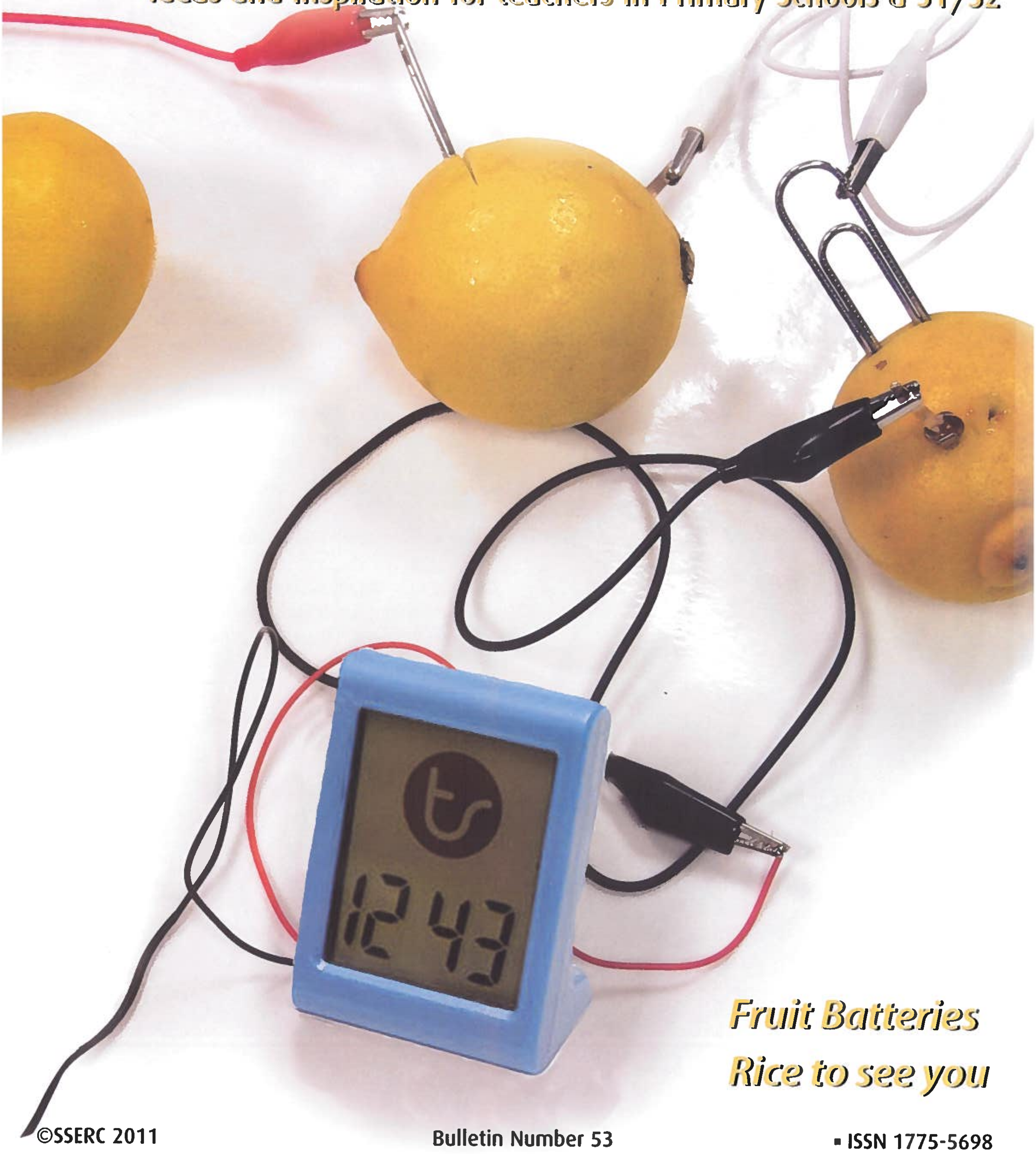
Primary Science & Technology Bulletin

Ideas and Inspiration for teachers in Primary Schools & S1/S2



Fruit Batteries

Rice to see you

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Fruit Batteries

To begin to understand how batteries work, I can help to build simple chemical cells using readily-available materials which can be used to make an appliance work **SCN 2-10a.**

Alessandro Volta built the first "battery" using copper and zinc discs and blotting paper soaked in salt solution. This arrangement became known as a voltaic pile and is easy to recreate in the classroom. You need discs of two different metals and an absorbent material that has been soaked in a suitable electrolyte (a conducting liquid). It works well with 2p coins and aluminium foil. Cut the foil and absorbent paper towel to the same size as the coins. Soak the paper towel in a salt solution (table salt will do) and build up the pile as follows: foil, towel, 2p, foil, towel 2p... It is important that if you start with foil you finish with a 2p coin and vice versa.

Figure 1 shows a variation which you may find easier to handle where the paper towel has been replaced with small packaging discs from cd and dvd packs which were soaked in salt water prior to use. (Sponge cloths also work well, as like the packaging discs, they are thicker than paper towel – they need to be cut to the same size as the coins). The layers

Figure 1 - Multimeter set to measure voltage and connected to the 'battery' of coins, foil and packaging discs.

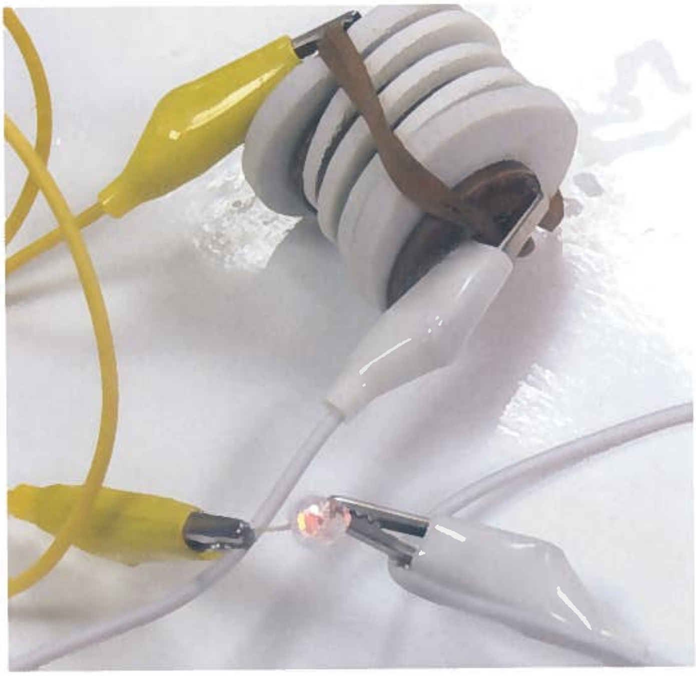


Figure 2 - The same 'battery' can be used to light an LED.

can be held together with an elastic band making it easier to attach wires and if linked to a multimeter you can measure the voltage as shown in Figure 1. The arrangement shown in Figure 1 will light an LED. (see Figure 2). If it doesn't, try connecting it round the other way.

LEDs are available from Rapid Electronics [1].

Children may already be familiar with electric circuits and will know that it is electrons which flow round the circuit, transferring energy to the bulb (or other component that they may have used) to make it work.

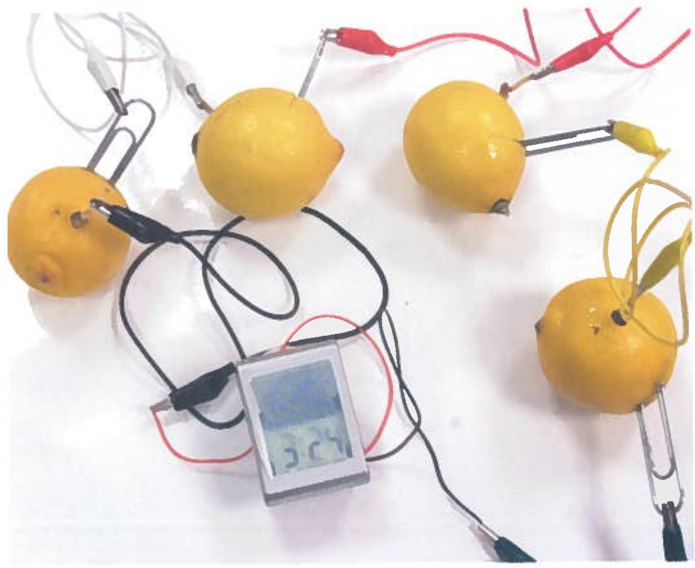


Figure 3 - A battery of four 'lemon cells' can power a wee clock.

Time for fruit and vegetables (the Lemon Clock)

One of the problems with making fruit batteries has been finding components which will work. A clock is now available from MUTR [2] with leads attached which makes it ideal for this purpose. Figure 3 shows 4 lemon cells, connected in series to make a battery, with the clock. The clock would not work with only one cell (lemon) but did work with two. In this case, we have used paper clips and brass paper fasteners instead of aluminium foil and 2p coins.

Do other combinations of everyday metal objects work? Will the clock work with other fruit or vegetables? How long will the clock continue to run?

The fruit used in these experiments must not be eaten. The metals should be cleaned with wire wool before using again to remove any deposits. (See Figure 4).

How does it work? – information for the teacher

Electrical cells/batteries are powered by chemical reactions. A reaction that gives out heat and light, like a fire, is a familiar concept. Less familiar are ones that only produce light e.g. the reactions in glow sticks. The reactions in batteries directly convert the chemical energy to electrical energy.

For the cell to produce electricity the following conditions need to be met:

1. You need two different metals as electrodes (see Figure 5).
2. There must be an electrolyte (a conducting liquid e.g. lemon juice) in contact with the two metal electrodes.
3. The electrodes must not touch each other.

The voltage produced depends on the metals used and so different pairs of metals will give different voltage readings.

The iron (paper clip) – copper pairing above (brass is mainly copper) will usually generate about 0.5 V and a few milliamps. Replacing the iron with aluminium gives you up to about 0.8 V, with zinc (a galvanized nail for instance) you get about 1.0V and with magnesium ribbon will give around 1.8 V.

Different electrolytes may also affect the process.

Batteries like these utilise what are called redox reactions, a very common type of reaction. In the battery, electrons are added to positively charged ions (cations) at the cathode (the positive electrode): this reaction is reduction. At the other electrode, the anode (which is negative), electrons are removed from negatively charged ions (anions): this reaction is oxidation. (Combine **red**uction and **ox**idation and you get redox.

The reaction taking place in the Lemon Clock here is known as Galvanic Corrosion. It is similar to the reactions happening in a Voltaic pile but with the lemon juice taking the place of the salt-soaked blotting paper.

Figure 4 - Clean metals with wire wool before you use them again. Don't eat the fruit after it has been used to make a cell.

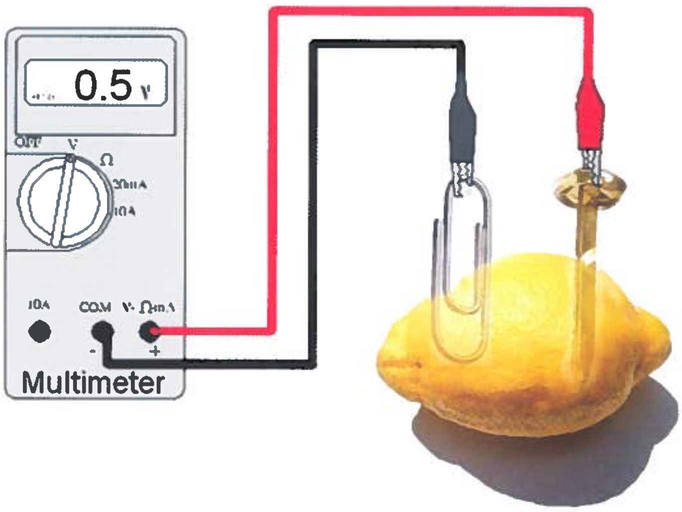


Figure 5 - Red wire to +ve socket on multimeter and brass paper fastener ('copper' electrode). Black wire to -ve socket and paper clip ('iron' electrode). The electrolyte is lemon juice.

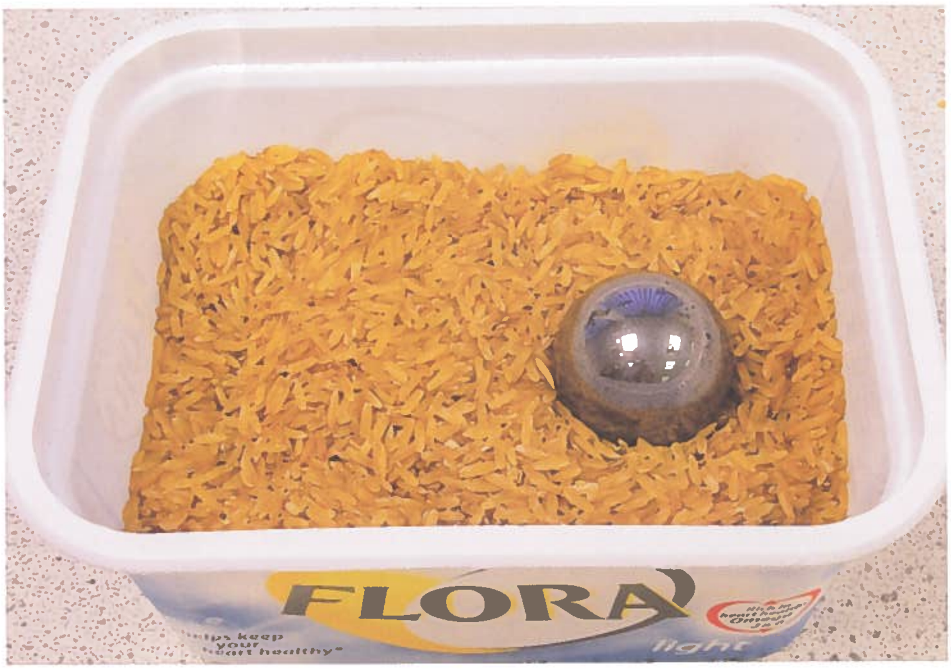
References

[1] http://www.rapidonline.com/searchresults.aspx?style=0&kw=55-2476

[2] http://www.mutr.co.uk/product_info.php?products_id=792

Rice to see you

SCN 2-08b Understanding buoyancy
By investigating floating and sinking of objects in water, I can apply my understanding of buoyancy to solve a practical challenge.



You need:
An empty margarine tub with a lid, a ping-pong ball, a solid metal ball that is roughly the same size as the ping pong ball and enough rice to half-fill the tub.

Bury the ping-pong ball in the rice but don't show the pupils that you have done this. Place the metal ball on the rice and show this to the pupils. Put the lid on the tub. Give it a shake, then take the lid off. The metal ball appears to have turned into a ping-pong ball!

How does it work?
When you shake the rice, it behaves like a liquid. The metal ball sinks and the ping-pong ball floats to the surface. This is because the metal ball is more dense than the rice and the ping-pong ball is less dense.

Something like this can happen in an earthquake. The shaking makes the soil behave like a liquid and buildings sink, undamaged, into the ground.

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