Primary Science & Technology *Bulletin*

Ideas and inspiration for teachers in Primary Schools and S1/S2

> Get set - investigations with jelly

> Battery safety

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Get set - investigations with jelly

You and your learners may well have enjoyed a trifle, or other jelly based pudding recently. When following the instructions for making up the jelly you may have noticed some interesting information. If you look at some recipes for setting fruit into jelly [1] you may see a warning about using certain fruits (Figure 1).

This raises several questions which could lead to investigations which are suitable for the primary classroom. Firstly, is it true?

At its most simple level learners could be provided with pots of set jelly and be asked to put various fruits onto the jelly. Although we used a Petri dish for our initial investigation a small amount of jelly set in the bottom of a plastic cup would also be suitable. If left for a few hours any pots to which fresh pineapple is added will not be solid. See Figure 2. Is the same true for the other fruits listed in Figure 1?

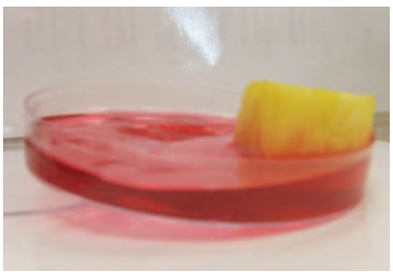

***Figure 2** - When a piece of pineapple is left on it, the jelly becomes liquid.*

Rather than putting fruit onto jelly which has already set, jelly could be poured into cups containing various fruits to see whether the setting process is affected. A cup with no added fruit should be prepared as a control. See Figure 3.

The suggestion in the recipe notes (Figure 1) was to avoid fruits with high acid content - but do the fruits listed have a high acid content? Are there other fruits with similar or higher acid content that do not stop the jelly from setting? See Table 1.

***Figure 1** - Warning not to use fruits which prevent the jelly from setting.*

The fruits which prevent the jelly from setting all contain enzymes from a group known as proteases. These enzymes break up long protein molecules.

The setting agent in jelly is gelatin, a long protein molecule, and as it cools in the jelly-making process the long strands become tangled, trapping the water and thus giving us the familiar wobbly solid we know as jelly. The gelatin used in many commercial jellies is often obtained from animal products but vegetarian jelly options are available.

In the presence of fruits which contain proteases the protein molecules in the gelatin are broken into shorter chains which are unable to trap the water and hence the jelly cannot set.

It is interesting to note that in the case of tinned pineapple the jelly has set. Researching what happens during the canning process [2] can explain this. During the process the foodstuff is heated to a very high temperature. This denatures (makes inactive) the enzyme and thus the gelatin is unaffected by tinned fruit.

By contributing to investigations into familiar changes in substances to produce other substances, I can describe how their characteristics have changed - *SCN 2-15a*.

It would appear that the non-setting of the jelly is not linked simply to the acidity of the fruit (see Figures 3 and 4).

***Figure 3** - Anti-clockwise from bottom left: Control - jelly with no added fruit (set), pineapple (not set) and raspberries (set), blueberries (set) and kiwi (not set).*

Battery safety

Figure 1 *- The usual suspects – common sizes of battery. From left to right- D Cell, C Cell, AA, AAA, PP3 and button cell.*

Fruit	pH
Kiwi	4
Lemon	2
Orange	4
Tinned pineapple	4
Pineapple	3
Raspberry	3
Blueberry	3
Kiwi	4

Table 1 *- pH of fruits used (tested at SSERC).*

Remember - the lower the pH the more acidic the item being tested. The pH of fruits may vary.

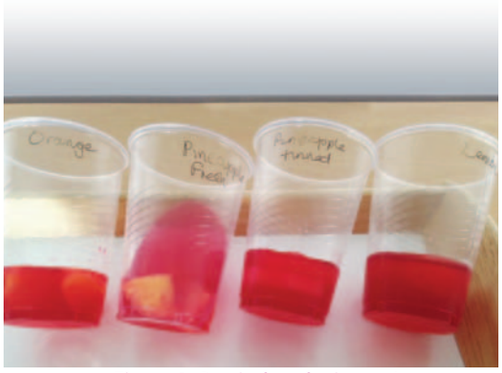

Figure 4 *- Results from further testing - orange (set), fresh pineapple (not set), tinned pineapple (set) and lemon (set).*

References

[1] http://www.kidspot.com.au/kitchen/recipes/fruit-and-jelly-cups-2330?ref=collection_view%2Cjelly-recipes (accessed March 2017).

[2] http://www.britannica.com/topic/canning-food-processing (accessed March 2017).

Pupils and students must, of course, never build circuits that run directly from mains electricity. Batteries make a safe, effective substitute, provided you follow some simple advice.

There are two significant hazards in using batteries in school:

- Swallowing a small battery.
- Severe overheating due to short circuiting.

Swallowing

This only concerns "button cell" batteries. The hazard here goes beyond choking or poisoning. There have been a significant number of cases when toddlers have swallowed button cells that have become lodged in the oesophagus. The mucus in that part of the body forms an electric circuit with the battery, creating a chemical that can cause severe internal burns. Whilst it is most likely to be younger children who put button batteries in their mouths, older ones might also do so to try to feel the tingle of a mild shock. In general, you will not use button cells in circuits at primary schools. Having said that, these batteries are used in some remote controls, novelty toys, small torches, musical birthday cards and so on. Do not let primary or nursery children have access to devices where the button battery can be removed without undoing a screw.

Overheating due to short circuits

Batteries used in circuits should be in holders (Figure 2). When children wire up circuits, some inevitably make mistakes. One type of mistake is known as a short circuit. Short circuits can be hard to spot. If you ▶

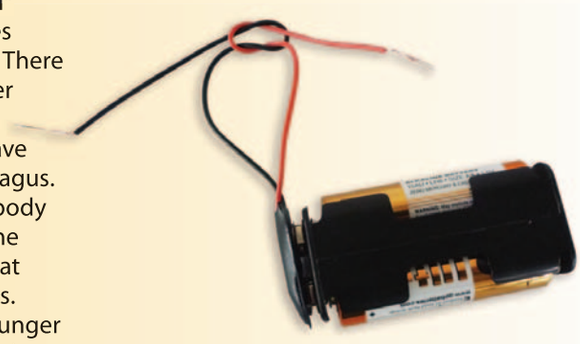

Figure 2 *- Battery holder with connecting leads tied in a reef knot to ensure that the wires do not touch while the rest of the circuit is being built.*

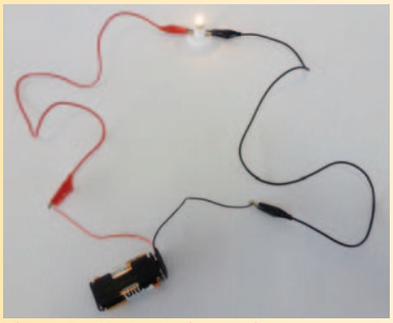

Figure 3 *- Circuit wired correctly.*

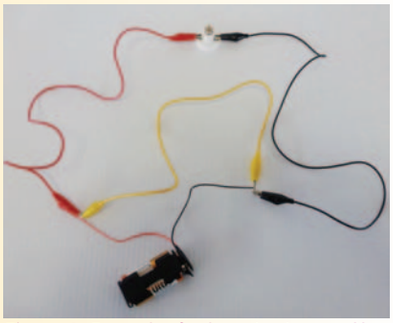

Figure 4 *- Example of a short circuit caused by the yellow wire.*

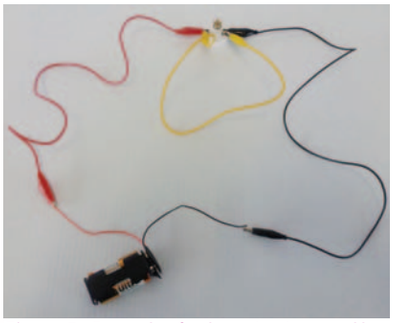

Figure 5 *- Example of a short circuit caused by the yellow wire.*

start at one end of a battery and follow around the circuit it should not be possible to get from one side to the other without going through a component such as a motor, bulb or buzzer. If there is ANY route from one side of the battery to the other that goes through only wires or switches then you have a short circuit (see circuit examples in Figures 3, 4 and 5). When learners are making up and using models, games and circuits beware of the metal parts of crocodile clips or components inadvertently touching and causing a short circuit.

The problem is that a short circuit is a very easy route for electricity to take. This causes overheating in wires and within batteries. Batteries may become dangerously hot and even burst, releasing hazardous chemicals. The battery drains quickly, but that is the least of our worries. The severity of overheating depends on the current. This is governed by the internal resistance of the battery which is determined by the battery chemistry. If there is a short circuit and the battery has a low internal resistance, then there is a much higher chance of overheating as there will be a large current in the circuit. If a battery has a high internal resistance then even if there is a short circuit the current will be smaller and the chance of overheating will be less. Rechargeable batteries have low internal resistances whereas that of zinc carbon or zinc chloride batteries is relatively high. Alkaline and lithium batteries are somewhere between. This leads us to issue the following advice:

- Do not use rechargeable batteries for circuits that pupils build.
- The best batteries to use are zinc carbon or zinc chloride.

Alkaline and lithium batteries are not as prone to dangerous overheating as rechargeable batteries, but they are not as safe as zinc chloride or zinc carbon batteries. At SSERC we always say that if there is a safer way of doing something that is not ridiculously more expensive or inconvenient, do it the safer way. Most people know not to mix old and new batteries in the same device. Do not mix battery chemistries i.e. always use batteries of the same type.

It is perfectly OK to use rechargeable, lithium and alkaline batteries in cameras, calculators etc. unless the manufacturer says not to. Use the correct charger for your batteries and be aware that some chargers are smarter than others. Basic chargers work on timers whereas smarter ones monitor battery voltage and/or temperature.

Figure 6 *- Taping batteries for safe disposal.*

Buying batteries

Buy from a reputable source. It is not always easy to work out whether a battery is, say, zinc carbon rather than alkaline. Beware of batteries that are the same size as AAA or AAs but are higher voltage, for example the 14500 battery used in e-cigarettes. This type of battery can have a voltage of 3.7 V.

Storing and disposing of batteries

If equipment is not to be used for some time, remove the batteries to prevent leakage. Do not open battery packs until you need the batteries. Be careful how you store loose batteries or batteries in holders. Could a piece of metal (or another battery) cause a short circuit? As you should not throw batteries out with normal rubbish, most schools will have a battery bin. There are collection points for used batteries in some shops and at civic amenity waste sites. If disposing of batteries, tape over the terminals before putting them in the battery bin. Examples are shown in Figure 6. Keep the bin out of reach of small children.

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