SSERC Bulletin

No. 232 ▪ Summer 2010

Ideas and Inspiration supporting Science & Technology for all Local Authorities

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ISSN 1759-1082

Brine shrimps - the lowdown

Brine shrimps (*Artemia*) are amazing little salt lake creatures that can light up a classroom and provide, with little maintenance, an opportunity for live animals to be kept in schools.

At SSERC we started our brine shrimp population when we received the Wellcome Trust *Survival Rivals* free experiment box *Brine Date* [1]. Our shrimps flourished and we ran workshops to try and help teachers and technicians to get the most out of the practical in the classroom. Through the workshops and also feedback from teachers on other courses we found out that some schools were having trouble maintaining their brine shrimps or had not yet been able to set up a tank.

This article offers some suggestions and information for technicians and teachers to maximise the populations of brine shrimps in school. Although the basic information given in the Brine Date box is very useful and the set up information is easy to follow, we present a few extra hints and tips to ensure the brine shrimp tank is kept in prime condition.

Maintain a food source for your brine shrimps

Dunaliella salina is the algae used in this kit and it can be grown up simply on the window sill. You will need a starter culture of the algae, available from Sciento www.sciento.co.uk, (*A115 Dunaliella salina* from £6.85 plus p+p) or you can get replacement algae from Philip Harris www.philipharris.co.uk (Product Code *B8R03075* £12.95 plus VAT and p+p). We found that the algae grow best in *Marine Algae* culture media, also available from Sciento (*K13 Marine Algae Medium* £6.20 plus p+p). Using this you can be flexible in the feeding regime, grow up algae continuously, then subculture and retain for future use. We found the algae grew best on the window sill and lasted around a month or so before needing to be sub-cultured on to new media (40 cm^3 algae to 200 cm^3 marine algae media). The brine shrimps should be fed around 40 cm^3 algae per week. As a rough guide, only add algae until a light green tinge appears in the tank (Figure 1). If too much is added you may get an algal bloom which can kill the shrimps. You can easily take samples from your tank to check quality and quantity of algae under the microscope. We have also used another algae *Tetraselmis suecica*, available from Sciento (*A324* £6.85 plus p+p) to feed the brine shrimps which grew well under the conditions described above. If you do not have the resources or time to maintain algal cultures you could feed the brine shrimps solid food such as Mikrozell (follow feeding instructions carefully).

Figure 1 *- Brine shrimp tank with a hint of algae growing.*

Stir tank at least once a week

Stirring the tank helps re-circulate nutrients which fall to the bottom, dislodge algae which have settled on the sides and bottom and helps to aerate the tank. The tank looks a bit murky after this but soon clears after the feeding frenzy.

Keep a constant temperature under a light-bank to ensure population growth

The brine shrimps prefer a constant temperature and this can be easily maintained by placing the tank under a light-bank (Figure 2). The optimum temperature is around 22-30°C which allows the brine shrimp population to flourish. By keeping the temperature above 25°C you can ensure fast life cycles and maximum populations [2]. The distance between the lamp and the tank can be easily adjusted to increase or decrease the temperature. Our tank is at 23°C in the winter and 26°C at other times and the brine shrimps have been very productive at these temperatures.

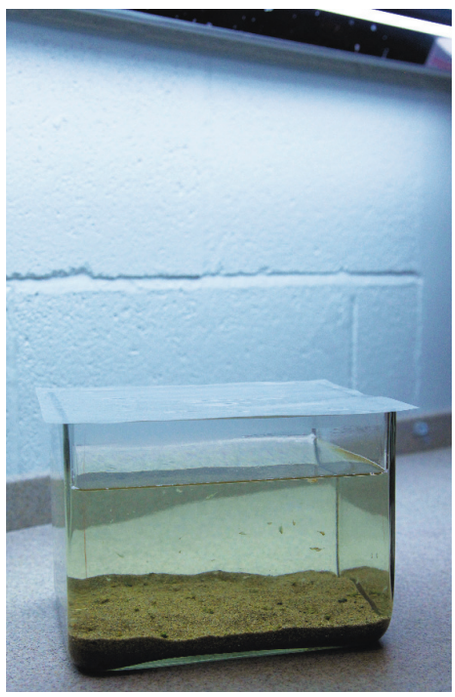


Figure 2 *- Tank under a light bank*

Put a lid on the tank

A clear lid (Figure 3) will prevent evaporation under the warm light-bank and stops unwanted visitors getting into your tank. An A3 laminating sheet put through the laminator makes a very simple but effective lid. If the tank has no lid there will be a considerable amount of evaporation, which will affect temperature and salinity. Do not top up with new sea water as this will increase the salinity. In the case of water lost through evaporation just add distilled or chlorine free water to the tank as the salt is still dissolved in the remaining water.

Figure 3 *- Use a lid on the tank.*

Brine shrimps - the lowdown

Making the most of Brilliant Brine Shrimps in the classroom

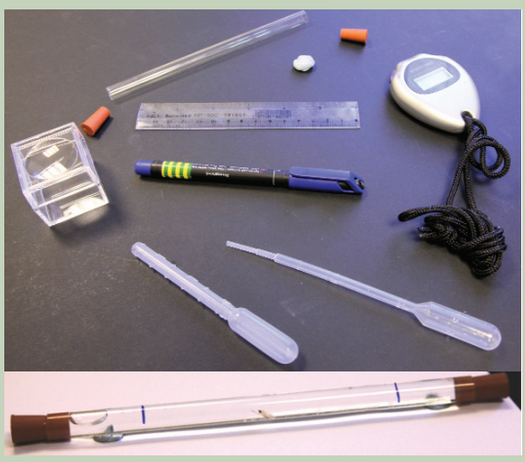
Brine Date - sexual selection in action	Brine shrimp Bottle Ecosystem	Speedy shrimps - how fast can they go?
		
This experiment was inspired by Darwin and developed by Wellcome to celebrate Darwin 200.	Create a complete mini-ecosystem in a bottle and investigate food chains, population cycles and nutrient cycling.	A novel way to learn about measuring speed and developing investigation skills, while finding out if all shrimps are equal?
Free, downloadable resources: www.survivalrivals.org (includes instructions)	Free, downloadable resources: www.science3-18.org (search for "brine shrimps")	Free, downloadable resources: www.science3-18.org (search for "speedy shrimps")

Table 1 *- Brine shrimps can be used for many excellent practical activities. Follow the links for more details. Each practical is referenced to CfE experiences and outcomes.*

Clean out the tank

We have only had to completely clean out the tank once so far (after six months of operation) as the brine shrimps were feeding on the sludge that had built up at the base of the tank. The sludge was getting caught between their legs this was stopping them from feeding and moving, and it caused their eventual demise. Overfeeding and lack of attention had caused this, so beware of this happening to you. To clean the tank, remove some of the tank water and put it in a large beaker. Rescue all the remaining shrimps by using a fine tea strainer and place them in the beaker, strain the rest of tank water and remove debris. Wash the shell and sand thoroughly before re-introducing water and the surviving shrimps. If necessary add some freshly-made seawater to top up the tank.

If your school does not have the Survival Rivals Brine Date kit, there are plenty of options available to start up a brine shrimp tank from scratch. Eggs and marine salt can be bought from a local aquarium shop and Sciento stock a Brine Shrimp Kit (*ZK19 Biobred Brine Shrimp Culture Kit* for £22.60 plus p+p [3]). This Biobred kit comes with comprehensive instructions and everything you need (apart from a tank) to get your brine shrimps going.

The method is slightly different from the Brine Date instructions, but this is a great kit for the money. Also, if you need an instant supply of brine shrimps Sciento sell them in a tub with enough algae to feed them for a week (*Z175 Artemia salina* adult brine shrimps ca. 100 for £10.85 plus p+p). This population could also be used to start off a long term population.

Rock Salt Solution

Finally a tip from an expert whom we have worked with closely over the years - John Watson from Strathclyde University's Faculty of Education, who has developed working protocols for Brine Shrimp cultures. He has been working with Saxa "Rock Salt" as an alternative to the expensive synthetic sea salts and found that his populations are thriving in this 'additive-free' salt water. To read John's full protocol see our www.science3-18.org website (search for "brine shrimps protocol"). Thanks to John for all his help and support with brine shrimp cultures and sharing his ideas with us.

Sources of brine shrimps and equipment

All information on "Brine Date" downloadable from www.survivalrivals.org, well worth looking at.

"Brine Date" Kit available from Philip Harris www.philipharris.co.uk (product code B8R02980 £49.95 plus VAT and p+p)

Brine Shrimp Kit, algae and media available from www.sciento.co.uk.

Antioxidants: Tastes good, good for you?

Introduction

Our bodies contain billions of molecular cells that are joined together by bonds. When these bonds are broken the cells transform into harmful free radicals. Although this happens naturally in our metabolic systems it is thought that environmental factors such as pollution, stress and lack of sleep can increase the concentration of free radicals in our bodies.

These free radicals are unstable and will attack healthy molecular cells which will in turn produce even more free radicals. This chain reaction is known as oxidative stress and is thought to contribute to arthritis, premature aging, hardening of the arteries and increase the risk of cancer.

Antioxidants help to stop this chain reaction by donating their electrons to free radicals without themselves being converted into more free radicals. This is known as the oxygen radical absorbance capacity (ORAC) test. Foods can be placed in order of their ORAC rating. The larger the number the more able the antioxidants is to stop the oxidative stress of the molecular cells. [1]

This would indicate eating more of these foods would improve our health and well being and it has been reported some 40% of women and 30% of men are taking these supplements and spending over £333 million per year on them. However studies involving 230,000 women and men in 67 cases have shown that there is no convincing proof that antioxidants can make you healthier. [2]

The following practical investigation can engage pupils in the research and discussion of media items with regard to the so called “superfoods" in healthy diets and their subsequent impact on modern life.

It can be linked to the following experiences and outcomes from The Sciences in a Curriculum for Excellence : -

Local aquariums will stock brine shrimp eggs, Mikrozell, aquarium tanks and pumps and marine salt or are available online from reputable stores.

Light banks can be purchased from www.progrow.co.uk T5 Light Wave 54 W Four Tube (20000 lumen, L = 1200 mm, W = 350 mm, D = 60 mm) Ref. 4265 - £125.01 plus VAT and p+p), and www.blades-bio.co.uk Plant Grow Lighting System 55 W Four Double Tube (L = 600 mm W = 320 mm D = 100 mm, product code ACS300 £140 plus VAT and p+p).

Local DIY superstores and IKEA will stock desk lamps for illumination and clear plastic boxes which could be used as tanks.

Top tips on maintaining your populations

- Feed regularly - as described above. Maintain water temperature between 25°C - 30°C - maximises population, preferably under a light bank.
- Stir tank regularly to help circulate the nutrients and aerate the tank.
- In general, it is a case of setting up your brine shrimp system following these guidelines, but it may take a little trial and error to get a system that suits your particular school and resources available. Please get in touch with us if you have any problems with setting up your brine shrimp system.

For further information contact gordon.moore@sserc.org.uk

‘Brine shrimp bottle ecosystem’ and *‘Speedy shrimps’* are adapted from the book *Brine Shrimp Ecology* by Michael Dockery and Stephen Tomkins.

This book is full of excellent ideas for brine shrimp practicals and can be downloaded free. [4]

References

1] - www.survivalrivals.org

[2] - Brine Shrimp Ecology (2000) Dockery, M., Tomkins, S, published by the British Ecological Society. This is free to download from - http://www.britishecologicalsociety.org/educational/brine_shrimp/index.php

[3] - http://www.sciento.co.uk/catalog/item/515/

[4] - http://www.britishecologicalsociety.org/educational/brine_shrimp/index.php

Antioxidants: Tastes good, good for you?

Materials - Earth's materials - Extracting useful substances - **SCN 3-17b** - I can participate in practical activities to extract useful substances from natural resources.

Topical science - Innovative research & development - **SCN 3-20a** - I have collaborated with others to find and present information on how scientists from Scotland and beyond have contributed to innovative research and development.

Topical science - Science in the media - **SCN 3-20b** - Through research and discussion, I have contributed to evaluations of media items with regard to scientific content and ethical implications.

Topical science - Current & future developments - **SCN 4-20a** - have researched new developments in science and can explain how their current or future applications might impact on modern life.

Materials - Properties & uses of substances - Researching novel materials - **SCN 4-16a** - I have carried out research into novel materials and can begin to explain the scientific basis of their properties and discuss the possible impacts they may have on society.

It is likely to feature as one of the areas in the new Higher Chemistry course.

Practical Investigation

It is possible to determine the relative levels of antioxidants present in everyday foods and drinks using the Briggs-Rauscher reaction. [3] This reaction is very complex and involves iodide ions and iodine molecules. It is thought that the colourless solution arises when I_2 is low and I^- is high; it is yellow when I_2 is high and I^- is low; and blue when I_2 and I^- concentrations are high (when both are high they form pentaiodide ions which give the blue complex with starch). The changes in the relative concentrations of the I_2 and I^- are brought about by the species hydrogenoxyiodide (HOI). As its concentration rises and falls, it triggers oscillations in the I^- and I_2 concentrations.

For this practical, 5 cm^3 of solution A (0.2M potassium iodate and 0.07M sulphuric acid) is added to 5 cm^3 of solution B (0.15M malonic acid and 0.2M manganese sulphate) in a 100 cm^3 beaker and placed on a magnetic stirrer. This is switched on and 5 cm^3 of solution C (4M hydrogen peroxide) is added to the beaker. When the sudden blue colour appears for the second time the clock is started and is stopped when it re appears for the third time. This can be seen in Figures 1 to 5. This is repeated a further two times and the average time is calculated. The average time is now the reference sample.

The experiment can then be repeated with the addition of 1.5 cm^3 of the food sample with a Pasteur pipette to the mixture of the three solutions. The preparation of the samples requires one gram to be weighed, crushed and diluted with 100 cm^3 of distilled water. This is then filtered to remove any excess solid. A Pasteur pipette is used to place 1.5 cm^3 of the sample into the 3 solution upon the second appearance of the sudden blue colour. This is repeated a further two times and the average time is calculated. The antioxidants in the food will delay the colour cycle, thus giving a greater the time interval meaning there is a relatively higher the level of antioxidant in the food.

The average times for the reference and food samples are then plotted as a bar graph (see Figures 6 and 7).

Beware of any food allergies when preparing the food samples.

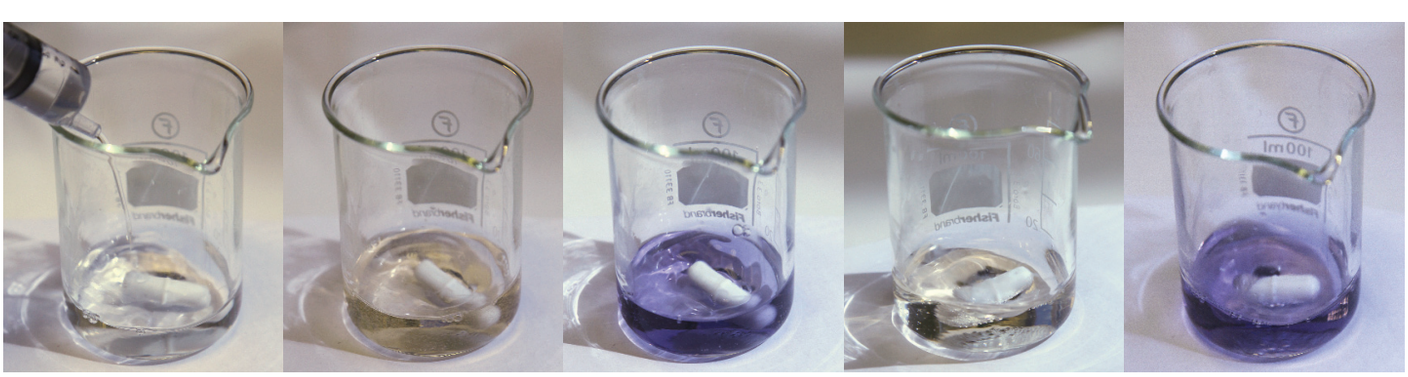
Foods recognised to be high in antioxidants

Small red beans (dried), red kidney beans, pinto beans, cranberries, artichokes, blackberries, prunes, raspberries, strawberries, Red Delicious apples, Granny Smith apples, pecans, sweet cherries, black plums, Russet potatoes, black beans (dried), plums or Gala apples. Most of these can be found in your local supermarket.

Specimen answers for superfoods

NOTE – not all these foods have been tested and some will require prior testing before using with the pupils to ensure completion of the practical within your allocated time. It may be necessary to further dilute food samples.

e.g. Compared to the foods tested in Table 1, tea samples in Table 2 had to be diluted 100 fold in order to give a viable time for completion of the experiment.



Figures 1-5 *- The colour cycle.*

Type of Superfood	Time 1 (s)	Time 2 (s)	Time 3 (s)	Average Time (s)
Reference Sample	48	62	58	56
Carrots	73	70	77	73
Raisins	80	85	81	82
Cranberry Juice	99	100	96	98
Blueberries	289	296	227	271

Table 1 *- Typical results for 'superfoods'.*

For example blueberries shows the highest relative levels of antioxidants as the colour cycle took 271 seconds compared to the reference sample of 56 seconds (Figure 6).

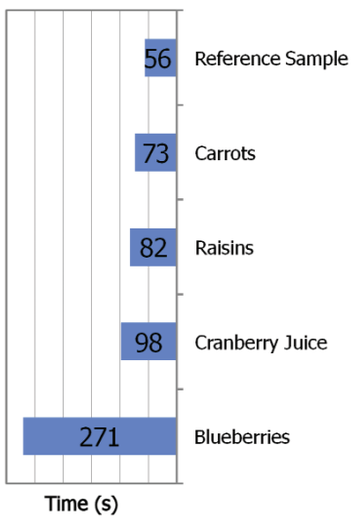


Figure 6 *- Bar graph results from Table 1*

Specimen answers for tea leaves

Type of Tea	Time 1 (s)	Time 2 (s)	Time 3 (s)	Average Time (s)
Reference Sample	40	45	49	45
Sweet Cranberry	66	69	68	68
Assam	67	75	72	71
Aromatic Earl Grey	80	77	79	79
Pure Camomile	86	84	80	83
Peppermint Punch	83	83	87	84
Tea	98	103	95	99
Green Tea Lemon	116	102	102	107
Classic Traditional English	132	116	112	123
Pure Peppermint	171	168	168	169

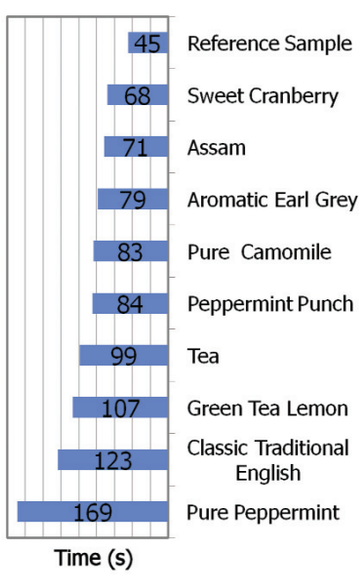


Figure 7 *- Bar graph results from Table 2*

For example Aromatic Earl Grey shows a mid range of relative levels of antioxidants as the colour cycle took 79 seconds compared to the reference sample of 45 seconds (Figure 7).

After the reactions have oscillated back and forth the solution remains as a blue-black mixture with the smell of iodine. Occasionally some purple fumes of iodine can be seen (HARMFUL & DANGEROUS FOR THE ENVIRONMENT). Therefore work in a well-ventilated area. Care should therefore be taken if the demonstration is scaled up to volumes using litres – work in a fume cupboard.

For further information on the experimental technique and on safety and disposal, contact SSERC, (andrew.boswell@sserc.org.uk)

References

[1] http://www.youtube.com/watch?v=fTBz9ipkWhE
[2] http://onlinelibrary.wiley.com/o/cochrane/clsysrev/articles/CD007176/frame.html
[3] T.S. Briggs and W.C. Rausher, Journal of Chemical Education, "An Oscillating Iodine Clock", July 1973, Ed 50, p 496. (Original paper) http://www.chem.leeds.ac.uk/delights/texts/expt_11.html (detailed descriptor of stages of reaction)

Security and safety for air travel using millimetre waves

In order for pupils to be able to make a decision about whether they agree with the use of whole body scanners at airports or not they need to be informed about the properties of millimetre waves [1]. SSERC recently hosted part two of their Physics Residential course and were delighted to welcome Dave McFarlane (photo opposite) from the *Millimetre Wave Group* [2] at St Andrews University to update teachers on their knowledge of mm waves and their uses. Dave gave a well illustrated talk; he introduced it by looking at uses of radiations in the electromagnetic (EM) spectrum and had an infrared imaging camera which everyone enjoyed using. Having identified where mm waves are in the EM spectrum he then gave demonstrations of their use in radar speed guns using their radar Doppler unit and in imaging using their room-imaging radar equipment. The radar imaged the lab and much fun was had looking at the movement of people on the whiteboard (Figure 1).

We were delighted to learn the mm wave outreach group have been funded for a further two and a half years from October of this year. If you are interested in having a school visit from the outreach programme, either a talk or workshop, or would like to visit the department at St Andrews University, email Dave at dgm5@st-and.ac.uk

With whole body scanners being in the news there are media articles pupils could evaluate, thus addressing the experience and outcome from The Sciences in a Curriculum for Excellence - Topical science - Science in the media: *Through research and discussion, I have contributed to evaluations of media items with regard to scientific content and ethical implications.* ***SCN 3-20b***
Another St. Andrews application of mm wave technology, and no doubt much in demand given recent events, is the All-weather Volcano Topography Imaging Sensor (AVTIS) [3]. They describe some of the problems involved in observing an active volcano thus:

Figure 1 *- Dr David McFarlane demonstrates the room-imaging radar.*

Figure 2 *- Icelandic volcano Eyjafjallajökull [4].*

"Watching to see how a volcano changes might seem like a simple thing to do, but most volcanoes are usually covered in cloud making it really difficult to see what is happening. Sometimes months can go by without a good view. Even when the weather is clear gas and smoke obscure the most active parts of the volcano in exactly the places that scientists need to look if they are going to try and tell what is going to happen next. AVTIS was built to look at the volcanic lava dome on the Caribbean island of Montserrat. Since mm waves pass right through cloud, gas and smoke, AVTIS can see what is happening all of the time. This is really important if you are trying to predict when the volcano might explode. The idea with AVTIS is to measure exactly where activity is greatest on the lava dome surface and help predict where new explosions might happen".

Figure 3 *- Imaging the Monteserrat volcano with AVTIS*

If *Hekla*, Iceland's most active volcano erupts in sympathy with its near neighbour, *Eyjafjallajökull*, the research into the technology needed for full-body mm wave scanners at airports may well have to be redirected into more devices like AVTIS.

References

[1] http://www.st-andrews.ac.uk/~mmwave/mmwave/what.html
[2] http://www.st-andrews.ac.uk/~mmwave/mmwave/index.html
[3] http://www.vision4thefuture.org/s4_resources/files_avtis/r_avtis.htm
[4] http://commons.wikimedia.org/wiki/File:Eyjafjallajokull-April-17.JPG

Dave McFarlane from the Millimetre Wave Group [2] at St Andrews University

CPD - Leading for Excellence in Science

Leading for Excellence in Science is SSERC's response to supporting those with leadership responsibilities for science education in secondary schools. Current and ongoing changes to the science curriculum in schools and changes to management structures in schools have resulted in a continued demand for such support from practitioners and recognition of its importance from a number of stakeholders.

Leading for Excellence in Science is aimed at all of those who have, or aspire to have, responsibility for leading science education in their establishments. Those with responsibility for science now form a diverse group including Heads of Faculty, Principal Teachers (Curriculum) of combinations of science and other subjects, Principal Teachers of Biology, Chemistry or Physics and Class Teachers with assigned responsibilities in science education. SSERC aims to support all of these in their leadership roles.

The first phase of support is the SSERC publication *The Excellent Science Department – A Guide to Self-evaluation and Leadership,* written by Jim Stafford. This booklet, published in 2007, has been distributed on the basis of five copies to every school in Scotland that is a member of SSERC. The publication is designed as a free standing point of reference on key aspects of leading a science department and includes sections on leadership qualities and skills, the curriculum, resource management, health and safety, self evaluation and planning for improvement.

The next phase of support is the training course *Leading for Excellence in Science*. This residential CPD course is in two parts, an initial four days followed by a recall of two days after a gap of around four months. During the gap between the two parts of the course, participants are expected to carry out an action research, management or similar task and share the outcomes of their task with fellow participants during the second part of the course. The course is coordinated and organised by staff from SSERC and delivered by nationally recognised experts in their fields. Where the course includes generic leadership skills in addition to specific development issues and management responsibilities in science these are developed in science specific contexts. The course includes topics such as:

- Curriculum and course development issues with particular reference to Curriculum for Excellence
- Areas for development highlighted in the HMIe Report *Science: A portrait of current practice in Scottish schools* [1]
- Improving learning and teaching through self evaluation
- Managing science health and safety issues
- Addressing science department/ faculty management issues and policy development
- Leading teams and managing change

Course participants are provided with a variety of supporting publications and resources as well as on-going access to advice both during and once the course has been completed. Participants can also access a further two day course designed to allow them to share their progress and refine their leadership skills around 12 months after completion of the second part of the *Leading for Excellence in Science* course.

SSERC continues to pursue sources of funding from partner organisations so that such courses can be offered at little or no cost to schools. At present, through funding from the Scottish Government (Support for Scottish Science Education through CPD Project) and from the National Science Learning Centre (ENTHUSE Project), funding is available to reimburse schools for the course fees and to provide a small amount of money to support follow up work in schools. In addition, participants are eligible to submit their gap task action plans for consideration for a Rolls Royce Science Prize of £1,000 or more to spend on science teaching in their schools. The first course run under this funding regime has already produced one recipient of a £1,000 Rolls Royce Science prize [2] who will now go forward to further stages of the prize scheme where further additional prizes of £5,000, £10,000 and £15,000 can be awarded.

Course evaluations have shown that almost all participants rated the course sessions *very useful* or *useful* and considered it highly likely that they would use the information gained from the courses in their current post. Particularly pleasing were evaluations

New Teltron equipment

Here we look at four of the latest Teltron Tubes for use in the physics laboratory: the Perrin Tube, Thomson Tube, Electron Diffraction Tube and the Dual Beam Tube.

All the tubes examined incorporate electron-gun assemblies contained within an evacuated clear glass bulb.

This new breed of tube can be mounted in a universal tube holder set at an angle, unlike the older ones. This new style holder (Figure 1) allows for easy access to the tube connections using five built-in 4 mm sockets at the rear of the neck brace. The cathode in each tube can be heated either directly or indirectly. Like the anode, it is in the form of a cylinder. A filament protection circuit is integrated into the neck brace to prevent excess voltage being applied to the cathode heater circuit. The base of the holder has a guide slot built in for attaching Helmholtz coils at distances varying from 68 mm to 150 mm apart. An auxiliary coil can also be inserted into the stepped front of the holder in an axial configuration.

A table summarising the experiments that can be performed with each tube can be found at the end of this article.

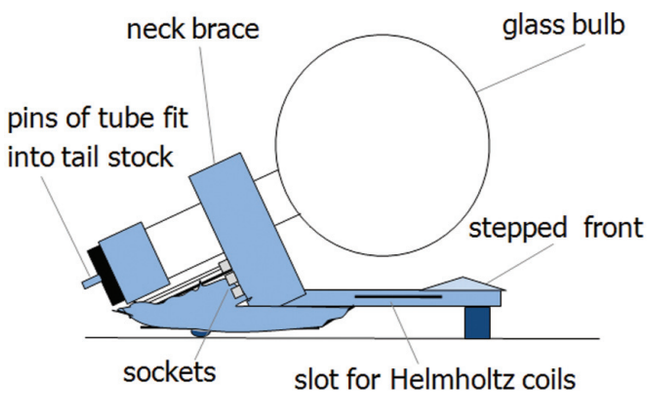


Figure 1 *- Teltron Tube in new-style holder.*

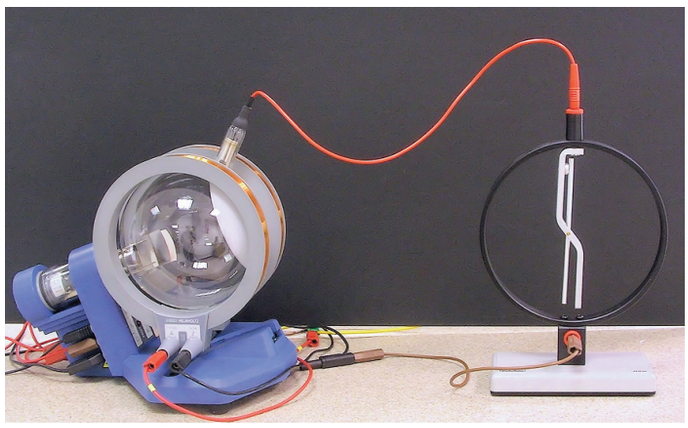


Figure 2 *- Perrin Tube attached to electroscope*

Perrin Tube

Description: In this tube, electrons emitted by the gun form a narrow beam of circular cross section which produces a spot on a fluorescent screen coating the end of the tube. A small glass tube with a Faraday cage is set on the top of the glass bulb at an angle of about 45^{o} to the undeflected beam. The electron beam can be deflected into the Faraday cage electromagnetically by means of Helmhotz coils. Lissajous Figures can be produced on the fluorescent screen by deflecting the beam in two perpendicular planes, either with two sets of Helmholtz coils, or one coil set plus electrostatic deflection with the small plates near the anode.

Thomson Tube

Description: In this tube, the deflection of the electron beam can be achieved either electrostatically by means of built-in parallel plates or electromagnetically by using the Helmholtz coils. The beam is intercepted by a flat mica sheet. One side of this is coated with a fluorescent screen. The other side is printed with a millimetre graticule so that the path of the electrons can

where participants commented that the course had given them the confidence to tackle challenging leadership issues and the high value they placed in learning from other participants' experiences in addition to the sessions provided by nationally recognised experts.

In addition an independent evaluation by the Scottish Centre for Research in Education (SCRE) [3], a requirement of Scottish Government funding, commented that overall SSERC CPD has had a substantial impact on many CPD participants and, perhaps more importantly, has also been translated into changes in the practice of many teachers.

Currently applications are being accepted for a *Leading for Excellence in Science* course on 21st to 24th November 2010 and 17th to 18th March 2011 (closing date - 17th September 2010).

Application forms are available from: sheila.maclellan@sserc.org.uk and a draft programme is available on the Science3-18.org website [4].

References

[1] - http://tinyurl.com/Science-Portrait
[2] - http://science.rolls-royce.com/award_winners/finalists_2009-10/
[3] - http://tinyurl.com/CPD-evaluation
[4] - http://tinyurl.com/Leading-for-Excellence

New Teltron equipment

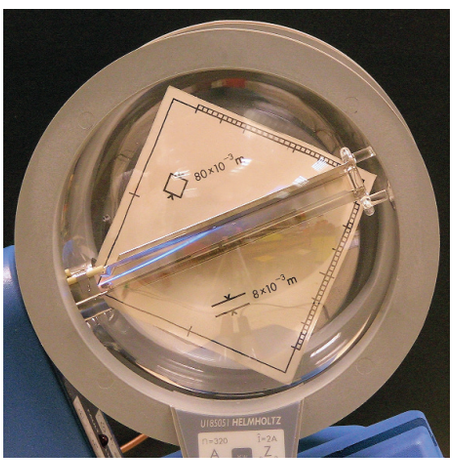


Figure 3 *- Thomson Tube.*

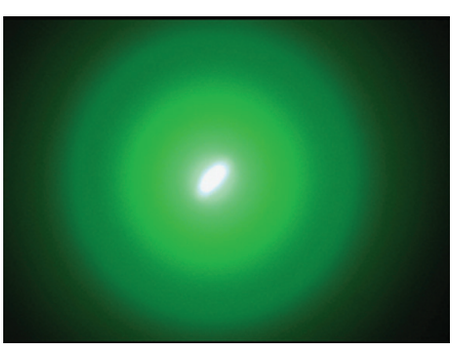


Figure 4 *- Display from Electron Diffraction Tube.*

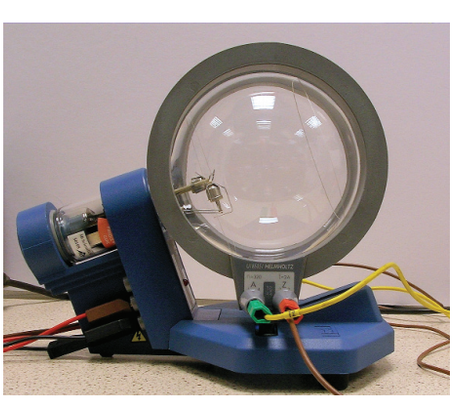


Figure 5 *- Dual Beam Tube.*

be easily traced and the radius of curvature measured. In a separate experiment, by applying a high voltage to the deflection plates and suitably adjusting the current flowing in the Helmholtz coils, it is possible to cancel out the deflection produced by each field.

Electron Diffraction Tube

Description: In this apparatus, electrons emitted by the heated cathode are constrained to a narrow beam by an aperture and are then focused by means of an electron-optical system. The resulting tight electron beam passes through a micro-mesh nickel grating situated at the aperture of the gun. Onto this grid a thin layer of polycrystalline graphitised carbon has been deposited by vaporisation. This layer affects the electrons in the beam much like a grating. As a result of diffraction, an interference pattern, comprising of two concentric rings, is formed on the fluorescent screen. The undeflected electron beam continues to be visible at the centre of the rings. Decreasing the anode voltage makes the rings appear wider apart, supporting de Broglie's postulate that wavelength increases as momentum is reduced.

Dual Beam Tube

Description: The Dual Beam Tube has two electron guns - axial and perpendicular. The tube is filled with helium at low pressure. A common deflector plate is provided for both guns. The electron beam source is an oxide cathode heated indirectly via a heating coil. The electron paths show up as a fine, slightly greenish beam due to impact excitation of helium atoms in the

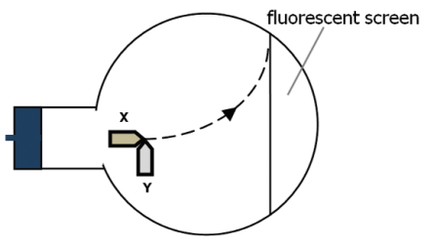


Figure 6 *- Using axial gun X.*

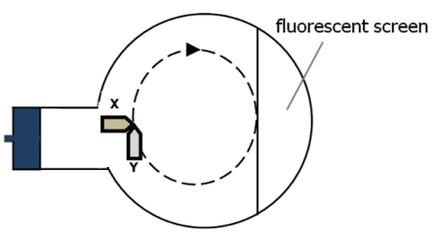


Figure 7 *- Using perpendicular gun Y.*

tube. The specific charge *e/m* of the electron can be determined from measurements of the curved path produced when either of the electron beams (from axial or perpendicular gun) passes at right angles through the magnetic field generated between the Helmholtz coils (Figures 6 and 7).

Other Possible Uses. These experiments could be used to support the teaching of magnetic and electrostatic electron deflection in the Electrical Phenomena unit at Advanced Higher Physics level and of particle accelerator studies in the new Higher Physics course. They could also form the basis for an Advanced Higher investigation. Advice on safety issues with Teltron Tubes can be found in SSERC Bulletin 208 [1].

Tube	Experiments which can be performed
Perrin	Evidence for particulate nature of cathode rays; estimation of *e/m* ; demonstration of Lissajous Figures.
Thomson	Estimation of *e/m* by means of magnetic deflection or by field compensation; determination of electron velocity.
Electron Diffraction	Support for de Broglie's postulate; estimation of the wavelength of moving electrons.
Dual Beam	Estimation of *e/m* using two different methods, one using the axial beam, the other using the perpendicular beam; studying the helical path of electrons.

Reference

[1] http://tinyurl.com/teltron

Ultrasonic welding of plastics

In 1960, Sonobond Ultrasonics Co. (USA) developed the first ultrasonic welding machine suitable for joining metals in the aircraft industry. The use of ultrasonic welding has since spread throughout a variety of manufacturing areas, for example, packaging, medical, aerospace, automotive, toy, computer and electrical industries. Ultrasonic welding can join many materials, for example, small welds in copper, nickel and aluminium, but is most often used for joining plastics and is particularly efficient when joining dissimilar materials.

Today, ultrasonic welders which can spot weld and seam weld any plastic material in seconds are just becoming available for educational use.

Ultrasonic welding of plastics involves holding two plastic surfaces under pressure between an anvil and a sonotrode (Figure 1). The latter applies mechanical vibrations to the weld area. Ultrasonic frequencies between 15 – 70 kHz are used. Welding is due to local melting as a result of absorbed vibration energy. Ideally, both pieces to be welded should have close/similar melting points. Because the energy transferred and the heat released across the weld is constant, the weld quality is very uniform.

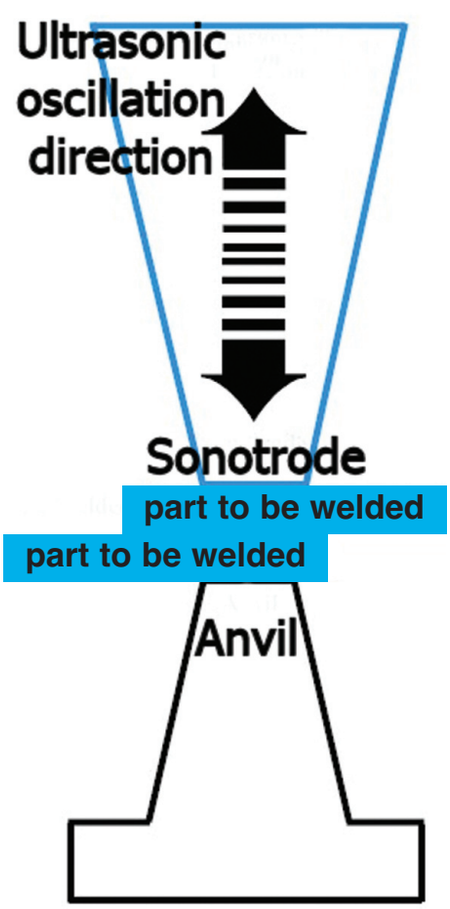


Figure 1 *- cross section of an ultrasonic welder*

Figure 2 *- The Solar-Sonic Ultrasonic Welder*

Notice in Figure 1 when welding plastics, the direction of vibration is vertical (90°) to the plastic surface, for welding metals the direction of vibration is parallel to the metal's surface. Hence, sonotrode design for metal welding is different from that required in plastic welding. Materials which are too thick will not weld. Ultrasonic welding is a fast method of joining materials which can also be easily automated. Weld times, typically of a few seconds or less require no LEV (local exhaust ventilation system).The anvil's shape determines the size and shape of the weld.

The Solar-Sonic ultrasonic welder illustrated in Figure 2 was designed specifically for use in educational establishments. It operates at around 35 kHz and the arm allows for welding of material up to 300 mm long.

Unfortunately, at present to set up ultrasonic welding in a school department would cost typically £2950 + VAT, that's including educational discount! Cost represents the complexity of the electronics and other systems within the sonotrode. Great technology! but currently an item for our 'dream on' list! until at least, the price becomes affordable to educational establishments.

Useful Websites:

www.solarlasers.co.uk
www.solar-imaging.com

Laboratory taps and backflow

The Water Regulatory Advisory Scheme (WRAS), which is the UK water industry's approval scheme, has recently issued further comments on laboratory taps.

The issue, for those who have missed previous debate, is concern over the potential for backflow into these taps, leading to contamination of the water supply.

The design of laboratory taps in general is fine, as the gap between the tap and the sink is above the minimum distance required to prevent backflow (300 mm). The problem comes with the fairly commonplace practice of having hoses attached to the taps, which can be constricted, or in some other way compromise backflow prevention.

Scottish Water companies are now advised to "require alternative means of backflow prevention at the point of use in premises", where concerns are identified.

If the taps in your labs are fed from a header tank or you have a new lab with compliant backflow prevention installed (check with your Local Authority/Management Company to be sure) then you do not have a problem.

If your labs do **not** meet the criteria outlined above, i.e. do not have backflow prevention that complies with current regulations, SSERC has the following advice:-

- Make sure that any hose outlet is **above** the level of the overflow in the sink (Figure 1). Only attach hoses to the taps when specifically required and remove them at the end of the activity (Figure 2).
- Make sure that devices such as water driven filter pumps are not left permanently attached to taps – disconnect them immediately after use.
- The same applies to the hoses from water cooled condensers. The hoses from these are often long and lie in the sink – it would be a good idea to have them as short as possible so they will still drain without being dragged out of the sink but will still be above the level of any standing water. In any case, they should be disconnected after use.
- If you have a still connected to a laboratory tap, fix the outlet pipe in such a way that it cannot dangle in the sink.
    - A good fix for this would be to use a short length of copper pipe (or something similar) fixed to the worktop, using pipe clips, so that its end overhangs the sink. You can then connect the outlet from the still to this pipe ensuring that there is never any risk of backflow through the still.

We hope this is the last on the topic; for a while at least.

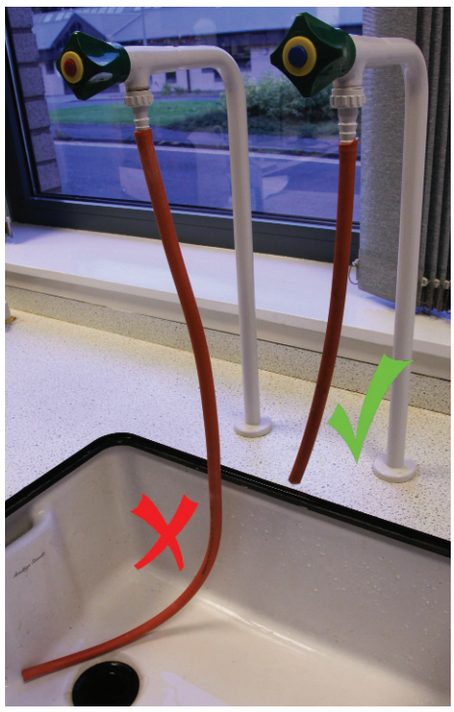


Figure 1 *- If is use, the hose outlet should be above the sink overflow level.*

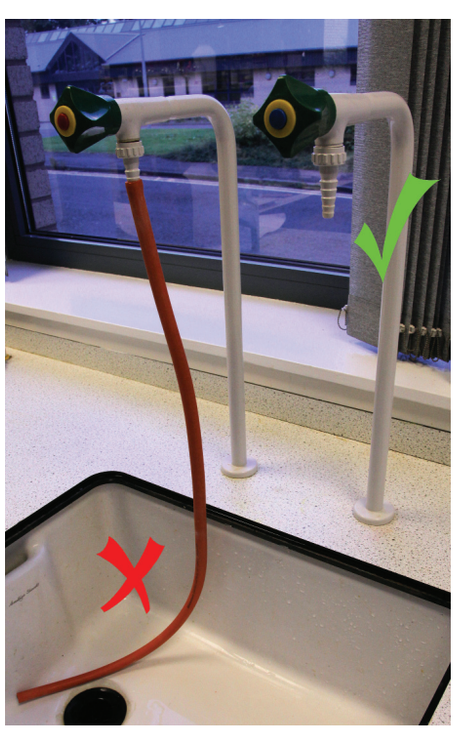


Figure 2 *- Only attach hoses when required and remove them at the end of the activity.*

The SSERC Bulletin is published by SSERC, 2 Pitreavie Court, South Pitreavie Business Park, Dunfermline KY11 8UB
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