

SSERC *Bulletin*



Ideas and inspiration supporting science and technology for all Local Authorities

No. 255 - Summer 2016



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Separation and identification of amino

Background

Chromatography is used to separate mixtures of substances into their components. In paper chromatography the stationary phase is a very uniform absorbent paper. The mobile phase is a suitable liquid solvent or mixture of solvents. In both paper and thin-layer chromatography (TLC) a sample is typically applied as a spot near one end of the sheet or plate using a microsyringe or microcapillary. The sheet is allowed to dry fully and is then transferred to a tank (often glass) containing a shallow layer of an appropriate solvent mixture. The solvent will travel up through the paper, or sheet, dissolving the sample and carrying it with it. Some compounds will travel almost as far as the solvent; some will stay closer to the base line. When the solvent front has travelled 80-90% of the length, the sheet is removed from the solvent and allowed to dry. In some cases spots may need to be rendered visible by reacting them with a substance which produces a coloured product.

The movement of a substance can be expressed in terms of its 'relative front' (R_F value) relative to the solvent.

$$R_F = \frac{\text{distance travelled by compound}}{\text{distance travelled by solvent}}$$

Protocol

A mixture of unknown amino acids can be separated and the amino acids identified using paper chromatography. The positions of the unknown amino acids can be compared to those of known amino acids on the same chromatogram. These positions can be detected by

Paper chromatography of amino acids is one of the practical learning activities suggested in Higher Biology [1]. Distinguishing between different amino acids using chromatography is also included under the mandatory course key area 'Laboratory techniques for biologists' in the 'Cells and Protein' Unit of Advanced Higher Biology [2].

spraying the chromatogram with ninhydrin which reacts with amino acids producing coloured spots.

The following experimental protocol (also available for download from the SSERC website (www.sserc.org.uk) has been adapted from one produced by Dart Publishing in 1996. Please read the accompanying health and safety guidelines prior to starting this procedure.

Equipment required (per pair)

- amino acid samples (0.25% in distilled water): asparagine, lysine, proline, tryptophan, leucine
- mixture of unknown amino acid samples (we suggest a mixture of proline, asparagine and leucine)
- chromatography tank (a large glass beaker will suffice)
- cling film or aluminium foil to act as a 'lid' for the tank
- 50 cm³ chromatography solvent (80% ethanol, 10% 0.880 ammonia, 10% distilled water by volume)
- chromatography paper (~20 cm x 20 cm)
- capillary tubes (x 6)
- access to a fume cupboard
- ninhydrin spray
- disposable gloves
- safety goggles
- pencil and ruler
- hair dryer, or oven at 105°C

Method

- 1) Place 50 cm³ of chromatography solvent in the chromatography tank and cover the tank with a lid, or clingfilm. Leave for 15 minutes to allow the atmosphere in the tank to become saturated. Make sure the tank is placed where it can be left undisturbed.
- 2) On a piece of chromatography paper, draw a pencil line 2.5 cm from the bottom edge. It is essential that the solvent level is below this line. Place 6 crosses on the line each 2.5 cm apart (Figure 1). These will be the 'origins' for the amino acid samples. **Wear gloves when handling the paper because sweat contains amino acids which will contaminate the chromatogram.**

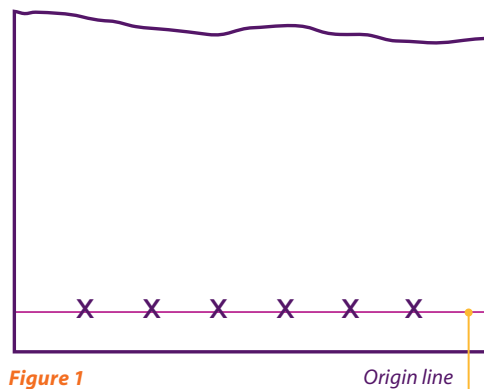


Figure 1

Origin line

acids using paper chromatography

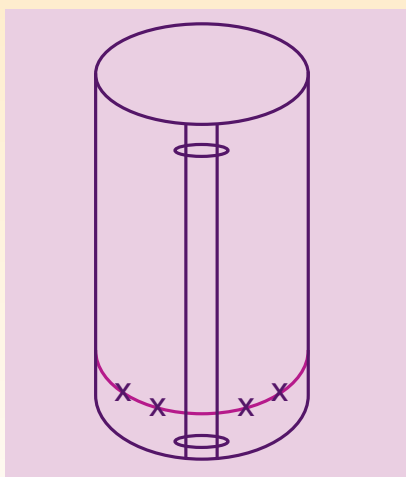


Figure 2

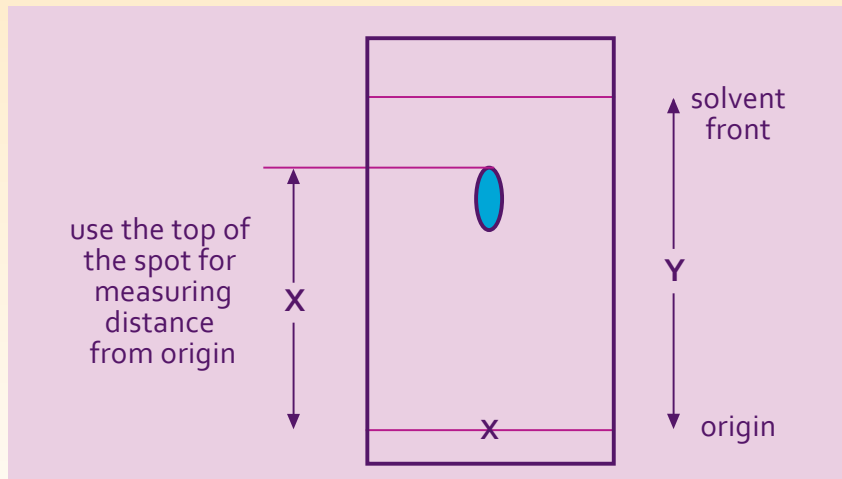


Figure 3

- 3) Below the cross on the right mark 'mix'. Below the other 5 crosses mark which amino acid will be used (e.g. asp, lys, pro, try, leu).
- 4) Place the paper on a dry, clean area of workbench. Using a clean capillary tube for each sample, spot a drop on to the appropriate origin. Allow the drops to dry between each application and apply 3 drops to each origin.
- 5) Form the paper into a cylinder with the origin line at the bottom. Staple the paper at the top and bottom edges to hold the cylinder in place - make sure the edges are not touching (Figure 2).
- 6) Lower the paper cylinder into the solvent in the chromatography tank. Take care that the lower end is horizontal as it touches the solvent and that the paper does not touch the sides of the tank. Replace the lid of the tank and allow the solvent to run for about 2 hours. Don't allow the solvent front to reach the top of the paper.
- 7) Wear gloves to remove the paper from the tank taking care only to touch the edges. Carefully remove the staples and quickly mark the solvent front with a pencil. Hold the paper in a fume cupboard until the solvent has evaporated.
- 8) Attach the paper to a clamp in the fume cupboard and taking great care spray lightly with ninhydrin.
- 9) Using a hair dryer carefully dry the chromatogram while it is still in the fume cupboard. Or, place the chromatogram in the oven at 105°C for 2 minutes.
- 10) Once the chromatogram is dry, the amino acids will show up as coloured spots. These will fade in time, so outline them in pencil.

Results

It should be possible to calculate the R_F values for each of the amino acids. These are the distance moved by the compound relative to the solvent front (Figure 3). They are always the same for a particular compound relative to the solvent front if the same mobile

and stationary phases are used. R_F values can therefore be used to identify the compounds in a mixture of unknowns.

$$R_F = \frac{\text{distance travelled by compound}}{\text{distance travelled by solvent}} = (X/Y \text{ on the diagram})$$

A typical developed chromatogram is shown in Figure 4. ▶

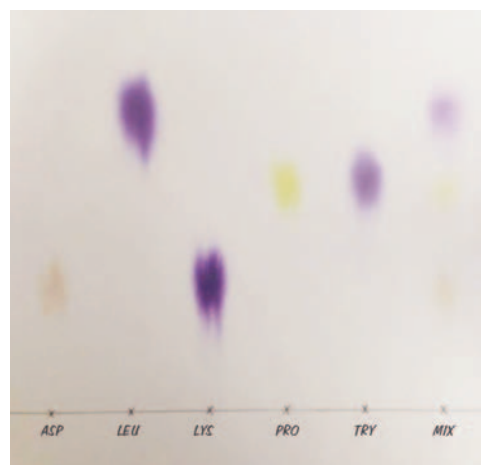


Figure 4 - Paper chromatography of amino acids (asparagine, leucine, lysine, proline and tryptophan). Ninhydrin spray has been used to show the presence of amino acids. The unknown sample (marked 'mix') contained asparagine, proline and leucine.

Safety

Precautions should be taken when preparing the chromatography solvent which contains ammonia solution and ethanol. Precautions are also necessary when using ninhydrin. Ammonia solution (.880) is corrosive and gives off toxic fumes. Ethanol is highly flammable. Ninhydrin is harmful if swallowed and is also a skin, eye and respiratory irritant. Ninhydrin is NOT a carcinogen. The amino acids listed in the protocol are all of low hazard.

A risk assessment should be carried out by the individual preparing the chemicals and by the teacher supervising pupils carrying out this activity.

Please note the following:

- Goggles (BS EN 166 3) and nitrile gloves should be worn by the technician for handling ammonia in the preparation of the chromatography solvent and the

solvent should be prepared in a fume cupboard.

- Keep ethanol and the prepared chromatography solvent away from sources of ignition.
- Goggles and nitrile gloves should be worn by pupils when setting up the chromatogram. Pupils should be reminded to keep the solvent away from sources of ignition and to keep the lid off the bottle of solvent and chromatography tank for as short a time as possible. Once the chromatography is underway there is little hazard, but care should be taken when filling and emptying chromatography tanks.
- Ninhydrin should be sprayed in a fume cupboard and pupils should

either be supervised following a demonstration, or a teacher, or a technician should spray chromatograms. In each case nitrile gloves and goggles should be worn.

- We suggest placing a cardboard box on its side within the fume cupboard, and hanging chromatograms inside this, or in front of large sheets of paper to absorb the ninhydrin spray.
- Some amino acids are irritant and harmful. Those listed in the protocol are of low hazard. If amino acids other than those listed are to be used, the hazards need to be checked and taken account of in the risk assessment.

References

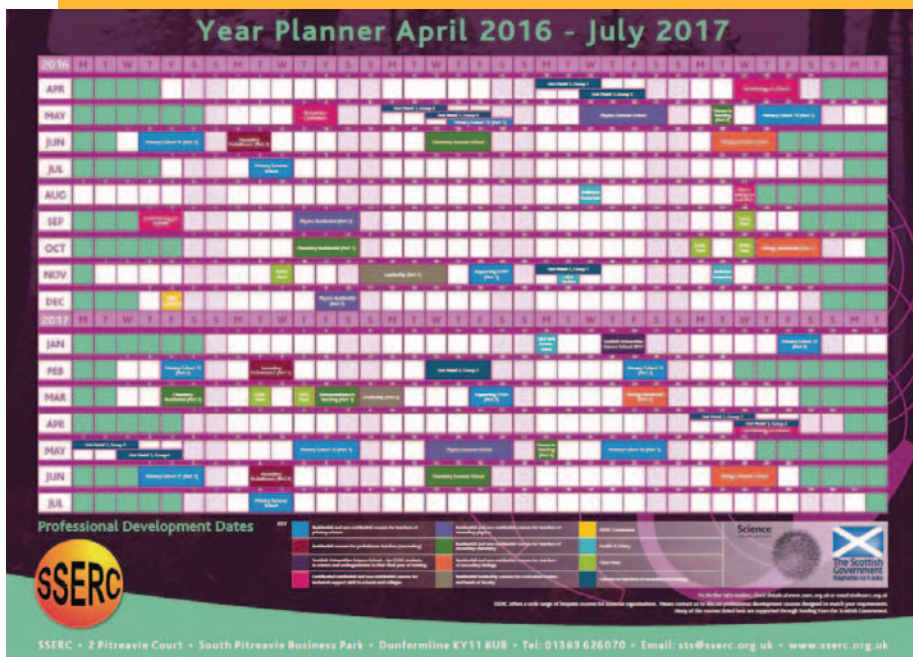
- [1] SQA (2014) Higher Human Biology Course Support Notes - can be downloaded at www.sqa.org.uk/files_ccc/CfE_CourseUnitSupportNotes_Higher_Sciences_Biology.pdf.
- [2] SQA (2014) Advanced Higher Biology Course Support Notes - can be downloaded at http://www.sqa.org.uk/files_ccc/AHCUSNBiology.pdf.

What's new?

The Scottish Government has indicated that it will provide welcome financial support for our professional development activities across the primary and secondary sectors.

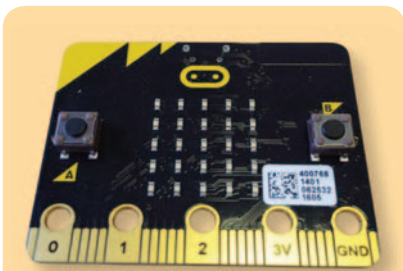
As has been the case previously, this has allowed us to publish a Year Planner to the end of June 2017. Copies of the planner have been sent to all secondary schools throughout Scotland and other members of SSERC. The planner can also be accessed on the SSERC website.

Further printed copies of the Year Planner are available, email us at sts@sserc.org.uk.



The future is here and it is BBC micro:bit

The giveaway of the BBC micro:bit free to all S1 pupils in Scotland could be the most important recruitment tool for future STEM related careers in a generation.



“The micro:bit aims to inspire young people to get creative with digital and develop skills in Technology, Engineering and Science.”

BBC website

The first thing that is clearly obvious about the micro:bit is its small size, just 50 mm x 40 mm which is less area than a credit card. However, it does manage to pack lots of features such as an attractive LED light array, 2 user controlled push buttons, an impressive 256k Flash Memory with both USB and Battery connectors, a 23 pin edge connector and also the potential for Bluetooth control!

Using the free Microsoft Block Editor software from <https://www.microbit.co.uk/> allows simulation of commands and outcomes as soon as the micro:bit comes out the box. In fact you don't actually require a micro:bit to simulate outputs and outcomes, which may be a big plus point should your pupil numbers outweigh the micro:bit numbers in front of you.

The BBC micro:bit has recently been launched in conjunction with a series of teacher CPD opportunities all across the UK. Every S1 pupil in Scotland is eligible to receive a BBC micro:bit free of charge and schools will make the decision whether they go home in their school bags or remain on campus as a resource. The small device can use a variety of different coding languages and is aimed at increasing STEM engagement across the board.

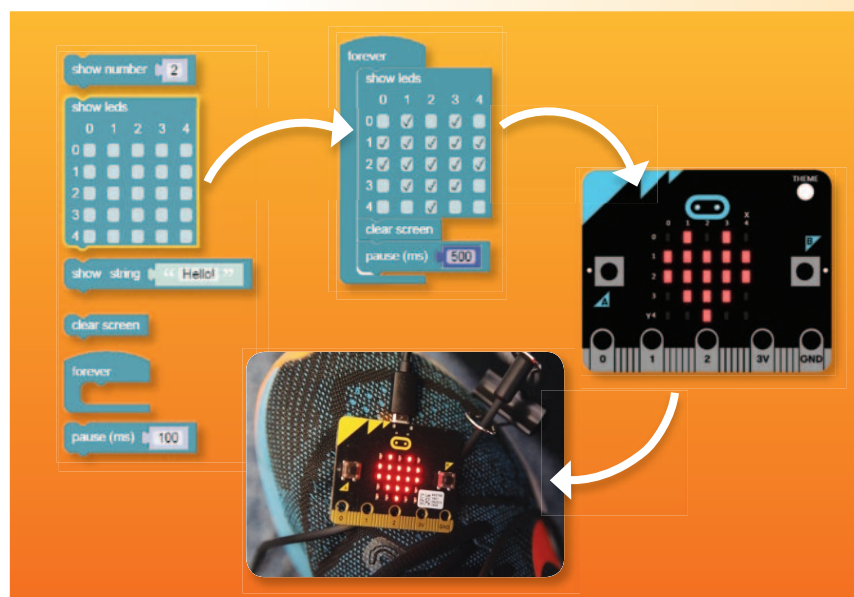


Figure 1 - Simply click and drag the required commands into a sequence, arrange the timing options of the LED lights as required, then simulate on screen before sending the command to your own micro:bit.



micro:bit CPD event.

The click and drag features of Block Editor mean that no prior knowledge of coding or language is required and that enthusiasm can be very quickly generated in your classroom.

SSERC hosted the first official BBC micro:bit CPD event for secondary teachers in March. The event was hugely over subscribed with guest presenters arranged by The Institution of Engineering and Technology and the National STEM Learning Centre.

During the CPD event, the teachers of various subjects worked through different tutorials similar to the ones they may teach in schools. An atmosphere more commonly associated with university or college tutorial labs for undergraduates or postgraduates soon evolved as the teacher groups went through a process of trial and error, and learning the basics of using Block Editor and Python language.

Recommendations for equipment purchases in schools, links to available online teacher resources and a very well engaged Q&A session during the plenary finished off an extremely valuable learning day for all involved.

In conjunction with the previously issued Quick Start Guide booklet the CPD at SSERC saw delegates receive a free copy of the IET Teaching Resources booklet (Figure 2).

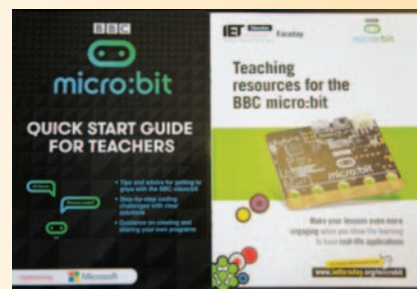


Figure 2 - BBC and IET Teaching Resources booklets.

BBC micro:bit quick links

- 1) www.microbit.co.uk - this is the official home page of the micro:bit and where the different language editors are kept. It has a very simple layout and is easy to follow.
- 2) www.kitronik.co.uk - an official partner of the BBC micro:bit and everything they use in their demonstrations is available to buy from the site.
- 3) www.techwillsaveus.com - a technology start up who have embraced the fun value of the micro:bit with lessons and products to purchase on their site.
- 4) www.sciencescope.uk - a more science focused education organisation with resources, lessons and available products on their website.
- 5) www.microbitgadgets.co.uk - a website full of promise including the legendary resource "How to pilot a Raspberry-Pi robot with your micro:bit!"
- 6) <http://faraday.theiet.org> - 13 classroom lessons form an official partner to get you started. Complete them all and very quickly you'll find yourself more than confident with the micro:bit.

Local Authority equipment

As was the case in 2015, SSERC has been able to source pieces of science and technology equipment which we will give to local authorities on a permanent loan basis. Further details of the various items are given in the articles that follow.

Local Authority physics equipment 2016

Two years ago, SSERC loaned every local authority a Vernier Labquest 2 data logger and spectrophotometer to lend out to schools. Last year, a fibre optic probe was supplied, making it much easier to study emission spectra with the apparatus. The Labquest 2 isn't designed solely to work with the spectrophotometer. We are taking advantage of that fact this year and supplying a range of sensors.

Looking at Figure 1 and working from the top left, we have a UV-A sensor, voltage probe, Geiger-Müller tube, light sensor, gas pressure sensor and magnetic field probe.

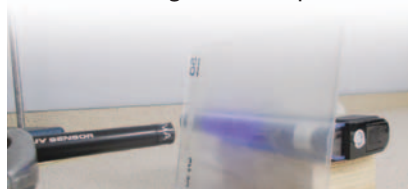


Figure 2 - Possible set up for sun cream investigation.

The following table gives some suggested uses but it is not intended to be in any way exhaustive. We are sure you can think of many other ideas.

We chose these sensors based on requests from teachers to borrow equipment from SSERC and from our own experience. If you want to know who to contact in your local authority to arrange to borrow the equipment, please get in touch with us at SSERC. We hope that you and your students find this addition to your pool of apparatus very useful.

Local Authority chemistry & biology equipment 2016

We are pleased to say that we are providing an additional set of 5 Mystrica colorimeters to each Local Authority.

Colorimetry is a valuable analytical technique in many areas of biology and chemistry particularly for students in the senior phase.

| Sensor | Possible use |
|-----------------------|---|
| UV-A | Sun cream experiments for Researching Physics Skin Cancer topic (Figure 2). |
| Voltage probe | Capacitor and inductor voltage/time graphs. |
| GM tube | Researching Physics Environmental Radiation topic (balloon experiment, etc.). |
| Light Sensor | Researching Physics Exoplanets topic (Note that the units used by the sensor are Lux. This is like irradiance but readings are weighted according to the human visual response to different wavelengths. Provided the spectral distribution of your light source does not change during an investigation, all relationships, proportionalities, etc. should be the same). |
| Pressure sensor | N5 Gas Law experiments. |
| Magnetic field sensor | Advanced Higher core experiments and investigations. |



Figure 1 - Sensors supplied in 2016.

The colorimeters are robust and easy to use and can be connected to PCs, iPhones, iPads and Android devices thereby allowing greater flexibility.

More details on how these colorimeters can be used can be found in the accompanying article in this issue of the Bulletin.

Local Authority technology equipment 2016

Our Technology department has found the so-called 'Band Saw Buddy' to be a particularly useful piece of equipment (see accompanying article in this Bulletin) and so we are delighted to be able to announce that we will be providing one to each Technology Department in Scotland. Keep an eye on our website and social media pages for further information.



Figure 3 - Mystrica colorimeter.

Magical Mystrica Tour

Colorimetry is a technique that we have written about in the pages of this publication before. And no wonder: it is a simple, powerful and versatile analytical method. The main issue tends to be that of cost; we addressed this in one fashion a few years ago in an article about how to build your own colorimeter [1]. There are times, though, when a commercial device is the only one that will do. There are many devices on the market and we will try to review some of the more common models in future editions but in this article we are going to focus on one in particular - the Mystrica type II (see Figure 1).

We wrote about the Mystrica Mark 1 version back in 2009 [2]. The new version is very similar but with added functionality. For information about the performance of the device, refer to the article in Bulletin 228. It is at the cheaper end of the market, coming in at around £120 and this is still a substantial amount of money for schools who would like to use a class set. To try to alleviate their problem in a small way, last year SSERC placed a set of four Mystrica type II colorimeters with each of the Local Authorities on permanent loan. This year they have been augmented with another 5 so there is a set of 9 that can be borrowed within your authority. (For details of where they are held in your authority, contact SSERC).

Unlike some colorimeters, though, even having just the one will allow some good work to be done with a whole class via the connectivity with computers and/or phones and tablets. The particular advantage of these purpose-built devices is the ability to take readings at set intervals which allows good work on kinetics to be done.

Having made these colorimeters available, we feel a certain amount of responsibility to ensure you know how to use them - hence this article.

Using the Mystrica

For use as a stand-alone device, the Mystrica is very simple and straightforward and there is probably no need to cover it here. In most cases, you will just be recording the readings manually from the display. We will concentrate on taking automated readings.

Using a PC

This is still fairly old school, being done by means of a USB cable. It does mean however that you can display the data to the whole class. Downloading the data means it is easy to arrange that each pupil gets a copy for individual analysis. The software is free to download



Figure 1 - The Mystrica colorimeter.

from the Mystrica website [3]. It only works on windows machines. Sorry all you Mac fans and the few Linux aficionados. It functions in exactly the same way as the older Mark 1 has for several years.

- 1) Switch on the colorimeter and select the appropriate LED.
- 2) Make sure the Mystrica software is installed on your device and open it. The top left hand corner of your screen will look like (Figure 2).

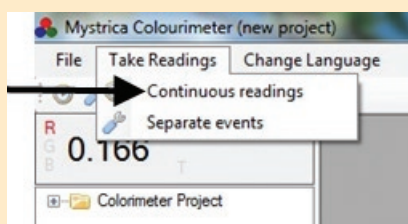


Figure 2 - taking readings with a PC.

- 3) Go to the 'Take Readings' tab and select 'Continuous readings'.
- 4) Just click 'next' on the first screen - unless you really want to name the project.
- 5) That takes you to this screen (Figure 3).
- 6) Select the, Time to Run and the 'data capture' interval, both of which will vary depending on the experiment you are carrying out. Click 'Next'.
- 7) Prepare your reaction mixture. As soon as you have added the final reagent, quickly invert to mix the solutions and put the cuvette into the colorimeter.
- 8) As soon as the cuvette is in the colorimeter, press 'take readings'. This will follow the reaction for the length of time you specified, taking readings at the interval you decided on.

If following the reaction automatically, as described above, you should export the data to allow the concentration to be calculated from the absorbance.

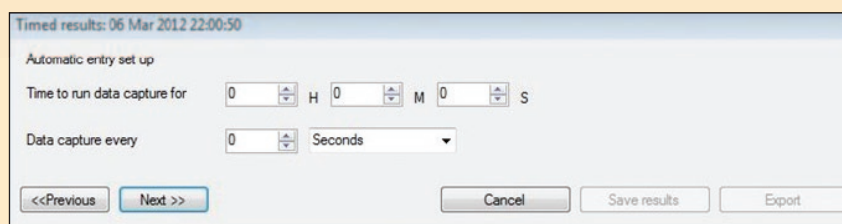


Figure 3 - Setting times for data capture with a PC.

Using a phone/tablet

This is via Bluetooth (only with Bluetooth 4.0 and above - it is best to check if you are using an older device). Being Bluetooth, it only connects on a 1:1 basis but connections are fast and simple so it is not a problem to pass on from pupil to pupil. The data collection interface is intuitive and easy to use and you have the option of emailing the data (in .csv format) so that further analysis can be carried out.

iPad/iPhone app

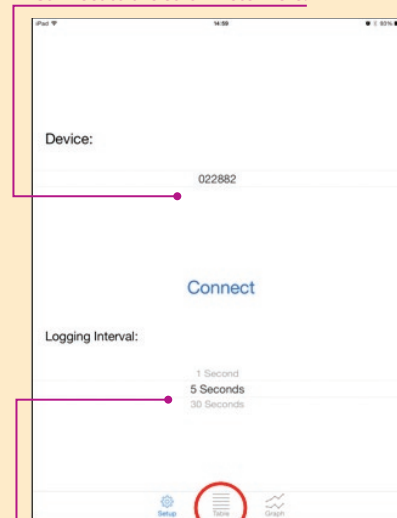
- 1) Switch on the colorimeter and select the appropriate filter
- 2) Download and install the app from the app store. Open it.
- 3) Here you will see the serial number of any Mystrica devices nearby that are switched on (Figure 4).
- 4) Select the logging interval (Figure 4).

The original version of the app only had a choice of every 1, 5 or 30 seconds - which was perfectly adequate - but this has now been extended to with options for 2 minutes and 30 minutes.

- 5) **Now** click on the connect button.
- 6) Once you are connected. Switch to the data table view using the bottom tab (Circled in red), or graph view using the button to the right of it.

The top of both screens has the same layout - as shown in Figure 5.

Connect to the colorimeter here.



You will need to change the settings before connecting to the device.

Figure 4 - Connecting and setting sample times with the iOS app.

- 7) Select the red, green or blue LED (or you can do this manually from the colorimeter itself).
- 8) Remember to calibrate the colorimeter with an appropriate blank solution.
- 9) If you want to take individual, one-off readings manually. Just press the 'Separate Event' button. The reading will then appear.
- 10) If you want to record a continuous series of readings, press 'Start Logging', the software will start recording data at the frequency you specified earlier.

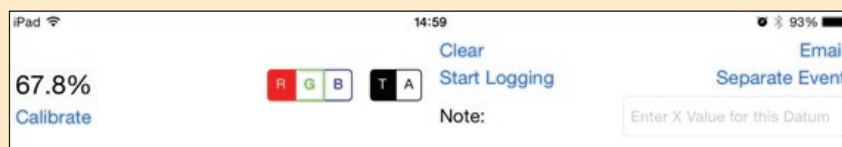


Figure 5 - Controls in iOS app.

| Time | Transmittance | Absorbance | Colour | Note |
|------|---------------|------------|--------|------|
| 0 s | 30.3% | 0.519 | R | |
| 5 s | 32.0% | 0.496 | R | |
| 10 s | 33.6% | 0.474 | R | |
| 15 s | 35.3% | 0.452 | R | |
| 20 s | 37.0% | 0.432 | R | |
| 25 s | 38.7% | 0.413 | R | |
| 30 s | 40.3% | 0.395 | R | |
| 35 s | 42.0% | 0.378 | R | |
| 40 s | 43.6% | 0.361 | R | |
| 45 s | 45.2% | 0.345 | R | |
| 50 s | 46.9% | 0.329 | R | |
| 55 s | 48.5% | 0.315 | R | |
| 60 s | 50.0% | 0.301 | R | |
| 65 s | 51.6% | 0.288 | R | |
| 70 s | 53.1% | 0.275 | R | |
| 75 s | 54.6% | 0.263 | R | |
| 80 s | 56.1% | 0.251 | R | |
| 85 s | 57.5% | 0.240 | R | |

Figure 6 - Sample data table in iOS app.

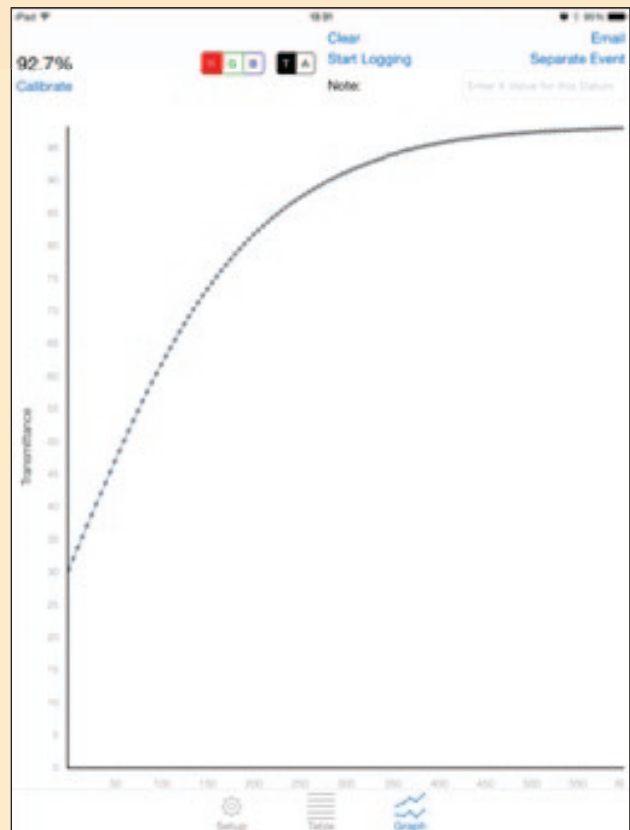


Figure 7 - Sample graph screenshot from iOS app.

The data is shown here in table view (Figure 6). Note that there is no need to select transmittance or absorbance as the software records both. As each new reading is taken, it is added to the bottom of the table.

You can switch between table view and graph view at any time without interfering with the readings - but you can't switch diodes during a run.

- 11) To start again, just press 'Clear' (Figure 6).
- 12) To download the data for future analysis, just click the 'Email' button at the top right and your email will automatically pop up with the file attached for you to send to yourself, or anyone else. The data is exported as a .csv file which will open in Excel (or other spreadsheet program).
- 13) If you just want the graph, you can take a screenshot with the iPad/iPhone as you normally would. See Figure 7.

- 14) The latest version of the app, just out, has the same functionality the Android app does in that it allows you to save sessions on the device for later use, rather than having to email them - See the section on the Android app for more details.

Android app

There is now also an app for devices running Android 4.4 and above but we have yet to manage to put that through its paces. It is quite similar but there are some differences. On tablets the screen is landscape and shows table and

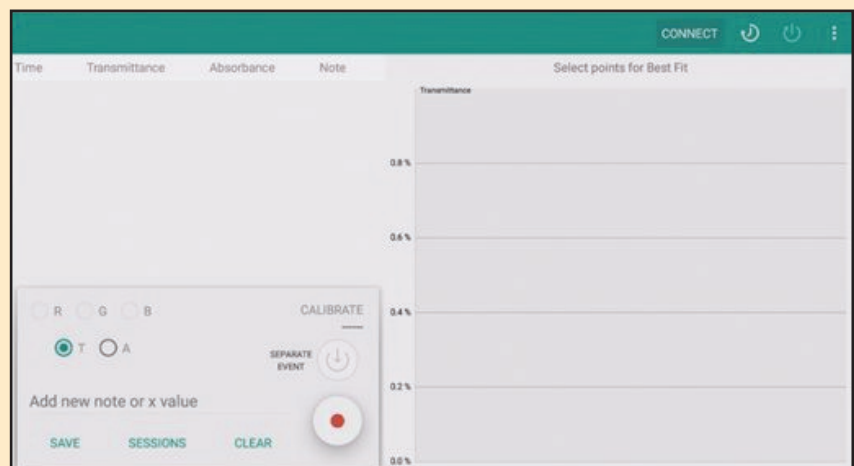


Figure 8 - The Android screen.

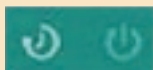
graph simultaneously: on phones the screen is portrait and you can toggle between table or graph.

Opening the Android app on a tablet brings up a screen like this (Figure 8).

To connect to a colorimeter, making sure you have switched on Bluetooth!) click on the 'connect' button at the top.

This opens up a new screen where you can select the device if there is more than one in range.

To the right of that are buttons to select the timing options.



Clicking on the left hand one enables selection of the timing interval, as in the iOS app, while the icon to its right allows you to set the duration of capture so you can go away and leave it.

To start the session, just tap the record button at the bottom. As in the iOS app, there is also the option for manual operation (or adding in data manually) with the 'separate event' button.

The main difference between the Android and the iOS app (though this is being changed in the new version of the iOS app) is the ability to store sessions on the device. At the bottom left of Figure 8 you can see two buttons marked 'save' and 'sessions'. 'Save', obviously, allows you to name and save your session, while tapping on 'sessions' opens up the screen in Figure 9.

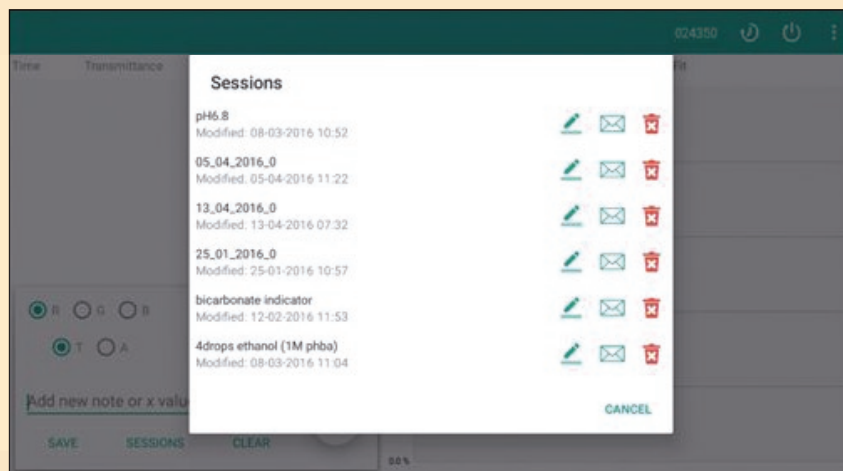


Figure 9 - Session recall in the Android app.

You will see all the sessions you have saved and you have a few options.

Tapping on the name allows you to rename the session should you wish to.

You also have three icons on the right of each session.

The 'pen' icon will let you recall the session to see the data and make any edits.

The 'letter' icon allows you to email it (the data as a .csv file and the graph as a .png file) and the 'bin', not surprisingly, deletes the session.

This save/store functionality is being added into the new version of the iOS app in the very near future.

For more details, there are videos of the apps in use and interactive image maps highlighting the various functions in the Mystrica website [4].

Overall, while this device may not be able to replace the larger, more advanced machines for certain pieces of advanced work, it is more than suitable for the vast majority of the colorimetry carried out in schools at all levels. The addition of the mobile apps gives a welcome added functionality and it comes at a price that is hard to beat - especially if you are only borrowing the ones SSERC has put into the Local Authorities. ◀

References

- [1] Colorimetry on the cheap (2012), SSERC Bulletin, **240**, 4-8.
- [2] The Mystrica colorimeter (2009), SSERC Bulletin, **228**, 10-12.
- [3] <http://www.mystrica.com/Software/Download> (accessed April 18th 2016).
- [4] <http://staging.mystrica.com/Wireless> (accessed April 18th 2016).

A particle detector to

SSERC has been given a new piece of apparatus to lend to schools. We think you and your students are going to like it. It is a particle detector (Figure 1), capable of detecting alpha, beta and gamma radiation and other types such as muons.

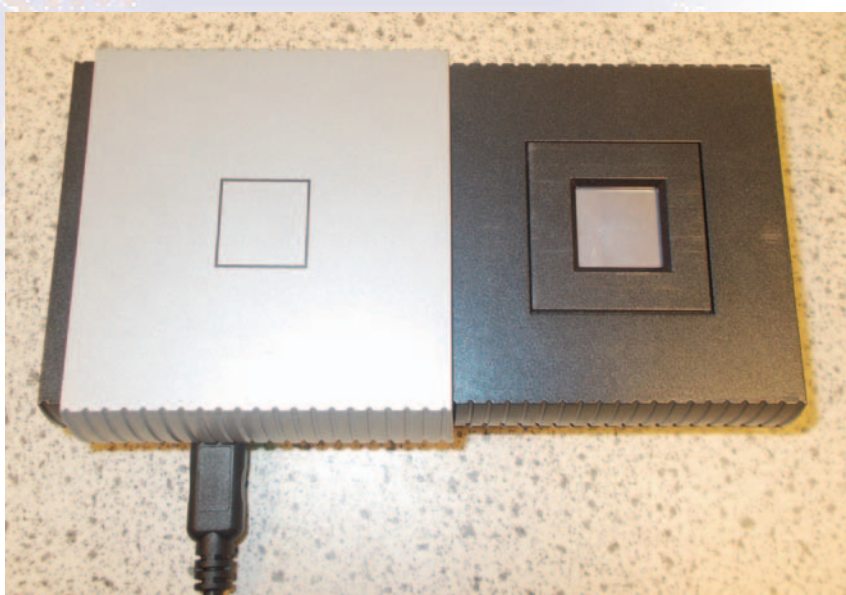


Figure 1 - Particle detector,

The detector is a Jablotron MX-10. It connects to a laptop (supplied to borrowers) that runs Pixelman software. What makes this system special is that the detecting chip, originally designed for medical imaging, is an array of 256 x 256 detector elements. It is effectively a digital camera for radiation detection. When a particle interacts with the detector, charge is deposited in the sensor. This charge diffuses. The device can measure how long each detector element remains above a particular energy threshold. The upshot is that different types of radiation show up as different pixel patterns. In a way, this is similar to the different types of track you see in a cloud chamber. Not only can you see the spatial distribution of the radiation, you can identify the type. Figures 2 and 3 illustrate this. Here we have

updated Becquerel's Experiment. Becquerel used photographic film as his detector and a copper Maltese Cross as a mask. We have gone digital with respect to detection and our mask is the key for our radioactivity store. The radiation is emitted from a 3.7 kBq americium source. The experiment needed to run for only 10 seconds to obtain the results shown.

Americium is usually used in schools as an alpha radiation source. We're not surprised, then, to see an area of shadow corresponding to the position of the key. Alpha particles are absorbed by a sheet or two of paper, let alone a steel key a millimetre or more thick. Look closely at Figure 3. The large red dots are where alpha particles were detected. Americium also emits gamma rays. These show

up as much smaller dots. You will see some amongst the alphas, but there are also a number that can be seen where they key lay. The gamma radiation has been able to penetrate the metal.

The software can be set to show individual counts for alpha, beta, gamma and "other" forms of radiation. In practice, we found that it had trouble distinguishing high energy gammas and lower energy betas, though other analysis software is available.

We have also used the detector with standard lab experiments - absorption of radiation, half value thickness, inverse square law, electrostatic deposition of radon daughter products on a charged balloon and potassium



Figure 2 - Updated Becquerel's Experiment.

borrow

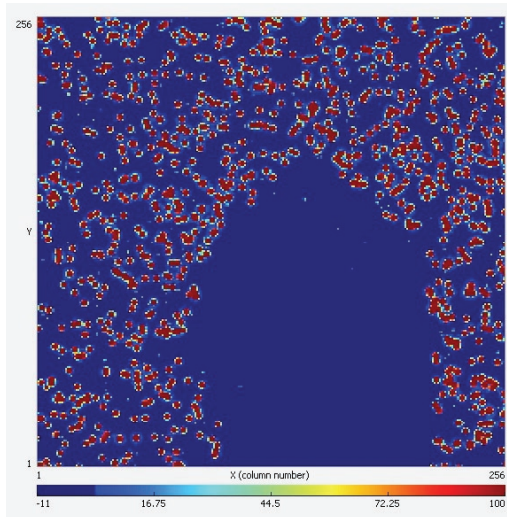


Figure 3 - Screenshot from Pixelman software, using the set up shown in Figure 2.

chloride investigations. It is worth saying a little more about the last two. The detector gave us more information on the nature of the radiation emitted by the daughters of radon, giving us clues to their identities. We also took the sensor back to its medical roots, modelling a medical tracer by filling a straw half full of sodium chloride, half with potassium chloride and laying it over the element. The potassium chloride part was considerably more active, as could be seen on the Pixelman image. We were also able to show the deflection of beta radiation much more quickly and convincingly than we ever could with a GM tube.

Our detector and laptop came in a backpack, which encouraged us to take it out and about. Though it is not weatherproof, as long as the laptop is charged, the system is quite portable. We decided to recreate an experiment by Scots Nobel Prize-winning physicist CTR Wilson (he is the only one so far unless you count Peter Higgs). Wilson knew that a charged electroscope discharged over time and that this must be due

to ionisation in the air. He made the startlingly creative suggestion that this ionisation might be due to radiation from space, what we would now call cosmic rays. To test this out, he examined electroscopes inside a railway tunnel near Peebles, reasoning that they would be shielded from this radiation and would not discharge like those outside. His electroscope in the tunnel did discharge so he abandoned his cosmic ray hypothesis, not knowing that background radiation from rocks and building material was present.

Our team included Laura Thomas, a freelance science communicator who has been involved with the detector initiative, and work experience student Calum Duff from St. Margaret's Academy in Livingston. (Figures 4 and 5). We had the advantage that the railway tunnel is now disused. CTR Wilson had to wait until night time.

Comparing readings inside and outside the tunnel, we found that radiation levels were statistically



Figure 4 - Monitoring radiation outside the railway tunnel.

significantly higher within. Further analysis is needed, but this could be due to being enclosed by rock and by the build up of radon - the tunnel is long and not well-ventilated.

We have been given the detector by the Institute for Research in Schools who run the CERN@school project. We hope that you will want to borrow the kit, not just to carry out experiments that support the curriculum but also to encourage your students to carry out original research. Do get in touch. ◀



Figure 5 - Entering the tunnel.

Meet your new Band Saw Buddy



Figure 1

SSERC has purchased an Axminster Tools Band Saw Buddy for every Technical Education department in Scotland. The tool is extremely well manufactured here in the UK and handy to have attached to the band saw whilst working in a school work shop.

After our lengthy trials here in our own Technology department, we felt that the multi-purpose features of the Band Saw Buddy meant it would be a great addition to departments everywhere (Figure 1). It should be particularly useful to technicians prior to prepping timber and plastics on a band saw. For more information on delivery schedules, check out our website and social media pages.

How does it work?

The tool has two centrally placed magnets which make it easy to attach to a band saw blade.

The central magnets allow the Band Saw Buddy to be attached directly to the blade and ensure that the fence being used is as close to parallel as possible (Figure 2). This check improves the direction of the blade cut and should be completed after any change of blade, adjustment of the wheel tension or replacement of the fence being used.



Figure 2 - Central magnets allow the Band Saw Buddy to be attached directly to the blade.

The edge has a 20 mm accurate thickness gauge which allows small thicknesses to be cut between the blade and fence (Figure 3). This feature can also be used after Planer/Thicknesser work.

Also present is diameter/radius marking holes which make drawing circles from 70 mm to 400 mm

diameter incredibly simple and accurate (Figure 4).

The Bandsaw Buddy comes with chamfered and right angled corners allowing it to be used as an accurate straight edge for marking out in the workshop (Figure 5). **WARNING - Remember** to remove the Band Saw Buddy before turning the bandsaw on!



Figure 3 - A 20 mm accurate thickness gauge.



Figure 4 - Diameter/radius marking holes.



Figure 5 - Accurate straight edges for marking out.

Radiation protection - how is your record-keeping?

Perhaps it's an "end of the financial year" thing, or perhaps people are more confident buying radioactive sources now that disposal legislation has been fixed (see Bulletin 254). Whatever the reason, we have had a flurry of requests for approval to buy new items. This is probably a good time to remind you of what you should be doing if you own sources, with particular regard to checking, testing and record-keeping. Here is a summary.

- Display the "What you should know and do" poster, downloadable from our website.
- Keep an inventory.
- Do a monthly stock check (except during the summer holidays).
- Store your sources in a locked, metal cabinet.
- Carry out leak tests every two years, or annually for older sources.
- Have a contingency plan.
- Have risk assessments for all activities involving radioactivity.

Guidance on how to do all this, plus templates for recording stock checks and so forth, are available in the password-protected area of our site: tinyurl.com/SSERCradpro. The above list does not give every single legal requirement that has to be addressed if you have sources. There is also guidance on handling and buying, for example.

Case study

A school owned an alpha source, two beta sources, a gamma source and an eluting half life source. One day, it was discovered that there was only one beta source in the store. The school had no inventory listing the types and activities of source, had not carried out leak-testing when this was no longer done by a visiting council



employee and did not do regular stock checks. They did keep a log of use, but did not unambiguously identify which sources had been taken out for experiments. As a result, there was no way of knowing when the beta source went missing. SSERC investigated and, from our own records, were able to identify the missing source as a 74 kBq strontium-90 Hi-Tech source. Unlike many school sources, this one's activity was below that which would have required SEPA and HSE to be notified of its loss. Note that the threshold is different for different types of source and different isotopes.

Strontium sources such as this come in a storage pot that absorbs all beta radiation. If it is removed from this pot, the source's construction is such that beta particles can only emerge in a cone from its front. It is unlikely that anyone was harmed by the loss. Having said that, SSERC considers this to be a serious incident. Fortunately, staff at the school are most willing to ensure that this sort of occurrence will not happen again. We are confident that the procedures listed in part 1 of this article will be put in place immediately. ◀

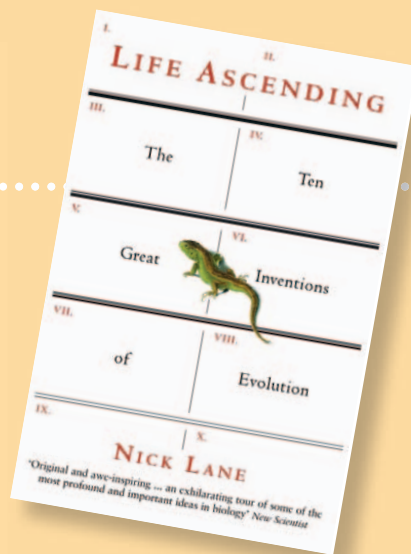


In issue 245 of the SSERC Bulletin in 2013 we reported that we were planning to produce a series of reviews of 'popular science' books in biology.

Biology books

Our focus with these reviews was to support the new areas of biology that have been introduced to the revised and CfE Higher Biology, Higher Human Biology and Advanced Higher Biology courses.

We have recently added the 10th review *Life Ascending - The Ten Great Inventions of Evolution*, Nick Lane, Profile Books, London, 2009.



All ten reviews are available on the SSERC website at www.sserc.org.uk/index.php/biology-2/biology-resources/book-reviews.

Health & Safety

A tale of two coats

Recently we received an enquiry from a school technician with a whole school remit. Their question was "Can I wear my Science lab coat in the Technical Education department?" In short the answer is no, but the detail of the answer requires more explanation. Personal Protection Equipment (PPE) must be provided to technicians to safely carry out their duties in a working school environment. However if a technician works for a period of time in a Science department wearing a traditional white lab coat, they run the risk of transferring any possible contagions to the new department visited. The same goes if a traditional blue dust coat is worn in a Technical cutting and preparation room. It is common that wood dust and plastic granules end up on the dust coat so wherever the technician goes next, they may transfer the wood dust and granules. The control measure is to simply have



your school provide you with a Science lab coat which is only worn within that department and also a second dust coat kept within the Technical Education department.