SSERC Bulletin

Ideas and inspiration supporting science and technology for all Local Authorities

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Free *Fritzing*!

Fritzing **is a free to download Germany-based open sourced software (latest version is 0.9.2b and was released in April 2015) available from their website http://fritzing.org.**

Figure 1 *- Pull down menus from http://fritzing.org.*

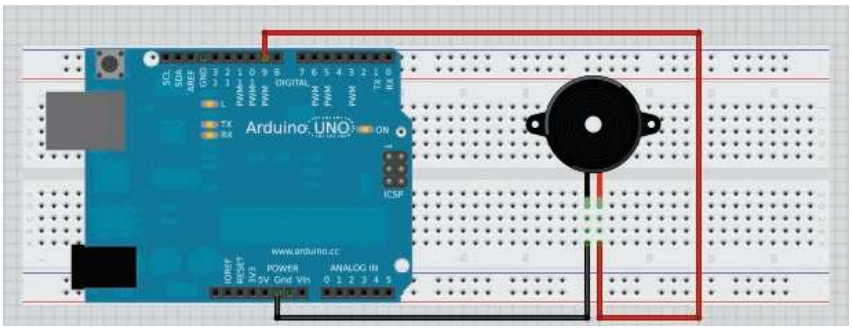


Figure 2 *- An Arduino Alarm Circuit.*

Free downloads are available for PCs, Macs and Linux based systems. This software allows electronics circuits to be graphically drawn and documented, then used throughout Engineering Science courses in your department. Project galleries are available from beginners to advanced circuits. *Fritzing*, however, does not simulate the circuits (for that read the overleaf article on Livewire and Control Studio 2!).

Use can be made of existing library parts or new parts created. Figure 2 shows the use of the library image of Arduino UNO together with a buzzer. Wires can be added during the editing phase of the circuit graphics.

The free software allows a breadboard view where virtual electronic components can be wired and placed on a virtual breadboard (Figure 2). Parts that do not exist can be created as well. The schematic view is where the former representation of the schematic can be viewed and edited (Figure 3). Changes can be made using the wide selection of options in the parts library.

The PCB view allows you to place parts on a printed circuit board. (Figure 4) An auto-router generates the traces and the final PCB layout can be exported to the necessary production formats.

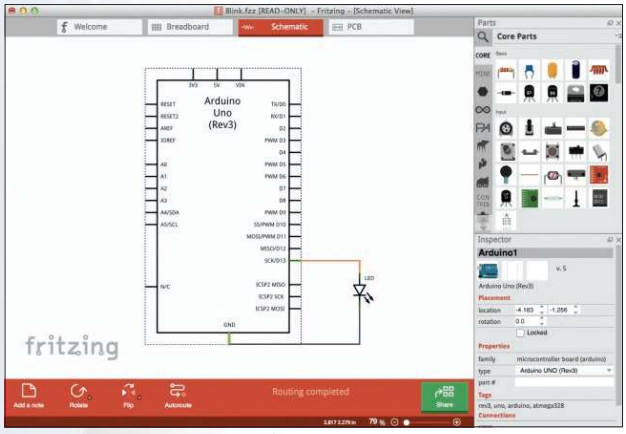


Figure 3 *- Examples of schematics and parts.*

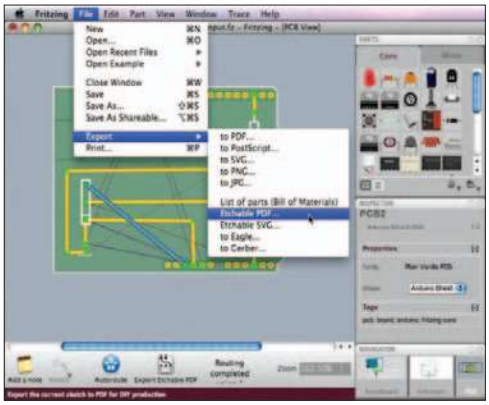


Figure 4 *- Example of PCB editing.*

In our judgement, *Fritzing* software provides teachers and pupils with a free and easy method of producing high quality electronics graphics, schematics, breadboard and PCBs.

Build yourself a robotic arm

The rise in popularity of the Engineering Science courses has seen a demand for affordable resources in the classroom. This self-assembly Robotic Arm with USB Interface allows your pupils to progress through a reasonably well instructed assembly process, allowing individuals or teams of pupils to achieve the satisfaction of completing the project with whatever levels of teacher input deemed necessary.

Assembly time can be around 2 to 3 hours depending on the ability levels of the pupils participating. The tools required for assembly are basic screwdrivers and pliers normally found in every department, so the only further investment is four 'D' model batteries.

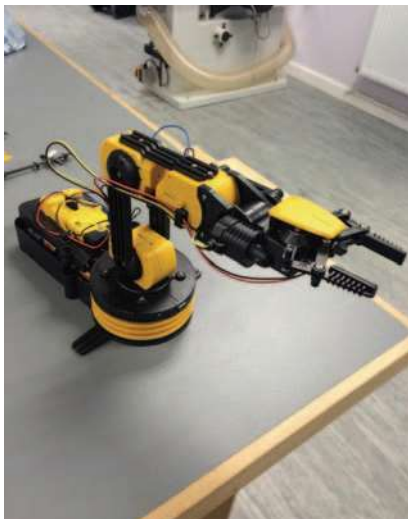
The assembly parts are well labelled but can be demanding to put together as some of the components are very small!

Putting the Robotic Arm together can be a rewarding team building exercise. But expect competition as to who gets to use it first!

The Robotic Arm has multiple rotating parts and allows up to 100 g max to be lifted with the grippers.

After a very simple upload of operating software to a school PC or laptop, you can operate the fully functional rotating model for a range of challenges. Pupils will enjoy the initial lessons and practices, and familiarising themselves with the control features becomes a really enjoyable (and addictive!) task. Once control of the robotic arm has been mastered more challenges can be created and the general fun to be had with the creation is really only limited by the life of the required four batteries!

When you or your pupils feel ready to take the controls to a more advanced level, movement sequences can be programmed, memorised, timed and then executed. These tasks can be used as a teambuilding process or to allow friendly competition to find the quickest or most efficient object moving challenge in your classroom. The retail costs of the Robotic Arm kit are around £50 and allow a great resource to be kept your department.



Demonstration corner

CHIP PAN FIRE

This is a spectacular demonstration which lends itself to quite a few teaching points. Not least it is an excellent demonstration of the dangers associated with oil fires, which still injure about 4,000 people each year in the UK.

It is extremely important not to exceed the quantities suggested here.

Before carrying out this experiment, read the more detailed information and the risk assessment that can be found at http://www.sserc.org.uk/index.php/chemistry-resources/chemistry-demonstrations/3866-chip-pan-fire.

- Do not do carry this experiment out in a fume cupboard (doing so may ignite the filter).
- The teacher/demonstrator should wear a face shield and heat resistant gloves. **Pupils must not attempt this activity**.
- All those present should wear eye protection and must be kept not less than 4 metres back.
- Safety screens must be positioned and secured to protect both students and the demonstrator.
- The experiment must not be carried out below a light fitting.
- Set out some heatproof mats to protect the bench from hot burning oil.
- Tape a small test tube to one end of a 1 m rule.
- Set up a tall form nickel crucible as shown in Figure 1. (Porcelain ones might crack and squat ones might spray the flaming liquid sideways). It should be firmly held and not tip over when the flame is put out.

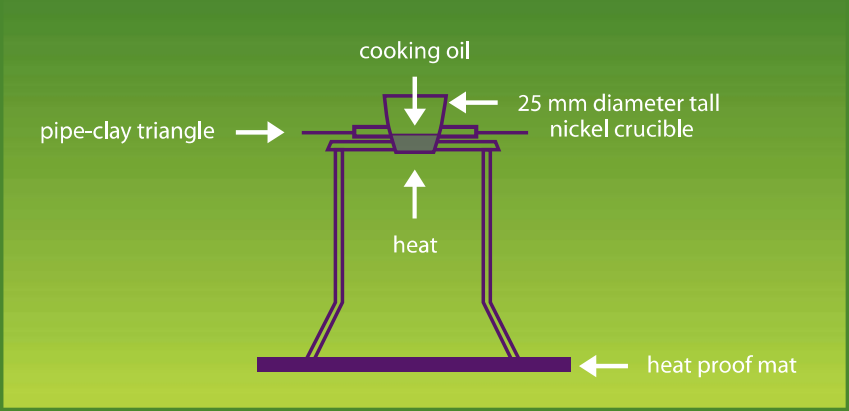


Figure 1 *- Set up.*

The demonstration

1) Place about 5 cm^3 of water in the test-tube ready for use
2) Pour 3 cm^3 of cooking oil into the crucible and place a lighted Bunsen burner beneath it.
3) Once the oil catches fire, switch off the gas, allow it to burn for a minute or two and then extinguish the flame by placing a small square of hardboard or aluminium over the crucible. This shown how you can safely put out this sort of fire.
4) Re-light the Bunsen burner and re-heat the oil until it re-ignites.
5) Switch off the gas supply again and let it burn again for a couple of minutes.
6) Hold the metre stick with the test-tube containing water at arm's length and pour the water to the burning oil. This will cause a ball of fire to rise about a metre, effectively demonstrating the hazard of attempting to put out a fat-pan fire with water.

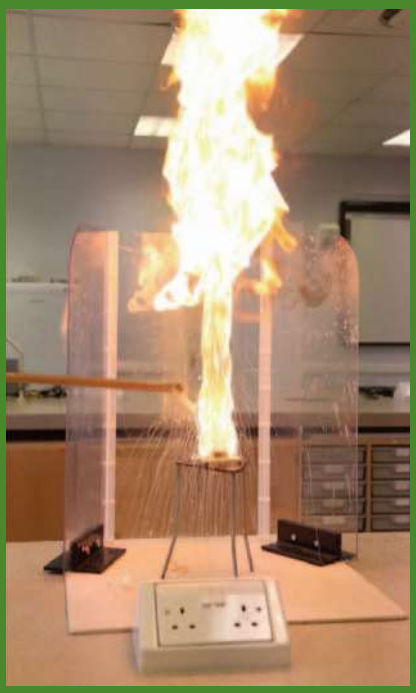


Figure 2 *- Fireball.*

What is happening?

In order to burn, oil needs to be close to or at its boiling point, around 220°C. (This will vary depending on the oil).

When the water is added, it sinks to the bottom as it is more dense than the oil. It then turns to steam, as the temperature is far above boiling point (100°C). The steam erupts out from under the burning oil, carrying it along too. As the burning oil is spread out into smaller droplets and mixes with the air, it burns much faster, hence the fireball (Figure 2).

Livewire & Control Studio 2

Free electrical circuit simulation software for your Technical Education department from SSERC.

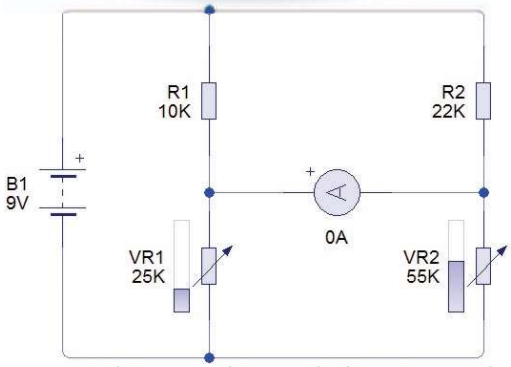


Figure 1 *- A Wheatstone bridge circuit example.*

What is it?

One free site licence for both Livewire and Control Studio 2 software have been secured for every Technical Education department in Scotland by SSERC. The software is intended to, but not limited to, impact the delivery of introductory lessons in Engineering Science (and even our friends in the Physics department might find them useful!).

What can it do?

The combination of both software packages allows teachers and pupils to design, simulate and analyse electronic circuits on a school computer without the need for hardware. These simulations offer a potentially infinite number of combinations. The software packages also allow departments who currently do not present Engineering Science for exams to explore and demonstrate electronic circuits in introductory lessons.

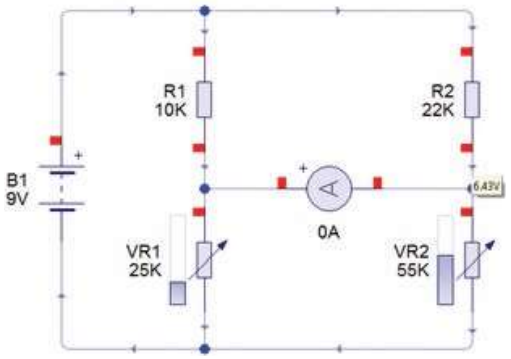


Figure 2 *- Allows the Wheatstone voltage levels also to be displayed simply by hovering over the red icons with the cursor.*

How can it help me?

Using Control Studio 2 and Livewire allows you to create and simulate the performance of electronic circuits in the classroom, and then allows the designs to be transformed into a Printed Circuit Board (PCB) diagram. This is incredibly helpful as pupils can make mistakes, change their minds and all without the risk of damage to costly electronics kit. Users can select from a large library of European or American circuit symbols and continually build to solve the challenges they have been set. It also means that previous examples of PCB diagrams from past papers and tutorial books can be created and simulated by pupils as part of their Engineering Science learning.

Demonstration of use!

With the software packages you can start from scratch or use the template designs already provided. If you wish to create your own circuit then simply:

- select an input from your available list
- attach a connector (remember the current will flow in the direction of the arrow!)
- select a process of your choice
- again add another connector
- finally from the list of outputs place it on the end of your circuit

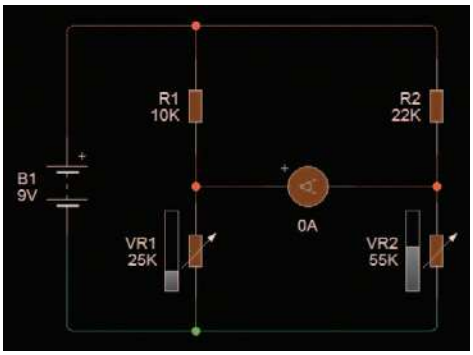


Figure 3 *- The Wheatstone current flow is displayed in clear colours.*

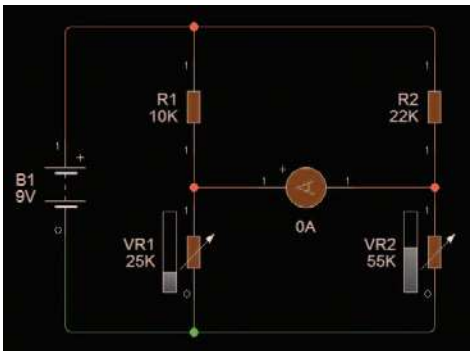


Figure 4 *- Identifies the logic levels with 1 or 0.*

- to simulate the circuit click on the play triangle at the top of the page, and fingers crossed your circuit works!

When will it arrive in my school?

SSERC has been communicating directly with all Heads of Education of every local authority and is compiling a contact list to ensure the software codes are delivered to each Technical Education department. Hopefully this process will start to see the introduction of the software packages at the start of the August term.

We have an app!

Using funding from SQA, SSERC has been working with a software developer to create a simple app to help students understand average speed. *SSERC Speed Camera* works like a real speed camera. It captures two successive images of a moving object. If we know the time between each image and the distance travelled in that time, the average speed can be found.

Figure 1 *- The icon for our app.*

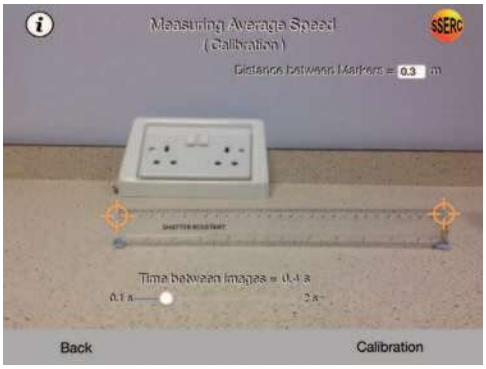


Figure 2 *- Calibration screen.*

It is important to realise what this app (Figure 1) isn't. It's not a highly accurate measuring tool suitable for gathering data in an Advanced Higher investigation. It is designed to encourage students to think about the concept of speed whilst taking real-life measurements.

When the app is started, tap the **Calibration** button. The calibration screen appears (Figure 2).

There needs to be a stationary object of known length situated in the plane where motion will take place.

Move the markers to the ends of the object. Enter the length in metres in the **Distance Between Markers** box. If you can rest your tablet or phone on a wall or bench whilst doing this, it will be much easier to set the markers as the camera is still "live" during this process.

Users will have to decide the appropriate time interval between images. Whilst there may be an element of trial and error in this, students should be encouraged to think about a suitable time interval. The time is set using the slider control.

Touch the **Back** button. When the moving object enters the field of view on the tablet or phone, simply touch the screen. Two pictures, overlaid, will be taken (Figure 3).

Move the markers to the same point on each image. The average speed will be displayed. To make another measurement, touch **Reset**. There is no need to recalibrate if the motion will be in the same plane.

We said earlier that this is not designed to be an accurate measuring tool. That is not to talk it down. It can be used to promote discussion about measuring speed and indeed uncertainties. What would be the effect of the moving object being behind or in front of the object chosen for calibration? Can you use this app to measure the speed of objects coming towards you? If you were in a moving vehicle, could you use it to measure your speed? What are the relative advantages of long and short time intervals between pictures? Whilst the app can be used in the classroom, we hope users will take it out into the real world to measure the speed of cars, bikes, runners and more. Perhaps some students will download it from the App Store (IOS) or Google Play (Android) to their own devices. Having had a simple introduction to motion analysis, learners may be better prepared for powerful applications such as Tracker [1] and Vernier Video Physics [2].

This is new territory for us. Please let us know what you think of *SSERC Speed Camera* and we also welcome suggestions for future apps.

References

[1] See SSERC Bulletin, **225**.
[2] See SSERC Bulletin, **240**, ("Start taking the tablets?").

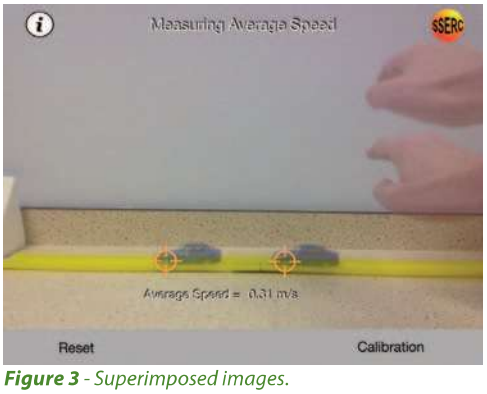


Figure 3 *- Superimposed images.*

Cyanotypes and sunscreens

Several years ago, we published a Bulletin article about the cyanotype process [1], an obsolete photographic process that is ideal for the classroom. As it used inexpensive iron salts and can be handled and developed in a laboratory without the need for a darkroom.

Here we share a variation of this process, developed in association with St Andrew's University [2], that can be used in place of UV beads for teaching about ultraviolet light and sunscreens.

Background

Sun cream protects our skin from harmful damage caused by ultraviolet radiation (UV). Exposure to UV light can result in molecules gaining sufficient energy for bonds to be broken. When UV light breaks bonds, free radicals are formed. Free radicals have unpaired electrons and, as a result, are highly reactive.

Sun cream contains compounds that absorb the UV light so that free radicals are not formed, therefore reducing/preventing damage to the skin. This experiment demonstrates the absorption of UV light using different strengths of sun cream against a control.

It uses a light sensitive solution (based on that used in the cyanotype photographic process) which changes colour from green to dark blue on exposure to UV light.

You will need

- Ethanedioic acid solution (8 g per litre)
- Potassium hexacyanoferrate III solution (30 g per litre)
- Iron III nitrate solution (12 g per litre)
- Petri dishes (or beakers)
- Source of UV light
- Sun cream
- Bottle wrapped in aluminium foil for the combined reagent
- Colorimeter

Health & safety

Iron III nitrate and potassium hexacyanoferrate III are irritant to skin, eye and respiratory system while ethanedioic acid is harmful if swallowed or in contact with skin. Avoid raising dust when making up solutions and wear eye protection and possibly gloves. The solutions are of low hazard.

Preparation

1) Make up the three solutions to the concentrations given above. For each test, you need about 20 cm^3 to cover the bottom of the Petri dish, so for 3 samples and a control you will need:
   - 40 cm^3 of ethanedioic acid solution
   - 1 cm^3 of potassium hexacyanoferrate III
   - 40 cm^3 of Iron III nitrate solution
2) Put 40 cm^3 of the ethanedioic acid solution in the light-proof bottle.
3) Add 1 cm^3 of the potassium hexacyanoferrate III to the oxalic acid solution.
4) Add 40 cm^3 of iron III nitrate solution to the reagent bottle and swirl to mix.
5) If using Petri dishes, wrap the bottom half of each in aluminium foil to prevent light coming in through the side. (Or use any other method to light-proof it).
6) Leave one of the lids untouched and apply sunscreen to the other three. Try to ensure you add the same amount of sunscreen in each case.

The experiment

1) Pour about 20 cm^3 of the combined reagent into each Petri dish, replace the lids and then expose to the light source.

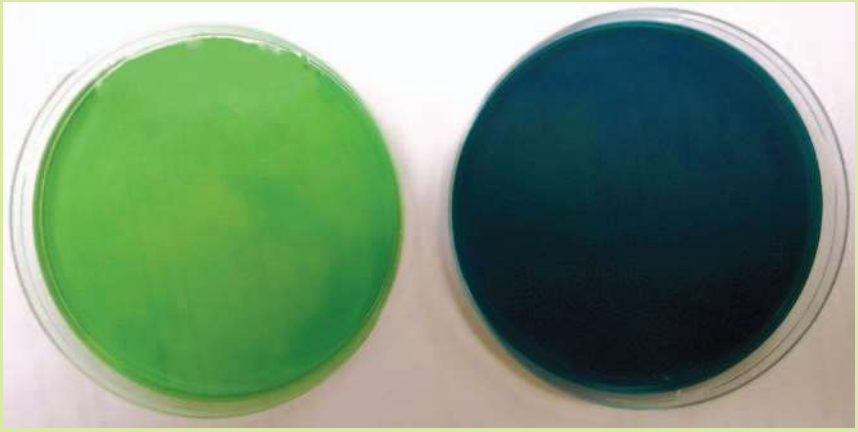


Figure 1 *- The colour changes.*

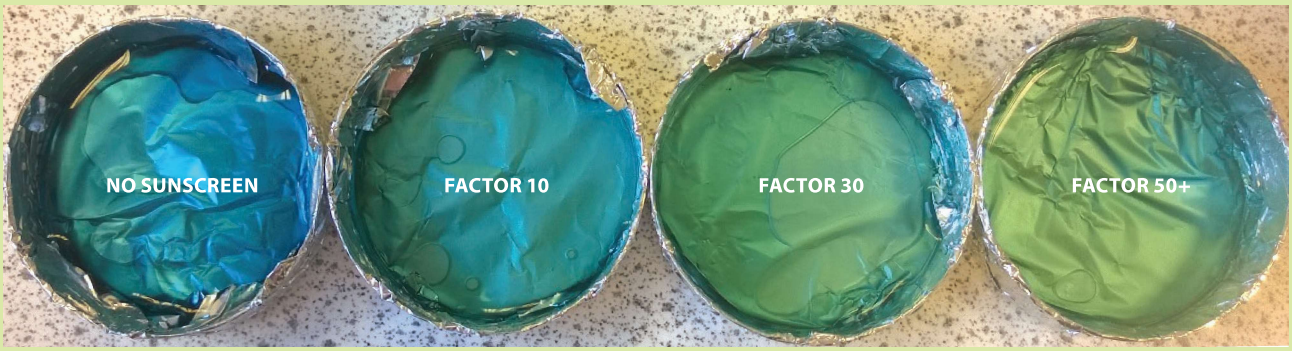


Figure 2.

The easiest way to make sure they all receive the same level of exposure is just to put all of them on the same window ledge.

2) Within a minute or two, depending on the light, you will see a dark blue colour appearing. The more UV light the dish is exposed to, the darker blue the solution will become (Figure 1).
3) In order to get some quantitative data, after a set time (which will be determined by the particular conditions) remove the dishes from the light source and transfer 3 cm^3 samples of each solution to cuvettes for reading in a colorimeter. Make sure you stir the solutions before taking the sample as the Prussian blue is insoluble and actually forms a suspension of very fine particles. The colorimeter should ideally be using a yellow filter. If using the Mystrica colorimeter, select the red LED.

Results

The bases of small Petri dishes were covered with aluminium foil to prevent light leakage.

The lids were covered as follows with as even a layer of sunscreen as possible with fingers using a 'blob' the size of a small pea. No sunscreen; Sainsbury's Factor 10, Sainsbury's Factor 30, Nivea Factor 50+ (Figure 2).

10 cm^3 of solution was placed into each Petri dish and it was placed in the dark prior to exposure while the other samples were prepared.

Coating	Absorbance
No Sunscreen	2.27
Factor 10	1.665
Factor 30	1.340
Factor 50+	1.137

***Figure 3** - The result table.*

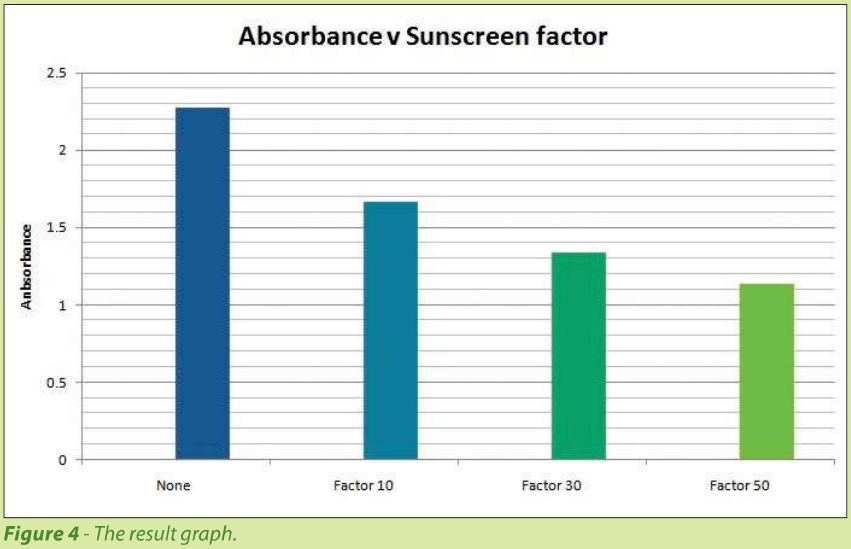


***Figure 4** - The result graph.*

All 4 Petri dishes were placed on the same windowsill for 2 minutes and then removed to more subdued lighting for analysis.

3 cm^3 from each Petri dish was transferred to a cuvette using a Pasteur pipette and the absorbance was taken using a Mystrica colorimeter with the blue LED (465 nm).

The results (Figure 3 and 4) clearly show that increasing the factor of the sunscreen reduced the amount of UV light reaching the solution.

Discussion

In 1842, William Herschel invented a photographic process using iron salts like this. It was called the cyanotype process and was very successful for a short period of time until the more sensitive silver emulsions were invented. The pictures produced are monochrome in shades of blue - from where we get the word blueprint.

The colour is known as Prussian Blue since it was first isolated in Germany. Prussian Blue is essentially iron(III) hexacyanoferrate(II) but there exists a whole range of such iron blues, having compositions which depend on their precise method of preparation. At the molecular level, they all have in common a characteristic cubic structure, but this lattice can accommodate variable amounts of water and metal ions within it, so formulae range from $KFe[Fe(CN)_6].5H_2O$ to $Fe_4[Fe(CN)_6]_3.15H_2O$.

Interaction of light with the ethanedioate ions leads to their oxidation and releases carbon dioxide and an electron (equation a) which then reduces Fe(III) to Fe (II):

a) $C_4H_4O_6^{2-} + hv = 2CO_2 + 2C(OH_2) + 2e^-$
b) $Fe^{3+} + e^- = Fe^{2+}$

The Fe(II) formed combines with CN^- present in the solution to form the complex $[Fe(CN)_6]^{4-}$ which, in turn, gives the insoluble blue Prussian blue, $Fe(III)_4[Fe(CN)_6]_3$:

c) $Fe^{2+} + 6\,CN^- = [Fe(CN_6)]^{4-}$
d) $[Fe(CN_6)]^{4-} + 4\,Fe^{3+} = Fe(III)_4[Fe(CN_6)]_3$

Turner *et al* [3] have determined that the cyanotype reagent responds to all three sections of the UV spectrum, A, B and C as well as to violet light to some degree.

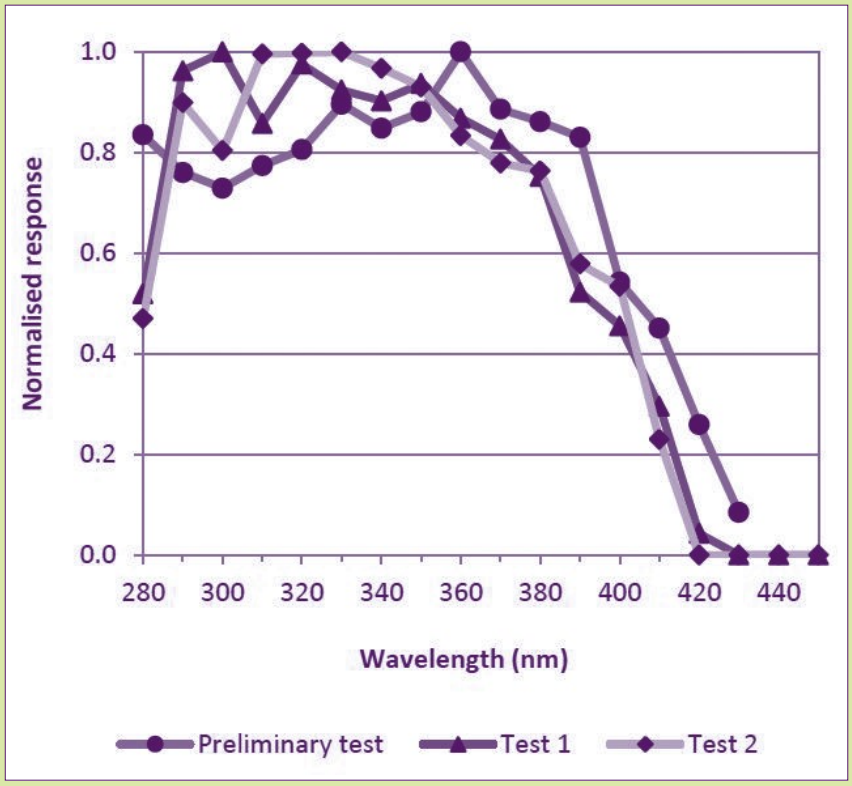


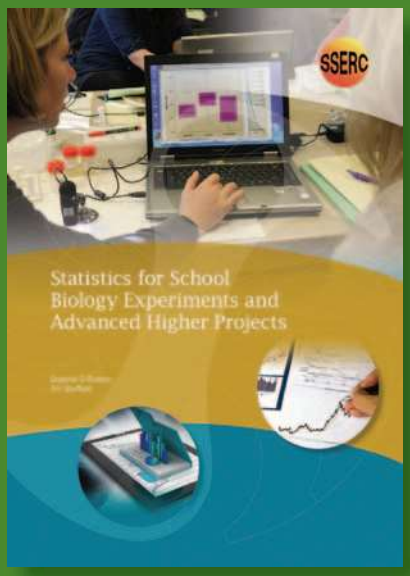
Figure 4 *- Sensitivity of cyanotype paper: Turner et al [3].*

References

[1] SSERC Bulletin, **234**, http://www.sserc.org.uk/index.php/bulletins226/2010/234.
[2] Thanks to Iain Smellie and Megan Russell at St Andrews University for developing this particular recipe for the solution.
[3] From Ultraviolet to Prussian blue: A spectral response for the cyanotype process and a safe educational activity to explain UV exposure for all ages. Turner, J, Parisi, AV, Downs, N and Lynch, M. University of Southern Queensland, Toowoomba, Australia. https://www.academia.edu/8928524/From_Ultraviolet_to_Prussian_blue_A_spectral_response_for_the_cyanotype_process_and_a_safe_educational_activity_to_explain_UV_exposure_for_all_ages.

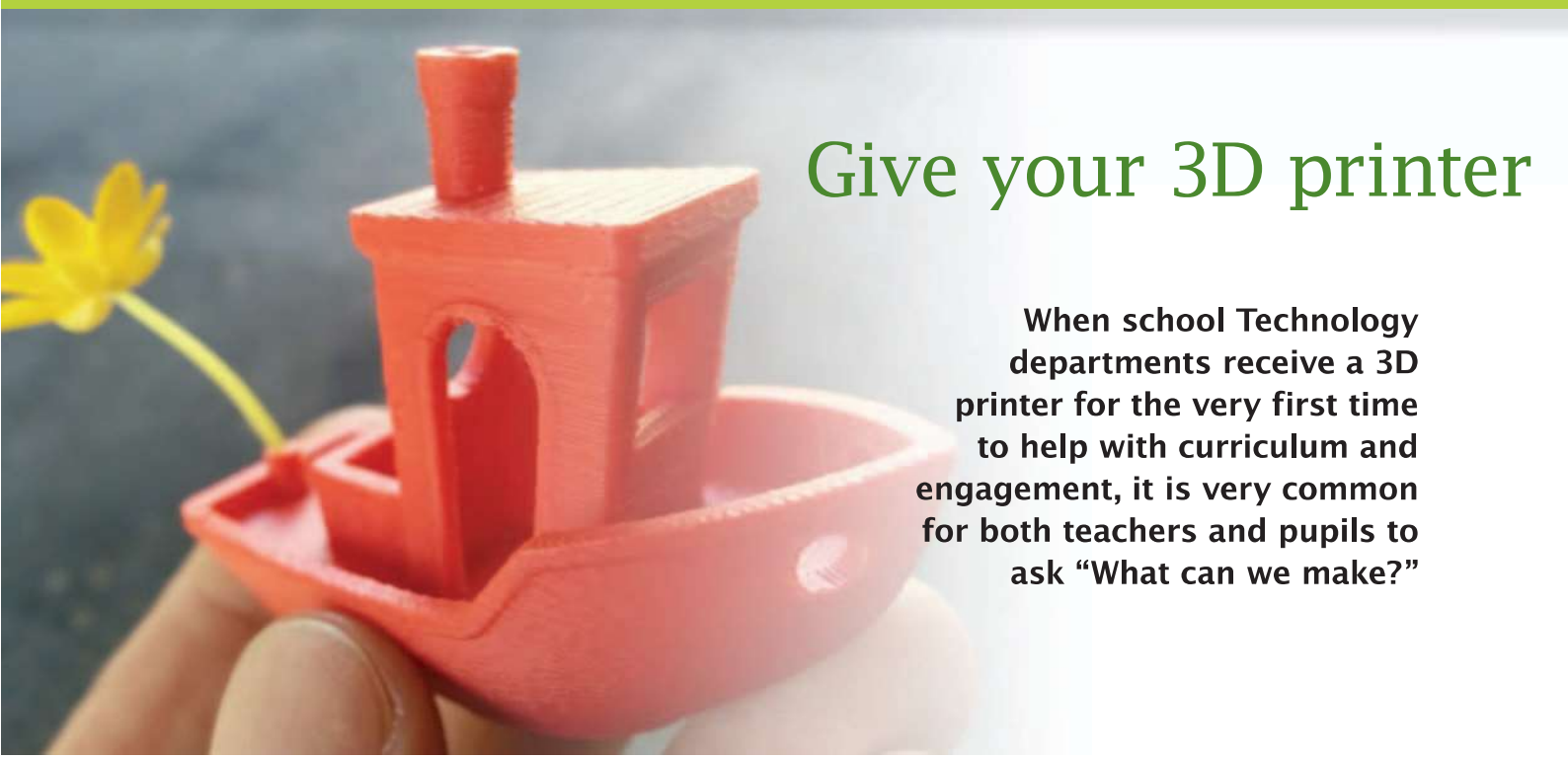
Coming soon....

In a recent issue of the Bulletin (Issue 250, Spring 2015) we announced the publication of a new guide entitled 'Advanced Higher Biology Project investigations' written by Jim Stafford.



We are delighted to say that Jim has recently teamed up with Professor Graeme Ruxton from St Andrew's University to produce a new guide entitled 'Statistics for School Biology Experiments and Advanced Higher Projects'.

As was the case for Advanced Higher Biology Project investigations, a copy of this new, exciting resource will be sent to all schools and colleges in the near future. Further copies of the guide will be available through the SSERC website.



Give your 3D printer

When school Technology departments receive a 3D printer for the very first time to help with curriculum and engagement, it is very common for both teachers and pupils to ask "What can we make?"

Figure 1 *- Benchy boat model can be produced in any colour (image © Creative-Tools.com).*

Even for more experience departments who are familiar in producing models for students it is important to regularly put their 3D printers through check tests (like you would M.O.T. your own car.) This fantastic little scale model (Figure 1) has been designed by Creative-Tools.com to be quickly produced (at SSERC our first attempt took only 3 hours to complete before the support material was then washed off) and economical with the amount of material used (we calculate each 1:1 model we make costs around £3 to manufacture, including electricity!).

The 3D Benchy boat model can be produced in any colour of your choice and has also been designed to be suitable for use with both high-resolution 3D printers and also 3D printers that do not use support materials when printing. The plans and files from the 3DBenchy website are completely free of charge and you are encouraged to share your department's results on social media using the tag *#3DBenchy*.

Ensuring your 3D printer settings are accurate is vital when producing student models and when confidently forecasting both manufacture times and costs of production. The 3 simple steps for the "jolly torture test" allow all of these common issues to be analysed by:

1) Download the 3DBenchy STL file for free at www.3DBenchy.com/download.
2) Use the STL file to produce the model on your department 3D Printer using your own choice of colours and materials.
3) Measure the various aspects of your model using callipers and a protractor to gauge accuracy and success!

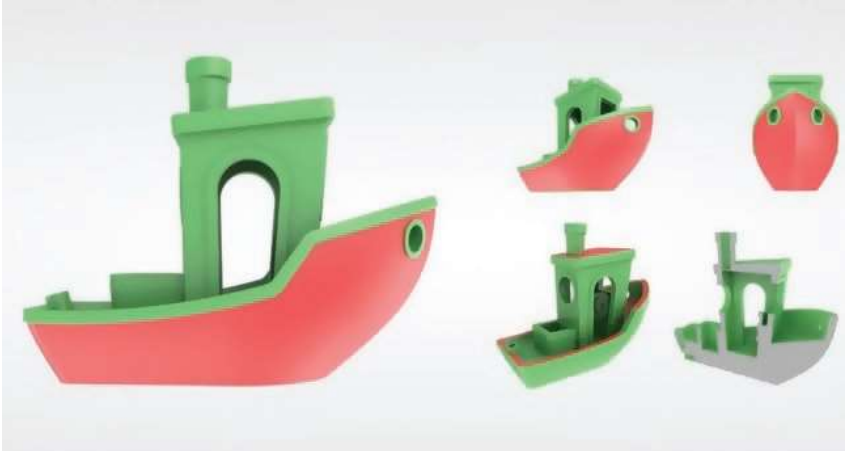


Figure 2 *- Image © Creative-Tools.com.*

There are many different sizes, angle and surface finish accuracy tests that can now be applied to your own model (even more if you are lucky to possess a high-resolution 3D printer) and each test can very quickly tell you if one or more of you settings are inaccurate or require adjustment (Figure 2).

the jolly torture test!

Figure 3 *- The elevation and comparison in size with a 20p.*

Figure 4 *- The end elevation and angle of the model front.*

How this process helped us at SSERC

Using the 3DBenchy model with our own 3D printer at SSERC allowed us to identify a breakage in the support material supply tube (Figure 6).

Because of this we were able to suspend manufacture of other products as it would have cost us lots of time and printer material that would not hold together (shown in Figure 5).

Figure 5 *- The support material blockage results.*

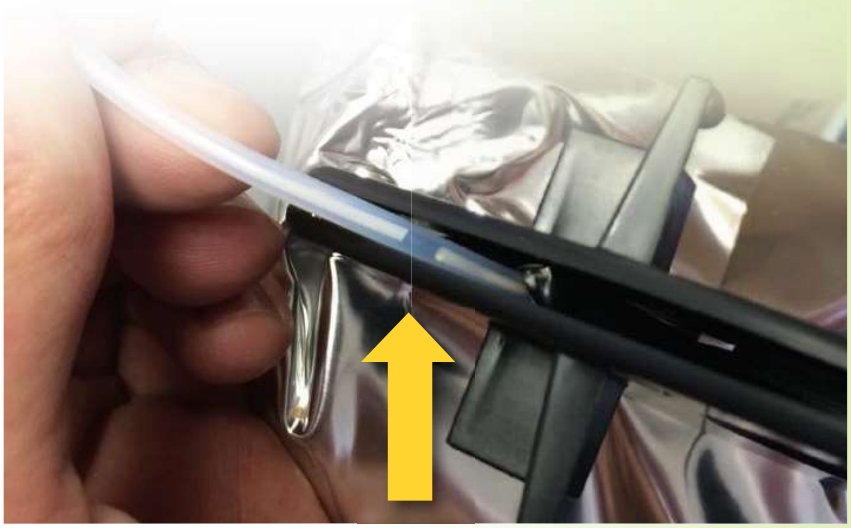
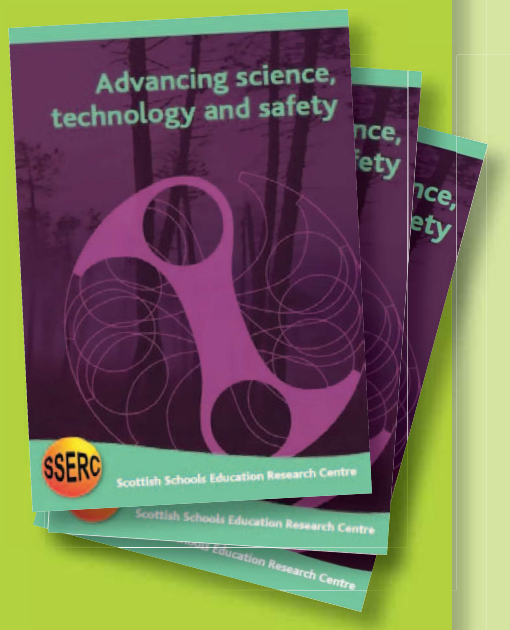


Figure 6 *- The breakage in the support material supply.*

How are we doing?

SSERC is fortunate to receive funding from a range of different sources. The Scottish Government has for a number of years provided support for many of our professional development programmes and as we reported in the previous issue of the Bulletin the government has offered further support for our professional development activities across the primary and secondary sectors. As we come to the end of one tranche of funding and the start of another we have been reviewing some of the statistics related to our CPD programmes.

According to the Scottish Government's Statistical Bulletin Education Series (February 2015) there are 362 local authority secondary schools in Scotland and during the period April 2012-March 2015 we have had representation on one or more SSERC courses from the 359 of them; just 3 more to go...!



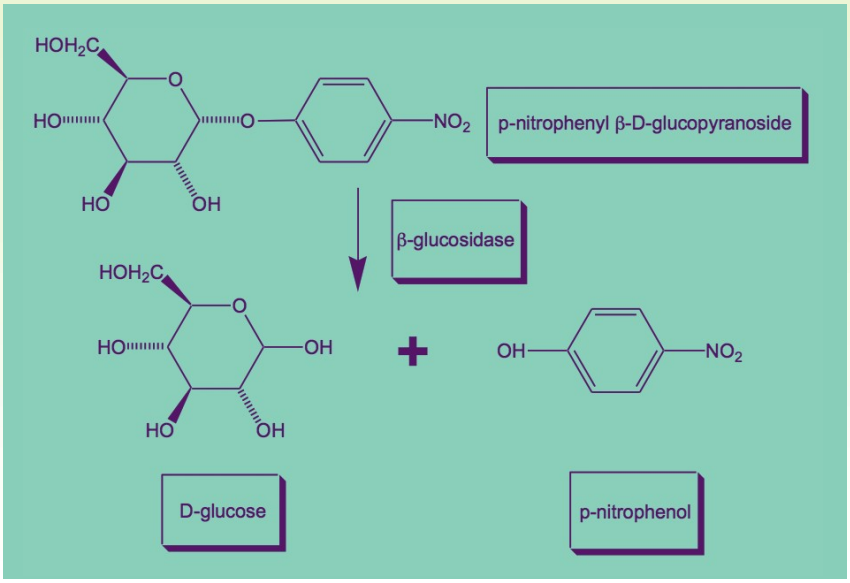
Kinetic studies with

As mentioned in a recent article in the SSERC Bulletin [1] the Biology Team in SSERC is always on the look-out for 'good' enzyme systems to support the new Higher and Advanced Higher qualifications in Biology and Human Biology [2-3].

Robust enzyme assays should ideally meet a number of criteria, for example:

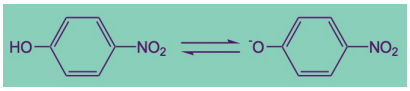
- it should be possible to monitor the change in either product or substrate concentration (preferably product)
- the effects of pH and temperature on enzyme rate should be minimised
- there should be a convenient method for measuring initial reaction rates
- the initial reaction rate should be proportional to enzyme concentration.

Many enzymes meet the above criteria and in this article we explore the merits of β-glucosidase which is found in both prokaryotic and eukaryotic systems and has been shown to play important roles in a variety of biochemical processes. In particular, β-glucosidase is capable of hydrolysing the β-glucosidic linkages of disaccharides, oligosaccharides or conjugated glucosides and it is this property that is utilised in the assay system described here. Typically, both substrates and products of reactions involving β-glucosidase are colourless and so they do not lend themselves to assays involving colorimetric determination.
To overcome this problem the substrate of choice for reactions in the school/college laboratory is likely to be 4-nitrophenyl β-D-glucopyranoside (also called p-nitrophenyl β-D-glucopyranoside or p-nitrophenyl β-D-glucose).



The enzyme reacts with the substrate to produce glucose and p-nitrophenol as shown above.

In solution p-nitrophenol exists in 2 forms *viz* the protonated form (which is colourless) and the anionic form (which has a yellow-green colour); the pK_a for the following equilibrium has been reported to be 7.4:



Consequently in solutions at pH 7.4 equal amounts of the protonated and anionic forms will be present. In order to take advantage of the coloured nature of the anionic form, the enzyme assay described in the following sections is carried out at pH 7.4.

Materials and methods

The enzyme, β-glucosidase, and substrate, p-nitrophenyl β-D-glucopyranoside, can both be obtained from Sigma Aldrich (www.sigmaaldrich.com/).

All solutions should be prepared using a phosphate buffer (0.2 mol dm^{-3}, pH 7.4). Stock solutions of the enzyme (β-glucosidase, 1 mg in 10 cm^3 phosphate buffer) and substrate (p-nitrophenyl β-D-glucose, 2.5 x 10^{-2} mol dm^{-3}, prepared in phosphate buffer) will need to be provided.

The change in colour should be measured at, or close to, 405 nm. Such a choice of wavelength will be problematic for many colorimeters used in schools but it should noted [4]

β-glucosidase

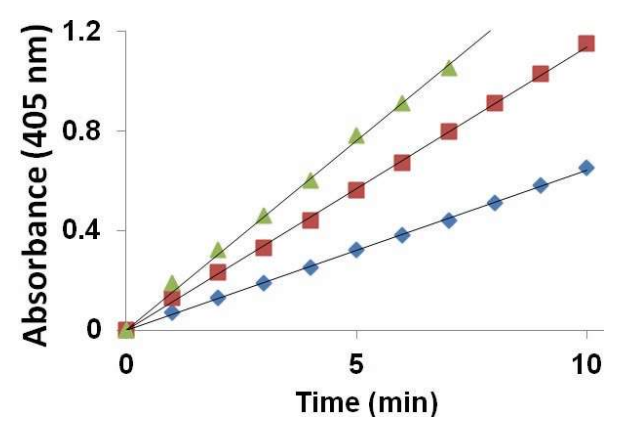


Figure 1 *- Effect of increasing enzyme concentration on the rate of breakdown of p nitrophenyl β-D-glucose by β-glucosidase: ▼ 0.25 cm³ of enzyme stock, ■ 0.5 cm³ of enzyme stock, ▲ 0.75 cm³ of enzyme stock. Further details are given in the text.*

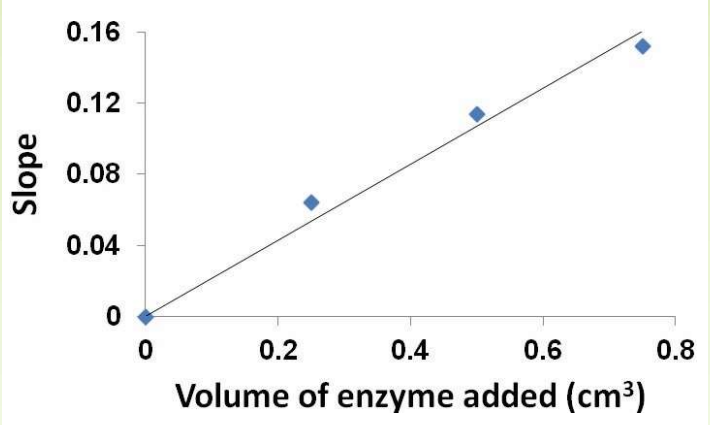


Figure 2 *- Slopes of the plots shown in Figure 1 as a function of added volume of β-glucosidase.*

that during 2014 SSERC was able to provide a spectrophotometer for each local authority and this would be an ideal piece of equipment to use for such experiments.

The experimental protocol

Please note - when dispensing solutions it is important that cross-contamination is avoided!

1) In a **clean** cuvette mix substrate (0.25 cm³) and buffer (2.0 cm³).
2) Place into the colorimeter and set the absorbance at 405 nm to read 0.00. This will be your t = 0 reading.
3) Now add enzyme (β-glucosidase) 0.25 cm³.
4) Mix quickly and measure and record the absorbance at 405 nm every minute for 10 minutes or until the absorbance is > 1.2.
5) To measure the effect of enzyme concentration on the rate of reaction repeat steps 1-4 but use 1.75 cm³ of buffer and 0.5 cm³ of enzyme (don't forget substrate (0.25 cm³)!).
6) A further increase in enzyme concentration can be achieved by using 1.5 cm³ of buffer and 0.75 cm³ of enzyme.

Results and discussion

Typical data sets for the 3 different enzyme concentrations are shown in Table 1 and plotted in Figure 1.

As can be seen there is an increase in production of the product, p-nitrophenol, as the volume of enzyme present is increased from 0.25 cm³ (▼) to 0.5 cm³ (■) with a further increase as the enzyme volume is increased to 0.75 cm³ (▲).

The plots in Figure 1 represent a measure of enzyme activity. Under the conditions of the experiments the linear relationship between absorbance and time means that it is possible to calculate the slopes of the lines in Figure 1 and present these as a function of enzyme volume and this is shown in Figure 2.

	Absorbance at 405 nm		
Time (min)	Volume enzyme 0.25 cm³	Volume enzyme 0. 5 cm³	Volume enzyme 0.75 cm³
0.0	0.00	0.00	0.00
1.0	0.07	0.13	0.19
2.0	0.13	0.23	0.32
3.0	0.19	0.33	0.46
4.0	0.25	0.44	0.60
5.0	0.32	0.56	0.78
6.0	0.38	0.67	0.91
7.0	0.44	0.80	1.05
8.0	0.51	0.91	
9.0	0.58	1.03	
10.0	0.65	1.15	

Table 1 *- Effect of increasing β-glucosidase concentration on the absorbance at 405 nm in a cuvette of 1 cm pathlength. All solutions were prepared on 0.2 mol dm⁻³ phosphate buffer at pH 7.4. Total volume in the cuvette was 2.5 cm³ and the initial substrate concentration was 2.5 x 10⁻³ mol dm⁻³. See text for more details.*

Solution N°	Volume stock p-nitrophenol (cm^3)	Volume buffer (cm^3)	Concentration of p-nitrophenol ($mol\ dm^{-3}$)	Absorbance (405 nm)
1	0.0	10.0	0	0.00
2	1.0	9.0	2×10^{-5}	0.21
3	2.0	8.0	4×10^{-5}	0.40
4	3.0	70	6.0×10^{-5}	0.63
5	4.0	6.0	8.0×10^{-5}	0.77
6	5.0	5.0	1.0×10^{-4}	0.98

As described the β-glucosidase enzyme system is convenient for showing the relationship between rate of reaction and the concentration of enzyme. Such a robust system lends itself to a range of investigative work. We acknowledge that both the substrate and enzyme are not 'cheap items' but it should be remembered that quite small amounts are needed for the assay.

The Biology Team within SSERC has been asked on a number of occasions if we can provide data sets which could be used to support students following Higher Biology and Higher Human Biology programmes. Providing students with the data in table 1 and inviting them to generate and explain the plots in Figures 1 and 2 may be a useful exercise.

Extension activity

There is no need for students to calculate the concentration of p-nitrophenol present in the cuvette although you may wish them to do so for the sake of completeness. In order to make such calculations it will be necessary for students to produce or interpret a standard curve of the absorbance of p-nitrophenol solution as a function of concentration. This can be conveniently achieved as follows:

1) Prepare a stock solution of p-nitrophenol in 0.2 mol dm^{-3} phosphate buffer (pH 7.4) at a concentration of 2×10^{-4} mol dm^{-3}.
2) Make dilutions of the stock p-nitrophenol solution as per the table above. **Note** all dilutions should be made using 0.2 mol dm^{-3} phosphate buffer (pH 7.4).
3) Measure the absorbance of these solutions at 405 nm (or as close to 405 nm as your colorimeter will allow).
4) Use solution 1 to zero the colorimeter at 405 nm.

Plots of absorbance against concentration of p-nitrophenol (see Figure 3) would allow conversion of the data in Figure 1 into plots of product concentration as a function of time and the generation of slopes with 'more meaning'.

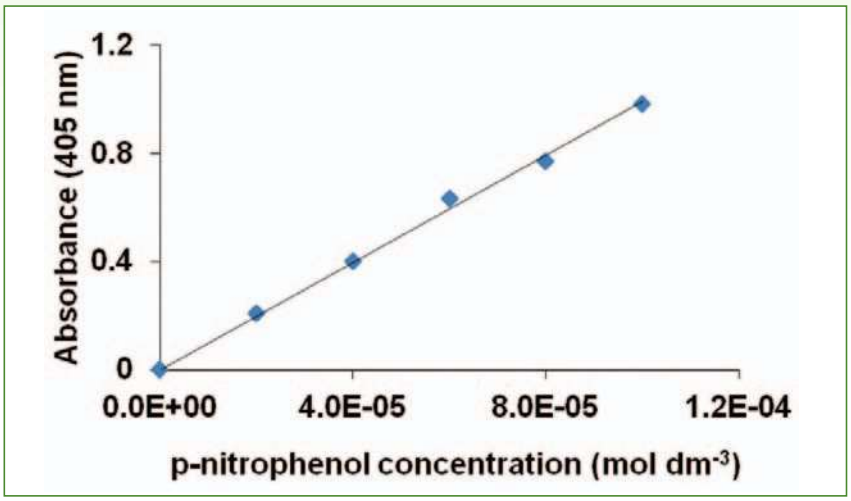


***Figure 3** - Absorbance (405 nm) of p-nitrophenol as a function of concentration. All solutions were prepared in 0.2 mol dm^{-3} phosphate buffer at pH 7.4. Cuvette pathlength was 1.0 cm.*

Health and safety

β-glucosidase, like many enzymes, is a sensitiser. When making up solutions, avoid raising dust, wear gloves and perhaps a mask. p-nitrophenol is harmful if swallowed, inhaled or in contact with skin. To make up solutions, wear eye protection and possibly gloves. The solutions are of low hazard.

References

[1] Fun with phosphatase (2015) SSERC Bulletin, **251**, 6-8.
[2] SQA (2014) Higher Biology Course Support Notes - can be downloaded at www.sqa.org.uk/files_ccc/CfECourseUnitSupportNotes_Higher_Sciences_Biology.pdf (accessed July 8th 2015).
[3] SQA (2014) Higher Human Biology Course Support Notes - can be downloaded at www.sqa.org.uk/files_ccc/CfECourseUnitSupportNotes_Higher_Sciences_HumanBiology.pdf (accessed July 8th 2015).
[4] A present for everyone (2014). SSERC Bulletin, **247**, 2.

REVIEWS

Technology books

Using books as learning and teaching resources is extremely valuable to both teachers and pupils. Ensuring that your Technical Education department's books are up to date though has proven difficult in the past with the speed of change in the various subjects and the unit costs of each book.

As a result of the changes to the new *CfE Higher* and *Advanced Higher Design and Manufacture* we present an occasional series of popular school book reviews.

Manufacturing Process for Design Professionals, Rob Thomson, Thames & Hudson (London), 2007

This book can be a valuable addition to your department with its large colour glossy pictures and in-depth detail on a wide range of Design & Manufacture manufacturing processes. Whilst the book is aimed at design professionals in industry, the language and explanations used are suitable for pupils studying from National 5 level onwards. This makes it a great resource for manufacturing investigation and design assignments.

Also featured consistently are the various products than can be manufactured using different processes and this feature will hopefully allow pupils to consider and reflect on it being possible to make a similar product using a multitude of methods.

Drawing for Product Designers (Portfolio Skills), Kevin Henry, Laurence King (London), 2012

Drawing for Product Designers offers the potential to develop manual graphics skills of both teachers and pupils in the classroom. This tutorial tasks target step-by-step learning and offers great visual and written detail on how to use different common classroom media resources to achieve a wide range of material effects and product looks.

Using different graphics pens and pencils commonly found in the classroom the book encourages repetition and time being invested to make one-off drawings even better or just raising the overall standard of a whole graded folio.

So if you feel the need to sit down over the summer holidays and spend some time developing your skills for classroom demonstrations or even updating impressive resources for displays on your classroom walls, this book is the ideal starting point.

New name for the Torula food yeast (*Candida utilis*)

Candida utilis was the subject of a previous Bulletin article [1]. It is a yeast of industrial interest for the production of single cell protein. It is suitable for work in schools. The control measures for working with microorganisms listed in Appendix 2 of *Safety in Microbiology* [2] are suitable and sufficient to control any risk associated with *Candida utilis*.

C. utilis has now been renamed as *Lindnera jadinii*. Fungi (including yeasts) are classified primarily by their structures associated with sexual reproduction. However many fungi only reproduce asexually and some fungi produce both sexual and asexual states. *C. utilis* shows phenotypic similarities to *L. jadinii* and has now been shown to share a high percentage of its DNA with *L. jadinii*. As *C. utilis* has not been observed to reproduce sexually it is now considered to be the asexual or anamorphic state of *L. jadinii*.

Cultures of *L. jadinii* (code NCYC 707) can be obtained from the National Collection of Yeast Cultures (NCYC) [3]. NCYC provide cultures free of charge to schools.

Reference

[1] *Candida utilis* - the Torula food yeast, SSERC Bulletin, **247**, 2014, http://www.sserc.org.uk/images/Bulletins/247/SSERC%20bulletin%20247_web_12_12.pdf.
[2] Safety in Microbiology (2012), SSERC, www.sserc.org.uk.
[3] National Collection of Yeast Cultures (NCYC) http://www.ncyc.co.uk/.

Health & Safety round-up

Check your tubing

Remember to keep an eye on your Bunsen tubing. There is no problem using the 'traditional' orange rubber tubing but you do need to check it regularly as it has a tendency to perish and crack. We have had a recent report of some tubing becoming 'sticky' as well.

If you use neoprene tubing, make sure you don't have tubing that is too stiff. This can be unsafe, causing Bunsen burners to fall over. If you have the tubes with thickened ends where they attach to the gas tap and the Bunsen, these will still need careful checking as they can break at the junction of this thicker section.

Thermit

The thermit reaction is an excellent, spectacular reaction that can, as long as you carry it out carefully, be an exciting addition to your demonstration repertoire.

We heard recently though of an incident involving this. The procedure was carried out as recommended on our website but the mixture did not ignite. The teacher decided to leave it and try again another day. 15 minutes later at the end of the lesson the pupils were filing out and the teacher saw they were passing quite close to it so decided to move the safety screens to be absolutely sure they wouldn't be at any risk. She took hold of the top of the screen and at that moment the mixture ignited, throwing out sparks and as a result the teacher got some nasty burns to her hand.

We have not come across another instance of this sort of a delay with the thermit reaction but to be on the safe side, if your reaction mixture doesn't ignite and you are going to leave it for another day, squirt some water onto the top from a wash bottle to make sure it won't go off.

YouTube and others

There are lots of great-looking experiments on YouTube and other websites and you might well be tempted to give them a go. There are various problems with this. Even if the experiment is being carried out by a competent chemist - and that is often not the case - not only might there not be any health and safety advice given, even if there is it may well not be applicable in Scotland.

New experiments are a great idea. But if you see a new one, please get in touch with us before you try it so we can check it out for you.

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