SSERC *Bulletin*

Ideas and inspiration supporting science and technology for all Local Authorities

No. 262 - Spring 2018

Background photo: Les Pounder/flickr.com

 - ISSN 1759-1082

Copper and Le Chatelier

There is a well-known experiment that is used to great effect to show the effect of heat on the position of an equilibrium. The solution used contains cobalt chloride and hydrochloric acid resulting in an equilibrium between cobalt ions that have either pink aqueous or blue chloride ligands.

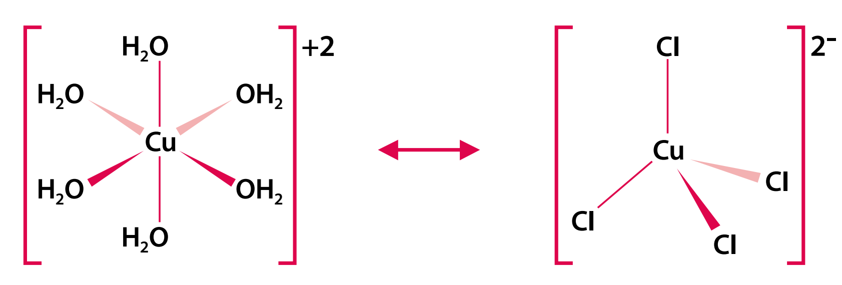


***Figure 1** - Structures of water and chloride complexes of copper.*

Cobalt, however, is significantly carcinogenic so here is a safer version using copper rather than cobalt: one that students can carry out themselves with negligible risk.

Background

The effect of temperature on the position of an equilibrium can easily be seen by observing the colour changes of the octahedral hexaaquacopper(II) cation and the tetrahedral tetrachlorocopper(II) anion as the sample is moved from a low temperature to a high temperature (see Figure 1).

The change in co–ordination number from 6 to 4 comes about as a result of the larger size of the chloride ion ligand resulting from the complex ion shape changing from octahedral to tetrahedral.

The colour of the complex changes from blue to green (In fact the chloride complex is actually a yellow-brown but is rendered green due to residual blue).

The complex changes from a cationic complex ion (2^+, unaffected by water) to an anionic complex ion 2^-, (2^+ countered by 4 x Cl^-). But there is no oxidation state change at all, copper is in the +2 state throughout the reaction.

The change is not as clear as using cobalt but it is certainly observable.

What you will need

- 1.0 M copper(II) chloride solution
- Distilled water
- Saturated sodium chloride solution
- 100 cm^3 measuring cylinder
- 250 cm^3 beaker
- 100 cm^3 beaker of hot water
- 100 cm^3 beaker of iced water

The equilibrium equation can be expressed as follows:

$$Cu(H_2O)_6^{2+}(aq) + 4Cl^-(aq) \longleftrightarrow CuCl_4^{2-}(aq) + 6H_2O(l) \quad \Delta H +ve$$

Blue **Green**

***Formula 1** - Equilibrium equation.*

Optional

- Hair dryer
- Small square of polystyrene with hole cut in it (diameter of the test tube)

Preparation of the solution

1) Prepare a 1.0 M solution of the copper chloride in the large beaker by dissolving 17.0 g in 100 cm^3 of distilled water.
2) Place 20 cm^3 of the solution in each of three test tubes.
3) Add a few cm^3 of the sodium chloride solution to one tube until the solution turns bright green.
4) Taking this tube and one of your originals as your end points, add a small amount of the sodium chloride solution until its colour is a green/blue - half-way between the two others. (See Figure 2)

The activity

1) Take 2 beakers, one containing boiling (or very hot) water and the other with iced water.
2) Divide your 'balanced' solution between two test tubes and place one in each beaker.
3) Leave for a minute or two and then inspect the colours.
4) Now swap them over and see what happens.

OR

1) Place the polystyrene collar about a third of the way down your test tube.
2) Place the test tube in the beaker of iced water to a depth of about a third its length. At the same time use the hair dryer to heat the top third of the solution above the polystyrene.
3) (The polystyrene is to stop the middle third of the test tube heating up).
4) Observe the colour changes! (See Figure 3)

If desired, test tubes of the solution can be prepared for students to carry out the experiment for themselves.

Figure 2 *- Left to right, Cl, mix, H_2O.*

At Higher level, if they are given the equilibrium equation and the colours of the ions in solution, their observations of the colours at low and higher temperatures can lead them to predict if the ΔH for the forward reaction is positive or negative.

It must be said that the colour changes are not quite as clear as with cobalt chloride, which could perhaps be done as a demonstration to begin or end the lesson, but it is significantly safer.

Figure 3 *- Result of using a hairdryer.*

ENTHUSE Celebration Awards

If you or a colleague attended a professional development course during the academic year 2016-2017 which qualified for ENTHUSE funding (through the National STEM Learning Centre), then you are eligible to apply for recognition via the ENTHUSE Celebration Awards, which are a celebration of the impact of CPD across all STEM subjects.

The awards are presented each year to recognise the impact that teachers, technicians, and support staff have on their students, colleagues, schools, colleges, and peers, as a result of ENTHUSE-supported professional development. Successful applicants, whether individuals or institutions, enrich STEM subjects within the institution, and extend the impact of their work into wider communities.

The categories of Award are:

Individual
- ENTHUSE Award for Excellence in STEM teaching - Primary
- ENTHUSE Award for Excellence in STEM teaching - Secondary
- ENTHUSE Award for Excellence in STEM teaching - FE
- ENTHUSE Award for Excellence in STEM teaching - technicians and support staff

Organisational
- ENTHUSE Award for STEM Primary School of the Year
- ENTHUSE Award for STEM Secondary School of the Year
- ENTHUSE Award for STEM FE College of the Year

Further details about the awards can be found at: https://www.stem.org.uk/enthuse-celebration-awards.

Applications are now open until 1st April 2018.

Liberate your school's micro:bits

In the spring of 2016, Scottish schools were given one BBC micro:bit programmable device for every S1 pupil. The intention was to encourage young people to learn to code. There was an article about the giveaway in SSERC Bulletin 255 [1]. Since then, some schools have given out the micro:bits to pupils, but when we ask teachers what happened to them in their schools, a common reply is, "They're all in a box in the computing department."

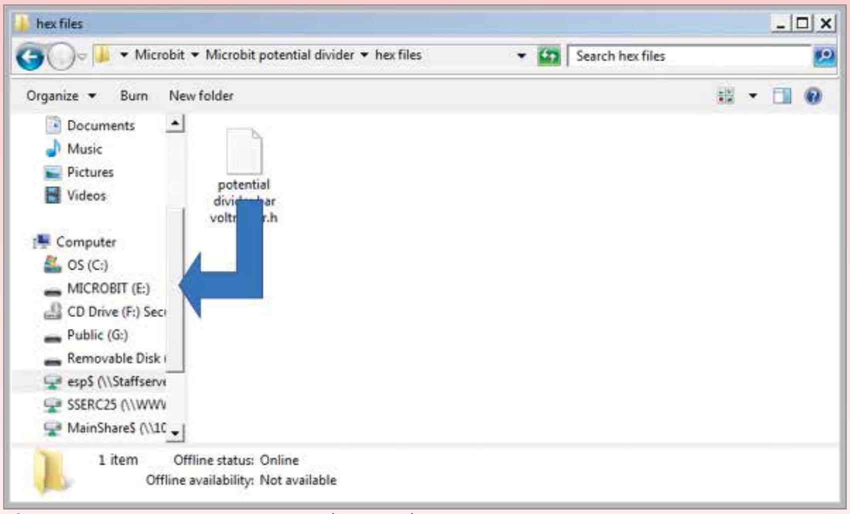


Figure 1 *- Dragging a program on to the micro:bit.*

If this is the case in your school, we're about to suggest that you liberate some of them as they are very easy to use as tools in science teaching. This might not be what was originally intended when micro:bits were given out, but we hope that what we're proposing will be a route towards some pupils coding for themselves.

If you visit the micro:bit area of our website [2], you will see a number of applications that we have devised. There are micro:bit versions of the Road Safety Reaction Timer [3] and the LED optics source [4]. We hope to cover the light gate system in a future Bulletin but the main focus of this article will be the teaching of potential divider circuits.

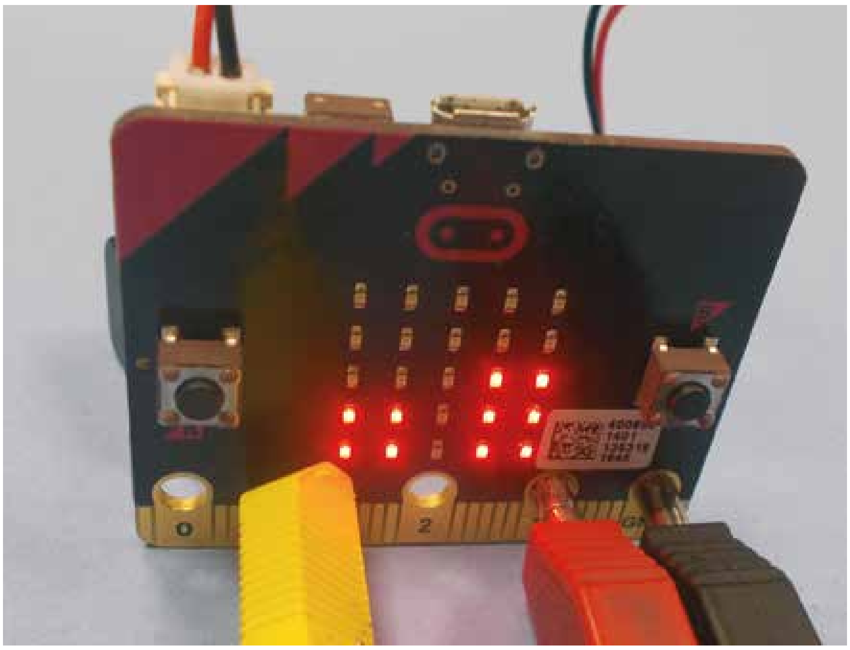


Figure 2 *- Bar voltmeter display.*

To get a micro:bit to run a pre-written program you need to do three things:

- Identify the program file you want to use. This might be one you have downloaded from our website. It will have the .hex file extension.
- Connect your micro:bit to a computer on which there is a copy of the .hex file you are going to use. Your micro:bit should show up as a drive on your computer - MICROBIT (E:) or (D:) or similar.
- Drag the .hex file on to the micro:bit, as shown in Figure 1.

All being well, a yellow LED on your micro:bit should flash. When it stops flashing, your micro:bit is programmed. It can only hold one program at a time.

Python files

Files with the .py extension are also program files, written in a language called Python, and are available from our website for those who want to study or tweak our programs. They can be adapted using an application called an editor, then "flashed" on to a micro:bit. Flashing is done by the editor. It converts the Python program into a .hex file and puts it on the micro:bit. This is the correct way to program the micro:bit using a .py file. If you drag and drop them, they will not run.

Once a program is installed on a micro:bit, it remains there until another is put on. The micro:bit can be powered via the lead that connects it to the computer, but most of the time you are likely to use it with a battery pack.

Go to the micro:bit area of the SSERC website [2]. Download the Potential Divider material. Extract it from the .zip file and drag the file *pd bar voltmeter.hex* to your micro:bit as described above. If you have any difficulty locating or extracting the file, please get in touch.

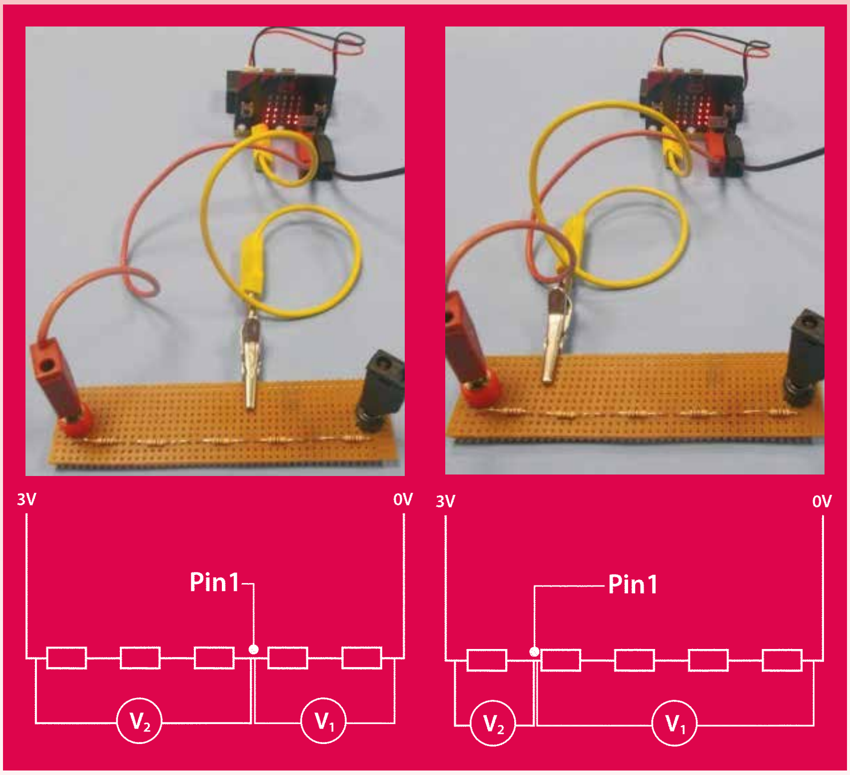


Figure 3 *- Resistor chain potential divider.*

Forgetting for a moment about the 4 mm leads in the picture, Figure 2 shows the sort of display you should see on your micro:bit.

The two columns of LEDs represent voltages across components in a potential divider. The connections, marked 0,1,2,3 V and GND, are called pins.

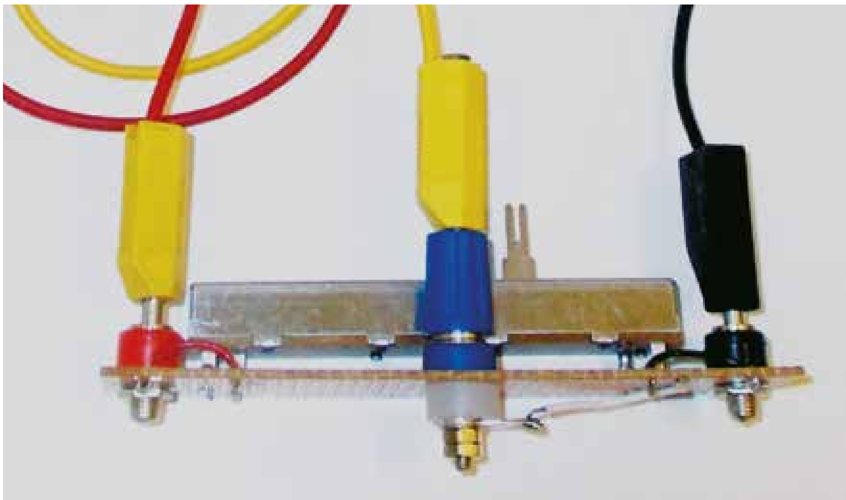


Figure 4 *- Resistor chain replaced by potentiometer.*

Figure 3 shows a simple potential divider circuit made up of a chain of 5 identical resistors. Whilst ours is soldered to strip board, we have also successfully made them using block connectors.

The ends of the potential divider are connected to GND and 3 V on the micro:bit. This means that there is a potential difference of 3 V across the resistor chain. Pin 1 on the micro:bit is connected to a lead that can be clipped to different points between the resistors. The micro:bit is programmed to read the voltage between Pin 1 and GND (0 V) and to display a bar proportional to this voltage on the right of its display. The bar on the left shows the potential difference between Pin 1 and the 3 V pin. The heights of the bars represent V1 (right bars) and V2 (left bars) in Figure 3.

It is thus fairly easy for pupils to investigate the relationship between resistance and "share of the volts".

An optional next step could be to connect a sliding potentiometer to the micro:bit (Figure 4).

Figure 5 shows a potential divider consisting of a 1 kΩ resistor and an LDR. The connection to Pin 1 is made to the junction between the LDR and resistor. The other connections are to GND and 3 V. The LDR's resistance increases when it is dark. If we cover the LDR, there is therefore an increase in the share of the volts across it which will be indicated on the micro:bit display. Although the resistance of the fixed resistor has not changed, its share of the volts must decrease if the LDR's share has increased.

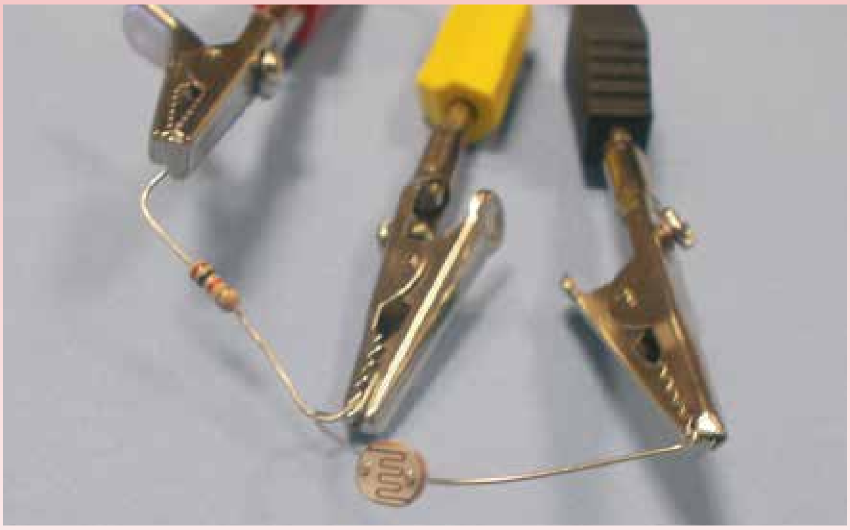


Figure 5 *- LDR in potential divider.*

Capacitors

If you replace the LDR with a capacitor, say 100 microFarads, and the resistor with one of resistance 220 kΩ, it is possible to get data to enable students to plot a charging graph by finding the time to reach a particular voltage. Voltage could be measured in "bars", or you could convert. In our program, 1 bar = 0.65 V.

The micro:bit is also capable of "writing a voltage" to a pin. This means that there will be a potential difference across any component connected between the pin and GND. The program used here writes a voltage of 3 V to Pin 2, but only when the voltage across the right hand component in the potential divider equals or exceeds 4 bars.

Figure 6 shows an LED and protective resistor connected using a block connector. If this is used with a micro:bit running the potential divider program, the LED should come on when the LDR is in darkness. The program is set to make this happen when the voltage at Pin 1 exceeds a voltage determined by the coding. Essentially, it is mimicking a MOSFET circuit. However, the micro:bit is programmable. It is very easy to change the code so that it switches the output device on at a lower or indeed greater Pin 1 input voltage.

These set-ups are intended to help children to understand what happens to the voltages across components in a potential divider. They can then add an output device to make a circuit that actually does something. The next step is to adapt either the circuit or the program.

We are grateful to physics teacher Graham Crawford of Liberton High School in Edinburgh for testing out some of our ideas with his classes and feeding back their suggestions for improvement. A delegate at a recent course reported that he had adapted our light gates program to trigger the "Monkey and Hunter" experiment. We would love to hear from you too if you use the micro:bit.

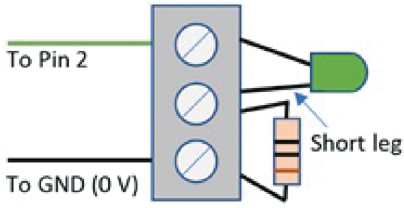


Figure 6 *- Wiring an LED using a block connector.*

References

[1] http://www.sserc.org.uk/images/Bulletins/255/SSERC255p5_6.pdf.
[2] www.tinyurl.com/microbit-sserc.
[3] http://www.sserc.org.uk/images/Bulletins/241/SSERC_bul241_p7.pdf.
[4] http://www.sserc.org.uk/bulletins226/2007/222-autumn-2007/1227-led-source-for-optics242.

SSERC professional development courses

Our professional development courses range from twilight events, day-courses through to residential meetings lasting up to 6 days in total. Our curriculum coverage spans both primary and secondary sectors and we offer events for teachers as part of their career long professional learning, newly qualified teachers and technicians. Many of our events receive funding from the ENTHUSE awards scheme or the Scottish Government.

Courses available for online booking include:

COURSE NAME	RESIDENTIAL?	DATES	CLOSING DATE	SECTOR
Safe Use of Fixed Workshop Machinery (Refresher: March)	No	9 March 2018	23 February 2018	Secondary
Safe Use of Fixed Workshop Machinery (March)	No	21-22 March 2018	27 February 2018	Secondary
Safe Use of Fixed Workshop Machinery (April)	No	17-18 April 2018	3 April 2018	Secondary
Safety in Microbiology for Schools	Yes	25-27 April 2018	23 March 2018	Technicians
Safe Use of Fixed Workshop Machinery (Refresher: April)	No	27 April 2018	13 April 2018	Secondary
Safe Use of Fixed Workshop Machinery (Refresher: May)	No	9 May 2018	20 April 2018	Secondary
Engineering Bench Skills	Yes	17-18 May 2018	20 April 2018	Secondary
Physics Summer School	Yes	9-12 May 2018	6 April 2018	Secondary
Microbiology for Teachers	No	23-24 May 2018	27 April	Secondary
Safe Use of Fixed Workshop Machinery (May)	No	29-30 May 2018	15 May 2018	Secondary
Safe Use of Fixed Workshop Machinery (June)	No	12-13 June 2018	29 May 2018	Secondary
Laboratory Science National 5	Yes	13-15 June 2018	4 May 2018	Secondary
Safe Use of Fixed Workshop Machinery (Refresher: June)	No	15 June 2018	1 June 2018	Secondary
Maintenance of Fixed Workshop Machinery (May)	No	20-22 June 2018	25 May 2018	Secondary
Super Summer Science (Primary)	Yes	21-23 June 2018	25 May 2018	Primary
Biology Summer School	Yes	26-28 June 2018	25 May 2018	Secondary
Maintenance of Fixed Workshop Machinery (September)	No	5-7 September 2018	29 June 2018	Secondary

Game cards.

Synthetic Biology:

Dr. Liz Fletcher [1] and her colleagues at the University of Edinburgh's Centre [2] for Synthetic and Systems Biology (*SynthSys*) have developed a useful resource for students of National 5 and Higher Biology.

Dr Fletcher writes:
Synthetic biology is a new and highly multidisciplinary area of research that is quickly making its mark on our world. We've developed a card game that we hope will help learners to explore the many facets of this exciting, and sometimes controversial, area of science.

Over the past 5 years, the UK Government has invested over £300 million in accelerating the development of so-called synthetic biology. The University of Edinburgh was fortunate to win some of that funding and we are keen to share our excitement about participating in this fast moving area of science.

Synthetic biology is a new area of research that applies engineering principles to biology. Its goal is to (re-)design and fabricate biological components and systems that do not already exist in the natural world. Put another way, it views a living cell rather like a car engine where each component has a defined function; synthetic biologists then use these parts in different combinations to create new 'engines' (or cells) that can have new and improved functions. In theory, we could design and build completely new life forms.

Synthetic biology differs from genetic modification in both scale and ambition. Genetic modification generally refers to the transfer of individual genes from one organism to another; by contrast, synthetic biology aims to assemble, de novo, novel genomes using a set of standardized genetic parts.

Technical breakthroughs in the speed and cost of making DNA has accelerated this area of biology; it is now feasible and affordable to design and synthesize modified chromosomes of plants and microbes. Indeed, Edinburgh is now home to the Genome Foundry, a laboratory that uses robotics to build large stretches of DNA with minimal human input.

The field of synthetic biology is moving fast and has already had some striking successes. For example, researchers reconstructed the complex plant metabolic pathways of the herb Artemisinin and inserted it into yeast. In this way, they could manufacture the antimalarial drug Artemisinin by 'brewing' yeast rather than harvesting plants.

Other projects include engineering microbes to produce higher yields of oils (for biodiesel), novel medicines and brand new types of materials. Yeast is the most commonly used 'biofactory' but plants, algae, bacteria and even human cells can be 're-engineered' for different purposes. Indeed, researchers in our Centre are modifying human cells for use as cell-based treatments for conditions such as Parkinson's disease.

Hundreds of companies have been set up to turn these ideas into products and services. For example, a company called Synpromics, based at the Easter Bush Campus outside Edinburgh, is building tunable genetic controllers to help make gene therapy a reality. The US company Bolt Threads is making spider 'silk' proteins in yeast and then spinning these into fabrics. (You can, at a price, buy a tie made of spider's silk). Others are developing ways to make burgers without cows, by culturing muscle-producing cells in the lab.

For now, of course, much of our work is still very basic biology. Most of our scientists are using synthetic biology as a tool to 'learn by building' - getting deeper insights into how the natural world works by recreating it in the lab.

learning by playing cards

Worksheet for students.

Last summer the Centre was fortunate to host an MSc student, Miss Ellie Powell, who worked to develop some classroom activities to support learning around synthetic biology. Ellie developed the 'What research would you fund?' card game and tested it with local schools. We hope it will educate, provoke and inspire your young people whether doing National 5 or Higher Biology. Synthetic biology is not without its controversies as you might expect for a technology that, at least in theory, seeks to do better than Nature. It raises some difficult questions: Just because we can, should we? Do the benefits outweigh the risks? Are some applications more acceptable that others, and why? How can we regulate such new technologies to protect consumers? Can we prevent this technology from misuse by criminals or terrorists? The card game highlights the importance of not just the science but also the wider social, political and economic environment in which researchers work and governments invest.

Another appealing aspect to synthetic biology is that it is a highly multidisciplinary requiring teamwork among individuals with expertise in biology, engineering, medicine (human and veterinary), computer science, art and design, physics, mathematics, chemistry, information and data science, and (not least) the social sciences. It also reflects an ongoing shift in both academic and industrial research away from subjects taught in traditional 'silos' towards much greater cross-discipline working. Indeed, it is at the interface between disciplines where the greatest innovation happens. As such, it is a great area for exploring teamwork and discussion, whatever the career aspirations of your young people.

I hope I have convinced you that it is worth finding out more about synthetic biology! We'd welcome feedback on the game [3] and if there are other ways we can support your teaching by introducing you to other areas of modern biology.

Thanks to Miss Ellie Powell (who did all the hard work), Mrs Kate Andrews of SSERC (for her guidance and advice), Mr Graham Russell (for his lovely artwork) and to the UK Research Councils and the University of Edinburgh who have help to fund the project.

Dr Liz Fletcher

References

[1] Dr Liz Fletcher, Centre Manager. e-mail liz.fletcher@ed.ac.uk, telephone 0131 650 7292.

[2] Centre websites: www.synbio.ed.ac.uk and www.synthsys.ed.ac.uk

[3] You can download the game from http://www.synthsys.ed.ac.uk/materials-teachers.

Manual screwcutting - part 2

Following from our previous article [Bulletin 261] on manual screwcutting, where we looked at the process of producing internal threads, our intention was to supplement this with a look at how external threads are created. So let's have a look at the tools and techniques that will get you started.

Dies

An external thread is cut on a cylindrical bar or tube by means of a die which is securely held in an instrument called a stock or die holder. Dies are made from high speed steel (HSS) and come in various forms. The main ones being; a circular split die or a die nut. There are other forms such as half nut dies though these are not as common now in school workshops. The circular split die (Figure 2) is the most commonly used die to create thread forms from scratch in the workshop as there is some scope for adjustment. Die nuts (Figure 4) are more useful to repair damaged threads or clean thread forms that have been previously cut.

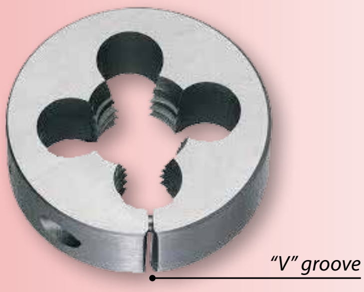


Figure 2 - Circular split die.

Figure 3 - Die nut.

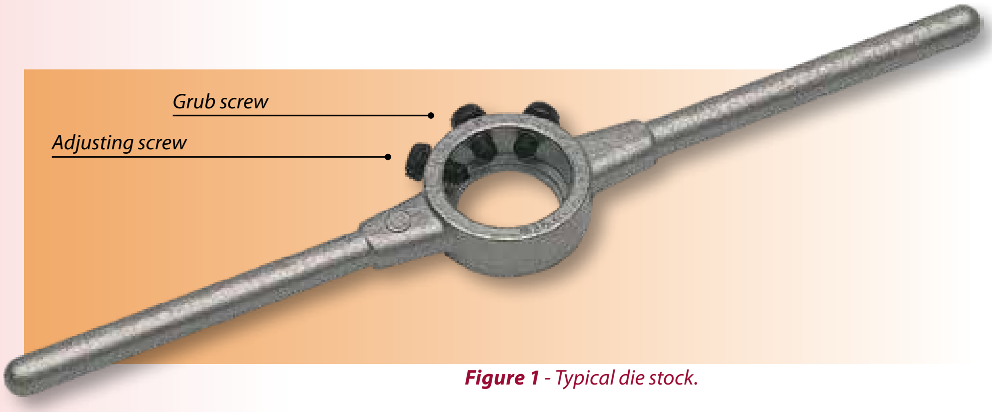


Figure 1 - Typical die stock.

Cutting an external thread

To cut an external thread on a round bar of metal, for example mild steel, the die is placed in the stock with the tapered end outwards. This also has the details of the size and thread stamped on it.

The stock is flanged at the opposite side to enable the die to be correctly located and also to enable positive pressure to be applied to the die when in use.

To take the first cut, the die must be opened wide. This is done by screwing the adjustment screw as far as it will go into the "V" groove (see Figure 2). The grub screws are then tightened to secure the die (see Figure 1).

The rod to be threaded must have a taper filed on one end as an aid to starting the die (see Figure 4). Just as for tapping, the stock and die must be pressed down on the rod and rotated clockwise, pausing to check the "squareness" of the stock and die to the rod from front and side. If the stock and die are not square with the rod a "drunken" thread will result (see Figure 5).

Figure 4 - End of rod tapered to assist start of cut.

Figure 5 - Even pressure applied downwards, while being rotated. Check for square against rod.

Figure 6 - Die stock is turned clockwise half a revolution.

Figure 7 - Die stock turned a quarter turn back to "break" and clear the cutting.

Figure 8 - Note the cutting compound.

Once cutting has started the die should be turned half a revolution forward, then back a quarter turn to break off and clear the swarf (see Figures 6 and 7). Once the cut has been completed, the stock and die is wound back up the rod and the die is removed and adjusted before taking a further cut. Cutting oil should be used throughout the process (see Figure 8).

It should be noted that taps cut an internal thread to a fixed size and no adjustment is possible. Dies, however, can be adjusted by loosening or tightening the adjustment screw. This forces the circular split die open (if tightened) or closed (if loosened). This allows small cuts to be taken at a time thereby making the thread on the bolt to the desired fit (Figure 9).

For this reason the internal thread on the nut must always be cut first. The external thread on the bolt is then cut to fit it.

Figure 9 - Completed thread ready for test fit.

Check out the video link!

http://www.sserc.org.uk/images/technology/video clips/general bench skills/external threading.mp4

Make your own 'Keck' clips

Any chemist will be familiar with 'Keck' clips - though they may not know the name. These are the plastic clips that are used to hold Quickfit glassware together.

It is important that Quickfit setups hold together for two main reasons:

1) If the setup comes apart there may be a leak of hazardous chemicals that could cause harm.
2) If it comes apart and falls, there is a good chance that you will break some of your expensive glassware.

Despite the fact that these clips are just specifically shaped pieces of plastic, they are surprisingly expensive - even 'own brand' clips come in at around £3 each.

However, help is at hand. Many schools now have 3D printers and there is a freely downloadable file to enable you to print your own for only a few pennies each [1].

Reference

[1] https://www.thingiverse.com/thing:275336.

Figure 1 - Keck clips in use (© Cole-Parmer).

Figure 2 - 3D printed clips.

Henry Rae accepting his STEM Ambassador Award at the House of Commons.

Scottish success at STEM Inspiration Awards

The STEM Inspiration Awards celebrate individuals and organisations working to inspire young people in STEM subjects.

The outstanding STEM Technician award recognises efforts to inform and inspire young people with apprenticeships and technician careers. It is aimed at those working in STEM who have a technical, non-graduate background and have used this to help inspire the next generation of technicians.

Henry Rae

St. Andrew's University Public Engagement department nominated Henry Rae for the Outstanding STEM technician award. He was shortlisted and invited to the House of Lords for the award ceremony and, much to his surprise and delight, was announced as the winner by Lord Sainsbury.

STEM outreach and public engagement activities are well supported and popular within the School of Medicine and the wider University. After seven years of organising these Henry now has members of staff chasing him down the corridor asking if he has any events they can help with.

"I especially like activities with Primary 5, 6 and 7s as I find they are always excited and interested and not afraid of taking part in whatever is going on. My aim is to entice them into science by giving them interesting, fun and educational activities. I don't mind if they have forgotten the detail by the time they go to secondary school, just as long as the feeling of 'science is really interesting and fun' stays with them and hopefully will lead to careers in science."

"Although a lot of activities I do can stand alone as a kind of "wow! that's cool" activity, if I ask the children why this particular thing happens it makes them think and try to understand what's going on. I have found that teachers have a lot to cram into their lessons and have to know a lot about a lot of wide and varying subjects. Having STEM activities delivered by external experts help both staff and pupils understand the subject more deeply."

Henry has delivered STEM activity sessions to over 1000 school children and been told many stories about the positive impact on the children. One was about a boy that the teacher couldn't get to write more than 2 lines. When asked to write a thank you letter he wrote 2 full sides of A4 in one sitting!

To find out more about the STEM Ambassador Programme visit https://www.stem.org.uk/stem-ambassadors

Career speed-dating success using STEM Ambassadors

"I wish there had been an event like this when I was at school."

"There are so many STEM opportunities out there that school pupils need to find out about."

"Flexibility is important. Lots of people change jobs during their working lives."

Kirsty Ross, a STEM Ambassador with a wealth of school outreach experience.

These are just a few of the comments made by the STEM Ambassadors who generously gave their time to attend St. Joseph's College's 4th Annual STEM Speed-dating afternoon. Organised jointly by the Science and Technology department and the Mathematics department, a total of 29 visitors from a diverse range of career and qualification backgrounds such as engineering, pharmacy, medicine, web design, robotics, finance, nursing and management were quizzed on their careers in five minute slots by groups of S4 pupils.

The purpose of the event, which has grown each year, is to enthuse pupils about STEM subjects by making them more aware of the wide range of STEM related career opportunities available. By interviewing positive role models from industry and academia, pupils are encouraged to make more informed subject choices, as they will have a clearer idea of the careers and areas that interest them. The research and question preparation by pupils before the event and the fast-paced format during the afternoon also promote effective communication skills.

STEM AMBASSADORS

The 2017 event coincided with the publication of the Scottish Government's STEM Strategy Key Performance Indicators which highlight the need for young people to understand the benefits and value of STEM; for improved gender balance in uptake of STEM training opportunities and for increased collaboration between schools, colleges, universities and employers. Seven different universities and colleges were represented and St. Joseph's College staff were especially pleased with the balance of female STEM Ambassadors as well as professionals who could provide information on apprenticeship routes in to successful STEM related careers.

Kirsty Ross, a STEM Ambassador with a wealth of school outreach experience, is responsible for leading the outreach activities of the OPTIMA Centre for Doctoral Training and the Bionanotechnology theme of the Technology Innovation Centre at Strathclyde University. Kirsty was able to provide many good examples of the usefulness of STEM subjects and enthused pupils by bringing along some interesting props. Mrs Julie MacGregor, Principal Teacher Science & Technology said: "*Kirsty was a fabulous STEM Ambassador - a big hit with St. Joseph's College pupils who seem to remember a lot of what she told them*".

Mark McGrady, a Research Scientist with DuPont Teijin Films, became a STEM Ambassador in early 2017 and this was his third speed networking event. He explained the interdisciplinary nature of many projects in a large company and talked about the opportunities available to change career direction - reassuring pupils who were perhaps undecided about their future subject choices. "*If you're not sure exactly what field of work you want to specialise in at this stage, that's O.K!*"

To find out more about the STEM Ambassador Programme visit https://www.stem.org.uk/stem-ambassadors

Mr A. McAdam, a Biomedical Scientist at the Dumfries and Galloway Infirmary, said: "*I hope the fourth year pupils learn how interesting science is and gain a better idea of what they might do as a future career. I wish there was something like this event when I was at school - I would have known what I would have wanted to do then*".

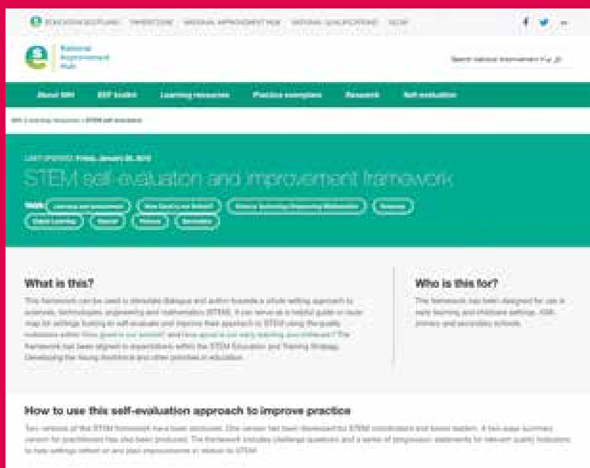
Suzanne Paterson, a Senior Support Officer for Dumfries and Galloway Council, said: "*Fourth year get to see a variety of jobs on offer in the area. They can gain an idea of what jobs they could do and see a pathway to that destination*".

Aileen Hamilton, Operations Manager of the West of Scotland STEM Ambassador Hub, helped St. Joseph's College source a number of STEM Ambassadors for the event but many were repeat visitors who have attended previously. "*It's great for a school to build up their own network of STEM Ambassadors and be able to use them regularly for events such as these. STEM Ambassadors are keen to build relationships with schools and get to know teachers and pupils well so that they can maximise the benefits of their visits*".

Pupil and visitor evaluations of the event have been extremely positive. Uptake of STEM subjects at St. Joseph's College remains high and lots of pupils have offered to return in future years as STEM Ambassadors!

STEM self-evaluation and improvement framework

Education Scotland's new STEM self-evaluation and improvement framework [1] is available to download from the National Improvement Hub.



This STEM framework can serve as a helpful guide or route map for early learning and childcare establishments, primary, additional support needs and secondary schools looking to evaluate and improve their approach to STEM using the quality indicators within *How good is our school?* and *How good is our early learning and childcare?* The framework has been developed in partnership with 50 early-learning and childcare settings and schools that participated in Education Scotland's National STEM Project.

The framework is also aligned with national priorities and policies including the STEM Education and Training Strategy for Scotland, Developing the Young Workforce and the Scottish Attainment Challenge. Two versions of this STEM framework are available: one for STEM coordinators and senior leaders and a two-page summary version for practitioners.

Reference

[1] The framework can be accessed at https://education.gov.scot/improvement/learning-resources/STEM-self-evaluation.

Pressure systems - again

Sometimes it feels like it wouldn't be a proper SSERC Bulletin without an article on the Pressure Systems Safety Regulations (PSSR). Our recent article in Bulletin 259 and the follow-up advice in 261 caused a stooshie in some quarters. Indeed, there were a small number of people who felt that SSERC was insisting on examiners having to meet higher standards than those required by the Health and Safety Executive.

In November, representatives from SSERC, CLEAPSS, HSE and two pressure systems engineers met to discuss the proportionate application of the regulations in schools. HSE were unambiguous. The SSERC/CLEAPSS approach, as outlined in our Bulletins, was in line with their own thinking.

Another issue arose at this meeting when SSERC and CLEAPSS asked for clarification on a regulation that seemed to imply that a Written Scheme of Examination was required before a pressure system could be used, even though the scheme would not itself be used until a year had passed and the pressure cooker, steam engine or autoclave required to be examined. There were two scenarios we could think of that made this seem a bit, well, daft.

Scenario 1

A school decides not to get involved in this annual inspection malarkey and instead elects to buy a new pressure cooker every year, scrapping the old one rather than having it examined (this is not something endorsed by SSERC). Does the law mean that although they never intend to have it inspected they still have to get a WSE before they can use it?

Scenario 2

A school buys a thermostatically-controlled autoclave. Staff have read SSERC guidance and know that it cannot be inspected inhouse. Do they still need a WSE that nobody in the school will ever use before they can begin working with the autoclave?

Before you write to one of the rabidly anti-HSE newspapers, we must say that we understand why this regulation is in place. Firstly, some pressure systems are so complex they need to be inspected before use. Also, the WSE specifies the inspection frequency. How do you know when to inspect your equipment if you don't have a WSE?

HSE were pragmatic. The Approved Code of Practice (ACoP) for PSSR says that a WSE must be **prepared** before you use the pressure system. You do not actually have to be in possession of a copy and you do not have to test before use. It just has to exist somewhere. Based on this, we have the following advice regarding what should happen if you decide to buy a new steam engine, autoclave or pressure cooker.

- Contact us at SSERC and tell us exactly what you plan to buy.
- We will tell you whether or not we are aware of a WSE for this equipment.

If we are, you can buy the equipment and use it. Remember, at this time you do not have to have the WSE in your hand, you only need to know that there is one out there. We will tell you when to have the equipment inspected. This is likely to be a year after it has been supplied to you. Bulletin 259 will tell you what to do then.

If we are not aware of a WSE, you are going to have to source one yourself.

From SSERC's point of view, this helps us to help you avoid buying something unsuitable. We heard of a well-meaning technician who sought to save his school money by buying a cheap autoclave from America from an online vendor. The technician used his own credit card for the purchase. Sadly, when the autoclave arrived it was clear that it did not meet UK safety standards. Nobody was willing to reimburse the technician, who was left out-of-pocket.

We do not want to end on a downbeat note. Our recent meetings and discussions with HSE regarding PSSR have demonstrated that they are prepared to be pragmatic and proportionate when addressing safety issues in schools. Long may this continue.

Whoosh bottle alert

Our colleagues at CLEAPSS reported an incident with this demonstration in the South West of England last year with a whoosh bottle containing methanol.

Instead of burning with the trademark 'whoosh', it exploded, shattering the bottle and causing minor burns to some young children watching it.

The demonstration was carried out on a warm day and the methanol was left in the bottle for at least 15 minutes before lighting it. The exact cause of the incident is not clear. It may be that there had been some weakening of the plastic - methanol does attack polycarbonate though only slowly. Another possibility is that the demonstrator had been unfortunate enough to create an explosive mixture which then detonated. However, methanol has quite a wide explosive range in air (6% - 37%) so it would seem surprising that such an incident should not have happened before if this is the reason.

Whatever the cause, it is probably best to stick to ethanol and propanol unless there is a good reason for using methanol. Neither of these two alcohols forms explosive mixtures and sticking to them also avoids the problems of toxicity associated with methanol.

A thank you from SSERC

At the turn of the year, the Ionising Radiation Regulations changed. It became necessary for employers whose employees were working with sources to register with the Health and Safety Executive.

In state schools, the council is the employer, so registration took place at local authority level. Independent schools and colleges had to apply individually. SSERC asked each employer to give us the name of a link person to whom we passed on our guidance on registration. Many of those nominated will be bulletin readers, and we would like to thank you for your work in making sure that this fascinating part of the curriculum can continue to be studied in a way that is compliant with legislative demands.

The SSERC Bulletin is published by SSERC · 2 Pitreavie Court · South Pitreavie Business Park · Dunfermline KY11 8UU
Managing Editor Alastair MacGregor · **Telephone** 01383 626 070 · **Fax** 01383 842 793 · **E-mail** sts@sserc.scot · **Website** www.sserc.scot