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STEM bulletin

Supporting STEM for all Local Authorities through advice, ideas and inspiration

Activities and professional learning

Wider STEM Engagement

Health & Safety

SSERC Biology Summer School

by Stephen Watson

Stephen Watson, Biology and Science Teacher, Berwickshire High School, Scottish Borders.

The Biology Summer School brought to us by SSERC was a phenomenal practical experience and an incredible opportunity to network with other practitioners. The programme was very well thought through allowing us to gain better understanding of conducting practical work across the biology curriculum both within the classroom and as outdoor learning. Special recognition should be given to Annie McRobbie in executing a flawless and smooth programme over the three days, especially with it being her first Summer School at SSERC.

The budget within a science faculty must always be carefully considered when it comes to resources for the year ahead. During the Biology Summer School, microscale biology was a focal point. It was brilliant to see how to conduct practical work, such as catalase activity with hydrogen peroxide using simple drops on a wipeable board. It was a much quicker method, less glassware, thus less cleaning up and more importantly it avoids cognitive overload by focusing on the main fundamentals of the practical itself and the important theory behind the results.

Illustrating aerobic respiration is not always as clear, but using immobilised yeast, certain variables can be focused on and therefore used for potential projects. Immobilised yeast can be used alongside changing the sugar type, type of yeast used and the temperature the investigation is exposed to. Using the immobilised yeast to see the effects of aerobic respiration, further skills can be developed by using colorimeters and resazurin dye. Colorimeters can be useful tools for more than aerobic respiration practical work as they can also be used to identify enzyme inhibition. Using beta-galactosidase, ONPG and galactose, the presence of a competitive inhibitor can become more obvious than some other practical work that is completed within Higher Biology investigations. Colorimeters can be borrowed from SSERC on request.

Ecology study on Pitreavie Playing Fields.

Continuing with glucose, there was focus on qualitative studies. Using potassium permanganate and different concentrations of glucose, the time taken for the permanganate to lose colour is directly correlated to the concentration of glucose. From this a standard curve can be presented and therefore three unknown glucose concentrations can be estimated from this curve. This is important for our learners as not only does it allow them to develop further skills, especially since said skills can be used in exam style questions, where interpretating data from graphs can be somewhat challenging.

Ever since the introduction of the micro:bits into schools, I have never really been aware of what to do with them. In my school we use them in the science faculty for a very brief area of a physics topic, but beyond that I was not sure how to implement them. Being able to see how many different ways micro:bits can be used in the classroom was >>

astonishing. Coding and technology is at the forefront of society and allowing learners to be exposed to interdisciplinary learning through the use of these micro:bits is a brilliant experience to have in school. The micro:bits can be programmed and coded by the learners themselves, or done prior to a lesson, but then can be used in a very simple way as a light meter. In schools I believe there needs to be more of a link between other subjects as a lot of the time learners do not realise the interconnections between everything they do.

Further to sampling, learners throughout the biology curriculum need to understand the importance of randomised investigations. Through the Exploring the World session, Annie shared with us a very simple way of randomising the identification of plant species using a quadrat; using a random number generator to identify coordinates in a specific area of a field. Moreover, I would be naïve to think that the quadrat could only really be used to identify the abundance of different plant species in each area. I never thought to ever do a comparison between grass that has recently be mown versus unmown to identify species diversity.

As stated, technology is at the forefront of society and should be used more often in the classroom when appropriate. When it comes to identifying the rate of photosynthesis, pond weed and counting oxygen bubbles seems to be the go-to investigation. This practical is brilliant to show that oxygen released at different light intensity levels changes, but it relies solely on the learners conducting the

Microscale experiments.

investigation. Through the use of a carbon dioxide sensor connected up to the Go!Link software on a laptop, inserting it into a respiration chamber with basil leaves, the rate of carbon dioxide consumption can be calculated and immediately plotted on an electronic graph. The reliability of these results are higher than that of counting oxygen bubbles and also allows for the learners to conduct the investigation over a greater period of time as it can be left to be completed on its own. Using neutral density filters, this can also demonstrate that light intensity is an important factor for the process of photosynthesis.

SSERC staff are not the only individuals who made this experience so worthwhile. Further special recognition should also be given to Paul Beaumont, Erin Cowley and Douglas McDonald for their guest sessions. The guest sessions allowed us to see that learners need to be more aware of reliability of sources of information, how to link current diseases, such as motor neuron disease within the biology curriculum and that there are vampires among us. (I will leave that one to your imagination).

After experiencing the Biology Summer School, I can now confidently trial the practical work focused on throughout the programme to give my learners a better experience whilst undergoing their Higher Biology. It is also one of the best ways to network with other members of the biology teacher community, as well as staff at SSERC, such as Annie McRobbie and Margaret Louis who did a fantastic job pulling off such a successful programme of events.

This opportunity comes up every year and always takes place in June at SSERC in Dunfermline. When you see this programme advertised, I would highly recommend you sign up for it as it will change the way you do things within your classroom, for the better.

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Biology Summer School, The Roslin trip

by Lauren King

During the Biology Summer School, we took a trip to The Easter Bush Science outreach centre. We got the opportunity to participate in a session that is offered to schools, involving the ability to taste PTC.

We took samples of our own genes for the practical which we then amplified using PCR and determined our genotypes using gel electrophoresis. The session would be perfect for learners. The staff have looked at the curriculum and made sure the session is tailored to the course specification notes for the Higher Biology and Higher Human Biology courses.

The session also involved us looking at some of the resources that the centre has produced for use in schools. My particular favourite was the gel electrophoresis wall tank, which is an amazing activity to demonstrate the process of gel electrophoresis. I liked the idea of this activity so much that I used it only a week later with my Higher class with a little spin on it, where they had to solve a crime.

The class really enjoyed the activity and it was a great way of teaching the concept without carrying out the practical work. There was also reference to a DNA PCR paper-based activity that takes learners through the process of PCR using paper resources. This was also demonstrated using something more tactile in the form of coloured toys. The staff were very knowledgeable about the process and were aware of the specific wording etc. of the SQA and stuck to this as far as possible.

During the session we also had the opportunity to speak with some of the researchers at the Roslin Institute to find out as little bit more about what is going on at the centre.

The Roslin Institute.

This was very informative and put some of these more complex lab techniques into a real-life application scenario for learners. I also used some of the other resources on the Centres website with my class such as some videos showing the process of PCR and Gel electrophoresis.

Delegates preparing samples for PCR.

While this is not an ideal replacement for carrying out the technique themselves, the videos produced were clear and informative with a few interactive questions to keep the learners engaged. We ended the day with a very quick tour of the research facilities at the Roslin institute. It would have been nice to have longer on the tour, but the practical session had taken up most of the day. Overall it was a really positive experience, I learned about lots of useful resources to use to bring some of these concepts to life in the classroom. <<

SSERC professional learning courses

We offer professional learning (PL) courses and events for teachers in both primary and secondary settings, school technicians, and other educators. Many of our PL offers are financially supported via ENTHUSE funding from STEM Learning or from the Scottish Government. Such funding for our courses helps towards covering course costs and allows us to provide delegates with resources to support learning and teaching back in their centres.

Courses available for online booking include:

COURSE NAME	RESIDENTIAL?	DATES	CLOSING DATE	SECTOR
Technology Probationers Residential	Face-to-face	10-11 November 22	14 October 2022	Secondary Technology
Working with Radioactive Sources	Face-to-face	16 November 2022	21 October 2022	Secondary Physics
***Hot & Cold Metal Forming**	Face-to-face	17-18 November 22	21 October 2022	Secondary Technology
Safe Use of Fixed Workshop Machinery	Face-to-face	23-24 November 22	21 October 2022	Secondary Technicians
***Laboratory Science Nat 5**	Face-to-face	23-25 November 22	21 October 2022	Secondary Science
Science Probationers Residential	Face-to-face	2-3 December 2022	21 October 2022	Secondary Science
Safe Use of Fixed Workshop Machinery (Refresher)	Face-to-face	7 December 2022	4 November 2022	Secondary Technicians
Science Probationers Residential	Face-to-face	13-14 December 22	11 November 2022	Secondary Science
Biology SSERC Meet	Online	15 December 2022	9 December 2022	Secondary Biology
Science Probationers Residential	Face-to-face	11-12 January 2023	11 November 2022	Secondary Science
***BGE Biology for Non-Specialists**	Face-to-face	17-18 January 2023	1 December 2022	Secondary Biology
Science Probationers Residential	Face-to-face	25-26 January 2023	1 December 2022	Secondary Science
Safe Use of Fixed Workshop Machinery	Face-to-face	26-27 January 2023	9 December 2022	Secondary Technicians
***BGE Physics for Non-Specialists**	Face-to-face	1-2 February 2023	9 December 2022	Secondary Physics
Safe Use of Fixed Workshop Machinery (Refresher)	Face-to-face	2 February 2023	9 December 2022	Secondary Technicians
***Chemistry for Ad Higher**	Face-to-face	22-23 February 2023	6 January 2023	Secondary Chemistry
***Wood Turning**	Face-to-face	23-24 February 2023	6 January 2023	Secondary Technology
***Techniques for Senior Phase Biology**	Face-to-face	1-2 March 2023	13 January 2023	Secondary Biology
Radiation Protection Refresher	Online	1 & 8 March 2023	27 January 2023	Secondary H&S
Chemical Handling	Face-to-face	7-8 March 2023	3 February 2023	Secondary Technicians
Electrical Safety and PAT	Face-to-face	9-10 March 2023	3 February 2023	Secondary Technicians
***BGE Chemistry for Non-Specialists**	Face-to-face	14-15 March 2023	3 February 2023	Secondary Chemistry

*This course attracts ENTHUSE funding which offsets the course fee.

Please check our website pages at https://www.sserc.org.uk/professional-learning/calendar/ for the most up-to-date details on our professional learning calendar.

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New professional learning offers for 2022/2023

Biology SSERC Meets
This new online offer celebrates the wealth of teacher expertise across Scotland. Each of the five SSERC Meets will follow a theme with supported content from invited guests in their subject area.

BGE Biology for non-specialists
This two-day course focuses on practical activities to support BGE Biology experiences and outcomes outlined by Education Scotland. This course has been developed to support Science teachers who have not specialised in Biology.

BGE Chemistry for non-specialists
This two-day course has been developed to support Science teachers who have no specialist Chemistry background. We will explore a range of practical activities and techniques to support the delivery of BGE Chemistry so you can deliver this part of the curriculum confidently and safely.

BGE Physics for non-specialists
This two-day course is ideal for those teaching aspects of physics at BGE who are not specialist physics teachers.Topics covered will include: Van de Graff generator, multimeters, electrical circuits, electrical equipment, forces, magnets and energy to name a few.

Science Probationers Residential
A two-day residential course to support NQTs in the delivery of safe, high quality, hands-on practical STEM learning in the classroom. Delegates will have the opportunity to develop their skills in and out of their subject specialism. The residential aspect of the course offers a great networking and peer engagement aspect for delegates, creating opportunities to build new working relationships with other probationer teachers.

Technology Probationers Residential
A two-day residential course to support NQTs in the delivery of safe, high quality, hands-on practical learning in the technology workshops. The residential aspect of the course offers a great networking and peer engagement aspect for delegates, creating opportunities to build new working relationships with other probationer teachers.

Techniques for Senior Phase Biology
A two-day course exploring innovative practical techniques that support the delivery of senior phase Biology courses from National 5 to Advanced Higher Biology.

Up-coming professional learning to look out for in Spring/Summer 2023
- Microscale Mondays
- Using R in the STEM Classroom

Woodturning - part 2

Further to our previous bulletin article (273), where we looked at the basic parts of woodturning machines, safety and the tools used, we will now focus on the various ways workpieces are held in the lathe, techniques using some common tools and the process of grinding and sharpening tooling.

Work on the lathe can be divided broadly into either faceplate turning, where material is held in the headstock only end, or turning between centres where the work is held between the head and tailstock. Looking at today's marketplace, you will find a vast range of accessories which provide many useful features to undertake both types of woodturning. However, not all would be deemed essential. Within the school workshop the following would provide a good baseline covering most of the work likely to be undertaken.

Centres

Fork centre
For turning between centres, some form of "prong" centre is required at the headstock end which will engage into the workpiece to prevent it from slipping and transmit a positive drive. It consists of a dead centre surrounded by hardened teeth or forks which bite into the workpiece allowing it to be driven directly by the centre (Figure 1).

Tailstock centre
Often called the "dead" centre, since it does not rotate with the work, the tailstock centre is fitted into the tailstock spindle to support the length of material being turned. As it does not rotate, it is subjected to high temperatures due to friction. For this reason, it is made from hardened steel and greased/ lubricated at the point (Figure 1).

Revolving centre
The revolving centre, which fits into the tailstock spindle, is mounted in a precision ball- bearing. It is often used in place of the dead centre since lubrication is not required between the wood and the cone. This reduces burning and noise as the workpiece spins (Figure 1).

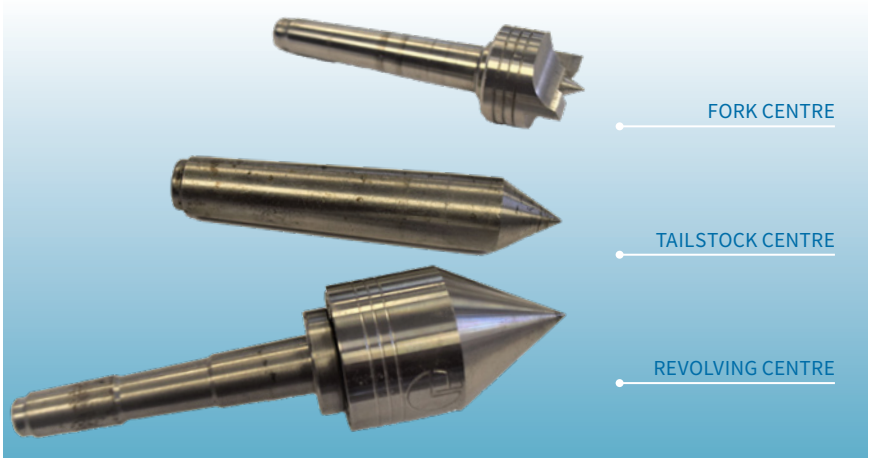


Figure 1 - Centres

Face plates

A face plate is used to secure material to the headstock of the lathe. It consists of a flat metal disc which screws onto the spindle and grips the wood by means of woodscrews passing through fixing holes in the plate. They are available in various sizes from 50 mm diameter upwards. Having multiple face plates means that more than one piece of work can proceed at a time. This is particularly helpful in school workshops. It should be noted that for turning to be carried out on either side >>

of the headstock mandrel then the relevant face plate needs to be used (i.e. left hand thread for fitment to the left of the headstock) (Figure 2).

Chucks

Four Jaw Scroll Chucks
Four Jaw Scroll Chucks allow material to be secured to the lathe quickly and offer flexibility with a range of jaw styles available. The chuck body houses a scroll mechanism operated by a removable key. When the key is inserted into the drive hole on the side of the chuck and rotated, it moves the four accessory mounting jaws either towards or away from the centre. This type of chuck is self centring, meaning all the jaws move together. The back of the chuck housing has a screw thread to match and fit to the lathe. To ensure that the chuck does not work loose, either by centrifugal force or running the lathe in reverse, a grub screw is fitted in the chuck body which can be screwed down to lock the chuck in place.

As mentioned, a variety of jaws are available for different applications. For safety and practical reasons, they should be chosen for the size of the chuck and the type of turning being undertaken. These are fixed onto the mounting jaws using small machine screws. Dovetail Jaws are the most commonly used; they can be used for gripping the workpiece internally or externally (Figure 2).

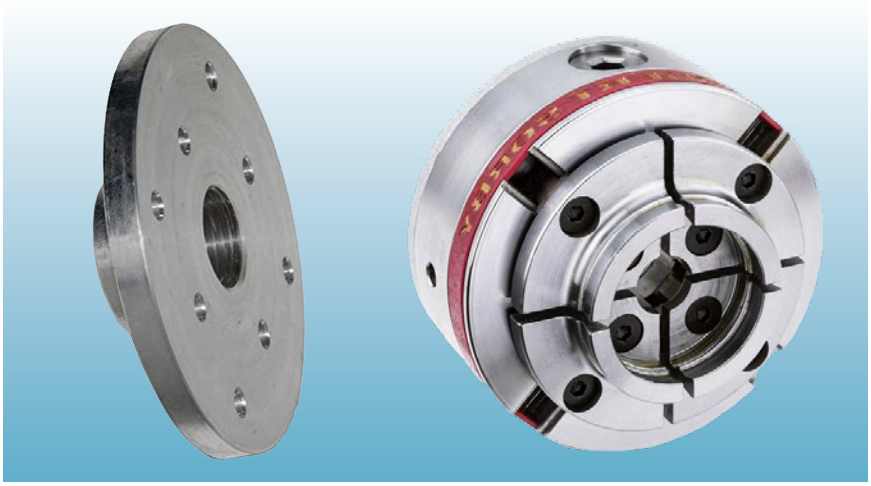


Figure 2 - Face Plate & 4 Jaw Scroll Chuck.

Techniques

Cutting tools
Mastering the techniques of each tool takes practise and time, so any beginner to woodturning should gain some confidence in the basics before tackling major or more elaborate work. Starting with turning between centres would be advisable. Before commencing work, the tool rest must be positioned as close as possible to the workpiece without coming into contact with it. The tool rest height must also be adjusted to ensure the cutting edge of tools are on the centre axis or slightly below (never above).

Starting with a roughing gouge (say 25 mm), lay the tool on the left-hand side of the tool rest, holding it lightly but firmly whilst sloping into the direction of travel. With the machine powered on, place the bevel of the tool on the wood so that it rubs and raise the right hand to bring the cutting edge into contact with the wood. At this point wood should be being removed; the thickness of shaving depends on how much the right hand is raised (Figure 3).

With a light cut, the tool should be passed quickly from left to right; this will bring the timber into a round shape. The surface however will be ribbed and require further smoothing.

To obtain a flat smooth surface a chisel must be used, such as a skew chisel. Again, with the left hand holding the blade and resting on the tool rest, slope the tool in the direction of travel and allow the >>

Figure 3 - Gouge tool position.

Figure 4 - Skew chisel position.

Figure 5 - Scraper position.

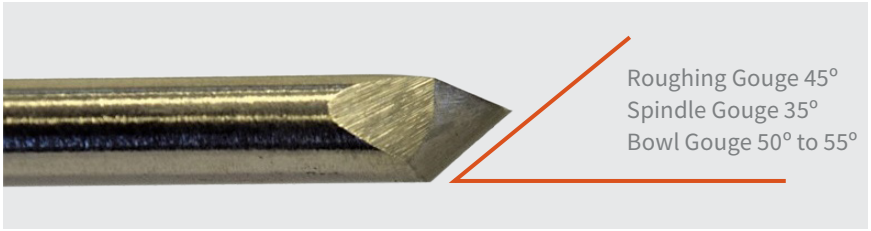


Figure 6

ground bevel to rub the wood. Raise the right hand, the centre of the cutting edge will cut the wood and a steady movement across the rest will produce a perfect surface (Figure 4). When parting off or marking out the same rule applies, allow the bevel to rub the wood and raise the right hand to get the tool to cut.

Scraping tools

Scraping tools require a slightly different technique in that they scrape a shaving, not cut it. This tool generally is easy to use and thus is often used at beginner level. It should be noted that although a scraping tool provides a reasonable level of finish, it will never be as good or smooth as that of a surface cut using cutting tools.

The scraper should be placed on the tool rest, slightly angled toward the direction of travel and held in a more horizontal position. You may find that the scraper cuts better if the handle is slightly tilted upwards, but this movement should not be overdone. The tool rest should be repositioned lower to ensure the top edge of the scraper is on the centre axis of the work piece. If the scraper is tilted too far, it can catch and become jammed between the tool rest and work, resulting in potential injury (Figure 5).

Tool grinding and sharpening

Turning tools should always be kept well sharpened, not only because they will give cleaner cuts, but they will also result in less effort from the individual doing the turning. Unlike regular bench chisels, which have two distinct bevels (a grinding angle and a honing angle), turning tools only have one bevel. A few of the commonly used turning tools found in the school workshop and their associated grinding angles and grinding techniques are outlined below.

It should be noted however, that when using powered grinding machines, the wheel speeds are generally very high and as a result great care is needed to ensure tools do not become overheated. This is obvious when a blue line or mark appears along the edge of the tool and will mean the temper will be lost. To avoid this, the tool being sharpened should be frequently dipped in water.

Gouges

A roughing gouge should be ground to an angle of 45°, a spindle gouge 35° and a bowl gouge between 50° and 55° (Figure 6) with it being held against the wheel, as shown in Figure 7. It should initially be held at a slightly steeper angle than required, then gradually raised until the full bevel comes into contact >>

Figure 7

Figure 8 - Burr removed using a wet/oilstone slip.

Figure 9 - Skew chisel.

with the grinding wheel. It is traversed back and forth across the wheel and at the same time the handle is swung through an arc with a rolling motion so that the whole surface of the bevel is ground evenly.

To finish, the gouge should be honed on a wet/oil stone. With the same motion as grinding, the gouge should be honed until a small burr or wire edge on the inside is achieved. This burr should then be removed using a wet/oilstone slip (Figure 8).

Skew chisel

Skew chisels should be ground flat on both faces, each bevel being 15° to 25° to the side. The tool should be kept moving across the face of the wheel. Honing is done so that the tool is kept at a constant angle and rubbed in a circular motion to keep wear on the stone as even as possible (Figure 9).

Scraper

Scrapping tools should be ground to 80° on one side only. The scraper is not sharpened like normal edge tools, in the sense that when it is ground on the wheel using a side-to-side sweeping motion the cutting edge is formed when a burr or wire edge is formed. It is this burr that gives the tool its scrapping capability and therefore should not be removed (Figure 10).

Parting tool

Parting tools are typically ground to 25° on both sides. With the tool pressed firmly on the tool rest of the grinder and presented at 90° (perpendicular) to the wheel light touch the grinding wheel to grind a single facet bevel on each edge (Figure 11).

<<

Figure 10 - Scraping tool.

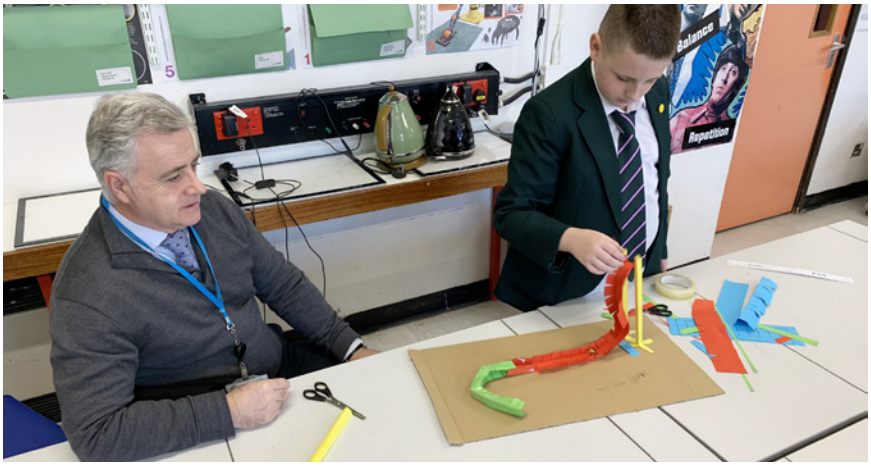
Figure 10 - Parting tool.

YOUNG STEM leader led by sserc

Budding Young STEM Leaders at St. Luke's High School Barrhead

by Mr K Ormond

At St. Luke's High School, a group of Young STEM Leaders have been busy engaging in a series of hands-on engineering challenges as they work towards completing their YSL Award.



For the past year a group of S1 learners, now S2, have been working with staff across the school curriculum to complete a series of problem-based learning activities covering a range of topics including; science, design, computing, and engineering. The Young STEM Leader programme, which is delivered out of the St. Luke's High Makerspace area has been created to give learners the opportunity to further develop their meta-skills but most importantly, it allows them a safe space to engage in STEM projects where they can build resilience should they fail.

Recently, the Young STEM Leader group have been working with Design & Technology teachers to build two electric kit cars. The group have been constructing the cars and hope to have them completed on time to take part in the Greenpower electric vehicle challenge.

This final project has been invaluable in building the group's confidence to be more independent. It has also allowed them to showcase the skills, they developed in S1, and work collaboratively on a large project. The group hope to have their first test run of their electric vehicles in the next few weeks and are looking forward to presenting their cars to the rest of their year group. <<

Young STEM Leader Week

The Young STEM Leader team are delighted to announce that this year's Young STEM Leader Week will take place on 31st October – 4th November.

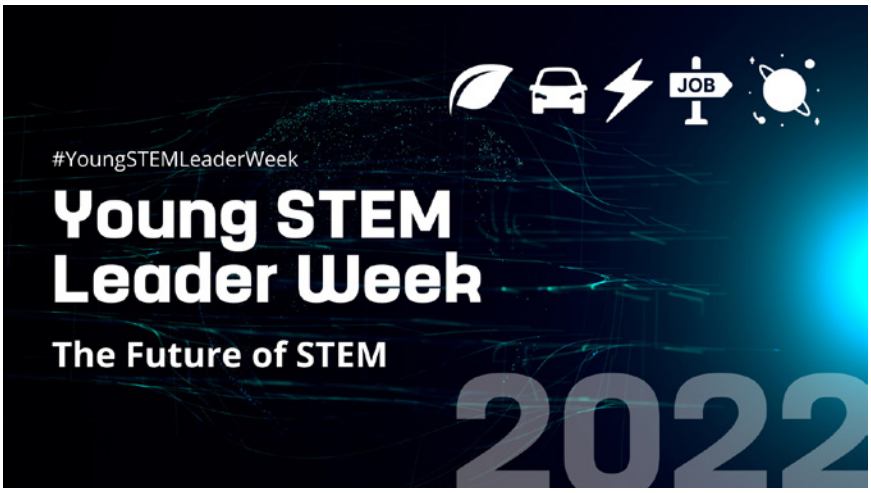
Last year, over 3000 YSLs engaged with the programme and this year's event has even more exciting opportunities to engage with. This year's theme will be 'The Future of STEM' and will have plenty of different ways for your YSLs to get involved including live online events, activities for them to lead andsocial media challenges. To showcase The Future of STEM, each day has its own theme.

Themes of the YSL week 2022

Monday 31 October	The future of **energy**
Tuesday 1 November	The future of **nature**
Wednesday 2 November	The future of **space**
Thursday 3 November	The future of **transport**
Friday 4 November	**Careers** of the future

Young STEM Leaders completing any level of the programme can get involved and lead activities, events or interactions to engage learners across your learning community.

And it's not only learners that can get involved, there will also be networking and Professional Learning opportunities for Tutor Assessors.



Find out more...

To learn more about the Young STEM Leader programme and start delivering it in your school community or youth group, visit **www.youngstemleader.scot**, email us at **youngstemleader@sserc.scot** or check out our **@YoungSTEMLeader**.

Celebrating successful partnerships between SSERC and STEM industry

Glasgow and West of Scotland Partnership Showcase 2022

Over the last academic year, and in line with our aims in Vision 2030, SSERC has grown the scale and number of Enthuse Partnerships (EPs) and Education Industry Partnerships (EIPs) it operates across Scotland. This means that not only does our Wider STEM Engagement portfolio continue to expand, but so does the resulting professional learning for educators as well as the opportunities for learners.

There are a range of ways to deliver EIPs and EPs with a common theme being a "Challenge-based" programme. This is where partner organisations and their team of STEM Ambassadors will work with SSERC and a group of recruited schools to set them a real-life STEM challenge to complete. Teams then work on their solution over several months, or even a full academic year, with the support of their Mentor STEM Ambassador(s). At or near the end of the partnership, the school teams come together to present their solutions at a showcase event.

> *"I'm blown away, it's amazing how they [the pupils] have interpreted the brief, it's just amazing, that outside-the-box thinking that you can often forget when you go into industry."*
>
> *Lloyd Walker – Jacobs*

In the summer of 2022, we were presented with a fantastic opportunity to merge two showcases into one, amplifying the success and positivity from two of our key partnership projects in Glasgow and the West of Scotland. Young people from the schools listed below, were there to exhibit their solutions to their chosen challenge and share their journey through this partnership with fellow learners and invited guests representing STEM education and industry. >>

Leidos STEM Challenge

Jordanhill School
St Margaret's High School
Lochend Community High School
King's Park Secondary School
St Andrew's RC Secondary
Cleveden Secondary School

Jacobs

Jacobs STE(A)M Challenge

Cumbernauld Academy
Barrhead High School
St Mungo's Academy
Brannock High School
Shawlands Academy

Speaking at the presentation, one challenge participant from St Andrew's RC Secondary in Glasgow described the opportunity to meet many key figures in Education and share her ideas with them:
"I just want to talk to people, hear their opinions on the stuff we've been working on for the past few months."

Our partnership work allows organisations to innovate, creating fresh and impactful engagements in STEM, direct from the world of work, for teachers and learners.

To get involved in our partnership programme contact us: partnerships@sserc.scot <<

"I'm so impressed by the content of what the young people have produced but also the way they are conducting themselves, to see that confidence to talk to people they've never met before, really professional."

Fiona Keady – Leidos Innovations UK

Some of the challenges that the partnership set their teams

1. **Locate, Design, & Repurpose** your own Spaceport, Windfarm, or Festival.
2. With a focus on technology, design the Leidos Glasgow office of **the future (2025+)**.
3. Design an app, website or social media platform to help **clean up the planet**.
4. Leidos has people working in the office, at home, and on customer sites, all across the world. How can we use technology to **keep everyone connected** and enjoying their work, from the first day they join through their whole career?
5. **Redesign the UK air traffic system** to make travel quicker, easier and more sustainable.
6. Plan a **New Year's party in space**.
7. STEM is for everyone and many people who work (or want to work) in STEM have accessibility requirements or specific needs to support them to do their job. Using technology, **provide additional support and solutions** for people in this setting to ensure nobody with this type of challenge(s) is restricted from a career in STEM.

Nuffield Research Placements: Year one successes

At the end of last year, SSERC was delighted to take on the coordination of Nuffield Research Placements (NRPs) in Scotland.

The NRP Programme provides an opportunity for S5 learners from disadvantaged backgrounds to develop a wide range of skills through an engaging, real-world STEM research placement experience.

Our first set of placements have now been completed for summer 2022 with a total of 90 young people within an array of different STEM organisations including: Howden, Siemens, Spirit AeroSystems, ThermoFisher, and many of the Scottish universities.

Learners worked closely with STEM professionals on 2-3 week independent research projects from a great variety of different areas including renewable energy engineering, digital chemistry, vaccine development, and software coding. With the support of their supervisor, learners planned their projects, collected and analysed their data, and have reported on their findings.

One of our learners has even gone on to collaborate on a scientific publication with their supervisor!

One of the highlights this year was that six young people we placed at the University of Glasgow's School of Chemistry had the opportunity to meet Nobel Prize in Chemistry 2021 winner Professor Sir David MacMillan. We are very grateful to placement hosts Dr Beth Paschke, Dr Frances Docherty, and Dr Cosma Gottardi for giving them the opportunity.

We have had lots of fantastic feedback from participants about their placements. One of our learners who was hosted by the Scottish Association for Marine Science (SAMS) said:

"I've had a great time at my placement, it was really awesome to see and work in SAMS and I have really enjoyed my project. I've also got to speak to some really interesting people, and I think this will have been great experience and look great for when I (hopefully) apply to study at SAMS when I leave high school. It's been a great experience overall and I'm so glad I was able to do it."

Applications will open soon for summer 2023 placements. If you are interested in the programme for current S5 learners, please contact laura.gordon@sserc.scot to arrange an information session for your school. <<

To learn more about Nuffield Research Placements visit https://www.stem.org.uk/nuffield-research-placements

STEM Ambassadors in action - ALIenergy Climate Quest

STEM Ambassadors are employees and students working in STEM focused roles who volunteer their time to help engage and inspire the next generation of learners.

In Secondary schools they will often speak to classes about their study route and job role or take part in careers events to promote the STEM Sector but that's not all they can do.

STEM Ambassadors can visit schools to carry out hands on STEM Activities linked to the curriculum just like Michael Wall did in his role as an Education Officer for ALIenergy when he visited Campbeltown Grammar and Tarbert Academy last year.

Along with colleagues and fellow STEM Ambassadors Michael helped deliver a specially designed 'Climate Quest' workshop, raising awareness of STEM learning and climate change, here Michael tells us how it went.

The session was designed around content to maximise the tie-in with other curriculum links at S1 including global warming and focused on the vital role STEM has in tackling problems associated with it.

Coinciding with the run-up to COP26 meant the activity capitalised on how much of the news agenda was focusing on Scotland and ongoing efforts here to support meaningful climate-related change.

The workshops strengthened pupils' understanding of both the causes and effects of climate change, as well as how human activity relates to this, importantly though they also highlighted the part STEM-related roles and industries can (and do) play in addressing these issues.

The workshops were full of interactive fun for pupils and gave lots of time for discussion and follow-up work around a specially created workbook we had produced.

There was even a STEM-themed version of a popular tower building game, giving small groups the chance to engage with different interactive challenges, while also trying to avoid the collapse of their towers. This was STEM in action in more ways than one!

STEM AMBASSADOR HUB

STEM AMBASSADORS IN SCOTLAND

Arrange a STEM Ambassador visit online or face-to-face

If you would like a STEM Ambassador to be involved in your setting here is how it works.

Login or register on the STEM database at www.stem.org.uk and add an activity giving as much detail as possible about what you would like the ambassadors to do and we will do the rest.

More information on requesting ambassadors can be found in our Teachers Guide to STEM Ambassadors. <<

Contact us

You can contact us by email or follow us on or

STEM Engagement calendar

SSERC offers a wide range of STEM engagement and enrichment programmes to further increase access to, and participation in STEM, well beyond the classroom setting. There are leadership opportunities for young people with the Young STEM Leader Programme as well as programmes to link educators in all sectors with industry partners and STEM Ambassadors to create enhanced STEM learning events for young people in Scotland.

UPCOMING EVENTS 2022

Young STEM Leader Tutor Assessor Training (all levels)	
Type	Online training session
Date	**Thursday 6 October** **16.00 – 18.00** **Tuesday 15 November** **16.00 – 18.00** **Wednesday 30 November** **16.00 – 18.00**
Details	Become a Tutor Assessor to deliver all levels of the Young STEM Leader Programme.

Tutor Assessor Connections – first Monday of every month	
Type	Online session
Date	**Monday 3 October** **16.00 – 17.00** **Monday 7 November** **16.00 – 17.00**
Details	Networking and best practice sharing session for existing Tutor Assessors for the Young STEM Leader Programme. Each month follows a different theme and has a range of speakers from centres across the country, as well as a chance to discuss your own ideas.

Young STEM Leader Tutor Assessor Training (non-formal levels)	
Type	Online training session
Date	**Tuesday 4 October** **16.00 – 18.00** **Thursday 27 October** **16.00 – 18.00** **Thursday 24 November** **16.00 – 18.00**
Details	Become a Tutor Assessor to deliver the Young STEM Leader Programme at Curriculum for Excellence Second, Third and Fourth Levels.

Young STEM Leader Week	
Type	Celebration week
Date	**31 October – 4 November 2022**
Details	Everyone involved in the Young STEM Leader Programme is invited to join in with this year's **#YoungSTEMLeaderWeek**. Across the week there will be events, training, challenges and more for YSLs to engage with. Visit www.youngstemleader.scot/young-stem-leader-week-2022 to find out more.

Young STEM Leader Programme Kickstart Session (for existing Tutor Assessors)	
Type	Online training session
Date	**Tuesday 25 October** **16.00 – 17.00** **Monday 21 November** **16.00 – 17.00**
Details	Trained to be a Tutor Assessor but need some more guidance on how to get started? This refresher course will help to kickstart your YSLP journey.

Young STEM Leader Information Session	
Type	Online session
Date	**Wednesday 8 November** **16.00 – 17.00**
Details	Find out more about the Young STEM Leader Programme and how it can be delivered in your centre.

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Available online soon...

If you have missed the September events listed below don't worry. These have been recorded and will be available via the STEM Ambassadors website in due course.

Maths and Art – Beethoven's Metronome	
Type	Online event for schools
Details	Meet STEM Ambassador and student Carmela Silva Mason as she looks into Beethoven's music and the differences between written and performed versions. Find out how the invention of the metronome had an impact on music history. This free talk is suitable for ages 11+ and practitioners who want to learn a new activity, available to all UK settings. https://www.stemambassadors.scot/event-details/maths-and-art-beethovens-metronome

Maths in the Real World – Vertical Farming	
Type	Online event for schools
Details	Cameron Williamson is a Mechanical Engineer who has worked on submarines and aircraft carriers and now puts his skills to use overcoming technology challenges in vertical farming. Find out how maths has played a role in Camerons career and the opportunities it has provided plus how he puts it to use creating indoor eco systems. Age 11+ https://www.stemambassadors.scot/event-details/maths-in-the-real-world-vertical-farming

STEMazing structures (interactive)	
Type	Online event for schools
Details	Anne Okafor, construction planner leads this session for learners age 5 - 10 all about picking the best shapes to build with. If you want to take part in the construction challange on the day you will need sellotape and 8 x A4 pieces of paper. This free talk is suitable for ages 5 -10 and practitioners who want to learn a new activity, available to all UK settings. https://www.stemambassadors.scot/event-details/stemazing-structures-interactive-session-shapes-in-construction

Maths and Art – symmetry and shapes in art and nature	
Type	Online event for schools
Details	Dr Elizabeth Dombi is a teaching fellow in Mathematics and leads this session looking at symmetries in art and nature. She will demonstrate how to create beautiful symmetrical shapes and patterns using only straight lines. This free talk is suitable for ages 10+ and practitioners who want to learn a new activity, available to all UK settings. https://www.stemambassadors.scot/event-details/maths-and-art-symmetry-and-shapes-in-art-and-nature

Maths in the Real World – Displaying Data in Finance	
Type	Online event for schools
Details	Alastair Robb is a Finance Manager at Balfour Beatty who turns large amounts of data into easily understood representations such as bar/line and pie charts. Find out how maths has played a role in Alastair's carer and within a large company. The talk will be followed by the opportunity for participants to ask questions. This free talk is suitable for upper primary and throughout secondary years across all subjects as well as for practitioner who want to develop their own knowledge. https://www.stemambassadors.scot/event-details/maths-in-the-real-world-displaying-data-in-finance

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Maths in the Real World – Science & Engineering	
Type	Online event for schools
Details	Dean McLean, Line Engineer will look at how various aspects of maths are used in engineering. From speed/distance and time to area, volume and statistics, find out why these skills could be important for your future. This free talk is suitable for upper primary and throughout secondary years across all subjects as well as for practitioner who want to develop their own knowledge, available to all UK settings. https://www.stemambassadors.scot/event-details/maths-in-the-real-world-science-engineering

Maths in the Real World – Construction Planning	
Type	Online event for schools
Details	Anne Okafor is a Construction Planner who despite having anxiety around maths in ealier years has gone on to overcome this and help others to do the same. Find out how maths is used to collect data and then used in the decision-making process during construction planning The talk will be followed by the opportunity for participants to ask questions. This free talk is suitable for upper primary and throughout secondary years across all subjects as well as for practitioner who want to develop their own knowledge, available to all UK settings. https://www.stemambassadors.scot/event-details/maths-in-the-real-world-construction-planning

Maths and Art – 3D Visualisation from the Glasgow School of Art	
Type	Online event for schools
Details	STEM Ambassador Daisy Abbot work for the Glasgow School of Art based in the School of Simulation and Visualisation. Find out how maths and technology such as laser scanning can be used in art, anatomy and much more using 3D visualisation. This free talk is suitable for ages 8 - 12 and practitioners who want to learn a new activity, available to all UK settings. https://www.stemambassadors.scot/event-details/maths-and-art-3d-visualisation-from-the-glasgow-school-of-art

Maths in the Real World – Match statistics in Rugby	
Type	Online event for schools
Details	Find out how maths is used to collect match data which is used to help coach teams to perform better, though maths didn't belong in sports? Think again. The talk will be followed by the opportunity for participants to ask questions. This free talk is suitable for upper primary and throughout secondary years across all subjects as well as for practitioner who want to develop their own knowledge, available to all UK settings https://www.stemambassadors.scot/event-details/maths-in-the-real-world-match-statistics-in-rugby

Maths in the Real World – Using Percentages for Community Benefit	
Type	Online event for schools
Details	Jane Elder is a Social Value Coordinator who helps to ensure the work that her construction company does also benefits the community. Find out how maths is used monitor and report social impact and the skills that are used such as percentages and formulas to convey this information to others. The talk will be followed by the opportunity for participants to ask questions. This free talk is suitable for upper primary and throughout secondary years across all subjects as well as for practitioner who want to develop their own knowledge, available to all UK setting https://www.stemambassadors.scot/event-details/maths-in-the-real-world-using-percentages-for-community-benefit

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Mud & blood

This short bulletin article will look at health and safety guidance relating to the culturing of soil microorganisms, and the use of human blood samples for microscopy.

A muddy issue

SSERC's Safety in Microbiology: A Code of Practice (CoP) for Scottish schools and colleges [1] outlines the methodology for carrying out a microbiological swab of an environmental sample (see 3.16 on page 10 of the CoP). Samples unsuitable for swabbing are stipulated, including mud, e.g. from a pond or field. Mud presents anaerobic conditions for microorganisms, potentially resulting in the growth of pathogenic organisms.

Recently, we had an enquiry about whether a practical, which involved culturing soil microbes, could be performed in secondary schools. The aim of the practical was to explore the effect of soil microbes on the degradation of different kinds of paper [2]. In the experiment, a soil sample was mixed with nutrient broth in a conical flask, to form a suspension. A small volume of this suspension was then added to a test tube with a piece of paper; the test tube was plugged with cotton wool and left at room temperature for at least a week (Figure 1).

Learners make observations about the appearance of the paper over the experimental duration, determining whether the microbial enzymes have degraded the cellulose in the paper. The hazard in this experiment is the potential to culture human pathogens and this risk is minimised by careful consideration of the soil sample. "Mud", with its high-water content and compact structure, offers anaerobic conditions and would be unacceptable to use for this experiment. Soil has a lower water content and loose structure, permitting adequate air movement to offer aerobic conditions. Soil must be obtained from a source that is free from animal grazing and thus free from contamination with animal waste. The test tubes must remain plugged with cotton wool to facilitate gas exchange and preclude contamination of the cultures by air-borne spores. The incubation must take place in a location inaccessible to students and visual observation of cultures during the incubation period must be supervised and carried out without removal of the cotton wool plug (see 3.17 CoP). At the end of the experiment, the cultures must be disposed by autoclaving to sterilise the contents (see 3.8 CoP).

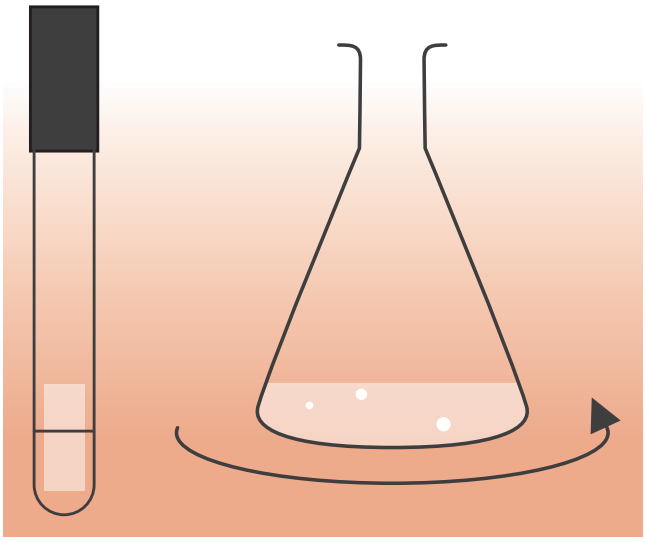

Figure 1 - Image of the experiment, Society for General Microbiology [2].

Bloody microscopy

The National 5 Biology course specification outlines the requirement for learners to understand osmotic effects on animal and plant cells. To support this curricular area, SSERC produced a microscopy activity to observe reversible plasmolysis of onion cells [3]. We recently received an enquiry about whether human blood could be used to observe osmotic effects on animal cells.

Taking human blood samples in schools and colleges is not banned by legislation; it is, however, possible your local authority has a local ban in place and, thus, the first step is to ascertain whether they will grant approval for blood sampling in your school. Although there is no legal requirement to obtain parental permission, it would be prudent to do so and an example permission letter has been provided by SSERC [4]. SSERC's Code of Practice, "Materials of Living Origin" [5] provides a detailed methodology on sampling blood and this must be followed. The risk with handling human blood is that microbes may be transmitted, the most significant of which include HIV and Hepatitis viruses B and C. Providing the correct sterile procedure is used (as outlined on page 20 of the CoP [5]), there is no significant risk of transmission of blood borne viruses.

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Figure 2 - Location to insert the lancet [5].

To minimise the risks associated with blood sampling, the maturity and behaviour of learners must be carefully considered such that they can follow the sampling procedures to the letter. Learners must only handle their own blood and equipment and use the correct sterile procedures with single use disposable lancets, which reduces the risk of "needle-stick" injuries. Blood should only be taken from the side of the finger, 5-10 mm from the lower corner of the nail (Figure 2). Lancets from finger pricking devices must be disposed of in a medical sharps container, so accessibility to this and its subsequent disposal must be considered during the planning stage. Other waste is not regarded as clinical waste and can be disposed of through the normal refuse system. Used glassware etc. must be placed in a disinfectant discard jar, soaked for at least 24 hours, prior to autoclaving for reuse or disposal. <<

References

[1] SSERC (2018), Safety in Microbiology: A Code of Practice for Scottish schools and colleges, available at https://www.sserc.org.uk/wp-content/uploads/2018/06/SSERC-Safety_in_Microbiology_Code_of_Practice.pdf.

[2] Nuffield foundation (2008), Microbes ate my homework, available from Practical Biology. Available at https://practicalbiology.org/environment/carbon-cycle/microbes-ate-my-homework?highlight=WyJzYW1wbGUiXQ==#:~:text=Microbes%20ate%20my%20homework%20Class%20practical%20Investigate%20the,waste%20and%20their%20place%20in%20the%20carbon%20cycle.

[3] SSERC (NA), Observing plasmolysis using the VehoTM VMS-001 USB Microscope, available at https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2F2g1hrx40gw3t1oo1bvqfy70u-wpengine.netdna-ssl.com%2Fwp-content%2Fuploads%2F2013%2F07%2FPlasmolysis-protocol.docx&wdOrigin=BROWSELINK.

[4] SSERC (2022), Example Parental Permission Form, available at https://sserccltd-my.sharepoint.com/:w:/g/personal/enquiries_sserc_scot/EVq0addLdfFJv_XBFJSRXocB9VCr7o53YjRrmZProLv_9g?e=8EoQZs.

[5] SSERC (2018), Materials of Living Origin – Education Uses: A Code of Practice for Scottish schools and colleges, available at https://www.sserc.org.uk/wp-content/uploads/2018/06/SSERC-Materials_of_Living_Origin_Code_of_Practice.pdf.

Mercury thermometers

We have had a few queries in recently about these so thought it worthwhile clarifying the situation.

It has not been legal to sell mercury thermometers in the UK (or most other mercury-containing instruments) since 2009, but there has been no legislation regarding the use of any purchased before then.

So if you have mercury thermometers you are perfectly entitled to use them. They are a little more responsive than other liquid in glass thermometers and can be slightly more accurate, but modern digital thermometers are more accurate than either, so there is certainly no need to use them.

If you are going to keep your mercury thermometers you should:

- Keep them separate from the other thermometers so they can't be used by mistake
- Only let them be used by competent people, staff or senior pupils.
- Not use them in situations where if they were to break they would release mercury vapour, such as in a melting point apparatus. <<

Oxygen in the laboratory

Figure 1 - Oxygen cylinder.

Oxygen is one of a small number of gases that is commonly used in schools and thus needs a more regular supply than might otherwise be the case. In this article, we look at some different methods of obtaining oxygen for use in the laboratory.

1) Cylinder/canister

This is the traditional method whereby you have a (usually large and heavy) cylinder of the compressed gas (Figure 1), often containing around 2,000 litres of gas, though there are smaller cylinders available. The cylinder is fitted with a regulator that allows the controlled release as required. There is much to be said for the convenience of this method but there are some disadvantages: the cylinders are heavy and unwieldy and proper procedures need to be followed for safe storage and use [1]. The cylinders are leased rather than bought, though that is probably an advantage, the gas is refilled as required and the regulators need to be replaced every 5 years at a cost of around £80. For a 2,000 litres cylinder, BOC currently quotes rental of £30 per month and a refill charge of £15.

A variation on this is to use smaller, disposable canisters. These are commonly available for hydrogen but harder to track down for oxygen. The gas is pressurised rather than liquified and they hold 110 litres. The canisters cost a £120 and usually come with a small but perfectly usable valve. Once empty, they are simply disposed of and replaced. While the cost per litre of gas is significantly higher there are none of the rental costs so this should work out cheaper unless you have very high usage. Our rough calculations suggest canisters become more expensive if you are using more than 5 litres of oxygen per week, every week. This seems unlikely in a school context.

Figure 2 - Oxygen concentrator.

2) Chemical generation

Oxygen can easily be generated using manganese dioxide to catalyse the decomposition of hydrogen peroxide. If you prepare your own 5 vol peroxide from 100 vol and can recover the manganese dioxide (straightforward if you use the granular form) then the cost in materials at least is vastly cheaper. However, it is significantly more time consuming and technician time is limited.

An alternative chemical method is to prepare gases in syringes on a microscale. The method is detailed in Bulletin 263.

3) Oxygen Concentrator

We have recently in SSERC been looking at these devices that are widely available on the market for domestic, clinical oxygen supply. They are electrically powered devices that produce a steady supply of oxygen from the air, using molecular sieves to remove the nitrogen (Figure 2).

The highest concentration available is 90% oxygen. Not suitable if you need 100% pure oxygen but we are not sure we can think of a situation where that would be essential. Once switched on, it will produce around 1 litre per minute indefinitely.

The devices cost £200 – £300 but other than the cost of electricity (not negligible these days) there is no other running cost so you will soon recoup your investment. <<

Reference

[1] https://www.sserc.org.uk/health-safety/chemistry-health-safety/hazchem_database-2/gas-cylinders-2/

Radiation dose

This article is about the dose of ionising radiation you would receive demonstrating or observing a school science experiment involving radioactive sources. We will discuss what dose is, how we calculate it and why, if you follow SSERC guidance, any dose you receive will be negligible. Before we go on to look at dose, we first need to know about a quantity called *activity*.

If you are familiar with the terms Activity and Dose, for example if you have been teaching radioactivity to N5 and Higher, you might want to skip straight to the section entitled *Calculating dose*.

Activity

The activity (A) of a radioactive source is a property of the source itself. It is a measure of how many nuclear decays take place every second. Each decay results in the emission of radiation. If you had two caesium sources and one was more active than the other, the more active one would be emitting more radiation per second.
Activity is measured in Becquerels (Bq). One Becquerel equals one decay per second. Normally, for school sources, we'll be dealing with kilobecquerels (kBq).
The old unit of activity was the Curie (Ci). Many older sources will have their original activity stamped on them in microcuries (µCi).

1 µCi = 37 kBq

The activity of a radioactive source decreases with age. For common school sources, the following happens:

- **Americium** – no observable decrease with age
- **Caesium** – activity halves every 30 years
- **Cobalt** – activity halves every 5 years (some older cobalt sources are barely radioactive)
- **Strontium** – activity halves every 29 years

The time taken for the activity to halve is called the half-life. The half-life of americium is 433 years, which is why you will not observe a significant decrease in activity with time.

Dose

There are formal definitions of dose but for our purposes, we will think of it as a measure related to the risk of harm from exposure to ionising radiation. At this point, it must be stressed that the risk of harm from working with the materials you are allowed to handle in schools is negligible if you follow our advice. SSERC guidance is geared to making the dose as low as possible whilst still being able to carry out practical work effectively.

Dose is not the same as activity, although activity is one of the factors used in calculating dose. You could receive a very small dose from a source with a high activity if, for example, you were far from the source or had some shielding material between it and you. None of the sources that you're permitted to work with in school are considered to be high activity.

Dose depends on:

- The radiation energy absorbed by your body – we'll look at how we can keep this low.
- The type of radiation.
- The type of tissue absorbing the radiation.

Dose is measured in sieverts (Sv). 1 sievert is a large and potentially harmful dose of radiation. We will be dealing with doses of microsieverts (µSv) and nanosieverts (nSv). When carrying out certain calculations, we may have to use femtosieverts (fSv).

1 µSv = 1 millionth of a sievert (10^{-6} Sv)
1 nSv = 1 billionth of a sievert (10^{-9} Sv)
1 fSv = 10^{-15} Sv or 10^{-6} nSv

We may also use millisieverts (mSv), but usually only if we are talking about annual doses. A millisievert is one thousandth of a sievert.

Dose rate is a helpful concept. It is the dose acquired in a specified time. Here, microsieverts per hour ($\mu Sv h^{-1}$) can be a useful unit. For instance, a dose rate of 2 $\mu Sv h^{-1}$ means a dose of 2 µSv in one hour, 4 µSv in 2 hours etc. Indoors in Scotland you can expect a dose rate of about 270 $nSv h^{-1}$. This is due to background radiation – the environmental radiation that we cannot avoid. Most of this comes from natural materials – rocks, building materials and the radioactive gas radon. Some comes from man-made sources – nuclear waste, nuclear accidents and the fallout from nuclear weapons. >>

If you are going to work with a radioactive source, you can reduce the dose you will receive in three ways:
- Shield yourself from the radiation
- Increase your distance from the source
- Decrease the time you spend working with the source.

Shielding

Shielding involves putting something between you and the source to absorb radiation.

An americium source emits alpha radiation and weak gamma radiation. The alpha radiation will be absorbed by a few cm of air.

A strontium source emits beta radiation. This can travel through a few metres of air before being completely absorbed. However, the metal parts that make up the source itself will shield you from beta radiation. The only radiation that is not absorbed emerges from the 'window' at the front of the source in a roughly 30 degree cone. This means that if you are behind the front of the source, you will not receive a dose of beta radiation. If it is not possible to have everyone behind the front of the source, 12 mm of Perspex can be used as a shield.

A tiny number of Scottish schools have a protactinium generator half-life source. This is non-metallic, so beta radiation emerges in all directions. A Perspex shield must be placed between the source and all onlookers. Caesium, cobalt and americium sources all emit gamma radiation. There is no effective shield that would still allow learners to observe an experiment. In the case of americium, the gamma radiation is low energy. As a consequence, the dose rate is much smaller than for caesium or cobalt.

Distance

Gamma radiation follows what is known as an *inverse square law*. Imagine the radiation spreading out in a sphere like light from a bulb. Just as the further from a bulb you are, the dimmer the light seems, the further you are from a radioactive source, the smaller the dose you receive in a given time. Because it's an inverse square law, the dose rate at 2 metres is one quarter of what it would be at 1 metre ($1 \div 2^2$). Similarly, at 3 metres it is only one ninth of what it would be at 1 metre.

Time

Inevitably, when setting up experiments, a teacher or technician may have to work only a few cm from an unshielded source. Handling tools can increase distance and dose can be kept very low by limiting the time spent manipulating radioactive materials.

Calculating dose

This example shows how we would calculate the dose rate at a particular distance from a 370 kBq caesium-137 source. Caesium-137 emits both beta and gamma radiation but the source is constructed in such a way that beta radiation is absorbed.

Dose rate (fSv h^{-1}) = dose rate constant x A/r^2

In the above calculation,
- A is the activity, in Becquerels, of the source
- r is the distance from the source
- *Dose rate constant* (strictly speaking, 'dose equivalent rate constant') is a conversion factor that depends on the radioactive substance – whether it is caesium, radium, cobalt etc. These can be found online.

Suppose a teacher is standing 1 metre from a 370 kBq Cs-137 source set up for an inverse square law experiment.

Taking the dose rate constant for caesium-137 to be 90 fSv m^2 Bq^{-1} h^{-1},

For a 370 kBq Cs source,
dose rate at 1 metre = $370 \times 10^3 \times 90/1^2$

= 33×10^6 fSv h^{-1}

= 33 nSv h^{-1}

For a demonstration lasting 30 minutes, i.e. 0.5 hours, the total dose will be 33 x 0.5 = 17 nSv

SSERC has examples of more detailed calculations. This calculation does not include any dose due to carrying the source, being close enough to manipulate equipment and so forth. These actions would result in additional doses to the body and hands. Even taking these into account, the total dose will only be of the order of 100 nSv.

Barring accidents or misuse, this scenario, or the comparable alternative involving a 185 kBq cobalt-60 source, is likely to represent one of the highest doses received when demonstrating an experiment. A school employee is likely to do no more than six demonstrations with this level of dose per year. Provided proper working procedures are followed, the chances of an employee or a learner receiving a dose above any legal limit are negligible.

>>

Limits

Teachers and technicians who work with radioactive materials in schools do not need to wear radiation monitors and dose records do not need to be kept. This is because no employee in a school could be designated as a "classified person". This is a term used by the Health and Safety Executive for someone who is likely to receive a dose of 6 mSv in a year. We calculated that no employee in a school could receive such a dose by considering:

- The dose from setting up and carrying out routine practicals following SSERC guidance (see above).
- The dose from working close to a school radioactive sources storage cabinet.
- The dose from a "worst case scenario" accident (taken to be the rupture of a protactinium generator).

These dose calculations are available on request. When carrying out the calculations, we found that it would require a gross disregard for SSERC advice for an employee or learner to receive an annual dose of 1 mSv. 1 mSv is the HSE dose limit from work activities for a member of the public.

The International Commission for Radiological Protection considers any dose of less than 10 microsieverts to be negligible. We base a lot of our advice around this figure. For example, guidance on how far a storage cabinet should be located from a workstation.

Note that if you followed SSERC guidance, you would have to do 100 experiments of the sort described in the calculation to receive a dose of 10 microsieverts.

Maybe you are thinking, "OK, but isn't no extra dose of radiation better than any extra dose of radiation, however small?" Using figures from the UK Health Security Agency's "Ionising Radiation and You" webpage [1], we find the following, see Table 1.

Image: Cedric Fauntleroy / Pexels.com

As you can see, all of these activities give you a significantly greater dose of radiation than demonstrating a school experiment. Obviously, the purpose of the table is not to put you off eating brazil nuts, getting a dental X-ray or flying to America. It's to highlight that there are many situations where the benefits, such as keeping your teeth in good condition, outweigh the risks of a small dose of radiation. At SSERC, we are firm believers in the educational value of working with radioactive sources in schools. Given that it is easy to keep doses to levels where the risk of harm is significantly below the threshold of what is considered to be 'negligible', we are convinced that the benefits greatly outweigh these risks. <<

Reference

[1] https://www.ukhsa-protectionservices.org.uk/radiationandyou/

Scenario	Typical dose (µSv)	Number of 100 nSv experiments you'd need to do to get a similar dose
Receiving dental X-ray	5	50
Eating 100 g of brazil nuts	10	100
Taking a return transatlantic flight	80	800

Table 1

The SSERC Bulletin is published by SSERC 1-3 Pitreavie Court South Pitreavie Business Park Dunfermline KY11 8UU
Managing Editor: Alastair MacGregor Telephone 01383 626070 enquiries@sserc.scot www.sserc.scot