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Bulletin 280
Activities & Professional Learning

The re-introduction of practical assignments and projects

The re-introduction of Practical Assignments and Projects at National 5, Higher and Advanced Higher Sciences reinforces the critical role that practical work plays in helping learners develop practical skills related to the generalisation, interpretation, and application of certain scientific ideas and materials.

In the academic session 2023/2024 SSERC supported this re-introduction by providing a range of professional learning opportunities focusing on assignment and project activities that could be used to support SQA assessment specifications.

In the academic session 2024/2025, we will provide proactive support for Practical Assignments and Projects which will have a focus on **new** practical activities that can be used to support SQA assessment specifications, but which takes into account the current resource (equipment and consumables) and financial restrictions that many science departments are facing. Significantly, a large amount of SSERC professional learning is either free or heavily subsidised.

Our professional learning is rightly focussed on supporting education practitioners across the 3-18 curriculum and we will ensure that our professional learning is scheduled early in the new academic session to ensure that teachers (and learners) have sufficient time to plan and prepare for assignment and project submissions – the dates of which are notified well in advance by SQA.

We will continue to support teachers with ongoing advice and support throughout the academic year, however, as the submission date for assignments and projects nears, we may be unable to support late requests e.g. equipment loans, and access to SSERC facilities to support learner activity. Any questions relating to assessment should be directed to SQA. Increasingly we are being contacted by individual learners seeking support relating to assignments and projects. In all cases, we will refer the learner back to their centre.

If you have any suggestions as to how we may be able to further support you, and your learners relating to any aspect of practical science, please contact the relevant Education Manager at SSERC. <<

Alastair MacGregor

Alastair MacGregor - Chief Executive Officer

Other topics

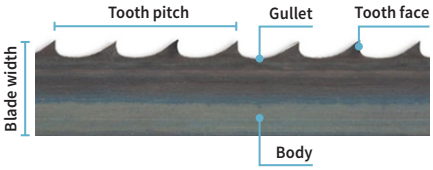
Bandsaw blade selection

Bandsaws are versatile machines, that are commonplace in school workshops as they allow for precision cutting of wood and various wood-based materials. However, the effectiveness of a bandsaw greatly depends on the quality, condition and type of blade used.

Choosing the right bandsaw blade is crucial for achieving clean cuts, maximising efficiency, and prolonging the life of the machine. In this short guide, we'll explore the key factors to consider when selecting the correct bandsaw blades to purchase for certain applications.

Blade anatomy

Before delving into blade selection, it's essential to understand the anatomy of a bandsaw blade. Blades consist of teeth, gullets, and a blade body. The teeth do the cutting, the gullets provide space for chip removal, and the blade body provides support and stability.



Blade width and thickness

Blade width and thickness impact the type of cuts you can make. Wider blades are suitable for straight cuts and resawing, while narrower blades excel at intricate curves and detail work. Thicker blades offer greater stability and are ideal for heavy-duty cutting, while thinner blades provide tighter curves and finer cuts.

Tooth pitch

The tooth pitch of a blade is determined by the type and thickness of the material being cut. For woods and plastics, a minimum of three teeth should be in the cut - e.g. for 12 mm thick wood use 6 teeth per 25 mm. For metals, between 4 and 20 teeth should be in contact.

Tooth form

There are various tooth form configurations, including hook, skip, and regular (also known as raker).

A hook tooth configuration is best suited for making fast, long cuts in thicker softwoods. As they cut quickly, they produce a noticeably rough finish.

A skip tooth is suitable for softer materials and general-purpose cutting. This is provided on coarse tooth blades and commonly supplied as 3, 4 and 6 teeth per 25 mm. They feature a wide shallow gullet to facilitate the efficient removal of waste.

The regular tooth configuration comprises of a repetitive pattern where one tooth is set to the right, the next to the left, and the third, known as the raker tooth, without any set. This arrangement is most effective when cutting materials of consistent thickness. It is particularly suited for contour sawing applications, where intricate curves or shapes are being cut into the material. Regular tooth blades, with a triangular tooth form, are preferred for finer cuts with 10 or more teeth per 25 mm, where waste storage is less of a concern.

3 tpi – skip form
Primarily used for cutting deep rip cuts, leaving a rough sawn finish.

4 tpi – skip form
Effective for cutting across and with the grain, this blade can achieve a reasonable finish.

6 tpi – skip form
An excellent all-around blade suitable for crosscutting up to approximately 150 mm and ripping sections up to 50 mm thick. It provides a good clean finish.

10 tpi – regular
Ideal for cutting plywood, MDF, non-ferrous metals, and plastics.

14 tpi - regular
Very fine toothed blade ideal for cutting thin plywood, plastics, laminates and MDF. It is not suitable for cutting thicker natural timbers as the teeth will clog with saw dust. This type of blade should be used on slow speeds and slow feed rates.

Blade tension

Proper blade tension is critical for achieving accurate cuts and prolonging blade life. Insufficient tension can cause blade drift and premature wear, while excessive tension can lead to blade breakage. Follow the manufacturer's guidelines for tensioning the blade, and regularly check and adjust tension as needed.

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Microscale biology: fermentation in a pipette

At SSERC, we've been developing a suite of experiments on a smaller scale. This article will explore a small-scale fermentation that takes place in the bulb of a pipette. The benefits of microscale experiments have been widely discussed in chemistry [1] and are equally applicable to biology.

Microscale activities are a source of variety across the practical curriculum, building skills in precision technique. When working with smaller volumes of reagents, there is a reduction in waste and use of materials, resulting in reduced costs.

A question of sustainability: re-use of plastic pipettes

The microscale biology experiments featured in this article rely on the use of plastic pipettes. While financially inexpensive (approximately 3p each), plastic waste should be minimised where possible. Worley *et al* [1]. explores the reuse of plastic pipettes and how this can be the subject of an investigation for pupils; ultimately, the book concludes that sufficient washing of the pipettes should mean they can be reused rather than thrown away.

Microscale fermentation

At Levels 4, 5 and 6, the Biology curriculum explores fermentation. The National 5 Biology course specification outlines that fermentation involves the breakdown of a substrate, typically glucose, in the absence of oxygen within the cell cytoplasm. In yeast cells, glucose molecules are broken down to pyruvate, which is then irreversibly converted to ethanol, carbon dioxide and two molecules of ATP (Figure 1).

In the experiment described in this article, this equation can be investigated practically. A yeast suspension is incubated with a sugar substrate within the bulb of a plastic pipette. At SSERC, we have purchased 0.2 cm³ plastic pipettes (from eBay); however, a 1 cm³ plastic pipette can be converted into a micropipette using a simple procedure outlined by RSC Education in Chemistry [2]. The micropipette, containing yeast and sugar within the bulb, is then immersed in a test tube of universal indicator (bicarbonate indicator could also be used). The progress of fermentation is observed in 2 ways:

1) The production of carbon dioxide can be observed as bubbles of gas produced from the end of the micropipette, which can be counted to determine a rate.
2) The production of carbon dioxide changes the colour of the universal indicator from green to yellow because of increasingly acidic conditions. The time taken for this colour change can be measured.

Glucose (substrate) → (Enzymes) Carbon dioxide + Ethanol + energy (products)

Figure 1 - Fermentation reaction in yeast.

Materials required (per pair):

- Test tube rack.
- 2 test tubes containing universal indicator.
- Empty test tube.
- Small volume of paraffin oil.
- Weigh boat.
- 100 cm³ beaker filled with water at 35°C.
- 1x 0.2 cm³ plastic pipette (or a 1 cm³ converted plastic pipette [2]).
- 2 small nuts that fit over the pipette stem.
- Blue roll for any spills.

Materials shared by class:

- Beaker of 5% yeast – made fresh; best to leave for around 30 minutes at 35°C to promote active fermentation.
- Beaker of 10% glucose.
- Water bath at 35°C.

Method:

An overview of the method can be seen in Figure 2. This has been adapted from a published method by Chan, K. [3].

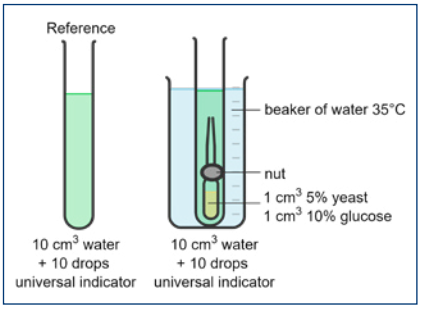

Figure 2 - Overview of method.

1) Place the 2 test tubes of universal indicator into the beaker of water at 35°C - this acts as a mini-water bath for learners. One of the test tubes serves as a "reference" to show the colour of the indicator in the absence of fermentation. The second will be used in step 5.
2) Combine 1 cm³ 5% yeast and 1 cm³ 10% glucose in the empty test tube and incubate in the beaker of water at 35°C.

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3) After 5 minutes, transfer the test tube contents to a weigh boat – this makes it easier to draw up into the small pipette bulb.
4) Draw up the yeast + sugar mixture into the bulb of a 0.2 cm^3 plastic pipette. Ensure the mixture fills the bulb but doesn't extend into the stem of the pipette.
5) Place two small nuts over the pipette stem (Figure 3) and then lower the pipette (bulb-side down) into the test tube of universal indicator. The nuts are required to weigh down the pipette – any suitable alternative can be used.
6) Add 2-3 drops of paraffin oil to form a layer on top of the universal indicator, to prevent gas exchange. Return the test tube to the beaker of water at 35°C.
7) Start the stopwatch and record how long it takes for the universal indicator to turn yellow (Figure 4). Compare the indicator colour with the "reference".
8) After 2 minutes for equilibration, count the number of carbon dioxide bubbles produced from the end of the pipette in 1 minute. Record this value in a suitable results table.

Figure 3 - A 0.2 cm^3 plastic pipette with 1 cm^3 5% yeast and 1 cm^3 10% sugar mixture held in the bulb. Two nuts are placed over the stem as weights.

Figure 4 - The fermentation reaction proceeds within the bulb of the pipette, immersed in universal indicator. A reference tube containing indicator only is used for colour comparison. After 5 minutes, the indicator has changed colour due to production of carbon dioxide. A bubble of carbon dioxide can be observed at the end of the pipette.

Results

A sample of expected results are shown below. <<

Glucose concentration (%)	Time taken for indicator to change colour (s)	Number of carbon dioxide bubbles produced/min
8	385	8
10	346	12
20	225	32

References

[1] Worley, B. and Paterson, D. (2022), Understanding chemistry through microscale practical work, ASE.
[2] RSC Education in Education (2018), Apparatus and techniques for microscale chemistry, https://edu.rsc.org/resources/apparatus-and-techniques-for-microscale-chemistry/4013407.artice.
[3] Chan, K.H. (2016), A simple microscale setup for investigating yeast fermentation in high school biology classrooms, The American Biology Teacher, 78(8), 669-675.

Leading the way in STEM

The delegates of cohort 2 on our Leadership in STEM Education course continue to make excellent progress as they work towards the completion of their professional enquiry.

Leadership in STEM Education

To date, the group of 21 aspiring/ existing school leaders have completed professional learning on:

- ✓ The Scottish educational landscape
- ✓ Key policies and drivers in education
- ✓ Internal STEM school audits
- ✓ Self-evaluation of their own leadership skills and qualities
- ✓ 2-day residential course at SSERC HQ
- ✓ Developing leadership skills, handling conflict, coaching and leading teams
- ✓ Designing their own critical collaborative professional enquiry

The six-unit course is a blend of online, face-to-face and independent research and study. Spanning around 160 hours, the course covers a broad range of professional learning topics. Aligned to the GTCS standards for career-long professional learning and middle leadership means the content and learning is so relevant to the ongoing professional learning for primary and secondary educators in Scotland.

Professional Recognition gtc SCOTLAND 2023-2028 ACCREDITED PROGRAMME

Our delegates will also gain the GTCS Professional Recognition Accreditation on completion of this course to acknowledge the *"enhanced, significant, sustained and reflective enquiry a teacher has undertaken and the development of their professional learning in a particular area".*

Our delegates aren't just supported by the delivery team at SSERC, each of them has the commitment from their Headteacher and In-school Coach to ensure they are given the time and opportunity to complete a range of research and leadership tasks back at their centre.

Furthermore, the course is designed to bring as many external partners and agencies together as possible, all working together with SSERC to put the practitioner at the centre, encouraging them to see themself as the learner, with input from:

- GTCS
- Education Scotland
- Skills Development Scotland
- Strathclyde and Stirling Universities
- Experts and consultants in leadership and management strategies
- Organisations that support STEM education

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Leadership in STEM Education course

"I have come to the SSERC Leadership in STEM course with almost 10 years of experience in a promoted post as Faculty Head of Science and have found the insight into leadership invaluable. Whether you intend to seek promotion or have experience in post the course has been an excellent opportunity to reflect on your skills and abilities within the profession and provides strategies to develop further. The modules have been engaging and have ignited a fresh sense of enthusiasm for reflective and enquiring practice within my career".

Andy, Renfrewshire.

"Participating in SSERC's Leadership in STEM Education course has had a positive impact on my personal and professional development, it has provided me with an insight into effective leadership strategies and principles and it has instilled a renewed sense of confidence and enthusiasm which has inspired me to take steps to progress in my career".

Donna, Midlothian.

"Like many of the other courses offered by SSERC, the Leadership in STEM Education course has been a highly valuable personal and professional development course for me. Not only has it allowed me to realise the skills and qualities I already possess as a leader but it has also provided me with tools and strategies to improve other areas of leadership as I progress through my teaching career".

Claire-Louise, Dundee.

"Taking part in the Leadership in STEM course from SSERC has really inspired me after ten years in teaching, giving me a renewed sense of excitement to career-long professional learning. It has allowed me to grow personally and professionally, and my colleagues have commented very positively on my development".

Ashleigh, Montros.

"The participation in SSERC's Leadership in STEM Education course has expanded my knowledge of STEM learning throughout the educational sector and given me a better understanding of the leadership skills and qualities I already have and how these might be developed further to improve my teaching of STEM subjects".

Rebecca, Glasgow.

"The STEM leadership course has allowed me to really study my school context and see more clearly my role in identifying and leading change where needed. I've enjoyed evaluating and developing my leadership skills in a supportive and encouraging environment and feel much more confident and motivated as a result. Leading the CCPE has given me a platform for introducing change at whole school level and strengthened relationships across the school."

Lorraine, Edinburgh.

Next steps

In June this year, our delegates will present the findings of their critical collaborate professional enquiry. This will see them complete the course and gain their final SSERC and GTCS certification.

Here's an example of some of the enquiries that have been investigated this year:

How can AI be used as an adaptive teaching strategy in a STEM classroom to build pupil autonomy and metacognition?

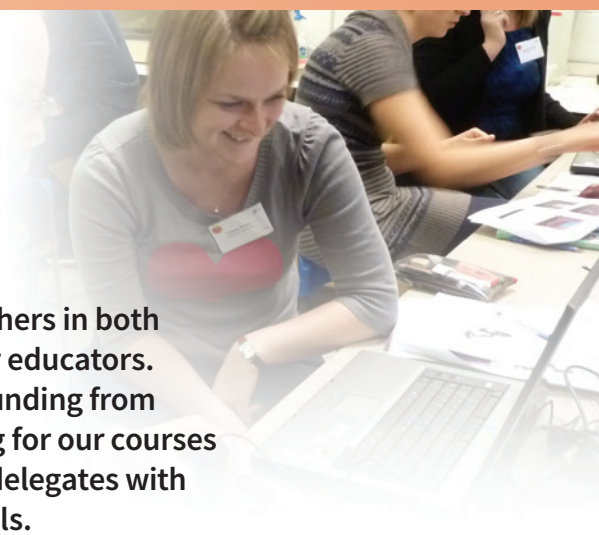
How/in what way does inter-disciplinary learning within STEM subjects impact the pupils' knowledge of STEM careers and pathways within the primary setting?

How does the delivery of a renewable energy-based STEM workshop change perceptions of STEM careers and green jobs?

Interested?

If you would like to know more about our Leadership in STEM Education course or are considering applying for a place for 2024/2025, please visit: www.sserc.org.uk/professional-learning/secondary-clpl/leadership-in-stem/ <<

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 schools.

Courses available for online booking include:

COURSE NAME	RESIDENTIAL?	DATES	CLOSING DATE	SECTOR
***Welding Skills**	Face-to-face	8-9 May 2024	22 March 24	Secondary Technology***
Safe Use of Fixed Workshop Machinery	Face-to-face	15-16 May 2024	15 April 24	Secondary Technicians**
Technicians Conference	Face-to-face	17 May 2024	19 April 24	Secondary Technicians
***Leadership in STEM**	Blended	May 2024 - June2025	22 April 24	Secondary Science
***Welding Skills**	Face-to-face	22-23 May 2024	15 April 24	Secondary Technology***
***Raising Attainment in Physics!**	Face-to-face	24-25 May 2024	19 April 24	Secondary Physics
Safe Use of Fixed Classroom Machinery	Face-to-face	29-30 May 2024	26 April 24	Secondary Technology
Safe Use of Fixed Workshop Machinery (Refresher)	Face-to-face	5 June 2024	10 May 24	Secondary Technicians**
***Ad Higher Chemistry Projects**	Face-to-face	6-7 June 2024	3 May 24	Secondary Chemistry
Introductory Physics	Face-to-face	12-13 June 2024	10 May 24	Secondary Technicians**
***Senior Phase Assignments for Biology**	Face-to-face	18-19 June 2024	17 May 24	Secondary Biology
Safe Use of Fixed Workshop Machinery	Face-to-face	19-20 June 2024	17 May 24	Secondary Technicians**
***Leadership for Technical Support**	Blended	Aug 2024 – June 2025	31 May 24	Secondary Technicians
Working with Radioactive Sources	Face-to-face	28 August 2024	7 June 24	Secondary Physics***
Chemical Handling	Face-to-face	3-4 September 2024	7 June 24	Secondary Technicians**
Safe Use of Fixed Workshop Machinery	Face-to-face	4-5 September 2024	7 June 24	Secondary Technicans**
Electrical Safety and PAT Testing	Face-to-face	5-6 September 2024	7 June 24	Secondary Technicians**
***Investigations for Ad Higher Biology**	Face-to-face	10-11 September 2024	7 June 24	Secondary Biology***
***Support for Practical Activities in Higher and Ad Higher Physics**	Face-to-face	19-20 September 2024	14 June 24	Secondary Physics***
***Laboratory Skills for Ad Higher Chemistry**	Face-to-face	25-26 September 2024	23 August 24	Secondary Chemistry***
***Practical Metalwork**	Face-to-face	25-26 September 2024	23 August 24	Secondary Technology***
Online Health and Safety	Online	4, 11, 18 Nov 2024	20 September 24	Secondary Science***
Intermediate Physics	Face-to-face	20-21 November 2024	25 October 24	Secondary Technicians**

* This course attracts ENTHUSE funding which offsets the course fee.
** May also be suitable for secondary teachers.
*** May also be suitable for secondary technician.

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.

Professional learning reflections
from three newly qualified teachers

In this section, three newly qualified teachers reflect on their experience of attending Professional Learning Courses at SSERC: Jordan Summers (Design and Technology teacher), Louise Evans (Biology teacher) and James Meechan (Chemistry teacher)

Technology probationers residential course

Jordan Summers is currently a teacher of Craft, Design and Technology at Queen Anne High School, Dunfermline in Fife. Jordan attended our professional learning course for technology probation teachers in November 2023.

The course outcomes and programme are provided below:

Course outcomes:

On completion of the course, participants will be able to:

- demonstrate a range of basic skills in woodworking, metalworking, machining processes and 'new' technologies such as sublimation printing.
- understand the importance of health and safety and apply the relevant safety measures within the technology workshop.
- use a variety of teaching strategies to promote learning in technology including demonstrations, exploration of new concepts, skills, materials, and the use of real-life applications to design, problem-solve and create.
- network with fellow professionals and explore mechanisms for ongoing support.
- understand the range of opportunities within the wider STEM engagement portfolio which SSERC offers.
- evaluate their own professional learning and its impact on learners.

In this article, Jordan tells us more about himself and why he attended this SSERC professional learning course.

Education and career history

I was previously a Primary teacher for Falkirk. I am dedicated to education and made the change from primary education to secondary education to explore all stages of learning. I wanted to utilise my subject knowledge of design technology, architecture and education by expanding into the secondary sector.

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Jordan Summers, teacher of Craft, Design and Technology at Queen Anne Highschool, Dunfermline.

sserc

Technology Probationers Residential
9-10 November 2023,
SSERC, Dunfermline, KY11 8UU
PROGRAMME

Time	Group	Thursday 9th November	Location
09.00 – 09.30	All	Arrival and Registration: *Delegates will be provided with a group number (1-4) which identifies their workshop rota.*	Main reception, Rosalind Franklin
09.30 – 09.45		Welcome, introductions & course outline: Alastair MacGregor and Duncan Lamb	Training Room 2, Rosalind Franklin
09.45 – 11.10		Introduction to micro:bit coding Kevin Reid	Training Room 2, Rosalind Franklin
11.10 – 11.30	All	**Break**	Training Room 1, Rosalind Franklin
11.30 – 13.30	1	Woodturning & Finishing Basics Chris Kerr	Workshop 1 Rosalind Franklin
	2	Metalworking Techniques & Ideas for BGE Duncan Lamb	Workshop 2 Rosalind Franklin
	3	Sublimation Printing – Creative Designing Alan Purves	CAD/CAM Room Rosalind Franklin
	4	Basic Electronic & Soldering Skills Norman Bethune and Graeme Paterson	Main Lab, Ada Lovelace
13.30 – 14.15	All	**Lunch**	Training Room 1, Rosalind Franklin
14.15 – 16.15	4	Woodturning & Finishing Basics Chris Kerr	Workshop 1 Rosalind Franklin
	1	Metalworking Techniques & Ideas for BGE Duncan Lamb	Workshop 2 Rosalind Franklin
	2	Sublimation Printing – Creative Designing Alan Purves	CAD/CAM Room Rosalind Franklin
	3	Basic Electronic & Soldering Skills Norman Bethune and Graeme Paterson	Main Lab, Ada Lovelace
16.15		**Close and depart**	

Time	Group	Friday 10th November	Location
09.00 – 09.30	All	Registration	Main reception, Rosalind Franklin
09.30 – 09.45	All	What can SSERC do for you? Duncan Lamb	Training Room 2, Rosalind Franklin
09.45 – 10.00	All	Wider STEM Engagement - Young STEM Leader and STEM Ambassador Programmes	Training Room 2, Rosalind Franklin
10.00 – 10.55	All	Health & Safety "Basics" Duncan Lamb	Training Room 2, Rosalind Franklin
10.55 – 11.15	All	**Break**	Training Room 1, Rosalind Franklin
11.15 – 13.15	3	Woodturning & Finishing Basics Chris Kerr	Workshop 1 Rosalind Franklin
	4	Metalworking Techniques & Ideas for BGE Duncan Lamb	Workshop 2 Rosalind Franklin
	1	Sublimation Printing – Creative Designing Alan Purves	CAD/CAM Room Rosalind Franklin
	2	Basic Electronic & Soldering Skills Norman Bethune and Graeme Paterson	Main Lab, Ada Lovelace
13.15 – 14.00	All	**Lunch**	Training Room 1, Rosalind Franklin
14.00 – 16.00	2	Woodwork & Finishing Basics Chris Kerr	Workshop 1 Rosalind Franklin
	3	Metalworking Techniques & Ideas for BGE Duncan Lamb	Workshop 2 Rosalind Franklin
	4	Sublimation Printing – Creative Designing Alan Purves	CAD/CAM Room Rosalind Franklin
	1	Basic Electronic & Soldering Skills Norman Bethune and Graeme Paterson	Main Lab, Ada Lovelace
16.00 – 16.15	All	**Closing Evaluations**	Training Room 2, Rosalind Franklin
16.15		**Close and depart**	

Technology Probationers Residential course programme.

I achieved my undergraduate degree from Edinburgh Napier University. Achieving my BSc in Architecture has given me a strong knowledge of architecture, science, technology and engineering.

I attended the University of Dundee where I gained my PGDE in Primary Education.

My involvement with SSERC

During my time as a Primary teacher, I worked collegiately to write a policy for STEM education to ensure STEM knowledge and skills are included as a natural and integral part of the curriculum planning, delivery and assessment throughout the school. I attended STEM assessor training with SSERC to assist with this. I successfully completed Young STEM Leaders tutor and assessor training. This will allow me to support this high-profile initiative throughout my career.

As a Craft, Design and Technology teacher, I want to ensure that the learners entering the classroom are excited, motivated and engaged. I always use learning and teaching strategies that encourage learners to achieve their best. Attending the SSERC training course provided me with a variety of teaching strategies to enhance my own teaching for the benefit of my learners.

I attended SSERC to increase my confidence in the workshop and to develop skills in woodworking, metalworking and machining processes. Health and safety is essential and SSERC increased my knowledge of safety measures within the workshop. The course also allowed me to network with fellow professionals and explore mechanisms for ongoing support.

For any school technician, or craft, design and technology teacher, I would definitely recommend a SSERC professional learning course – whether it be to upskill or refresh linked to health and safety of specific aspects of the curriculum. The staff are very professional and enthusiastic and my time at SSERC was so worthwhile. >>

Science probationers residential course

The Probationers residential Course in December 2023 was an excellent opportunity to connect with other NQTs as well as explore different practical activities across the different Sciences.

Miss Louise Evans, NQT Ross High Tranent, East Lothian.

The programme was an excellent balance of fun and engaging practicals and useful discussions around the real-life application of teaching points. It was well organised, easy to sign up for and the facilities were easy to find.

The 2-day course was billed as an opportunity to explore practical activities across the science spectrum while following the National curriculum. This meant we could gain hands-on experience in all science disciplines rather than just our own; it allowed us to do exactly what we would be asking our students to do and therefore experience any potential pitfalls.

My science background is in Zoology, so the opportunity to conduct chemistry and physics practicals with subject specialists was especially useful.

The course

The first day started off well; the centre was easy to find as was parking, the staff member welcoming us was extremely friendly and the building had accessibility equipment readily available. We were given the chance to mingle with the others who were attending the course and I even reconnected with a friend I had attended university with!

The welcome session explained the schedule for the two days very well and before we knew it we were off to our first workshops.

The main focus for the Chemistry and Biology workshops was micro-science, which is an excellent approach for schools with ever dwindling budgets. The skill in condensing practical activities down to such small levels while maintaining educational value cannot be understated, and while we were conducting experiments with small volumes of equipment we were not sacrificing any learning points or information. The resources included instruction sheets that are available on the new SSERC website for schools to print off, laminate and use themselves which removes a huge chunk of time – which teachers have so very little of.

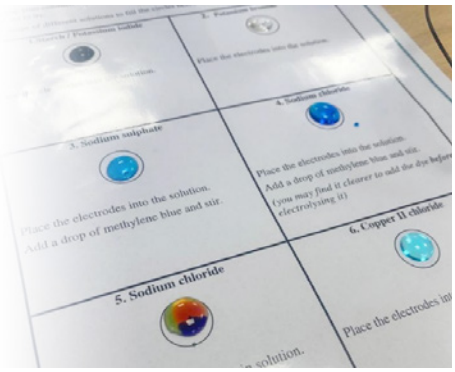
There are several benefits to the micro-scale science practicals but for me the major ones are the speed and ease of set up and clean up time. Teaching periods fly by, so having instructions on a sheet for pupils to refer back to as they go and being able to use considerably less equipment means I can focus on the learning portion of my lesson far more easily and less time on organising students and equipment.

It also means that I can better support students who need a little more help while allowing students who are more confident and capable the opportunity to stretch themselves and move onto the next example – with instructions.

I was impressed with the use of petri dishes to illustrate the production of gases such as ammonia, which can be too toxic for classes. Scaling down the volumes of chemicals used

Science Probationers Residential SSERC, Dunfermline, KY11 8UU Programme

Day 1		Day 2	
09.15 - 09.30	Arrival and registration	09.15 - 09.30	Arrival and registration
09.30 – 09.45	Welcome, introductions & course outline	09.30 – 11.00	**Session 6:** *Group A: Biology (Microscale Biology)* – **Meeting room** *Group B: Chemistry (Demos – It's more than just bangs)* - **Lab**
09.45 – 11.15	**Session 1:** *Group A: Biology (Photosynthesis)* - **Lab** *Group B: Chemistry (Microscale Chemistry)* – **Meeting room**		
11.15 - 11.30	Break	11.00 - 11.15	Break
11.30 – 12.00	**Session 2:** Health & safety basics for science teachers – **Unit 1**	11.15 – 11.45	**Session 7:** Data Science
12.00 – 13.30	**Session 3:** *Group A: Chemistry (Microscale Chemistry)* – **Meeting room** *Group B: Physics (8 simple experiments)* – **Unit 1**	11.45 – 13.15	**Session 8:** *Group A: Physics (Teaching forces and other tricky stuff)* – **Unit 1** *Group B: Biology (Microscale Biology)* – **Meeting room**
13.30 – 14.15	Lunch	13.15 – 14.00	Lunch
14.15 – 15.45	**Session 4:** *Group A: Physics (8 simple experiments)* – **Unit 1** *Group B: Biology (Photosynthesis)* - **Lab**	14.00 – 15.30	**Session 9:** *Group A: Chemistry (Demos – It's more than just bangs)* - **Lab** *Group B: Physics (Teaching forces and other tricky stuff)* – **Unit 1**
15.45 – 16.15	**Session 5:** Wider STEM engagement with the Young STEM Leader Programme and STEM Ambassadors in Scotland *Rosalind Franklin Teaching Room*		
16:15	Transfer to hotel (Pitbauchlie House)	15:45 – 16:00	Evaluations & Depart
18:00	**Dinner**		
19:15 – 20:30	**Evening Session:** Lion's Lair		



and enclosing the reaction in a petri dish allows students to explore the reactions to gain a more complete understanding of the processes involved.

My school already utilises some micro-scale practicals (no doubt from other colleagues attending SSERC courses) but I used the electrolysis practical with my Science club, who were very excited to see the range of reactions. If we had not used the small volumes of chemicals we would likely have only been able to explore a couple of different reactions. With this activity we could compare several chemicals and see colour changes as well as precipitates formed – all in a twenty minute lunch club! Our technicians also found it easy to adapt and set up and the chemistry department are interested in including more of these types of experiments in our curriculum.

The physics workshops were great fun and the tutor had a great way of getting people engaged in the concepts we were discussing. Most of the activities could be made using household items and can be used to demonstrate physics concepts to great effect. I was also intrigued by the suggestion that we suggest a practical activity as homework rather than written, I think that with the focus on attainment it is easy to forget that science is essentially curiosity given action and we can inspire our students in that way.

The Biology workshops were of special interest to me being a Biology teacher, and I liked the consideration of running the experiment at either BGE level or scaling up the information and skills required for a National level class. There was also a focus on sustainability and an eye towards disposal of samples after use. There was specifically a discussion around plants that are suitable for the experiments but are native to the UK rather than invasive species that could cause harm if improperly disposed of. It would be a good talking point to introduce to students as well, promoting their sense of connectivity and responsibility for our natural environment and community.

Being able to show the effects of light intensity on photosynthesis in one test tube means that every student would have the chance to conduct their own investigation, normally due to budget and time constraints and equipment availability practical's have to be done in pairs at the very least. Again the activities were easy to set up without sacrificing any teaching points, which leaves time for class discussion and promoting the students independent thought processes, not always easy to do in a practical lesson.

Arguably the highlight of the course was the carousel session of chemistry practicals, there were colour changes, fireworks, rockets and methane bubbles to name just a few. It was a good demonstration of the variety of activities available to inspire students while teaching and having fun.

The course was a lot of fun of course, but also inspired me to think about how I include practical's in my classroom and gave fantastic ideas of how to expand the options without sacrificing budget or making it a demonstration. There was constant referral and connection to the National Curriculum Es and Os or Benchmarks as well as consideration of IDL and Sustainability across the whole course.

I would recommend any teacher or technician make use of the SSERC resources that are freely available on the website. I would also thoroughly recommend the course to any probationer and very much look forward to attending other course with SSERC throughout my career, they provide inspiration as well as support to my own learning and my teaching practice. >>

The physics workshops were great fun and the teacher had a great way of getting people engaged in the concepts we were discussing.

Science probationers residential course

When I was old enough to read, I became fixated with my family's illustrated encyclopaedia. This led to an early fascination with science, an interest that would have remained purely recreational, were it not for the encouragement of my teachers. This encouragement pushed me to pursue science learning throughout my life.

I studied chemistry at the University of Glasgow, graduating with a BSc (Hons) in 2021. Recalling fond memories of my experience at school, and eager for a job that would provide challenge and emotional reward, I decided on a career in education, returning to Glasgow to earn my PGDE Chemistry teacher qualification.

For probationer teachers, full of enthusiasm for our new careers but lacking the experience and the pedagogical 'toolkits' of our more senior colleagues, we still have a tremendous need for professional development that equips us with the engaging lesson formats, practical knowledge and confidence to deliver high-quality teaching.

The Science Probationers' Residential provided by SSERC was exactly the kind of impactful professional learning that my peers and I needed. The 2-day course took place at SSERC HQ in Dunfermline and was aimed at supporting science probationers with delivery of practical learning, familiarising us with SSERC's STEM engagement programmes, as well as providing networking opportunities with peers and the SSERC team.

The Learning Outcomes for the course were:

- demonstrate an enhanced portfolio of ideas for practical work both within and outside their own subject specialism;
- use a wider variety of teaching strategies to promote learning in science including demonstrations and scientific enquiry;
- exemplify the importance of contemporary science and its applications in the context of the curriculum;
- network with fellow professionals and explore mechanisms for ongoing support;
- understand the range of opportunities within the wider STEM engagement portfolio which SSERC offers;
- evaluate their own professional learning and its impact on learners.

James Meechan is a probationer chemistry teacher at St. Ninian's High School, East Dunbartonshire.

The microscale biology workshop, led by Annie and Margaret.

After the morning registration, we received a warm welcome from Alastair MacGregor, a brisk introduction to SSERC, its role in Scottish education and the training and resources it provides to science teachers. We then transitioned to the biology, chemistry and physics workshops.

Annie McRobbie and Margaret Louis' photosynthesis session revealed how different types of seaweed such as bladderwrack can be used in the classroom for impressive experiments to demonstrate the biological process to learners. As well as covering the relevant biodiversity and body systems Experiences and Outcomes, the session also made links to Scotland's latterly expanding seaweed aquaculture industry. >>

It is an unfortunate realisation for probationers that many school science departments are forced to curtail some chemistry experiments due to budget constraints. The microscale chemistry session led by Chris Lloyd was in many ways a revelation. Microscale chemistry has quietly grown in adoption over the last two decades. It is an ethos of designing experiments to use tiny quantities, low concentrations and small volumes of chemicals, with the ultimate goal to minimise the financial cost of material in science classrooms, without compromising on learning. For example, a precipitation reaction using just two drops of dilute potassium iodide and lead nitrate solutions to produce lead iodide.

Linking closely to this session, was the microscale biology workshop, again led by Annie and Margaret. I was particularly impressed by the microscale titration experiment, and how it could make this analytical technique easier for learners to conceptually grasp. A perennial frustration of biology experiments, the lengthy waiting periods to complete, only to yield undesired results, are also mitigated by the microscale conditions, which are usually faster to complete and better suited for repeat measurements - extremely useful for learners working on assignments.

Both these workshops categorically demonstrated the versatility of microscale experiments and apparatus. Not only will they keep costs down, it also makes practical activities safer, easier to manage, minimises waste, reduces time spent repeating measurements and cleaning apparatus, and can be linked to environmental sustainability.

The physics workshop.

One aspect of science teacher practice that I think every new teacher seeks to master, is the 'art of the demonstration'. Chris' workshop on chemistry demos was exactly what my colleagues and I needed: a whistlestop tour of exciting and - quite literally - explosive teacher demonstrations, achieved with common lab materials and equipment. It took little imagination for us all to appreciate the buzz and enthusiasm for science that all of these demonstrations could generate in a classroom.

The physics workshops delivered by Norman Bethune at the residential also deftly exhibited the value of demonstration. In the first workshop, modestly titled *8 simple experiments*, our mentor revealed how a rubber balloon can illustrate electrostatic induction, Newton's third law of motion and the expansion of the universe. And that was just three of the experiments. The second physics session, by contrast, focused on the teaching of forces and navigating the cognitive conflict the concept can present to learners. I certainly will make a more conscious effort to avoid teaching forces by trying to explain what they are, but rather teach learners *what* they do to objects.

Some other non-subject specific sessions are equally worthy of praise. Chris Lloyd's talk on health & safety clarified the responsibilities of employers and employees, the importance of risk assessment, and helpfully pointed us to the wealth of relevant information and guidance provided by SSERC. Graeme Rough gave a comprehensive presentation on SSERC's myriad wider STEM engagement initiatives, such as the Young STEM Leader Programme, STEM Ambassadors in Scotland and Nuffield Research Placements. These programmes provide young learners with exciting new contexts to STEM learning beyond the classroom.

Norman led another session on data science, condensing this topical and rapidly evolving discipline into an informative and engaging exercise. Finally, John Cochrane's *Lion's Lair* evening session was as creatively fruitful as it was entertaining, and I believe everyone in the room could not wait to repeat the lesson format in their own classrooms. >>

I would emphatically recommend the Science Probationer Residential to every future probationer in Scotland. This was probably the most impactful and engaging professional learning I have received so far in my career. Upon returning to my department, I immediately wanted to share what I had learned with colleagues, and set up ways for implementing what I had seen at SSERC.

One moment I kept thinking about after the residential, was when Norman prepared to do the famous – or infamous – trick of holding a glass of water upside down above his head, with nothing more than a beer mat and surface tension keeping his head dry. Whilst he did this, he exhorted us all to embody total

and unshakable faith in science in our lessons. We must step into our classroom with the confidence in our subjects that they deserve.

This is the most succinct way I could summarise the feelings of my colleagues and I at the conclusion of the Science Probationer Residential. These were two days packed with professional wisdom that the SSERC team have distilled from decades of experience. At this stage in our careers, we value the refinement and knowledge afforded by that experience. This training has enabled us all to bring novel, engaging practice to our lessons, with the added confidence that these have been tried and tested by senior teachers. With the insights provided over the residential, we can all feel to have expanded our teaching 'toolkits' and deliver the best lessons we possibly can. <<

Microbiology matters

The Microbiology in Schools Advisory Committee (MiSAC) promote the teaching of microbiology in schools and colleges.

Annually, they run a poster competition for schools across the UK, focused on a specific area of microbiology; the 2024 competition encouraged learners to explore *Neglected Tropical Diseases and Climate Change*. The organisation offers a range of learning and teaching resources, including scientific articles that complement the Scottish curriculum.

To find out more, visit their webpage **www.misac.org.uk/browse-entire-collection.html**

Melting point

Determining the melting point of a compound is one way to test if the substance is pure and is often used to test samples made from organic synthesis (e.g. of aspirin or paracetamol).

Pure samples usually have sharp melting points, for example 149.5-150°C or 189-190°C; impure samples of the same compounds melt at lower temperatures and over a wider range, for example 145-148°C or 186-189°C. So if your sample has a melting point at the temperature you expect, it is probably what you think it is. If the melting point is quite sharp, then it is likely to be fairly pure.

The general method is to heat a sample indirectly by placing the prepared sample (usually packed in a glass capillary tube) in or on a heated medium and observing it, and the temperature, closely until melting is complete.

There are a few ways of doing this.

Melting point apparatus

This is the most common piece of apparatus for determining melting point. The sample is loaded in a capillary tube and the temperature of the sample gradually raised by means of a heated internal metal block.

Older, or budget, apparatus (like the one in Figure 1) is almost entirely manual. You have to manually control the rate of heating.

Figure 1 - Old MP apparatus.

More modern, advanced ones, (see Figure 2), allow you to program the rate of heating and allow it to heat rapidly to a set point and then go more slowly.

In both cases, though, you need to watch (carefully) through a magnifier and determine for yourself when melting starts and finished.

The one problem with the melting point apparatus described above is that of cost. It is possible to purchase manual ones from around £200, or less, but the more advanced ones start around £700 or more.

But these days, even £200 is quite a chunk of an impoverished budget. Fortunately, there are lower cost alternatives.

Melting point block

This is a very simple arrangement, costing about £25, and used with care can give reasonable results (Figure 3).

It consists of a block of solid aluminium with a hole drilled in at an angle for a thermometer. You place a thermometer in the diagonal hole and put a small pile of your solid in the middle of the block.

Figure 2 - A more modern device.

You then heat the block, gently, from the bottom. The heat is conducted up and will eventually melt the solid on the top.

When you see it starting to melt, record the temperature and record it again when all the sample has melted.

It can be difficult to avoid heating the sample too rapidly, especially if you are using a Bunsen burner, but with care it is possible to get decent results. >>

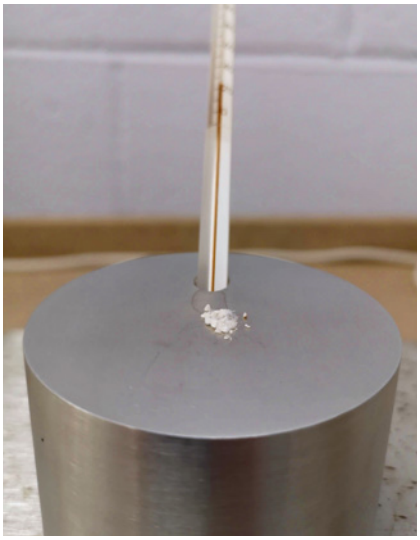


Figure 3 - A melting-point block.

Thiele tube

Another cheap alternative that can, with care, still produce accurate results, is the Thiele tube (Figure 4). These cost only about £10 or so. The Thiele tube is basically a boiling tube with a side loop (see diagram). The sample is placed in a capillary tube and is held next to the bulb of a thermometer by e.g. a band or wire and placed in the 'main', straight part of the tube.

The tube is filled to just above the loop with a liquid of a suitable boiling point, most commonly an oil, and the side arm is heated. As the tube is heated, convection causes the liquid to circulate around the system distributing the heat.

Care needs to be taken to ensure that heating does not happen too fast. A mini burner or a spirit burner is easier to use than a Bunsen for this. It is worth noting that the temperature may continue to rise by 2 or 3 degrees after you stop heating.

It is possible, if even a Thiele tube is too expensive, to just use an ordinary boiling tube, again with a capillary tube fixed to a thermometer. But this is even harder to control to get a good result.

Figure 4 - A Thiele tube in use.

How to use a Thiele tube

1) Place some of your sample in a capillary tube.
2) Fix the capillary tube to a thermometer.

We find the best option is to cut a small loop off a length of silicone tubing as a rubber band has a tendency to degrade and break in the oil.

3) Place the sample in your Thiele tube and start heating the side arm.
4) If you are testing the purity of your sample, you will have an idea of what the expected temperature is.

If you are identifying an unknown though, it might be quicker to carry out a rapid melting point determination initially (by heating rapidly) to establish the approximate melting point before repeating it more carefully.

5) Once the temperature is getting close to your expected point, take care. It can often continue to rise 2 or 3 degrees after you stop heating. Try to increase the temperature as slowly as possible, by moving the burner or the tube nearer to or further from the flame.
6) When you see the first sign of melting in the tube, note the temperature. It is a good idea to use a magnifying glass (or some other device to magnify) so you get a clearer view of when the melting starts (Figure 5).
7) Keep heating, gently, until all the sample is melted. Record this temperature.
8) It is usually a good idea to carry out **at least two** further careful determinations until you obtain **two** consistent values.

Note that unlike boiling point, the melting point is relatively insensitive to pressure and no pressure correction needs to be made.

Figure 5 - Taking a reading from a Thiele tube.

Conclusion

Determination of melting point is a useful analytical technique and although the apparatus can be expensive we hope this article has shown you that it is still possible to carry out a melting point analysis without breaking the bank. <<

Torsional pendulum

We first saw this apparatus at the 2023 IOP Stirling physics teachers meeting. We were impressed by the thought that had gone into the design and the very reasonable cost. We received the apparatus for evaluation.

It arrived complete, well packaged and included a comprehensive manual detailing kit contents, assembly instructions and details of four suggested experiments (including some background theory).

The assembly instructions run to five pages. Assembly is not difficult but there is an order to assembly and some subtle features in the construction that are easily overlooked. Construction took about 90 minutes.

Experiment 1

Experiment 1 examines torque v angular displacement. This, in theory, was the simplest of the experiments. Provide a force (using thread, paperclips and a pulley wheel) at right angles to the suspended rod at a measured distance from the axis and measure the angle of rotation. This enables the torsional constant to be measured. This proved to be the least accurate of the experiments due to the poor quality of the cobbled together pulley wheel as no pulley wheel is provided (see Figure 1).

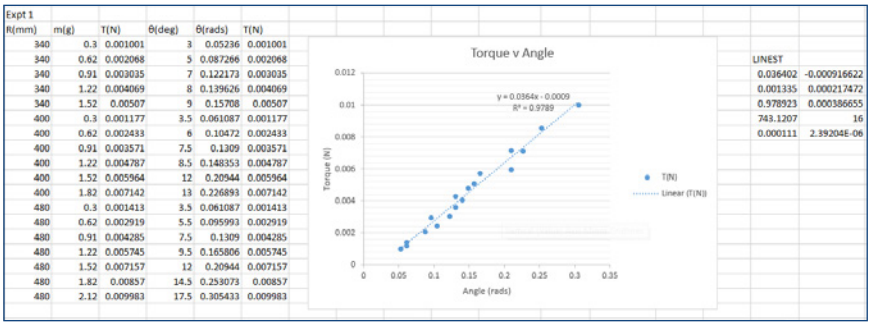


Figure 1 - Torque v angle rotation (Experiment 1).

Experiment 2

Experiment 2 examines the period of rotation v mass of the oscillating rod. The aim of this experiment is to show that the square of the period of oscillation is directly proportional to the moment of inertia of the tube/rod. The mass of the oscillating tube, and hence the moment of inertia, is altered by slotting lengths of copper wire into the tube (see Figure 2). Note the difference between the torsional constant calculated from the gradient of the graph in Figure 1 (0.036402N m rad^{-1}) with that obtained by calculation using the gradient in Figure 3 (0.031205N m rad^{-1}). As can be seen from Figure 3 the graph confirms the relationship.

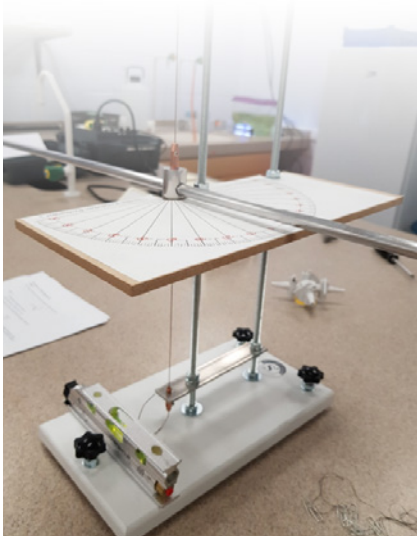


Figure 2

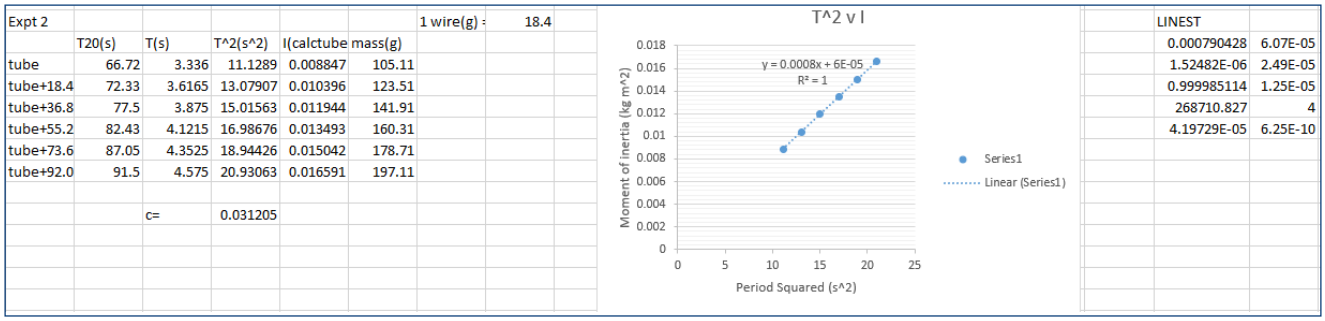


Figure 3

>>

Expt 3														
	m(g)	L(mm)	id(mm)	od(mm)	I (tube)	I(rod)								
tube	105.11	1005	7	9.5	0.008849	0.008847								
	m(g)	R(mm)	I(masses)	I(tot)			T20(s)	T(s)	T*T(s*s)	I(tot)	I(masses)	Isys from T^2		
	8.89	160	0.000455	0.009302			68.45	3.4225	11.71351	0.009302168	0.000455	0.009258744		
	8.89	180	0.000576	0.009423			68.83	3.4415	11.84392	0.009423072	0.000576	0.00936183		
	8.89	200	0.000711	0.009558			69.32	3.466	12.01316	0.0095582	0.000711	0.009495598		
	8.89	220	0.000861	0.009708			69.85	3.4925	12.19756	0.009707552	0.000861	0.009641354		
	8.89	240	0.001024	0.009871			70.55	3.5275	12.44326	0.009871128	0.001024	0.009835563		
	8.89	260	0.001202	0.010049			71.02	3.551	12.6096	0.010048928	0.001202	0.009967048		
	8.89	280	0.001394	0.010241			71.71	3.5855	12.85581	0.010240952	0.001394	0.010161659		
	8.89	300	0.0016	0.010447			72.56	3.628	13.16238	0.0104472	0.0016	0.010403986		
	8.89	320	0.001821	0.010668			73.06	3.653	13.34441	0.010667672	0.001821	0.010547864		
	8.89	340	0.002055	0.010902			74.05	3.7025	13.70851	0.010902368	0.002055	0.010835659		
	8.89	360	0.002304	0.011151			74.83	3.7415	13.99882	0.011151288	0.002304	0.011065134		
	8.89	380	0.002567	0.011414			75.74	3.787	14.34137	0.011414432	0.002567	0.011335894		
	8.89	400	0.002845	0.011692			76.65	3.8325	14.68806	0.0116918	0.002845	0.011609928		
	8.89	420	0.003136	0.011983			77.54	3.877	15.03113	0.011983392	0.003136	0.011881104		
	8.89	440	0.003442	0.012289			78.56	3.928	15.42918	0.012289208	0.003442	0.01219574		
	8.89	460	0.003762	0.012609			79.52	3.976	15.80858	0.012609248	0.003762	0.012495624		
	8.89	480	0.004097	0.012944			80.77	4.0385	16.30948	0.012943512	0.004097	0.012891557		
	8.89	500	0.004445	0.013292			81.56	4.078	16.63008	0.013292	0.004445	0.013144971		

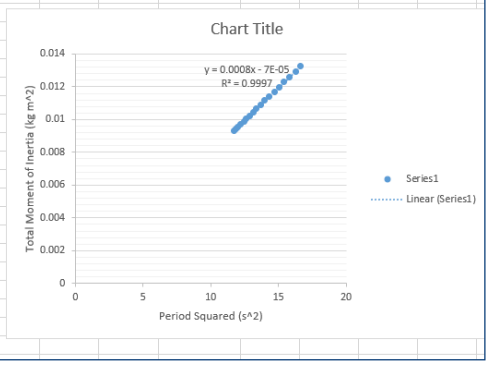


Figure 4

Experiment 3

Experiment 3 examines the relationship between period and mass distribution. Two collared masses are provided which slide over the suspended rod and are fixed at various distances from the axis of rotation using small grub screws. It is suggested that the moment of inertia of the system is plotted against the square of the period of oscillation. The value from the previous experiment is used for the moment of inertia of the tube to which we add the contribution of the two masses using mr^2.

We also calculated the moment of inertia of the tube and compared this with the assumption that the formula for a thin rod was valid.

We calculated I_{tube} = 0.008849kg m², I_{rod} = 0.008847kg m². Using the gradient this experiment gave a value for the torsional constant of (0.031643N m rad^{-1}).

Our results for this experiment are shown in Figure 4.

Experiment 3a

Not included as a suggested experiment in the instructions but we used the results from experiment 3 and plotted only the moment of inertia of the two masses against the period squared. The gradient (and hence torsional constant) was obviously the same but the offset gave a value for the moment of inertia of the rod which was 0.008921kg m²; very similar to that obtained in experiment 2 (see Figure 5).

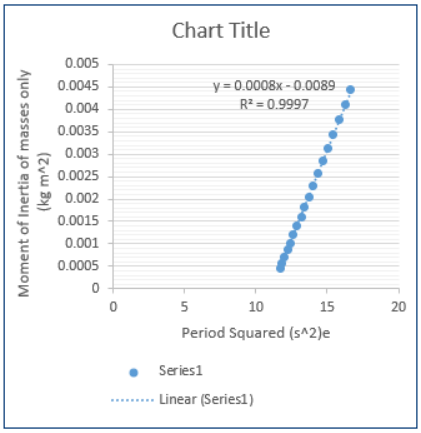


Figure 5

Experiment 3b

Again, not suggested in the supplied notes but an interesting alternative analysis of the collected data. We were, after all, starting to get carried away with ourselves. Again using the results from experiment 2 and 3 we plotted the logarithm of the moment of inertia of the masses (system moment of inertia calculated from the period of oscillation minus the rod moment of inertia) against the logarithm of the distance from the axis of rotation.

The gradient of this graph should be the power to which the moment of inertia depends on the radius and the offset should be the logarithm of the two masses combined (see Figure 6).

Exp 3c										
	R(mm)	Isys-Itube		LOG(R)	LOG(Im)					
	160	0.000412		-0.79588	-3.38535					
	180	0.000515		-0.744727	-3.28832					
	200	0.000649		-0.69897	-3.18801					
	220	0.000794		-0.657577	-3.09997					
	240	0.000989		-0.619789	-3.00499					
	260	0.00112		-0.585027	-2.95075					
	280	0.001315		-0.552842	-2.88118					
	300	0.001557		-0.522879	-2.80771					
	320	0.001701		-0.49485	-2.76932					
	340	0.001989		-0.468521	-2.70143					
	360	0.002218		-0.443697	-2.65401					
	380	0.002489		-0.420216	-2.60399					
	400	0.002763		-0.39794	-2.55863					
	420	0.003034		-0.376751	-2.51797					
	440	0.003349		-0.356547	-2.47512					
	460	0.003649		-0.337242	-2.43787		LINEST			
	480	0.004045		-0.318759	-2.39313		2.0734408	-1.735009		
	500	0.004298		-0.30103	-2.36673		0.010193191	0.005365		
							0.999613465	0.006381		
	gradient=	power of R=		2.0734408			41377.37789	16		
Total mass (g) =		18.40733					1.684983375	0.000652		
calculated mass (g) =		9.203663								

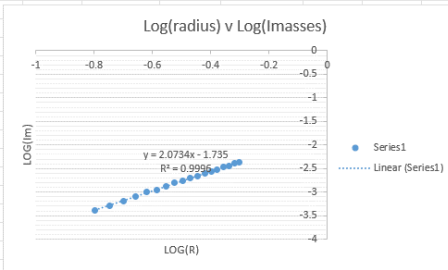


Figure 6

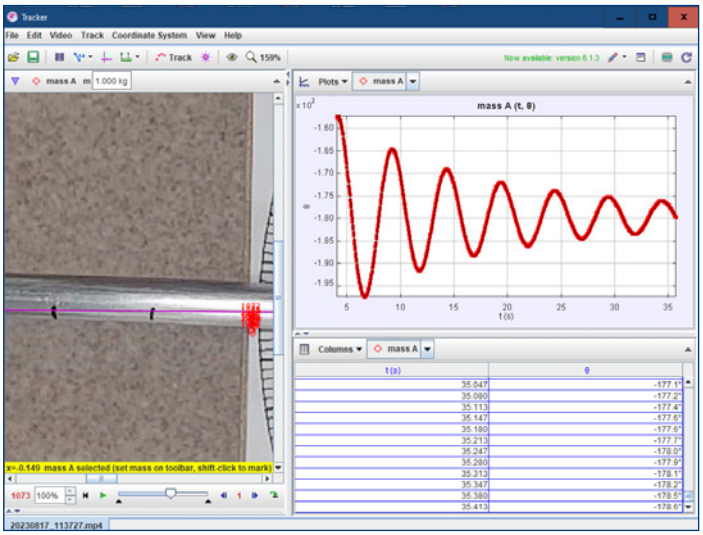


Figure 7

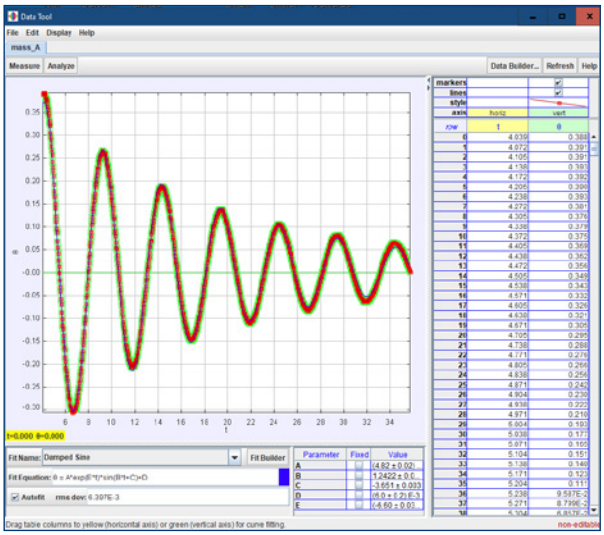


Figure 8

This yielded a value of 2.07 for the power of the radius and a value for each mass of 9.20g.

The measured value for each mass used in experiment 3 was 8.89g.

Experiment 4

In the instruction manual it is suggested that 'sails' can be added to each end of the oscillating rod and that the underdamped oscillation can be studied using tracker. We did this (Figure 7) and the results using the Tracker data analysis curve fitting tool are shown in Figure 8.

We published a a simple activity which shows under, critical and over damping in Bulletin 279. <<

References and resources

- A python article on data analysis and curve fitting can be found here https://www.sserc.org.uk/wp-content/uploads/2023/03/SSERC-bulletin-278-p2_5-Python-Pandas-Physics-Pendulums.pdf.
- The torsion pendulum used in this article can be found here: https://www.simplesciencesupplies.co.uk/shop/p/torsion-pendulum-ah-project.
- The current price of a torsion pendulum as at 18/08/2023 is £69.99.
- Critical damping demonstration can be found here: https://www.sserc.org.uk/wp-content/uploads/2023/10/SSERC-bulletin-279p5_6-Critical-damping-demonstration.pdf

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