STS
Scope includes Science, Technology and Safety

SSERC Bulletin

For those working in science or technology education

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Contents

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Life begins?

Insomniacs, stand by your beds! Yet again they've called on this old salt to do the 'waffly bits'. This is no tribute to my penman-(one finger keyboard?)-ship, few delusions here on that score. No, it's because this edition of the Bulletin should emerge from its chrysalis (who are we trying to kid?) round about the time of SSERC's 40th anniversary. I'm one of the few who've been around long enough to remember much, if not all, of the story. At least I can recall the bits from the 'seventies onward even though I can hardly remember what happened this morning. Perhaps that's the key. Only someone who's reached the full-on wibbling stage could face such a task. In tackling same, there's been some lifting from our 21st birthday edition. Okay, okay I wrote much of that as well. Recycling, it's an in-kinda-thing. So, those long enough in the tooth (teeth?), or sufficiently sensitive in the nasal regions, may well get a whiff of déjà vu from their carefully archived copies of Bulletin 150.

It's hard to believe that this organisation was founded in its original 'club' format[1], and first opened for business, in Autumn 1965. Ahh! Just smell that Woodstock and stitch up that kipper! You may be interested to hear we share our 40th birthday with some odd bedfellows[2].

Figure 1 *103 Broughton Street - an adapted Episcopal Church School - just as we remember it!*

The original organisation from 1965, the one with the surfeit of sibilants - SSSERC - the Scottish Schools Science Equipment Research Centre – was the brainchild of a peculiar partnership, one led jointly from the outset by Edinburgh and Glasgow, cried then "Corporations". They, in turn, recruited one or two others from the City and County Councils (at that time they were the education authorities). These core partners laid the legal and administrative foundations for what was to be a national advisory centre. Only when the initial stages were complete and premises found, was membership of the scheme offered to all of the Scottish City and County Councils as education authorities. Only one Scottish County Council 'opted out' [3]. SSSERC was born and our first premises, good old 103 Broughton Street, was built in 1869. A Royal Commission of the time investigated the "Scientific instruction and advancement of science" [1] - a look at some of the submissions from witnesses from Scotland show that the same problems faced students and universities 136 years ago!

So, you see, we were tiny trendsetters from the outset. Only now are Edinburgh and Glasgow again collaborating in joint initiatives (other than that well-established mutual pact always to abuse each other's people or architecture, whose turn it is depending only on who's got a festival on and the locations at the time of their respective citizens).

Continued on page 2/ over

1. An "unincorporated association" in fact, and much posher than a real 'club'.
2. Also celebrating ruby anniversaries in 2005 are the General Teaching Council Scotland, Learning and Teaching Scotland (but in 1965 it was known as the Scottish Curriculum Development Service) and the Times Educational Supplement Scotland (TESS).
3. You'll need to guess, we're not saying. Clue - they've done it twice in our life to date but each time rejoined.

By '65 SSSERC had had an unusually long gestation, well in excess of an elephant's worth - four years all told. The story really didn't begin there. The SSSERC egg was fertilised physically well before then. The embryonic SSSERC was a technical sub-committee of the Advisory Committee on Physics set up in 1961 to advise the Secretary of State on all matters relating to the teaching of physics. You guessed – yep – we had an educational 'crisis' under our feet. There were problems recruiting and retaining science teachers, we had outdated syllabuses, old-fashioned suffocating exams - (blah blah blah – zzzzzzzz!). Most importantly, the Russians were coming (only in a harmless, bleeping Sputnik, but we didn't know that at the time. Oh, and a wee space dug - forgot the dug, sorry! All those intrusive biological metaphors will also p**s off the physicists. Excellent, and nothing new there then).

That sub-committee chiefly assessed apparatus for its suitability in use with the modernised 'alternative' physics syllabus. They also designed prototype kit to plug the gaps where no suitable apparatus existed. This work was done by teachers in their spare time, with the help of the late Professor W.H.J. Childs. They worked in their own schools and at what is now Heriot Watt University. Byderway, the new, but alternative, physics syllabus took only a few months to write and agree on. Howzat, Higher Still! Careful, curriculum reviewers 3-18!

By then, in England and Wales, the original Nuffield Foundation Science Project had begun. Scotland was designated a "Region" (see - 'twas ever thus!) and a team was set up under the leadership of W.R. Ritchie.

Figure 2 *Bill Ritchie*

More development work on equipment began in schools and in the Apprentices' School at Ferranti Ltd. Kenspeckle figures such as "Physics is Fun" (Come back, all is forgiven!) man, Jim Jardine, the late John Emery of Glenalmond and the late Joe Stewart

Figure 2 *Joe Stewart - the first Director of SSSERC*

all worked with Bill Ritchie. They produced ground-breaking bits of teaching kit such as the linear air track, the Venner stopclock and magnetic pucks for frictionless motion. By the Summer of 1963, several members of this group were also heavily involved with the work of the Scottish Nuffield physics team. New biology and chemistry syllabuses were set to join the alternative syllabus already developed for physics.

With the backing of the Scottish Education Department, and the National Advisory Committee on Physics, the local authorities were asked to co-operate in the setting up of a national science centre. Within 18 months, a structure for the funding and governance of such a Centre had been agreed, premises identified and refurbished. As already noted, by the Autumn of 1965 the Centre was in business. From the outset, and for a long time afterwards, the Centre's team remained small (5 to 7 staff). Many of the ideas for development and testing programmes were still coming from teachers and technicians based in schools. Even now, forty years on and with the staff team swollen by secondees, semi-retirees working part-time and other folk on short-term contracts, we remain a fairly small group.

In recent years we've taken once more to concentrating on working collaboratively and closely with others based in the authorities as well as in schools. The recent edition of our additional and occasional publication Science CPD News provides a range of accounts of that type of involvement.

Other times when the staff team was expanded include the period when SSERC was the Scottish Joint Support Activity for the Technical and Vocational Education Initiative (TVEI).

By then we'd moved to new premises (June 1989) in a re-furbished printing works. Ironically, these premises had been previously occupied by Pillans and Wilson, the folk who printed the scary exam papers. Our first Bulletin (163) after moving in was a real bumper issue (48 pages) with articles such as "After the Master" - no not an obituary to the villainous renegade Time Lord and arch enemy of Doctor Who - but advice on where teachers should go after the BBC Master computer.

Perhaps it was the influence of our own in-house computer expert at the time (Clive Semmens) but we went the Acorn Archimedes route and persisted with this technology until we moved to our current premises at 23 Holyrood Road within the Moray House College complex (now part of Edinburgh University).

We survived the next Local Government upheaval - but only just. This was when the twelve Regional Councils were broken up. It's an episode still affectionately recalled as the second great disorganisation. It's a period which some might claim has yet to end. Incorporated as a Company Limited by Guarantee in 1991, SSERC was by then governed under the Companies Act. For quite a while a cash flow crisis put the Centre's solvency and future in

doubt. We ceased trading and sent staff back to councils from which they'd been seconded. This is different, despite irresponsible rumours at the time, from going bust. We were solvent but couldn't guarantee to remain so beyond a certain period. Meanwhile, we were desperately recruiting corporate members from amongst the 32 new councils as unitary authorities. Survive we did, but had to give up our leased premises in south Edinburgh and rent space in the University of Edinburgh. At the time of writing, we still have all the authorities in membership and another move is on the cards. Watch this clichéd space for further news of our evacuation (if you'll pardon the expression).

As when we published our 21st birthday bulletin edition, in preparing this for our 40th we've been struck by the similarity of the current concerns of 21st Century Scottish science educators with those being aired in the mid sixties, seventies, eighties and nineties of the previous century. If I didn't feel my age before all this stuff about centuries, I certainly do the now.

One of the strengths, we're told, of the SSERC Bulletin over the years has been that it tries to articulate the key contemporary concerns of school-based teachers and technicians. It's been said that although we're no educational "Private Eye", we are often willing to publicly print what many practitioners dare only say behind closed doors. When far fewer publications were going into schools, Joe Stewart, the founder Director, nevertheless well knew the power of a wee bit of controversy to grab readers' attention. He didn't merely court controversy though, nor did he stir it up if it wasn't already manifest. His more contentious pieces were nearly always spiked with the shards of his razor-edged humour. From personal experience we can vouch that he wrote very well and was an extremely hard act to follow. His career, sadly, was cut short by his untimely death when he was still only in his fifties.

Partly in tribute to Joe we'll follow this commemorative piece with a selection of quotes from Bulletins over the years. For a bit of fun we've set these up as a competition for those who like that kind of thing. The first prize is a free place at our commemorative annual conference and AGM in the Glasgow Science Centre on the 9th of December (see elsewhere in this issue) and the second prize?

Meantime, let me end this somewhat rambling and lengthy piece (it's a reflection of age rather than physique) by congratulating the SSERC Board and the staff, if only on the matter of the organisation's longevity and their own wretched stubbornness. Staff turnover down the years has been always very low but the SSERC corporate uniform - a pencil up each nostril, a banana in each ear and a propellor on the head - must take a lot of the credit for that. We've also had wonderful support in the governance of the Centre. In the forty-year lifetime of SSERC, we've only ever had 'four folk in the chair' [4], (sequentially not simultaneously). Firstly, there were three for the Governing Body and more recently only one for the Board of Directors. Councillor David McGrouther deserves special thanks for his unstinting efforts over many years, firstly as chair of the governors and then as chairman of the SSERC board since incorporation. My very best wishes go also to Fred Young who a while back foolishly accepted appointment as Chief Executive Officer of the Company, thus allowing yours truly to take on a new and usually enjoyable role, facilitating science CPD arrangements.

Here's to the next forty, Fred! You must be touched. I find that strangely comforting.

John Richardson,
Science CPD Projects

Quote Quiz

This is the competition promised, threatened even, in the opening editorial. The thesis is that many educational issues really aren't that new they just get recycled. So, to within one calendar year either side state (guess?) the dates of the following quotations.

4 The late Prof W.H.Childs and Councillor Joe McGinley; Councillor Ross Martin and Councillor David McGrouther.

In the event of a tie, correct attributions as to author may gain bonus points. Many SSERC editorials, however, were joint affairs with inputs from several staff. In the event of any dispute over the results you will simply be asked to go away.

1) "Just to twist the knife a little, much of the beauty is in the eye of the creator. Frequently there is little in the eye of the beholder. Desktop publishing is a profligate consumer of time".

2) "..I believe it to be impossible to teach chemistry without introducing some hazard to teacher and pupils. To insist on complete safety would be to remove from the (teaching) laboratory chemicals as widely used as sulphuric acid. It follows therefore that someone must determine an acceptable level of risk."

3) "We seem to be more concerned to smooth the paths of those few pupils who will pursue the subject beyond the school stage than with the effects on the great majority, who will be the laymen and women of tomorrow.

4) "With the increase in the pace of developments in science teaching, there are some developments with which we'll never catch up".

5) "It's the technological equivalent of water skiing, a quick trip around the bay only ever skimming the surface".

6) "Scottish science teachers stand in danger of being reduced from professionals to mere operatives - practitioners of other peoples' prejudices. If you wanted to learn to swim would you seek advice from a non-swimmer? Then why seek advice and direction on the organisation, management and assessment of open-ended investigative and project work from folk who have never done it? Would you ask a eunuch for practical advice on sexual technique? He might have observed quite a lot of activity and could write a tolerable theoretical guide. The point is: he cannot actually do it, may never have done it and - short of a miracle - he never is going to do it."

7) "The greatest danger is not that people don't know about a particular hazard, it is that they don't know they don't know."

Quote Quiz (continued)

8) "It is perhaps well past the time that pupils learned that dinosaurs have no monopoly in the extinction business".

9) "The difficulty ... is examinations. We must find a new form of examination – we are all groping for what form this must take".

10) "The danger lies in the improper use of inventory control where substances may be eliminated on the strength of the hazard data alone but where the actual risks in use could be readily controlled."

11) "Arguments over proper roles for assessment are not new. However it would seem that they are always ducked, never settled. If we can't solve the problem of national, external assessment perhaps it is time we changed the problem."

12) "Far better, we think, for the secondary schools learn from good primary practice, than that the sins of the former be visited on all."

13) "A lot thus remains rotten in the state of science and technology education on which so much of our future welfare - environmental, political and spiritual as well as economic - depends."

14) "It would be an especially good thing if more than the odd MP, senior civil servant or lawyer knew their Becquerel from their elbow."

15) "Investment is one thing. Exporting a whole quality of life and importing ecological damage is another. We just have to find more subtle and sophisticated ways of tackling environmental issues".

Send answers, stating your name, address, tel. no. by e-mail to sts@sserc.org.uk

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Annual Conference, 40th Anniversary & AGM of SSERC Ltd

Friday 9th of December 2005 at Glasgow Science Centre

Provisional Programme & Booking Form

9:15 - 10:00	**Registration, exhibitions open and coffee.**
10:00 - 10:10	**Welcome and introduction**: Councillor David L. McGrouther, BA, JP, Chairman SSERC Limited, West Lothian Council.
10:10 - 10:40	***Keynote Address:* 'The 3-15 Science Review'** by Walter Whitelaw, Midlothian Council
10.40 - 11:10	**Life begins at Forty!** Old and new hands recall the past as well as a look at what beckons for the future.
11:10 - 11:40	**Coffee and exhibitions**
11:40 - 12:10	**Relevance of SSERC Activities to 3-18:** Mapping against the Curriculum Review and the Curriculum for Excellence by John Richardson, Director of CPD Projects; Kath Crawford, Adviser in Science, SSERC & SAPS Biotechnology Scotland Project.
12:10 - 12:40	**Technician CPD:** Conference update & the way ahead by Brian Richmond, Project Manager and Phil Muggins, Project Officer for the Project: CPD & Related Activities for School Science & Technology Support Staff
12:40 - 12:50	**Health & Safety – Current Issues**
Closing remarks – Bristow Muldoon MSP	
13:00 - 14:00	**Lunch and Exhibitions**
14:00 onward	**Annual Report and General Meeting** **Board Meeting of SSERC Ltd.** (Directors & Officers of the Company) **Exhibitions**
15:00	Depart and see you next year

I wish to reserve a place at the Annual SSERC Science, Technology and Safety Conference:

Name :_____ Position_____ Date _____

Address _____

I enclose my cheque/official order* in payment of the delegate fee(s) of £60 + VAT (£70.50) for members*/£80 + VAT (£94) for non-members* [delete if inapplicable]. I wish*/do not wish* a receipt.

Return to: SSERC, St Mary's Building, 23 Holyrood Road, Edinburgh EH8 8AE

Support Materials for Teachers and Technicians

Here we summarise a number of resources on CD and DVD to support teachers and technicians

SSERC SafetyNet CD coming soon

We are in the final stages of editing the new *SSERC SafetyNet CD*. This brings together all our Health and Safety refences fom the SSERC Bulletins, previously published CDs and guidance booklets. These have been brought up-to-date and compiled on one easy-to-use CD for teachers and technicians.

Concentrating here on the *Hazardous Chemicals* section we take into account the COSHH amendments [1] where OES and MELs are replaced by a single (workplace exposure limit) called a WEL. Now you must not exceed a time weighted average (TWA) WEL.

We will also be updating our recommendations on the storage and handling of flammables to comply with *DSEAR*. See *Bulletin 213* [2] for more details.

With regard to disposal, new *Special Waste Amendment Regulations* [3] have just been published. Anything in the *European Waste Catalogue* (EWC) [4] is now defined in Scotland as "special waste". The same rules apply as before - just the definition of what is special waste applies.

The *Waste Elettrical and Electronic Equipment Regulations* (WEEE) [5] now have a requirement to collect electrical and electronic equipment separately.

A New *CHIP Approved Supply List* is due out at the end of October 2005 and this will affect the Risk/Safety Phrases. Individual pages and data sheets will reflect and incorporate any implications of the above changes.

ISE 5-14 Exemplar Materials CD

Learning and Teaching Scotland has published a *set of support materials for teachers delivering the science curriculum* [6]. This collection of exemplar materials has also been integrated within the structure if the Improving Science Education 5-14 website.

Formative Assessment in Science CD

Also available is the *Formative Assessment in Science CD* from *Learning Curve Software* [7]. A sample copy of this material has been made available to each Education Authority 'Assessment is for Learning' Co-ordinator and is designed to improve the quality of science teaching and raise attainment.

TSEC Strategies for Teachers of 5-14 Science

Improving Science Education CPD through Practical Activities (DVD/CD)

Although grounded in only one of three Attainment Outcome for Environmental Studies 5-14 Science (Living Things and the Processes of Life) the TSEC materials have great potential for application across the whole of 5-14 science, and probably well beyond.

The TSEC team have produced a comprehensive collection of materials and video clips of classroom practice covering a wide range of techniques from effective questioning through formative assessment and onto the development and assessment of skills such as those needed for investigative work.

They have also taken the trouble to build on and further develop the good practice exemplified by other practitioners - both within and outwith the ISE 5-14 consortia and from other national or local initiatives. The *TSEC pack of materials* [8] has been produced with the expert help of the Angus Digital Media Centre in Brechin.

References

1. New approach to good practice and exposure limits for chemicals - Amendments to COSHH 2004.

http://www.hse.gov.uk/press/2005/e05046.htm

2. SSERC Bulletin 213, Winter 2004, page 8.

http://www.sserc.org.uk/members/bulls/213/safety4.htm

3. Special Waste Amendment (Scotland) Regulations 2004

http://www.sepa.org.uk/guidance/waste/amendment_faq.htm

4. Interpretation of the definition and classification of hazardous waste

http://www.sepa.org.uk/guidance/waste/hazardous/

5. Waste Electrical and Electronic Equipment Regs. 2005

http://www.dti.gov.uk/sustainability/weee/

6. ISE 5-14 Support Material Exemplars, LTS, January 2005

http://www.ise5-14.org.uk/members/Exemplar_Materials/Overview.htm

7. Learning Curve Software - Formative Assessment in Science

http://www.learningcurve.info/fais/pricing.htm

8. TSEC Strategies for Teachers of 5-14 Science

http://www.ise5-14.org.uk/members/TSEC_DVD/News_and_Background.htm

Alas, more lost sources

Introduction

In the last issue, *Bulletin 214* [1], we gave a warning that there is a significant risk of radioactive materials being lost when laboratories are being refurbished. The warning had scarcely been published when we were notified of the loss of a locked steel cabinet thought to contain three sealed sources. This was from a secondary school in which a refurbishment programme has been underway for two years. The loss occurred during the transfer of chemicals and radioactive materials from one temporary store to another.

The case of the missing cabinet

The transfer had been arranged by the Depute Head (who played the captain's part, working in his holiday break). As a former chemistry teacher, he personally crated up the chemicals and instructed the removal contractors. The removal should have taken place on Good Friday (the first day of the school's Easter break), but the job ran on into Saturday. Having spent most of Good Friday in the school preparing the transfer, the DHT returned on Saturday morning to check on what was happening, finding that most of the chemicals and the two steel cabinets with radioactivity markings still had to be moved. When the premises re-opened after the holidays, school staff did not have free access to the temporary store containing these hazardous materials because it was located in a hard-hat area. Exceptionally the technicians got weekly access under the supervision of the site contractor. By mid May, staff had became concerned that one of the radioactivity cabinets had not been seen. The box was searched for and contractors queried.

The school had two radioactivity cabinets. The larger of the two cabinets had nothing in it, and this one had been correctly transferred with the chemicals to the new store in March. The other smaller cabinet – the one containing the radioactive materials had disappeared. The investigation indicates that it may have been dumped in a skip when the room was finally cleared, having been overlooked in the transferral of materials from one store to another.

Lessons learned

The lesson to take from this tale is not to trust sub-contractors but check on every stage of the work they do. When any safety-critical job has to be done either it should be entrusted to a dependable member of the school staff or, if it has to be contracted out, should be supervised by school personnel. If radioactive materials are to be shifted by contractors then there should be a member of staff handing over the materials at the beginning of the journey. There should be another member of staff receiving and checking the materials at the journey's end. The words of the Falkland's War reporter, Brian Hanrahan, are apt: "I counted them out and I counted them all back".

Of course the materials would be more secure and the job simpler if shifted by school staff than entrusted to others.

Radioactivity safety files

Two of SSERC's radiation safety files have been revised and converted from pdfs into Microsoft Word to facilitate electronic record keeping and editing. They are the radiation safety poster, and record and management list. We have also provided a risk assessment and control measures on working with geological specimens containing uranium- or thorium-based minerals. These three new Word files can be *downloaded* [2] from the SSERC website :-

- Working with radioactivity: What you should know and do
- Working with radioactive substances: Record & management list
- Radioactive minerals risk assessment

Figure 1 *Radioactive sources cabinet*

Ionising radiations – new UK review

The *Health Protection Agency* (HPA) have published a new review [3] of the exposure of the UK population to ionising radiation. It shows a rise in exposure since the last review six years ago, mainly due to increased medical diagnostic practices such as computed tomography. The average annual dose of ionising radiation exposure is now 2.7 millisieverts (mSv) compared to the previous figure, published in 1999, of 2.6 mSv. Another factor is the greater air travel by UK residents, resulting in a slight increase in the average annual dose from all cosmic radiation.

NRPB no more

From 1st April 2005 the National Radiological Protection Board (NRPB), an independent, government-funded agency providing scientific advice on radiation, became a part of the Health Protection Agency. NRPB Scotland is now:

Health Protection Agency
Radiation Protection Division
Radiation & Environmental Monitoring Scotland

Web: www.hpa.org.uk/radiation

Email: scotland@hpa-rp.org.uk or glasgow@hpa-rp.org.uk

Disposals of radioactive sources

Disposals are currently hard to arrange, and several options are being pursued.

In May SEPA wrote to SSERC withdrawing our authorisation to dispose of school waste to the landfill site we have been using. We lodged an objection, which resulted in SEPA agreeing to further landfill disposals until March 2006, but no more thereafter. There has therefore been a six-month interruption in disposals this year, inconveniencing several schools. There being very few other landfill sites that accept radioactive waste, we are not sanguine of finding another to replace the one being closed.

Next, SEPA has written to SSERC to allow protactinium generator contents to be disposed of to drain subject to the chemical contents being neutralised. Our view is that because of the risks to personnel and property from working with an open radioactive source, and legal requirements, any disposals to drain should be done in SSERC rather than locally. Because SSERC is relocating, SEPA has insisted that we leave the drains in our present building free from contamination, effectively preventing us from disposing of generators in Edinburgh. Any disposal by this route is thus postponed.

Next, we have been at a meeting convened by the Scottish Executive to plan for the disposal of all of the unwanted or aged sources held by schools and other places. The UK government has indicated that it would be prepared to part-finance this disposal. Because of the difficulties just discussed, this government-supported clearout looks like being the best option. We are at the stage of preliminary discussions, but are also anxious to set up a specially-financed scheme to restock schools with modern materials. There is a lot to arrange. We are hopeful that our current stock difficulties will be resolved.

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http://www.sserc.org.uk/members/bulls/214/physics.htm

2. http://www.sserc.org.uk/members/bulls/215/Safety6.htm

3. Ionising Radiation Exposure of the UK Population 2005 Review, HPA

http://www.hpa.org.uk/hpa/news/articles/press_releases/2005/050524_ionising_review.htm

Thionin - Light & Chemical Energy Demonstration

Introduction

We came across this reaction on an *American site* [1]. It also appears as one of a number of *interesting chemical demonstrations* [2] on a page from a US science supplies firm, Flinn Scientific.

Chemical reactions studied in schools usually involve the mixing of various chemicals or the application of heat. In this demonstration, it is not the addition of a new chemical, or heat, which starts the reaction. It is brought about by the introduction of a light source and is therefore called a photochemical reaction.

It is an excellent visual and fun demonstration for S2 and is directly relevant to the Attainment Targets in Environmental Studies 5-14, Science component, Earth & Space – *Changing Materials at Level F* [3]

For the chemistry courses, it can be used to show a colour change in a chemical reaction in Unit 1(ii) of the Intermediate 2 course, Unit 1(b) of the Access 3/Intermediate 1 course and in Unit 1 of the Standard Grade course.

It can also be used when teaching oxidation/reduction and oxidising/reducing agents in Unit 3 e(i) of the Higher course, Unit 3 (ii) of the Intermediate 2 course and Unit 10 of the Standard Grade Course, not to mention being used generally to illustrate reversible chemical reactions.

Theory

Thionin is an organic compound that can exist in two forms; a purple oxidized form and a colourless reduced form. When a reducing agent such as iron(II) (Fe^{2+}) ions is added to an acidified thionin solution, light induces the reduction of the protonated thionin molecule (here simplified to $Thio^+$) to its colourless form by the Fe^{2+} ions. This is an example of the conversion of light energy to chemical energy.

The reaction can also be reversed. When the light source is removed, the purple colour, due to the oxidized form of thionin, returns. If part of the solution is shaded, the solution on the side shaded from the light remains purple, while the side exposed to the light turns colourless. The boundary between the colourless and purple form is very sharp.

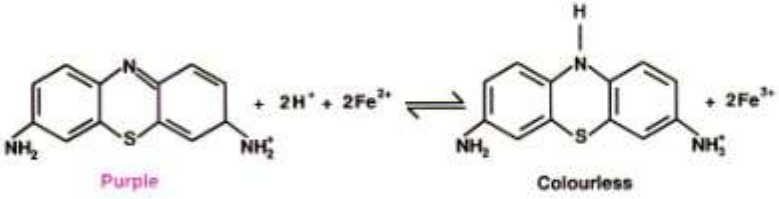
The reduction and oxidation equations are:

$Thio^+ + 2H^+ + 2e^- \longrightarrow ThioH_2^+$ reduction

$2Fe^{2+} \longrightarrow 2Fe^{3+} + 2e^-$ oxidation

The equation showing the reversible reaction is:

$Thio^+ + 2H^+ + 2Fe^{2+} \rightleftharpoons ThioH_2^+ + 2Fe^{3+}$ **OR**



For each demonstration you will require the following equipment and chemicals:

Aluminum foil and white card taped together
1 litre glass beaker
2 g iron(II) sulphate, ($FeSO_4.7H_2O$) (Harmful)
100 cm^3 1M sulphuric acid solution (Irritant)
100 cm^3 measuring cylinder
10 cm^3 of a solution of Thionin (Harmful)
500 cm^3 of distilled water
Overhead projector

Preparation of the thionin solution

Dissolve 0.02 g of thionin in a little distilled water and make up the volume to 100 cm^3 with more distilled water.

Just prior to the demonstration mix the following chemicals together in a 1 litre beaker:

10 cm^3 of freshly prepared thionin solution, 100cm^3 of M sulphuric acid and sufficient distilled water to bring the final volume to about 500 cm^3.

The demonstration

Add the 2.0 g of iron(II) sulphate to the thionin mixture. Stir to dissolve.

Note the colour of the solution. Place the beaker on the overhead projector stage. Turn on the lamp. The solution will change from purple to colourless in a matter of seconds. Turn off the lamp and the purple colour will return. (A piece of white card behind the beaker is useful for viewing the colour change). You could also try turning the room lights off for the demo.

Try this! Tape together a large sheet of white card or stiff paper (35 cm x 45 cm is ideal), and three layers of aluminium foil, to form two layers.
Place a 1 litre beaker on the card and draw round half its base.
Cut out a 'D' from the card/foil, using this mark as a template.
Fold the long side to give a white viewing screen 15 cm wide and place the foil/card on the OHP (lamp off).

Place the beaker in low light conditions until it appears purple and then on the projector stage so that half of the beaker is sitting over the cutout 'D' of the card. Turn on the projector lamp and observe the solution. A distinct vertical division between the purple side and colourless side should be clearly visible. (The vertical division indicates that the reaction is initiated by light and not heat and is best observed when the students are in direct line with it). The reaction can be reversed by turning off the light and is reversible for several days.

Tips

1. Prepare the thionin solution fresh. It has a poor shelf life so is best used within one week. However, we stored the thionin solution in a dark bottle and satisfactory results were still obtained after one month.

2. The extent of any colour change will fade over time from bright purple to a paler shade of blue to purple and the colour takes longer to return.

3. Direct, bright sunlight may also be used as a light source.

Source of Thionin

Thionin can be obtained from from Sigma-Aldrich [4] as thionin acetate (code T3387–5G) at a cost of £24.50/5g

References

1. http://www.elmhurst.edu/~chm/demos/thionintwofacereac.html

2. http://www.flinnsci.com/Sections/Chemistry/chemDemonstratoins.asp

3. http://www.ise5-14.org.uk/Prim3/New_Guidelines/Levels/TOPICS-F.HTM#1-3

4. http://www.sigmaaldrich.com/catalog/search/ProductDetail/SIGMA/T3387

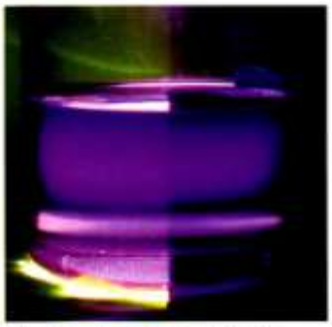


Figure 1 *Lamp just switched on*

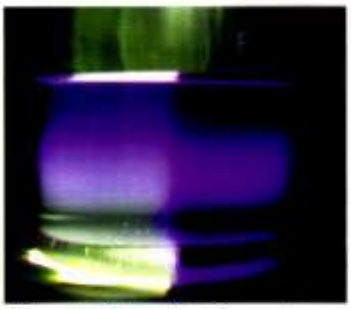


Figure 2 *Beaker after 10 seconds*

Substance	Generic risk assessment or results	Format
thionin	May be harmful by inhalation, ingestion or through skin absorption. Eye contact may result in permanent eye damage. Toxicology not fully investigated.	Avoid raising dust. Wear indirect vent goggles and gloves. Wash hands after handling.
sulphuric acid (M)	Irritant to eyes and skin. Repeated contact can cause dermatitis.	Wear goggles and nitrile gloves.
iron(II) sulphate	Harmful if ingested in quantity. Irritating to the skin and to the eyes.	Wear indirect vent goggles and pvc gloves.

Table 1 *Hazards and control measures*

Cabomba - a reliable alternative to *Elodea*?

Introduction

For those of you who have struggled in vain to persuade/cajole/force *Elodea* to perform reliably in front of your class, we offer a suggestion that you substitute *Cabomba*. *Elodea* (Canadian pond weed) is the aquatic plant that has been used traditionally in the classroom to demonstrate oxygen evolution in the process of photosynthesis. In theory, when *Elodea* is placed in a solution of sodium hydrogencarbonate in the presence of light of appropriate intensity, the *Elodea* will photosynthesise and produce bubbles of oxygen-containing gas. These bubbles can be counted and the rate of bubbling can serve as an indication of the rate of photosynthesis. When the light intensity is increased, the rate of bubble production should increase. Decrease the light intensity and the rate of bubbling should decrease. Remove the light source altogether and the bubbling should cease. As is sometimes the case with biological experiments, theory and practice can be at variance and *Elodea* fails to perform as expected.

Figure 1 *Cabomba*

Debbie Eldridge (of SAPS and algal balls fame) has investigated the bubbling performance of a number of other aquatic plants. She has discovered that *Cabomba* is highly reliable.

Cabomba is an aquatic plant that can be readily obtained from tropical fish suppliers. It is not easy to keep indoors but is available from suppliers all year round. We at SSERC have 'played' with *Cabomba* now on many occasions and under different conditions and it has not failed us yet!

The method for measuring the rate of photosynthesis using *Cabomba* is very similar to that using *Elodea*.

Setting up the *Cabomba*

You will need:

250 cm^3 measuring cylinder or a measuring cylinder that is just longer than your *Cabomba* sprig.

Cabomba sprig

400 cm^3 1% solution of sodium hydrogencarbonate

1. Cup your hand around the *Cabomba* sprig and gently flatten the fronds against the central stem (Fig.2).

2. Carefully lower the flattened *Cabomba* (Fig.3) into measuring cylinder, apex lowermost, and hold the end of the stem against the glass with your finger.

3. Fill the measuring cylinder with a 1% sodium hydrogen carbonate solution (Fig.4).

Figure 2 *Flatten the fronds*

Figure 3 *Lower into measuring cylinder*

Figure 4 *Fill with sodium hyrogen carbonate solution*

Preparing the equipment

You will need:

1 cm^3 syringe barrel
Clothes peg
1 cm^3 syringe
Small piece of rubber tubing
Micropipette tip

Figure 5 *Equipment required*

4. Place the small piece of rubber tubing on to the nozzle of the 1 cm^3 pipette.

Attach the micropipette tip to rubber tubing (Fig.6). The micro-pipette tip provides a straight-forward method of filling the syringe barrel with fluid.

Figure 6 *Preparing the syringe*

5. Seal the nozzle of the second pipette barrel with a small piece of blu-tak (Fig.7).

Figure 7 *Sealing nozzle with Blu-tak*

6. Use the microsyringe to fill the syringe barrel with fluid (either water or sodium hydrogencarbonate solution) (Fig.8).

Figure 8 *Filling the syringe barrel*

7. Balance the syringe on a beaker (Fig.9) so that it does not spill while you are preparing the *Cabomba*.

Figure 9 *Balance syringe on beaker*

8. Cut the stem of the *Cabomba* sprig at an angle under the surface of the liquid (Fig.10). This cut end must remain in the liquid or an air lock may form. You should be able to observe bubbles of gas rising from the cut.

Figure 10 *Cut stem under surface*

To measure the volume of gas collected

9. Ensuring it remains full of water, invert the syringe (Fig.11) over the cut end of the *Cabomba*.

10. The bubbles of gas evolved during photosynthesis will displace the water and the volume can be measured directly using the graduations on the syringe (Fig.12).

Figure 11 *Invert syringe over cut end*

Figure 12 *Collecting gas by displacement*

11. This shows the volume of gas collected in the syringe barrel (Fig.13) after the time indicated on the stopclock.

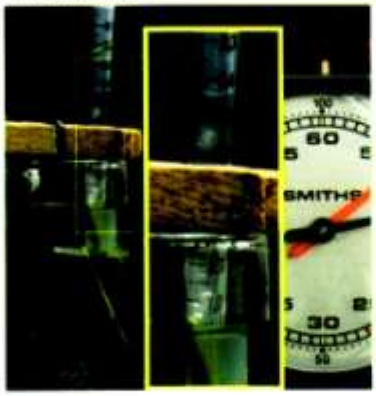


Figure 13 *Timed collection of gas*

The photographs below (Figs. 14 and 15) show the volumes of gas collected in the syringe barrel after five minutes and ten minutes. The arrows point to the level of the fluid in the syringe barrel. The apparatus was placed close to a window and the *Cabomba* was photosynthesising in natural light.

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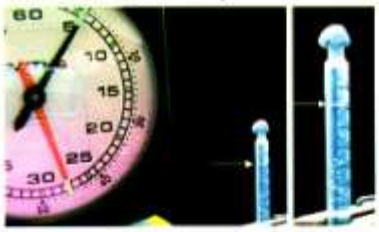


Figure 14 *Gas collected after 5 minutes*

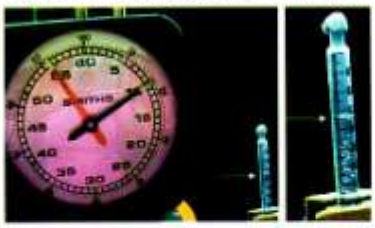
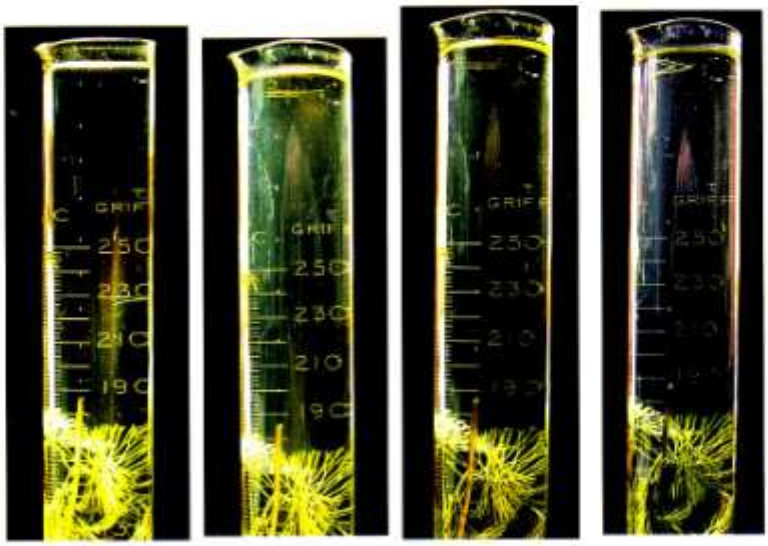


Figure 15 *Gas collected after 10 minutes*

Alternatively, the number of bubbles can be counted and the rate of bubbling calculated (Figs. 16 to 19). The measuring cylinder was placed above an artificial light source and the bottom masked by varying amounts (Figs. 20 to 22). The graduations on the flask can provide a convenient guide. Reminds me a bit of tickertape this (Ed.)



Figures 16 to 19 *Bubbles counted and count rate calculated. Graduations on the measuring cylinder can provide a useful guide. The first cylinder had no mask underneath.*

Figures 20 to 22 *Show the masks placed underneath the measuring cylinders to vary the amount of artificial light to which the Cabomba was exposed.*

Using carbon dioxide uptake as a measure of photosynthesis

To date, measurement of CO_2 uptake to demonstrate the process of photosynthesis has always involved an abstract or 'link' step, usually involving a pH change. pH change is determined by colour change in bicarbonate indicator, for example.

CO_2 sensors that have appeared on the market recently now allow direct measurement of CO_2 concentration and promise to have application in the classroom across a wide range of topics that include:

- measurement of CO_2 levels during cellular respiration
- measurement of CO_2 levels in photosynthesis experiments
- monitoring of the increase in CO_2 levels from small animals
- measurement of the rate of production of CO_2 in chemical reactions
- monitoring of CO_2 levels during fermentation or respiration of sugars

Watch out for more information about CO_2 sensors and probes in a future SSERC Bulletin.