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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CPD Grant awards

It's been wisely said of private money that there are only ever two problems. The first is getting any and the second is keeping it. In an educational context that first problem remains but getting money to where's it's needed, and spending it effectively, provides the second. Those of you who read sections of the TESS[1] other than the job adverts, may have seen recent references to three sets of grant monies awarded to various partnerships with SSERC as the lead body and fund-holder. Being in receipt of Scottish Executive grant monies is a relatively new experience for us. It takes a little getting used to. So, first problem's solved. We've got some extra money. What about the second – spending it wisely?

CPD for support staff

Just what are our plans? Well, in two cases these were largely pre-determined or pre-empted by the Scottish Executive's own invitations to selected organisations requesting them to apply for funding. This means that in one case the grant monies have been awarded to a partnership of SSERC and the local authority based Scottish Technicians' Advisory Group (STAG). That grant is for the specific purpose of developing a suitable Scottish qualifications and CPD framework for science and technology support staff.

Support for science through CPD

In similar vein, SSERC and its core partners will shortly be in receipt of other grant monies of about £330 K over the coming two financial years. Those funds will be applied, along with significant contributions from other sources and SSERC's own core funds, to underpin a number of CPD events and other activities. Each of these designated outcomes is intended to support contemporary Scottish developments in science education 3 to 18 (see below).

- Provide a continually evolving central resource covering and collating the range of advice and materials available across the science education community. (Provisionally known as the "Scottish Science Education Resource Centre" and partly website based.)
- Organise an annual national conference that will:
  - highlight current good practice in science education (including the use of ICT)
  - disseminate (information) and act as a forum for engaging practitioners in discussions on curriculum developments
  - consider the success of existing CPD in meeting teachers' professional needs, improving classroom practice and pupils' achievements
- Provide CPD opportunities that will . . . (catalogued in an itemised list and including Practical Workshops, update courses and Summer Schools etc.)
- Develop a productive working relationship with the UK National Science Learning Centre (NSLC) at York as a means of supporting NSLC's UK-wide mandate to provide CPD for Scottish science teachers and support staff. See also "News and Comment" on page 9.

Major outcomes required as activities of the "Support for Scottish Science Education through CPD" project. Grant monies will be used to 'top up' existing funding and so extend and enhance a range of successful activities of 'core' partners and other agencies.

Continued on page 2/ over

Initial teacher education

A third case was less pre-determined. Here, SSERC had already agreed to act as the lead body for a proactive application from a number of partners[2]. This was for monies to help fund joint residential events for all Scottish postgraduate science teachers in training. About £117 K has been awarded over two years. That same initiative also aims to arrange or provide administrative and technical back-up for other extant residential CPD events such as the now well-established Summer Schools for biology, chemistry and physics. In the past these have relied heavily on goodwill and much marginal staff time freely given. With the success of the other applications, the intention now is to also closely align such activity with the core project on supporting science education through CPD.

The CPD for support staff initiative, with separate funding of the order of £480 K over two years, will probably retain its own identity with its own project manager and steering group. It is likely to enjoy a considerable degree of autonomy. This is primarily so as to reflect the somewhat different professional development needs of teaching and support staff. Nonetheless, some joint teacher and technician events (as seen in previous SAPS and SSERC initiatives) are highly likely.

At the time of writing advertisements had already been published for the posts of Project Manager and Project Officer. It is perhaps critical to stress that the support staff CPD initiative is exactly that – a project concerned with professional matters and professional development. Whilst the outcomes of the project may well inform and influence decisions on career paths or structures and other related matters, such issues are primarily for the employers and employees, with their representatives, to negotiate and decide upon. They lie well outwith the scope of this present project.

Footnotes

1 The Times Educational Supplement Scotland

2 Scottish ITEIs, the Development to Update School Chemistry (DUSC) project, SAPS Biotechnology Scotland Project and the Scottish Institute for Biotechnology Education at the University of Edinburgh.

Online Discussion Forum for Technicians

This Forum is now available and we would encourage all Scottish technicians to try and make maximum use of it. The advantages of using the Forum will be that :-

- with the help of SSERC, SAPS & DUSC, you (the technicians) will make the Forum a success
- it should allow easy communication with other Scottish technicians
- you can help each other out
- you can keep up to date with developments and technician courses available
- feedback, follow-up and exchange of views/information after CPD will be possible
- it can deal with safety issues, sourcing of chemicals and equipment, problems with practicals, equipment problems, chemical storage and disposal, useful websites
- all the technician community can reflect and comment on any advice given. FAQs will become obvious.

To register, please send your first and last name plus your e-mail address to ian.birrell@sserc.org.uk

Note - you will also gain automatic access to the ISE 5-14 and SSERC Enquiries Forums (Independent Schools and Colleges not in membership of SSERC will not have access to the SSERC Enquiries Forum)

Once registered we will send your username and password to gain access to the Forums at :-

http://www.sserc.org.uk/forum/includes/forumlogin.asp

Trade News

Carolina and Blades Biological Ltd.

Blades Biological Ltd. have become the UK distributors for the Carolina Biological Supply Company. Carolina provides resources and materials for biology, chemistry, physics, science and maths, and offers technical support for their products. Catalogues for Blades and Carolina can be ordered from sales@blades-bio.co.uk or

Blades Biological Ltd., Cowden, Edenbridge, Kent TN8 7DX

Telephone: 01342 850242 Fax: 01342 850924

Depending on the demand, orders will be placed regularly with Carolina but will be dealt with separately from Blades Biological orders.

Due to favourable exchange rates, now is a good time to buy and products include seeds for monohybrid, incomplete dominance and dihybrid genetic crosses, synthetic blood kits and much more.

NGN pumps

The vacuum pump manufacturer NGN went out of business many years ago. NGN pumps can be serviced by, or spare parts obtained from, Creative Vacuum Services, based in Worthing, Sussex.

Creative Vacuum Services, 16 Willowbrook Road
Hambridge Trading Estate, Worthing Sussex BN14 8NA
Telephone: 01903 204542
Email: tony@creativevacuum.co.uk

A safer Biuret Reagent

The *SSERC Hazardous Chemicals - An Interactive Manual for Science Education CD2* recommends that Biuret reagent only be used at S3t (i.e. S3 with close teacher supervision) level or above due to the corrosive nature of the sodium hydroxide present. This means that S1 and S2 pupils carrying out food tests are precluded from using Biuret.

It is possible to use the quantitative formula of the reagent for qualitative food tests. This is a single solution, which lasts for several weeks and removes the need for students to mix the copper sulphate and sodium hydroxide solutions during the test. Unfortunately this version is also in the corrosive range as it is 0.75 mol l^{-1} with respect to sodium hydroxide.

Following a request for advice from a member we have looked at this recipe with a view to lowering the concentration of the sodium hydroxide so that it would be classed as irritant rather than corrosive. Our tests showed that when the reagent is 0.1 mol l^{-1} with respect to sodium hydroxide it still provides a working reagent and a positive result for protein.

The modified version was tried with albumin solution, grated cheese and fresh salmon. The colour change was definite and began to occur using warming by hand although the reaction was slow. Heating under a hot water tap speeds up the reaction.

Recipe for modified Biuret Reagent

1. Dissolve 1.5 g copper sulphate and 6g potassium sodium tartrate in 500 cm^3 of distilled water.
2. Add 50 cm^3 2M sodium hydroxide and make up to 1 litre of solution.

Substance	Hazards	Control Measures
sodium hydroxide	**solid** - strongly corrosive **2M solution** - strongly corrosive **diluted solution (0.1M) -** a little below the concentration required to be labelled as irritant.	Those preparing solution should wear goggles and gloves.
copper(II) sulphate	**solid** - harmful by swallowing or by inhalation of the dust. Irritating to the skin. **working solution (0.009M** with respect to Cu^{2+} ions**)** is unlikely to be irritating.	The prepared reagent (single solution) is best treated as an irritant. Wear eye protection and wash any splashes off the skin.

Radiation News

Radiation Protection Adviser

One of the requirements of the Ionising Radiations Regulations is that a radiation employer[1] must appoint a Radiation Protection Adviser (RPA) to advise them with their work. As from 1st January 2005 the person appointed must be qualified to work as an RPA under a scheme known as RPA2000 run jointly by the Health and Safety Executive (HSE) and the Society for Radiological Protection. One of our staff members, Jim Jamieson, has this qualification. Jim is the RPA for thirty-one councils, many independent schools and some FE colleges. Anyone seeking advice on radiological protection or radioactive sources should contact Jim at SSERC.

Stock checks

Ever since the 1985 Ionising Radiations Regulations came into force, schools have been required to keep a record of stock and make a formal, annual check that the stock is indeed intact. Because of the increased threat of terrorism in the UK, government regulators are now insisting that the frequency of checks on radioactive materials should be increased. Although the risk of harm from educational sources is so low as to be almost insignificant, the HSE are of the opinion that a once-a-year formal check of stock is not enough and they now insist that checks of stock should be made much more often. They asked for weekly checks, SSERC said termly, and we have settled on monthly, an exception being made for the long summer vacation where one check in two months will suffice.

Because of the lost sources reported in the February issue of *Education in Science*, and, as luck would have it, reports of other sources lost by schools last year, the HSE has fresh evidence to support their case. Please therefore ensure that stock is checked monthly, except for the summer vacation, making a record in the log book that the check has been done. One way of checking stock regularly is to ask each person withdrawing sources from the store to check that the stock is intact when the sources are being returned (Fig. 1).

Figure 1 *A radioactive source cabinet – stock should now be checked every month except in the summer holidays.*

Lost sources

The following incidents, published in the ASE journal *Education in Science* (February 2004), highlight the need to manage carefully the keeping and storage of radioactive sources.

1 A radiation employer is a legal term defined in health and safety regulations. The term applies to any employer of schools holding and using radioactive materials in science laboratories.

In one case, during the refurbishment of the laboratories in an independent school, the sources were being stored temporarily in the boiler room. The head of department had advised the senior management that this was not a suitable place for the sources to be kept, but his advice was disregarded. The sources disappeared. In prosecuting the school for the loss of sources, the HSE made it quite clear in court that no blame attached to the head of department, who had acted quite properly. The school was fined £1,500, with a further £2,000 costs.

In the second case, a post-16 college was closing down one of its sites and sold the contents at an auction, and although the bidder only wanted some of the furniture, the auctioneers insisted it was all or nothing. When the new owners came to collect their purchases, the technician questioned whether it was right that they were taking the radioactive cupboard as well, but take it they did. Later the college safety officer realised that there might be a problem, but was not sure because the only list of sources was locked in the cupboard which, by now, had been taken away. When the safety officer tried to find out what had happened to the sources the auctioneers were less than helpful, claiming professional secrecy. It was only when the Environment Agency investigated that the sources were tracked down and recovered. At the time of writing it is not yet clear whether either the HSE, or the Environment Agency, or both, will take action against the college.

School rebuilding or closure

The above incidents show what can so easily go wrong if work with radioactive materials is not properly managed. Arrangements must be made for radioactive materials to be kept securely and safely – especially during abnormal circumstances. If science laboratories are to be rebuilt, relocated, or closed down, transitional arrangements may have to be made to store materials. Guidance on storage can be downloaded from the SSERC website. If a school is being closed, or relocated to another site, or merged with another school, other issues to plan for are HSE notification, road transport and disposal. Please seek advice from SSERC.

http://www.sserc.org.uk/members/Safety Messages/Radioactivity/Store.doc

Receiving hospitals

One of the rules set by SEED is that each school must have the name and telephone number of a hospital for providing advice in the event of an accident. The Major Receiving Hospitals for Radiation Casualties in the various areas of Scotland are shown below (Table 1). The name of the hospital most convenient to your school should be inserted on your poster 'Safety Arrangements: Working with radioactive sources: What you should know and do'. Please note that unless you are responding to a radiation incident there is no need to contact the hospital because that would just create unwanted correspondence.

Area	Major Receiving Hospital for Radiation Casualties
Grampian	Aberdeen Royal Infirmary
Highland	Raigmore Hospital, Inverness
South East	Royal Infirmary, Edinburgh
Tayside	Ninewells Hospital, Dundee
West of Scotland	Royal Infirmary, Glasgow (adults) Southern General, Glasgow (adults) Royal Hospital for Sick Children, Glasgow (children) Crosshouse Hospital, Kilmarnock Dumfries and Galloway Royal Infirmary Royal Alexandra Hospital, Paisley Monklands Hospital

Table 1 *Major Receiving Hospitals for Radiation Casualties.*

Sources from PASCO

You may have noticed that PASCO stock a range of sealed radioactive sources mounted in 2.5 cm diameter plastic discs (Fig. 2). Individual sources cost £71; a set of three (SN-8110) costs £159. There are several issues to watch.

Figure 2 *PASCO's alpha source with the radionuclide Po-210 – its disposal is very difficult. (Photo by CLEAPSS.)*

Firstly, having carried out a prior risk assessment on these sources, we concluded that the risk of harm from working with them is very low, but the sources are significantly less robust than the standard Amersham source, or the new type from AEA described in *Bulletin* 211. Therefore the lifespan of PASCO's sources should be set at 2 or 10 years rather than the 15 or 30 years for AEA or Amersham types. Secondly, we are unsure whether SEED would approve of schools getting these disc sources. (Before anyone can purchase a source, they need a letter of approval from SEED.) Thirdly, the alpha-emitter is Polonium-210, which has a half-life of only 138 days. This is peculiarly short. You could monitor it monthly to log the decay - this would be a legitimate educational reason for getting this source - but after two years its activity would have diminished to such an extent that the source could then serve no useful purpose. The law would then require you to declare the source to be waste and arrange to have it disposed of as soon as practicable. Now the disposal of school sources is normally made easy by making use of one of the Exemption Orders (EO) to the Radioactive Substances Act. These EOs date back to the 1960s and were devised to meet the needs of users 40 years ago. They do not allow for the disposal of Polonium-210.

Therefore to get rid of this stuff you would need to apply to SEPA for an authorisation (the current charge is £773) to do so, then pay for its disposal (between £125 and £5,000). In conclusion, under present circumstances, do not buy this alpha source (Po-210).

You may also have seen that PASCO stock an Isotope Generator (Barium-137m) (SN-7995A). Again, for regulatory reasons, don't buy it. Because of its high activity, there is no EO to facilitate its disposal. As for Polonium-210, you would need a costly authorisation from SEPA, on top of which you would have to pay for the disposal.

In general, other types of sources aren't beset by these disposal difficulties. The lessen to be drawn from these stories is to check before buying that the source can be easily disposed of at low cost. Expert advice is needed. Ask your RPA.

Disposals

SSERC has a new authorization from SEPA allowing us to dispose of the following radionuclides, with conditions, to a landfill site: Americium-241, Caesium-137, Cobalt-60, Radium-226, Plutonium-239 and Strontium-90. It does not allow us to dispose of thorium or uranium compounds to the landfill site, but we can help you find other contractors that handle those materials. The charge for a disposal through SSERC is £10 a source.

Acknowledgement

We are grateful to the ASE for letting us reprint the lost source stories that appeared in the February 2004 issue of *Education in Science*.

Data projectors and whiteboards – are they a risk to eyesight?

An overexposure to the bright light from a projector is hazardous. The risk to eyesight is easily controlled by sensible behaviour.

Summary

There is a slight risk of harm to eyesight from the very bright light coming from a data projector (Fig.1). The risk comes from standing in the beam, facing the projector, and staring either directly at the lamp, or at an object elsewhere. It is similar to staring at the sun, or at some other object while directly facing the sun e.g. when driving into the sun while it is low in the sky. The risk is very slight because the eyes are protected by natural aversion responses such as blinking and turning the head away. The risk is easily reduced to a harmless level by engineering and procedural controls.

Figure 1 *LCD projector.*

Control measures

Procedural controls:

- Keep out of the beam whenever you can.
- If you have to enter the beam:
    - never stare at the lamp;
    - try always to keep your back to the beam;
    - do not face the class for more than a few seconds while in the beam;
    - do not try to counteract natural aversion responses;
    - step out of the beam to face the class.
- Children must be supervised at all times whenever a projector is used.
- Children should be warned of the risk to eyesight from extremely bright lamps. They should be given the above rules of conduct and an explanation for their purpose. They should be told that if by mistake they were to find themselves in the beam they should turn away and step out of the light.

Engineering controls:

- The brightness of a classroom projector should be no greater than 1500 lumens (ANSI units).
- If convenient, a classroom projector should be fixed to a ceiling mounting, or other inaccessible location, so that it is not easy to intrude into the beam and impossible to look at the lamp from close up.
- The screen height should be as low as possible for relatively unobstructed viewing. The top of the screen should not be too much above eye level, letting the viewer's head and neck be kept in a neutral posture – which avoids having to crick the neck for extended periods of time. (This measure is for ergonomic purposes and has nothing to do with eyesight risk reduction.)

Acknowledgement

This report is based on information from Andy Pearson at NRPB and augmented by advice to BECTA from the HSE.

Science Investigations with a PVA polymer

Introduction

When borax (hydrated sodium borate) and PVA (polyvinyl alcohol) solutions are mixed, the borax cross-links between the long PVA chains so that a gel or slime is formed. Details on how to prepare the PVA and borax solutions are available at:

http://www.sserc.org.uk/public/slime.htm

This type of slime lends itself to two investigations They are worthwhile doing at an early date in secondary, or even in upper primary, to develop pupil interest in an investigative approach to science (lets face it, pupils and teachers also love working with slime – yet another reason for including them!). Primary staff may wish to contact their (usually?) helpful high school for assistance in preparing the PVA and borax solutions to be used and to borrow any necessary equipment.

The investigations themselves are to observe the changes in the viscosity (gooiness) of the cross-linked polymer by:

a) altering the volume of borax added (and hence the number of cross-links)

b) adding varying amounts of talc to the polymer.

Pupil worksheets for these are available from the SSERC Website (see the on-line version of this article)

These investigations parallel varying the viscosity of oil for car engines and altering the composition of materials to make them bouncy or shock-absorbent.

a) Slime-o-meter: altering the volume of borax added

Apparatus: We made the slime-o-meter from a 2 litre plastic lemonade bottle with the base cut off. You will also require a clamp stand and ring, stop clock, measuring cylinders, ruler and plastic beakers.

Four dependent variable readings should be recorded for the investigation to enable data to be plotted. Prepare different slimes by mixing known volumes of the PVA solution with different volumes of the borax solution. e.g. 80 cm^3 portions of the PVA with 2 cm^3, 4 cm^3, 8 cm^3, 10 cm^3, etc. of the borax. In this method the total volume varies but it doesn't significantly affect the results since the experiment measures the time for the polymer to stretch 30 cm.

Method

Work the slimes to eliminate air, and then set up the apparatus as shown (Fig.1):

- Add one of the slimes to the funnel. Unscrew the stopper and at the same time start the stop-clock.
- Stop the clock when the slime has touched the bottom of the beaker. Note the time.
- Repeat with different slimes. Multiple readings for each experiment can be done and averages calculated. If a selection of similarly sized bottles is available, the experiments can be run simultaneously.

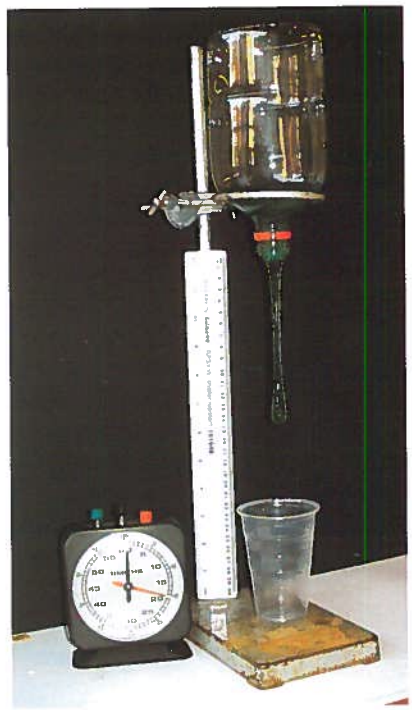


Figure 1 *Slime apparatus*

Volume of borax added (cm^3)	Average time (s)
4	10
5	24
8	67
10	86
12	101
15	108
20	119

Table 1 *Volume of borax added vs. time*

Using the described method the results in Table 1 were obtained:

It is worth noting that the actual times recorded will vary depending on the temperature on the day of the experiment:

A plot of time (Y axis) against volume of borax used (X axis) produces a graph (Fig.2) which eventually levels off since a point will be reached when sufficient borax has been added to complete all the cross-links. The addition of more borax will therefore have no further effect on the viscosity of the slime.

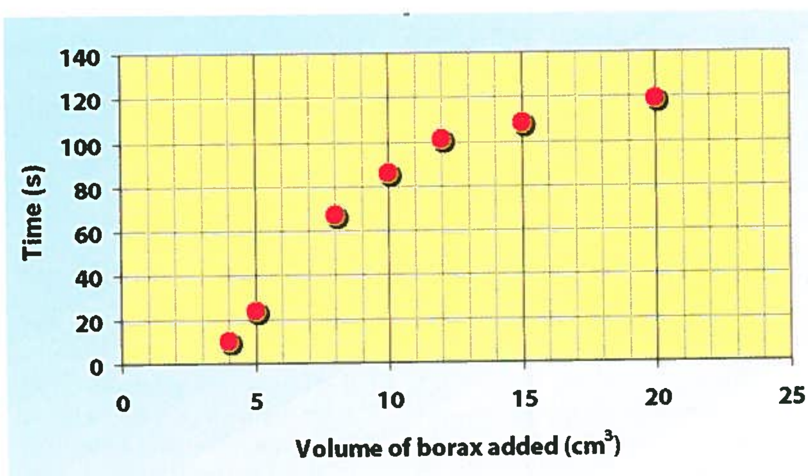


Figure 2 *Volume of borax added vs. time*

b) Fit a dough ball!: adding varying amounts of talc to the polymer.

Apparatus: We made the apparatus from a white tile. On this we drew a cross in indelible ink. We then drew round two different sized plastic chemical containers to give two concentric circles centred on the cross. The diameters of the containers were approximately 5 cm and 7 cm. You will also require a stop clock, talc, spoons, a ruler, measuring cylinders and plastic beakers.

A minimum of four dependent variable readings should be recorded for each investigation to enable data to be plotted.

Each slime is made by mixing 25 cm^3 of the PVA with the required number of level spoonfuls of talc. Stir this well to mix the talc into the PVA and only then add 5 cm^3 of the borax solution.

It is very important that you add the talc before you add the borax.

A teaspoon can be used and the talc levelled using a ruler. This ensures the same amount of talc is used each time.

A small measuring spoon (of the type sold in cook shops) could be used instead. Since these small spoons are graduated in *mls* this would enable units to be used in tables and graphs instead of 'number of spoons added'

The number of spoons (or mls) added could be 0, 2, 4, 6, 8 (Table 2). If much more than 8 spoonfuls are added, the viscosity increases to the extent where the slime does not flow. Will students predict this?

Method

Once the slimes have been made, take each of them and roll them into a ball for approximately 1 minute to dry the slime and to eliminate air.

Place each ball of slime in turn in the centre of the cross on the tile.

Wait until it spreads out to reach the inner circle and then start the stop-clock. If the slime has not been centred correctly, time from when the slime reaches the circle at one of the arms of the cross (Figure 3).

Stop the clock when the slime reaches the outer circle (if need be at the corresponding arm of the cross) and record the time taken.

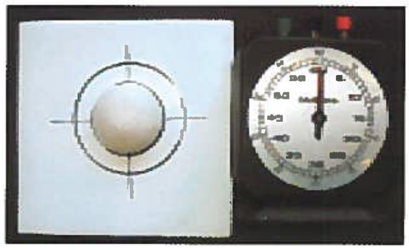


Figure 3 Spread-guide and stop-clock

Multiple readings can be taken for each experiment and average times calculated (Table 2).

The following results were obtained using 25 cm^3 of PVA solution and 5 cm^3 of the borax each time:

Spoons of talc	Average time (s)
0	132
2	166
4	196
6	229
8	260

Table 2 Number of spoonfuls of talc added vs. time

The times obtained will once again will vary with the temperature in the lab on the day:

A plot of time (Y axis) against number of spoons of talc added (X axis) produced a line graph (Figure 4).

A point will be reached when so much talc has been added that the polymer will not flow and the time will become infinite. i.e. the line should become vertical.

Safety

The solutions should be made up for the students.

Students should wear eye protection when making the slime.

Any borax or PVA solution spilt on skin should be washed off with water and, if necessary, soap. After handling the slime students should wash their hands carefully.

See also Table 3 and the *Hazardous Chemicals CD2 - An Interactive Manual for Science Education.*

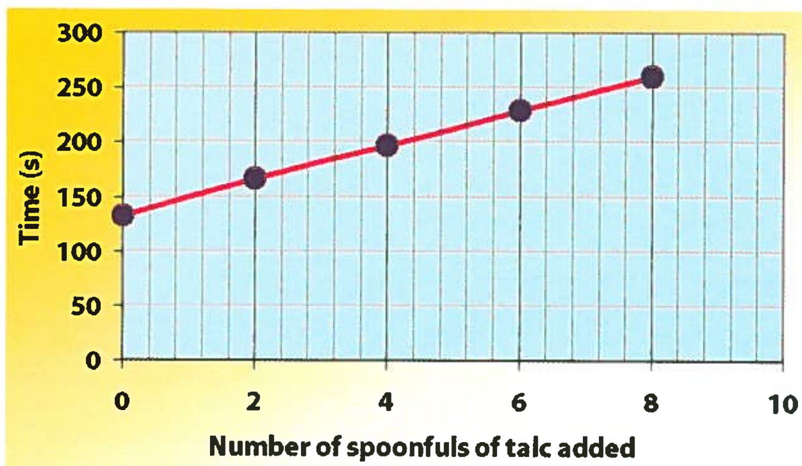


Figure 4 Number of spoonfuls of talc added vs. time

Substance	Hazards	Control Measures
borax	**solid** - harmful if ingested in quantity. Dust irritates the eyes and respiratory system.	When preparing the solution you should handle the solid carefully to avoid raising dust.
pva	**solid** - 'powder' may be harmful by inhalation, ingestion or skin absorption. May cause eye/skin irritation.	When preparing the solution you should handle the 'powder' carefully to avoid raising dust. Avoid skin contact with the solid and wear eye protection when making up the solution.
After handling slime ensure that students carefully wash their hands		

Table 3 Safety measures for preparing the solutions used in making slime

Spark Discharge Apparatus:

Philip Harris: H27167: £133

Purpose

This primitive radiation detector can help greatly in our appreciation of observed phenomena. A spark seen or heard is the result of an alpha emission, signifying the disintegration of a radionuclide. This single event, which can be witnessed by many, is caused by the action of one atom. The apparatus is of inestimable educational worth.

It can also show, by inference, that alpha radiation loses energy as it is transmitted through materials. An estimate of the range of alpha radiation in materials, including human tissue, can be inferred.

Product description

The apparatus (Fig. 1) consists of a pair of electrodes mounted horizontally with an air-gap separation of about 1.5 mm. The top electrode is brass gauze, 105 mm long, with a 1.25 mm mesh and should be earthed and connected to the negative terminal of an EHT supply. The bottom electrode is a phosphor-bronze bar, which, in its original state, was parallel to the gauze above, and is connected to the positive EHT supply terminal. Critically, this air-gap separation between top and bottom electrodes varies in an irregular, periodic fashion because the gauze is slightly rumpled. There are about four peaks and troughs along its length, with a peak-to-peak difference of about 0.5 mm. Therefore sparking occurs at the deepest trough, which is the main confounder with the apparatus as supplied.

To prepare the apparatus for detecting alpha radiation, the EHT voltage is turned up to the point where sparking occurs – signifying the breakdown of the air-gap's dielectric insulation – then turned down a little to stop the discharging.

Performance

The unmodified apparatus showed that when alpha radiation is directed at the gauze from close range, sparks are induced between the electrodes[1].

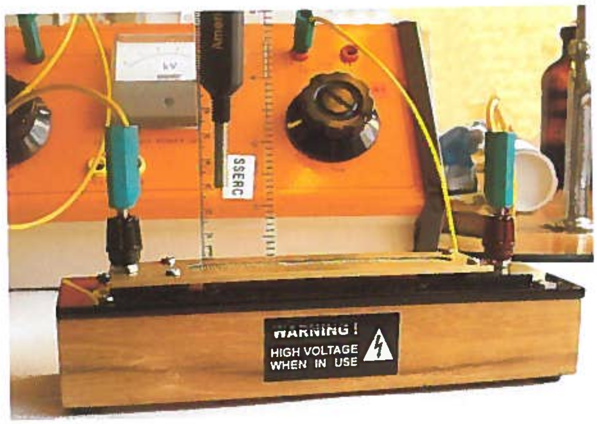


Figure 1 The Harris Spark Discharge Apparatus with an AEA alpha source from Frederiksen.

Beyond this basic effect we were unable to find the range of alpha radiation in air. Results with the apparatus were inconsistent. The only repeatable effects we could get were that sparking occurred when the alpha source was held within 1 cm of the gauze. The reason for this is thought to be the undulations in the gauze. If the alpha radiation is not incident at that part where the air gap is a minimum, then greater energy is needed to induce a spark discharge. The source then has to be brought near to the gauze to provide a suitable source of energy.

Modification

To get round the effect of the undulating gauze, a gradient was engineered in the air gap by raising one end of the top electrode by the width of two washers, or about 1 mm. The other end of the electrode was raised by the width of one washer, or 0.5 mm. Thus the relative size of the undulation with respect to the air gap was reduced, and the effect of the introduced gradient became greater than the effects of the undulations.

The apparatus now works as we want. When an alpha source is held above the end of the gauze where the air gap is at its smallest, we get sparking which starts when the alpha source is brought to a position of about 34 mm above the bottom electrode. This performance is repeatable and reliable. It can be inferred that the instrument is sparking at the limit of alpha radiation in air.

Some experiments partially shielding the spark counter from alpha radiation with polyester film support this inference (Fig. 2). Polyester has a density of between 1.3 and 1.4 g/cm^3, or about 1,000 times that of air. According to the theories of Bohr and Bethe, the stopping power of a material (to stop alpha radiation) is directly proportional to the density of the material. Thus the stopping power of 1 µm of polyester should be equivalent to 1 mm of air.

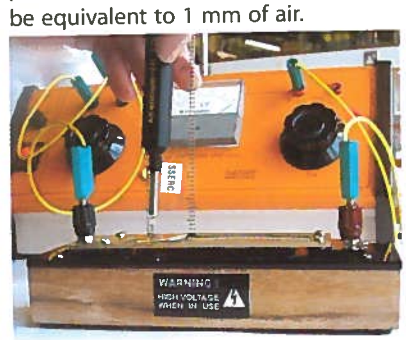


Figure 2 Reducing the energy of alpha radiation with polyester film.

Absorbing material	Distance (mm)
Air	34
Air + 12 mm poly	21
Air + 23 mm poly	8
Air + 35 mm poly	no sparking

Table 1 Stopping distances (from recessed source to bottom electrode) with the modified spark counter.

The readings made with a 3.7 kBq Am-241 AEA source are consistent within themselves (Table 1). The stopping effect of 12 microns of polyester is equivalent to about 13 mm of air.

[1] As expected, neither beta nor gamma radiation induce sparking.

The true range in air of alpha radiation will be the measured value (34 mm) augmented by about 10 mm to compensate for the attenuation by the 2 µm metal foil sealing the source. Thus the range might be about 44 mm. Because the density of human tissue is about 1 g/cm^3, the range in tissue from an open source should be about 44 µm, taking no other factors into account. In fact the range in human tissue is accepted to be about 50 µm.

Electrical safety

Because energy is drawn from a current-limited EHT supply and the system's capacitance is suitably low, the risk of dangerous electric shock is negligible. Nevertheless, to avoid discomforting shocks, the user should connect the top electrode to the earth terminal on the EHT supply (and common this to the supply's negative terminal). With this arrangement, the top electrode can be safely touched.

Conclusion

The Harris Spark Discharge Apparatus is the only spark counter on the market. With the simple modification described above, it is the best introduction to radioactivity and ionising radiation available. What simpler way is there to mark the event of a nuclear disintegration? Apart from this phenomenon, and showing the stopping power of materials, there are other useful inferences to be made from a spark counter demonstration, which space precludes from writing about. It is an instrument of great educational significance. A pity about the price – it's a bit steep.

Please note that stopping power demonstrations with an alpha source and a GM tube are not simple to show. One difficulty is the stopping power effect of the tube's mica window – equivalent to ten or more millimetres of air. Another is that alpha sources always also emit gamma radiation, which the GM tube will detect. It takes some clever experimentation to decide when the counter is counting only gamma after the alpha component has been removed by attenuation.

Samples of polyester film are available from SSERC at no charge.

News & Comment

MiSAC Matters

The *Microbiology in Schools Advisory Committee (MiSAC)* has launched a new publication entitled *MiSAC matters*. It is aimed at promoting and supporting the teaching of microbiology at post-16 level in schools and colleges. Initially there will be one issue per year. It will be made available free on paper and on the MiSAC website.

Contact details: MiSAC, Secretariat, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG.
Email: education@sgm.ac.uk
Web: www.microbiologyonline.org.uk/misac

Salters' Biology launch due

The *Salters-Nuffield Advanced Biology (SNAB)* course claims, probably justifiably, to be the first truly innovative advanced level course in the UK since the 1970s. September of this year should see it being rolled out "nationally" where *nationally* presumably means England and Wales. A few schools in Scotland do offer A levels but we suspect that the influence of SNAB in Scotland will be more far reaching than that. The thinking behind the development of this new course also has a lot to offer for those currently wrestling with the reform of post-16 science courses here as part of the long awaited 3-18 curriculum review. If you can't wait until September to learn more about the SNAB initiative then further information is immediately available at: www.advancedbiology.org/home/

"Improving achievement" report

At the end March HMIe published the second report in their new *Improving* series. This is entitled *Improving Achievement in Science in Primary and Secondary Schools.* This report is likely have a significant influence on future developments in Scottish science education in general and on the 3-18 curriculum review in particular. Bound copies of the report can be purchased from Blackwell's Bookshop price £10 or alternatively a pdf file can be downloaded from the HMIe website : www.hmie.gov.uk

Contact details : Blackwell's Bookshop, 53 South Bridge, Edinburgh EH1 1YS. T: 0131 622 8283 or 0131 622 8258 F: 0131 557 8149
Email: business.edinburgh@blackwells.co.uk

National Science Learning Centre

Independent biomedical research charity, the Wellcome Trust is providing £25 million to fund the National Science Learning Centre, which is due to open in Autumn 2005. It will be housed in a purpose built, high-tech venue at the University of York, and will provide professional development for science teachers and technicians from across the UK.

Teachers and technicians will be able to explore the advanced resources on offer at the National Science Learning Centre through residential courses, informal visits or online.

The leading aim of the National Science Learning Centre, together with all the regional Centres, is to upgrade the quality of professional development on offer to science teachers, technicians and support staff.

The rate of scientific progress and change, across industry and research, creates a real need for subject-specific professional development for science educators. Through partnerships with teachers, scientific organisations, industry leaders and technology developers, the National Science Learning Centre aims to offer support in teaching exciting science by drawing upon best practice highlighted by contemporary research in science and the teaching of science.

The National Science Learning Centre is also co-ordinating the development of the Science Learning Centres Web Portal, in order to create a central resource for the science education community: helping teachers and technicians identify their professional development needs; highlighting courses that can meet those needs; bringing together science educators, industry and researchers and providing ongoing support for all.

Test Report

Fuel Cell Car & Experiment Kit

Thames & Kosmos® Code: TK-FCC Price: £130.00 Supplier - siGEN

http://www.thamesandkosmos.com/products/fuelcell/fc1.html

This kit is well constructed and is supplied with a manual which has a series of excellent investigations that we believe fit well with the curriculum. As a result we award this kit an **A rating**.

We have in past bulletins waxed lyrical at the introduction of PIC controllers into the school curriculum whereby up-to-date technology can be introduced at reasonable cost. This technology, based on a fuel cell, is now available at affordable costs. We have experimented with a Thames & Kosmos® fuel cell model car kit and believe it has a place in the secondary science/technology curriculum. This is a comprehensive kit that comes with all that is needed to demonstrate a fuel cell in action. The car has to be assembled before use; this is a simple task taking less than 5 minutes. The Lab Manual supplied with the kit has 34 experiments or investigations that could be an excellent resource for staff in the science and technology departments.

Figure 1 *Model car with solar panel attached*

Fuel Cell Theory

There are a number of different types of fuel cells in commercial use; many others are under development. The fuel cell used in the model car (Fig. 2) is a Proton Exchange Membrane (PEM).

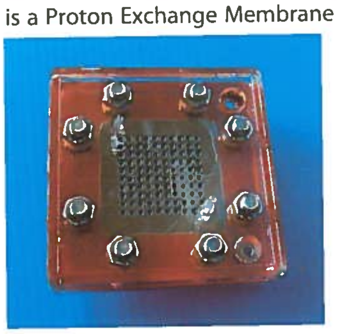


Figure 2 *Fuel cell module*

The fuel cell is an electrochemical system that converts the chemical energy of the fuel, in this case distilled water, directly into d.c. electrical energy.

The basic construction of a fuel cell is illustrated in Fig. 3.

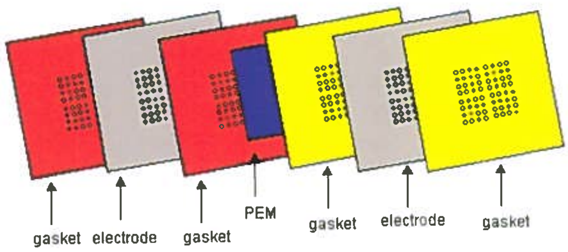


Figure 3 *Exploded view of PEM fuel cell*

The model car fuel cell comprises two porous electrodes, with a conducting membrane between them. A thin foil of the polymer Nafion ™, a perfluorosulphonate ionomer, is used as a membrane. At the anode, the hydrogen gives up electrons to the electrode, and hydrogen ions diffuse through the membrane as a positive ion (H^+), while at the cathode, the oxygen takes electrons and enters the membrane as a negative ion (O^{2-}). The properties of the membrane allow the hydrogen ions, or protons to pass through the pores but the larger oxygen ions are unable to pass.

The respective ions combine on the cathode and the result is the formation of water. It was necessary to use energy to break down water molecules during electrolysis, now when the combined energy from ions is released, electrical energy is produced across the cell.

The following reactions occur at the electrodes of the cell.

Anode: $2H_2 \rightarrow 4H^+ + 4e^-$ (Oxidation)

Cathode: $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ (Reduction)

Reaction : $2H_2 + O_2 \rightarrow 2H_2O$

If a load is connected between the anode and cathode an electric current will flow. As the cell makes use of a catalytic reaction there is no chemical change in the electrodes and therefore little heat is produced. This is known as cold combustion. Since the fuel cells do not rely on thermal energy conversion, they are not restricted by Carnot efficiency limitations; the cell is therefore much

Figure 4 *Water tanks*

more efficient than power sources dependent on combustion. Without this intermediate conversion into heat, theoretical Fuel Cell efficiencies reach around 80%. In practice about 50 %.

The manual also offers an insight into the design and workings of the solar panel supplied with the kit. This is followed by a number of investigations on the use and efficiency of solar panels. There is then a closer look into the energy used, efficiency and no-load voltage, operating voltage and short circuit current.

Figure 5 *Solar module*

For chemistry, suggested investigations are qualitative gas analysis, measurement of gas generation rates and efficiency of water electrolysis. Physics and technology investigations include the use of the motor as a generator, simple equations on energy, power and torque, efficiency of the fuel cell etc.

Apart from the above curricular input the fuel cell demonstrates that there are alternatives to the combustion engine. This potential may take a little time to realise in the family car. Meantime the model car can be seen to travel along a school corridor (or in sunlight a play-ground) with little or no pollutants, inexpensive fuel, silent running and adding just a little fun and magic to the curriculum.

Summer Schools - 27th June to 1st July 2005

Physics Summer School

Aim - The purpose of the summer school is to bring together physics teachers from across Scotland to give them scope to discuss contemporary issues on physics and physics education. By providing a forum for teachers to meet, share, discuss and enjoy physics together, the summer school aims to draw physics teachers into the wider group of professional physicists, helping teachers to feel that they are part of the physics community, and from this, to enrich their work as school-based physics educators.

Programme - The summer school will be a five-day event comprising presentations, workshops, site visits and a social programme. The lectures and visits will highlight the modern directions of physics. The workshops will engage teams of teachers in the collaborative design and production of ICT-based learning activities in support of key areas of physics. Some of the presentations will have periods for discussion, giving scope to reflect on methodologies.

Workshop sessions - Working in groups, teams of teachers will focus on particular curriculum 'hot spots'. Their shared expertise, combined with that available within the University of Glasgow, will direct their energies with the aim of producing an ICT-based learning tool by the end of the week. It is envisaged that the final products from all of the groups will be duplicated and taken away by all members of the summer school. The main outcomes from the workshops, apart from getting a set of tangible take-away learning resources, will be learning new skills in the design and fabrication of such materials, and the experience of working with others on some area of physics.

Invited speakers

Heather "The Weather" Reid, BBC Scotland & Glasgow University

John Girkin, Institute of Photonics, Strathclyde University

Shiela Rowan, University of Glasgow

Alastair Bruce & Wilson Poon, School of Physics & Astronomy, University of Edinburgh

Miles Padgett, Department of Physics & Astronomy, University of Glasgow

Bob Kibble, School of Education, University of Edinburgh

Topics covered in presentations

Physics, a route to better weather forecasting

On what Einstein did

BioOptics: a marriage of sciences

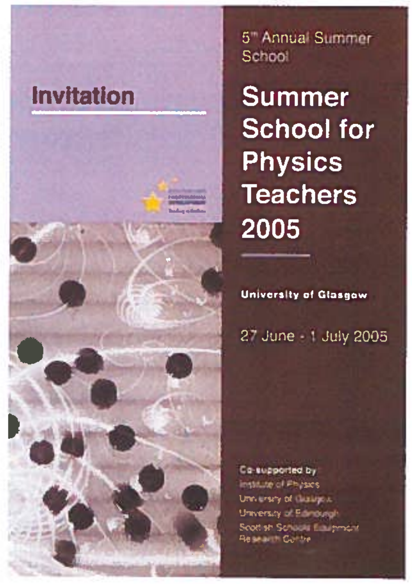
On a new first-year undergraduate physics course (and on what it draws from school physics and on what school physics can learn from it)

Skills shortage faced by physics-based industry and the reluctance of school leavers to study physics-based subjects in higher education

Physics meets biology - making the instruments needed for 21st Century healthcare.

Optical tweezers and spinners: using the momentum or angular momentum of light to displace or rotate particles

Wrinkles in relativity



Visits

Institute of Photonics (Strathclyde University)

Collaborative Optical Spectroscopy Micromanipulation & Imaging Centre (COSMIC), Edinburgh University

Royal Observatory, Edinburgh, including the Crawford Collection of historical books

Glasgow Science Centre (IMAX)

Hunterian Museum

Exhibition on light & colour (SSERC)

Venue - University of Glasgow. All participants will stay at the St. Margaret Halls of Residence.

Contact - Department of Physics & Astronomy, Kelvin Building, University of Glasgow, Glasgow G12 8QQ or Email :

lucy.murray@physics.gla.ac.uk

Cost - £190

Biology Summer School

Aims - Offer, through a range of keynote lectures and practical sessions, opportunities for participants to update their knowledge and skills in molecular biology and plant science.

Raise the levels of knowledge and confidence in the teaching of biotechnology and biosciences throughout the curriculum.

Offer opportunities to explore some innovative learning and teaching methods which can be taken forward into the classroom.

Target Audience - Those who have an interest in developing and refreshing the teaching of molecular biology and plant sciences in schools and colleges. The topics covered will reflect aspects of the content of Biology curricula. We would welcome teachers, FE lecturers and technicians. Applications from schools/colleges not previously represented at Summer Schools would be particularly welcomed.

SAPS is a registered provider of CPD and the Summer School is well-suited for inclusion in a CPD portfolio.

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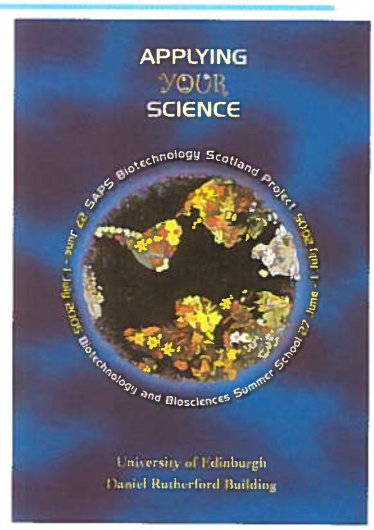


Biology Summer School (continued)

Programme - Building on the evident success of previous events, we have devised a new programme which will follow an applications-led approach to focus on the molecular biology and plant science content of the curriculum.

Plant Science - Plant Biodiversity, DNA fingerprinting brought alive, Science & Society.

GM Technology - Roslin Institute visit, Current issues in animal research.

Practical Applications - Photosynthesis overview, Algal balls, Digital images in teaching, Royal Botanic Garden (Edinburgh) visit, Medicinal uses of plants.

Issues in Biotechnology - GM crops (Ethical Issues), Societal & Ethical issues implemented in the classroom, Making a student resource.

Forensic Science - Lecture, Pollen analysis.

Venue - University of Edinburgh. Participants will stay in the Pollock Halls of Residence.

Contact - Maggie Bolt, SAPS, Homerton College, Cambridge CB2 2PH

Cost - £150

Chemistry Summer School

Aims - The previous four Higher Still Summer Schools highlighted the value of in-depth professional development for chemistry teachers with the sustained opportunity for sharing ideas with colleagues within a social context greatly valued by participants.

Following the success of these meetings, this is the second year of the new programme that has been organised with a range of fresh activities designed to help make the study of chemistry more attractive and exciting for students and stimulate the interest of teachers.

Accommodation - Participants will be accommodated in en-suite rooms in Edinburgh University Pollock Halls of Residence on a dinner, B&B basis.

(Breakfast and evening dinner is provided each day of the course except breakfast on Day 1 and dinner on Day 5)

All laboratory work and lectures will take place in Edinburgh University Chemistry Department at The King's Buildings on West Mains Road.

Lunches and light snacks can be purchased in the Union adjacent to the Chemistry department.

Target audience - The course is aimed for teachers and lecturers with an interest in developing the teaching of chemistry in their school or college. Steps have been taken to link the Summer School with accredited CPD.

Given the very positive formal and informal evaluations of last year's new programme, it is hoped that you will wish to nominate a member of your department to attend.

With the popularity of the previous courses, it should be noted that it is a condition of registration that all participants are residential and agree to be fully involved in all activities over the 5 days of the meeting.

Provisional Programme

Lectures - Given by staff of a university, these will present aspects of chemistry in a visual and interesting way.

Laboratory work - There will be an opportunity for delegates to try out, with support staff:

- A biotechnology session: learn about DNA fingerprinting and extract your own DNA.
- Prepare samples for Mass Spec and NMR analysis.
- Practical Investigations for S1/S2 science.

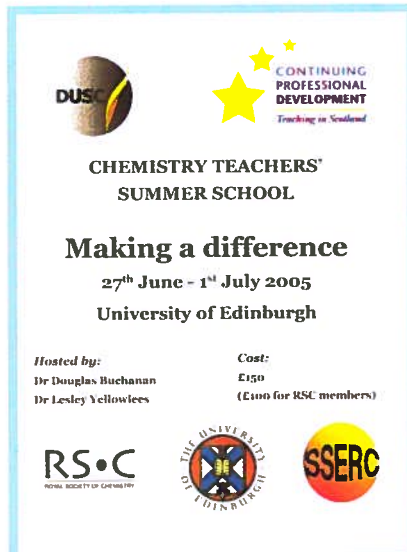
Workshops - These sessions will include a focus on:

- Interpreting spectroscopic data.
- Effective use of ICT: What can we expect as we look to the future?

  The use of Whiteboards will be considered along with Crocodile Chemistry and the DUSC support materials such as e-worksheets.
- Seminar: An update on the SQA review followed by discussion designed to make an impact on future work.

Presentations -

- Replacing Standard Grade with Higher Still courses.
- Assessment is for learning: Hear from a teacher who is effectively developing and using formative assessment materials for chemistry.



Visits - A range of visits are being organised, including:

- An Industrial visit.
- Behind the scenes at the Royal Scottish museum.

Social events -

- Wine tasting.
- Conference meal.
- Evening excursion (Ghost Walk or Murder and Mystery tour) in Edinburgh Old Town.

Contact - Douglas Buchanan, St. Mary's Land, Moray House College of Education, Holyrood Road, Edinburgh EH8 8AQ.

Cost - £150 (RSC Member - £100)