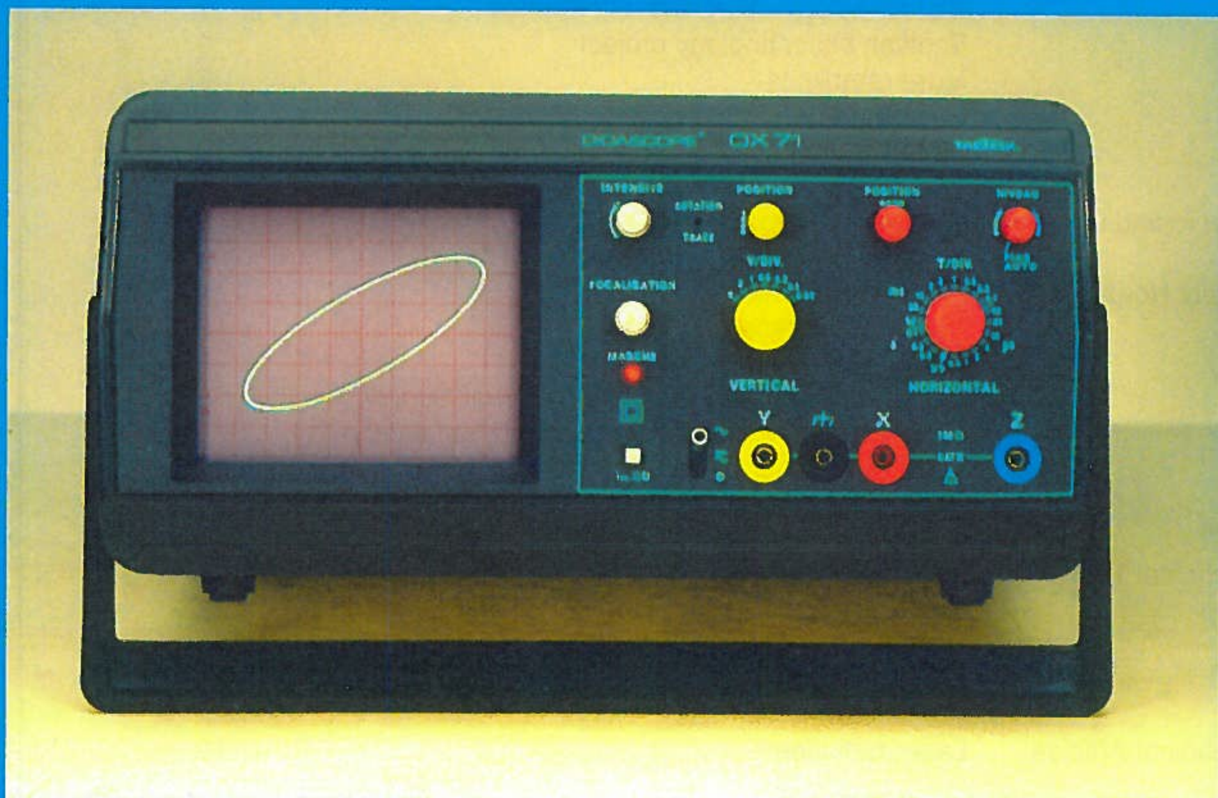
SCOTTISH SCHOOLS EQUIPMENT RESEARCH CENTRE



Science & Technology Bulletin

For: Teachers and Technicians in Technical Subjects and the Sciences

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Front cover : Metrix Didascope OX71 - see Equipment Notes, page 21 et. seq.

NEWS AND COMMENT

Smurfin' SSERC

Every cloud has a whatsit - I half recall. Our move has already brought us the first of these, whatever they are. Although I'm getting far too old to understand all of the technicalities, I do know that the nice Moray House men have said we can be cabled up to their net. Actually, I think they said it was this lady called "Jan" who owns the net. "What do we want with a share in someone else's fishing quota?"- I asked, quick of tongue and slow of brain as ever. This is a teacher training institute, so they told me all about it three times. Now I think I understand. Apparently, it means I can send this sort of verbal mince to thousands of people, anytime day or night, all across the globe, instead of to mere handfuls of Scots only three or four times a year. I can hardly contain my electrons! But, it seems first we need a special form of address. Can't think why, "Mr" has served fine up to now. I will let you know our new electronic location number thingy just as soon as . . Meanwhile - throw out the caveats and wax those beards! Or was it - "Get out your anoraks and wax those boards!"?

Learned Societies - education meetings

The second and third weeks of May could see a lot of half-empty Scottish school science departments. In that short period there will be educational meetings of each of the three major science organisations.

Institute of Biology

The second educational meeting of the Scottish Branch of the Institute will be held on Thursday the 15th of May, 1997. Again the venue will be the University of Stirling. The overall meeting title will be :

Biology for the 21st Century

With any decent luck you should receive a final version of the meeting programme as an insert with this edition of the Bulletin. There will be a booking form attached. At the time of writing we had had sight of the penultimate draft of that programme. Given the quality of the speakers and their chosen topics this second meeting looks set to prove as interesting and worthwhile as last year's bash.

Royal Society of Chemistry

Advance notice was given in the last issue (189) of a National Chemistry Conference organised jointly by St Andrew's University and The Royal Society of Chemistry. This conference will be held at the University on the 22nd of May 1997 and will be entitled :

"Issues in Chemistry Education"

Institute of Physics

This is the longest established of the three Institutes' Scottish Education Meetings. Yet again it will be held at the University of Stirling, on Wednesday 21st May 1997. This will be the 23rd Meeting. The keynote speaker will be Professor Russell Stannard of the Open University. Professor Stannard has written a number of books for young readers which deal with 'Big Ideas' in physics and tackle apparently difficult concepts. Examples include *Our Universe* and the Uncle Albert Trilogy :

The Time and Space of Uncle Albert,

Black Holes and Uncle Albert, and

Uncle Albert and the Quantum Quest.

Looks like IoP at Stirling could be fun!

Biotechnology - teachers' conference

A number of "Teachers' Conferences on Biotechnology" are being staged in the UK in 1997. They are being supported by the Wellcome Centre for Medical Science in collaboration with the Association for Science Education, the European Initiative for Biotechnology Education and the National Centre for Biotechnology Education.

The Scottish "Regional" (sic) Conference will take place on Saturday the 26th April 1997 at the University of Strathclyde, Glasgow. The programme includes a number of talks, which should be useful in updating knowledge, and two workshop sessions. For the workshop sessions participants will be offered a choice of two out of three, which are :

1. Resources for teaching

2. Biotechnology on the Worldwide Web

3. Practical Demonstrations

A registration fee of £25 is payable but this covers the cost of lunch, refreshments and conference information. The closing date for registration for the Scottish meeting is the 14th of April 1997. Further details are available from Sarah O'Donoghue at the Wellcome Trust (see Address List, inside rear cover).

Scottish biotechnology education project

The SBEP project has published its first, short, newsletter and this was circulated recently by SCCC. Anyone wanting further information about the project, or who has ideas, comments or articles they wish to contribute is invited to contact Majorie Smith, who is the Project's Development Officer (see Address List rear inside cover). The biotechnology education project is sponsored and supported by SOEID, Quest International and Unilever and managed by SCCC.

More ramblings

I nearly entitled this piece "Nice one Swampy!" but better judgement prevailed. I remain in the employ of a local authority - well last pay date I did - and must thus purge myself of any sentiment which might be construed as remotely big P political. This is no time to be green - in any sense of the word. This is especially so in the run-up to a General Election - that season when traditionally even the Civil Serpents cease heeding their masters and, along with HMI, take to the heather. Lucky for them that elections are rarely held in mid August.

What caused this mood? A few days ago I received the revised proposals for some chunks of Higher Still Biology. These are the bits originally known as "Micro-biology". A consultative bacterial transformation means they are now known as Biotechnology - Intermediate 2 and Higher. Ah, you're wrong! The purpose of this piece is not curricular carping. Apart from a few minor nit-picks, and a feeling that the Higher has a bit too much content and not enough practical - so, what's new? (ask a chemist) - I like the proposals. Never thought you would read that here, did you? No, it's not what is in the course which worries me. It's what the materials do not - and cannot - spell out, which is the problem.

Biotechnology is "a good thing". Isn't it? "Of course it is since it is a major key to sustainable development". Now, everyone is into this sustainable development business. It's real apple pie and mother stuff. There are things I would like to know a bit more about it such as - what is it, what will it look like, how will we know it when we see it and how will the application of biotechnologies bring it about?

The very phrase, Sustainable Development is - rather like Chaos Theory - to the layman at least an apparent contradiction in terms. How can one have a Theory with a capital T - the test of which is its predictive power - based on the idea of total unpredictability? Damn clever these physicists, but they don't need me to tell them that (nor anybody else, for that matter). All the same, they too promised us Sustainable Development, not based on biotechnology but upon an endless supply of cheap energy from the atom. Whoops!

Could it be that, like the post-war physicists, biologists and biochemists stand currently at a crossroads with the rest of us poor public suckers and the politicians right there, if not always right, behind them? It may be that what might be done with this new set of technologies is far less important than what should, or should not, be done (ask Mrs Blood)[1]. Here we are, back on Swampy's ground again (or I suppose, in his company, we would be under it).

So, do we use gene technologies and biochemical engineering to achieve a second or third phase agricultural revolution? Would that mean yet more rural depopulation and bigger food mountains throughout the northern hemisphere and shrinking export markets for those in the south? Perhaps we instead could afford to have a less energy intensive and more environmentally friendly, more humane, agriculture. If the former, just how do we accommodate those displaced from what's left of our land based workforce, which has never once stopped shrinking since the turn of this century? Will they get alternative work in new biotechnology based process industries? Or will the miracles of microelectronics mean that such processes need only the minimum of labour, or even none at all?

Expansion of aquaculture - of which salmon and scallops are two of the few extant Scottish examples - might bring similar problems in its wake. People are as easily displaced from a sea based economy as they might be from one on the land. There are also those who are vehement in their belief that Scottish aquaculture has not been expanded even thus far without any environmental price to be paid.

What of the therapeutic promises held out by the biotechnologies? From the viewpoint of the individual sufferer of hitherto incurable or genetically determined afflictions, or their families, these are never to be under-estimated nor taken lightly. In global terms, however, they are potentially extremely worrying. More and more people may live much longer whilst any strictly economic need for their number may diminish at an accelerating rate. So, will we yet see that golden age of leisure we all talked of in the twilight of the last great agricultural and industrial revolutions? Will the ramblers of Europe and beyond roam freely over our sunlit uplands - or get bogged down on their bikes in sodden, eroded and overcrowded, trail-marked ways and mugged on our drug strewn streets? Let's hear it for the Victor Meldrew Party!

Just as well then, that another group of Higher Still courses deals with Managing Environmental Resources. They should keep us teachers in a job. You see, there are a lot of pupils and students out there who think like Swampy and his mates. They have similar values.

How do I know? Trust me, I'm a biologist.

Footnote: For the removal of doubt perhaps I should state that the above piece was written *PD* - pre Dolly. One of the more revealing responses was made over the radio where some tongue-in-cheek townie type claimed not to understand why cloning sheep was such a big deal since, to him, they all looked identical already. Sums it all up really.

No comment

Seen recently, as a footnote to a letterhead used by the Castlemilk Economic Development Agency, a quotation from "*Beyond Re-Engineering*", by Michael Hammer, Harper Collins, 1997 :

"But what will become of the little people, those who lack the education, the intellectual capacity or the character to fill the jobs in the process centred organisation? . . . Must they be left behind, orphans of the new age?"

HOW TO FIND US

DIRECTIONS TO SSERC

We have recently had some visitors from the North and West who have gently chided us over the nature of the directions we gave on page 1 of the last issue. In their view "the Moray House Institute block nearest to the Holyrood Tavern" was just a tad imprecise. So -

If you know Edinburgh :

We are 40 yards east of the crossroads where the Pleasance, the Cowgate, St Mary's Street and Holyrood Road join (see map below). Proceding east down Holyrood Road from the traffic lights at this junction, take the second entrance on the left. This is immediately past another entrance called Gullan's Close, which itself is immediately past the Holyrood Tavern. This entrance takes you into our car park.

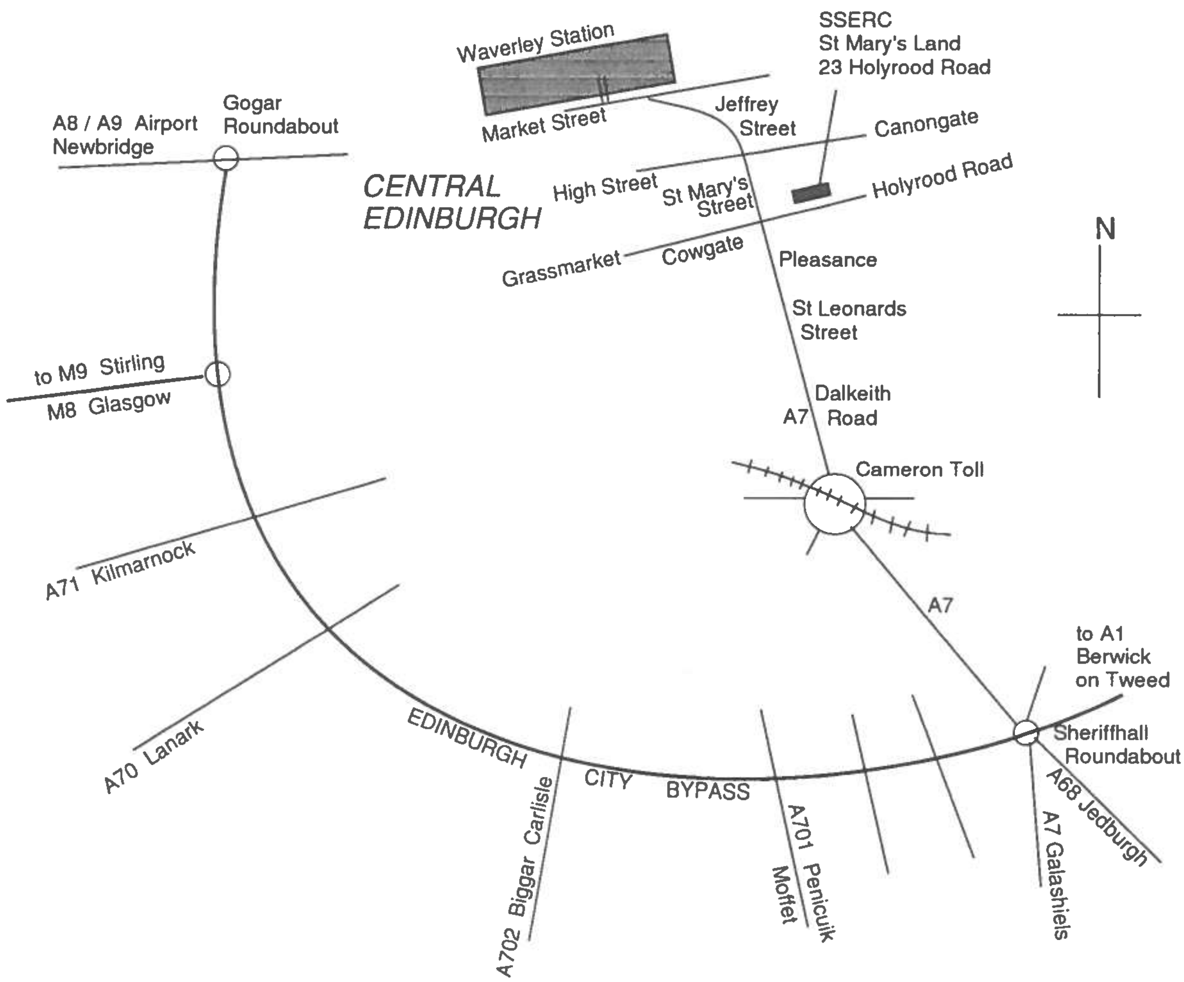
The pedestrian entrance is at the east end of the building (known as St Mary's Land), marked 23 Holyrood Road

If you do not know Edinburgh :

Follow the City Bypass to the Sheriffhall Roundabout. Take the A7 turnoff to the City Centre. Keep on the A7 past Cameron Toll, which is a large roundabout transected by a railway line. Keep on this road which at its first stage is called Dalkeith Road, then becomes St Leonards Street, then the Pleasance. The Pleasance ends on a steep downwards hill taking you to crossroads with traffic lights. Holyrood Road is on the right at these lights. Thereafter as directed in the opposite column.

By train :

Market Street Exit. Bear left. 1st right (Jeffrey St.). Across High St. to St Mary's St. Left into Holyrood Rd.



Air rifle experiments

Many teachers will have thought hard and deep about air rifle experiments following the events in Dunblane. Some will have read in the newspapers of a "*science teacher sacked for firing airgun in classroom*".

It is a fact that air rifle experiments in schools continue to be permissible unless your Council or headteacher has issued an instruction prohibiting them. Advice for performing these experiments safely was published many years ago by SSERC [1, 2] and other agencies. As recently as last year guidance was issued by the ASE [3] and DfEE [4]. What the law requires is that any work activity, such as this group of experiments, must be done safely. It is the duty of the employer and science teacher to arrange for this. Thus any guidelines should be studied and applied, amended, or adapted, as appropriate. We understand that the reason for the teacher's dismissal from his school in England was not because he had been firing an air rifle, but because he had not followed safety guidelines.

The crux of the matter is this - how should we respond to Dunblane? Because the shootings were so horrific, because newly proposed legislation on gun controls is unsettled and contentious, it would seem that at present it would be inappropriate for air rifles to be used. We should be sensitive to the sensibilities of the public, and especially pupils and parents, on the usage of guns in schools.

However let us plan for the future. The educational purpose for these experiments is good. It is worth stating. Broadly speaking, there are two groups of experiments - one centred around the kinematic relationship $v = s / t$, the other centred on dynamics and the conservation of momentum. The first experiment is often done just after the start of kinematics. Having used $v = s / t$ to measure the speed of things travelling at about 1 m s^{-1} the teacher then applies the technique to measure the speed of something outrageously fast - an air rifle pellet. There is no other suitable substitute at this order of magnitude of 100 m s^{-1}. Sound would not be nearly as good for this elementary introduction, being intangible and invisible. The interest in the collision experiments where the pellet embeds within a ball of plasticine mounted on a linear air track vehicle, or suspended as a pendulum bob, lies in the many orders of magnitude difference in relative masses. There is again perhaps no substitute as simple or effective.

Although air rifle experiments are not essential, they have been an aid to the comprehension of physical principles. It should also be said that the safety record is excellent. We have never had a report of anyone having been harmed.

Ethical code

If in the future these experiments were to be resumed, we suggest that any work should be subject to the following ethical code.

1. Air rifles must only be used for good purpose, such as improving pupils' understanding of physics, or enhancing the way that pupils view physics education.
2. Teachers preparing air rifle experiments should be sensitive to the sensibilities of pupils. No work with air rifles should proceed if it is felt that this might disturb or distress pupils.
3. All such work must comply with standard safety procedures.

Safety arrangements

Arrangements for safety procedures are recommended as follows :

1. The teacher should have good class control and the experiment should be done as a whole-class activity.
2. The air rifle or pistol must be the property of the school. Teachers must not bring their own guns into school, nor may they borrow a school gun for private use.
3. The air rifle or pistol must be bolted to a support and fired only when so placed in its support.

   (It has been suggested to us that the air rifle or pistol should be set up before the class enters the laboratory and removed after the class has left. This would avoid carrying a gun in front of pupils. However there may be some disadvantages. For one it might put out of action too large an area of the laboratory for the whole lesson. For another it might prevent two separate gun experiments being performed in one lesson.)
4. Measures should be employed to prevent the pellet ricocheting. Ideally the target should be of a material into which the pellet can embed - plasticine, polystyrene, or soft wood. If the target is small, then a large block of polystyrene should be placed behind it to catch any pellets that miss.
5. A safety screen should be placed near to the target. Except for the person firing, everyone else in the room should be situated such that they view the target through the screen.
6. Everyone in the room must wear eye protection.
7. Eye protection worn by the person who does the firing should have lateral protection and be resistant against low energy impact as a minimum specification.

   (Note : You can be reasonably assured of this criterion by using safety spectacles with kitemarking showing conformance with the standard BS EN 166. The ocular on the spectacles should be marked with a letter F and the frame should be marked -F, to signify resistance to low energy impact.)

8. The principal teacher should ensure that other teachers are informed of the health and safety arrangements and instructed to follow them. If any deficiencies in the arrangements are found then the arrangements should be reviewed and modified if necessary.

Substitution

An air gun is a convenient off-the-shelf device which can be used in the laboratory. Unfortunately it has and always did have other connotations. We should try and dissociate hunting or shooting from this set of experiments.

Is there any other apparatus that might be used instead? If it were not an air gun but a piece of equipment made by Harris, Leybold or PASCO for projecting a pellet - and did not look anything like a gun - then these associations would be absent.

The apparatus that closest fits with air gun experiments is the *Projectile Launcher* made by PASCO. The short range version (ME-6801) can project a 25 mm diameter nylon ball at about 6 m s^{-1} and has a maximum range of 4.5 m. While the projectile does not have the high speed of an air rifle pellet, the apparatus may be used for a wide range of experiments on projectile motion and the conservation of momentum and energy. However the *Projectile Launcher* is not dissociated from shooting. Its Monkey and Hunter experiment accessory is called *Shoot-the Target* because shooting is more politically acceptable in the USA than monkey hunting. This renaming is unfortunate. The idea behind this experiment's original name is entirely humourous, being the sort of farcical fantasy that someone like Roald Dahl might have dreamt of, whereas the thought of shooting in a classroom has become understandably unacceptable.

References

1. *Air rifle hazard*, Bulletin 132, SSERC, 1982.
2. *Air guns again*, Bulletin 133, SSERC, 1982.
3. *Safeguards in the school laboratory*, 10.2 Air pistols and air rifles, 10th Edition, ASE, 1996.
4. *Safety in science education*, DfEE, 1996, Table 18.1.

SAFETY NOTES

Microwave ovens

As surely all our readers are aware, there is a statutory requirement for work equipment to be maintained in an efficient state, in efficient working order and in good repair. One way of ensuring this is by a programme of periodic testing. For instance it is recognised that portable electrical apparatus should be inspected and tested routinely. Microwave apparatus would be included in such a programme in so far as its electrical hazards are concerned.

However with respect to the microwave hazard there is no legal requirement to test for microwave emissions. Such testing would be required only if there was reason to believe that there was a risk of emissions. The National Radiological Protection Board (NRPB) has carried out extensive surveys of domestic microwave ovens. Finding that emissions are insignificant, they thus recommend that it would not be worthwhile for an employer to have microwave ovens surveyed for emissions.

NRPB does suggest, however, that microwave ovens are inspected periodically for mechanical damage. For instance, if the door stops shutting because of warping or damaged hinges, if the wire mesh on the door is holed, or if the enclosure is punctured, then radiation might be emitted.

Defects such as these would be picked up by a visual inspection. It would not be necessary therefore to test for microwave radiation.

The door seal is interesting. Because the radiation wavelength is 12.5 cm, a 3 cm slot is built into the door seal assembly. This behaves as a quarter wave choke. Radiation impinging on the seal is destroyed by destructive interefence.

If a council does want to test for microwave emissions then the basic restriction and investigation levels for power density at microwave frequencies have been set [1] at 100 W m^{-2}, which is the same as 10 mW cm^{-2} in sub-standard units. These values are equivalent to an electric field strength of 194 V m^{-1}.

We understand that it would be more usual to apply the limit of the product standard [2]. This has been set at a power density of 50 W m^{-2} at 5 cm from the appliance.

References

1. *Board statement on restrictions on human exposure to static and time varying electromagnetic fields and radiation.* Documents of the NRPB, Volume 4, No. 5, NRPB, 1993.
2. BS EN 60335-2-25 : 1991 *Specification for household and similar electrical appliances : Microwave ovens.*

SAFETY NOTES

Liquid nitrogen

Although many teachers will be unfamiliar with handling liquid nitrogen, we do surprisingly often get enquiries about its use and recently had a report of an accident. The article looks at the cause of this accident and other hazards.

Accident report : Overpressurization

A vacuum flask containing liquid nitrogen in a science laboratory became overpressurized and exploded. We understand that the liquid nitrogen had been collected by the laboratory technician from a local university or college using a number of domestic, or outdoor activity type, vacuum flasks, either all or most of which were stainless steel. Prior to the lesson these flasks had sat on a trolley in the preparation room. Each flask had a stopper, or cap, sitting loosely in place to allow the flask to exhaust gaseous nitrogen. During the lesson after the trolley had been brought into the science laboratory there was an explosion which generated a hurtful sonic wave and resulted in the stopper of one of the flasks being projected vertically upwards so as to strike the ceiling. In discussing the cause, it would seem that while the flasks had been waiting in the preparation room, someone may have inadvertently screwed down this stopper - perhaps just partly so. What may also have happened is that the stopper's threads may have latched by themselves into the corresponding threads on the neck of the flask.

Discussion and recommendation

Liquid nitrogen has a normal boiling point at atmospheric pressure of -196°C. It is therefore unstable in its liquid form at room temperature and evaporation takes place. The ratio of the volume of gas to liquid, measured at 15°C and one atmosphere, is 682. It is therefore essential that the container is able to vent so as to exhaust gas. Otherwise the system will rupture - possibly explosively, as it did in this accident.

Liquid nitrogen should be stored in a flask that has been designed specifically for storing cryogenic liquids. Such a flask will have thermal relief to release gas produced by evaporation. The flask will be composed of a material that does not get brittle at the extremely low temperature to which it may be put. The usual material is austinitic stainless steel. Other suitable materials are aluminium or 9% nickel steel. Yet other materials which may sometimes be used are a type of ultra-low evacuated borosilicate glass and polypropylene.

The practice of using domestic, or outdoor activity, type flasks is dangerous because the stoppers on these flasks form a seal at the neck. Even although the experimenter may know not to screw down such a stopper, there is an ever present risk that some other person may do so, or that the stopper thread may itself engage with the thread on the flask and effect a seal. There is an added risk that the flask may become sealed by a plug of ice forming round the neck.

The danger can be removed by applying an engineering solution, namely utilising a proper cryogenic flask which permits venting. The danger could also be lessened by applying the administrative solution whereby, if a domestic flask were to be used, the stopper must never be secured. However engineering controls are always more effective than administrative ones. Since there is a feasible engineering solution, one which is applied throughout the cryogenic industry without exception, this is the only solution which can be tolerated.

Although so far as we are aware few schools work with liquid nitrogen, relatively more work with dry ice. There may be a similar risk of explosion due to containment in a sealed vacuum flask. However dry ice may be kept safely within a polystyrene container. Because of the ease with which such a container can be made, and the cheapness of its construction, there is less temptation is store dry ice in a sealable vacuum flask.

Flasks and sources

A 2 litre stainless steel vacuum insulated dewar (stock item 777024) costs £169 from BOC Cryospeed. Liquid nitrogen can be stored for periods of up to two weeks in such a flask.

Less effective dewars designed for storing liquid nitrogen are available from Whatman. Stock item 6602 3473 has a borosilicate glass inner, stainless steel outer and ventilated lid. With a capacity of 2 litres it costs £84.75. There is also a 2 litre insulated polypropylene flask, item number 6602 2513 at £83.85. One litre vessels of both these kinds are also available and are less expensive.

The cost of being self sufficient is great. Because the minimum volume of liquid BOC Cryospeed is willing to supply is 25 litres, if a school or college wanted to get liquid direct from them, it would be necessary to buy a 25 litre dewar at about £370 additional to a 2 litre one for handling at the bench. You would also need a transport and tipping trolley to carry the 25 litre dewar and decant from it safely. This costs about £168. Add to this the cost of liquid - £36.60 for 25 litres plus £17.50 for delivery - and you have sizeable bill. Because all this would be too much for most schools to countenance, and because of hazards discussed below, we suggest that you come to some arrangement with a local liquid nitrogen user and beg or pay for 2 litres of liquid as and when needed. Being dependent on the scale of nitrogen consumed, it may cost a large volume user less than 20p a litre. Thus your only significant expense would be the cost of a suitable small flask, as described in the preceding paragraph.

Liquid nitrogen hazards

The country's main producer of cryogenic liquids, BOC, categorizes the hazards into four types [1] :

1. Asphyxiation in oxygen deficient atmospheres
2. Fire in oxygen enriched atmospheres
3. Cold burns, frostbite and hypothemia from the intense cold
4. Overpressurization from the large volume expansion of the liquid

Asphyxiation : The standard percentage by volume of oxygen in dry air is 20.95%. Atmospheres containing less than 18% oxygen are potentially dangerous and entry into atmospheres containing less than 20% is not recommended. Thus a sudden release of up to, but not more than, 1% by volume of nitrogen into the atmosphere of a classroom would be tolerable. Since the standard dewar flask has a capacity of 2 litres of liquid, this has the potential to generate about 1.4 m^3 of nitrogen gas at atmospheric pressure. This might safely be released into a confined space of a volume greater or equal to 140 m^3. For a typical modern classroom ceiling that is 3 m high, this implies a minimum floor area of 48 m^2. Standard laboratories are typically larger than this, but some would be about this size, and many preparation rooms would be much smaller. Thus the rate of usage, even from a 2 litre flask, may have to be restricted dependent on where it was used. It would be essential to ventilate any workplace thoroughly by keeping doors and windows open for a prolonged period of at least one hour.

If larger volumes of liquid were to be used, then restrict the release to 1% by volume of the work area and reckon on four air changes per hour for a well ventilated room. Anyone planning to handle a 25 litre capacity flask should carry out a special risk assessment because of the different scale of such an undertaking.

Transporting lots of liquid nitrogen by car can be dangerous because of the risk of asphyxiation, but driving with a few litres of liquid is unlikely to be so. It is a statutory requirement that the driver is aware of what he or she is transporting and the flask cannot become overpressurized.

Fire hazards - oxygen enrichment : Since nitrogen has a lower boiling point than oxygen, there is a risk of condensing oxygen out of the atmosphere in the vicinity of large quantities of liquid nitrogen. Attendant upon this is the risk that materials not usually combustible in air will burn fiercely in oxygen enriched atmospheres. Such an oxygen fire can be ignited with a minimal energy source that would not, in air, be considered sufficient. By limiting the quantity of liquid nitrogen to 2 litres per lesson, and not releasing the liquid all at once, there would seem to be little risk of producing an oxygen enriched atmosphere.

Cold burns and other problems : Contact with the liquid, or even cold vapour or gas, can produce damage to the skin similar to heat burns. Wear eye protection (goggles) and non-absorbent leather gloves (see below).

If liquid is splashed onto the skin, the run-off is often enhanced by a layer of gas instantly forming by evaporation on contact with the warmer skin. Because of this effect, burns may not always occur when small amounts of liquid splash on hands or arms.

Entrapment is a hazard. Items which could entrap spilling liquid, or liquid running off limbs, include footwear, gloves, clothing and eye protection. Slip-off shoes are preferable to lacing ones. Non-absorbent leather gloves that slip off easily are preferable to gauntlets. If any clothing becomes contaminated the wearer should ventilate it for a minimum of 5 minutes whilst walking around in a well ventilated area.

Suddenly inhaling a very cold gas produces discomfort in breathing, can provoke an attack of asthma in susceptible people and can cause loss of consciousness.

Liquid spillages can result in structural damage caused by the embrittlement of materials.

Overpressurization : Use a proper cryogenic flask with thermal relief. This permits venting (as discussed above).

Summary : By way of a conclusion, provided you think small and keep the scale of usage to perhaps 2 litres at a time, use a proper flask and apply the precautions outlined, the use of this exotic substance should present minimal risk of harm in either science laboratories or technical rooms.

cont./next page

Appendix - cold burns

We would not normally include advice and information on immediate remedial measures (emergency aid) nor first aid proper in such an article. However, since this is a somewhat specialised topic it may lie outwith the experience of even a fully trained and qualified first-aider.

BOC advise [2] that the aim of treatment is to raise the temperature of the affected part slowly back to normal.

For minor exposures :

1. Move the victim to a comfortable room if possible.
2. Ensure that clothing is loose to provide unrestricted circulation. Do not remove clothing that is stuck to the body until thawed thoroughly.
3. Place affected part in TEPID WATER or run TEPID WATER over for half an hour until the skin changes from pale yellow through blue to pink or red. Do not use hot water or any other form of direct heat.
4. Cover the affected part with a bulky, dry, sterile dressing.
5. Send the victim to a hospital casualty department.

References

1. *Care with cryogenics*, BOC.
2. *Treatment of cryogenic burns and frostbite*, BOC.

SAFETY NOTES

Accident report : Unilab Klystron Power Supply 042.871

A senior pupil got an electric shock when working with this obsolete equipment. The source of the shock was the wire link which joins two 4 mm sockets marked *External modulation*. Unusually these sockets are not recessed within an insulated circle. The metal socket rims are slightly proud of the enclosure surface. The U-link is insulated by paint, but this was flaking off to expose metal. Thus the user may have made electrical contact either by gripping the U-link or by touching the socket rim.

The voltage on the socket has a nominal range of 0 V to -250 V d.c. set by a 1 MΩ potentiometer. In fact the voltage is a composite mixture of 600 Hz a.c. and d.c., with open circuit peak to peak values of -160 V and -500 V. The internal impedance of the source is an 82 kΩ resistor in parallel with a 16 μF capacitor plus whatever part of the 1 MΩ pot is also in operation.

There are two hazards. One is the system's capacity to deliver a continuous current to the shock victim - actual shock severity depends on the current's magnitude and frequency, its duration and the type of contact. The other is the energy of the capacitive discharge.

From theoretical considerations [1], neither hazard would be likely to cause ventricular fibrillation. The continuous current shock is likely to be quite painful, but would seem to be below the threshold of let-go. The capacitive discharge shock is likely to be far above the threshold of pain and could be very painful.

Control measure

The safest and simplest measure is to declare that the apparatus is unsafe, cease using it and dispose of the device. If you do not wish to pursue this option then, provided that you do not want to retain the external modulation facility, both conductors to the external modulation sockets should be disconnected from the sockets.

These conductors have blue and green coloured insulation. One of them should be rerouted to form a link between pin 7 on the octal connector and any of pins 1, 2 or 4 on gang 1 of switch 2. The other of these two conductors should be completely removed from the circuit. A diagram is available on application to the Centre.

The effect of this is to hard wire together the two parts of the circuit which at present are connected through the U-link at the *External modulation* sockets.

However if you do wish to retain the external modulation facility, then we recommend that the sockets are replaced with a shrouded type such as RS item 404-137, to which shrouded plugs (RS 446-838) should be fitted.

From discussion with Unilab, the main risk of electric shock comes, not from the *External modulation* wire link and sockets, but from the octal connector. Because the pins on this connector are not shrouded, there is a significant risk that the user might touch or grip on to these while inserting or removing the plug. The risk is compounded by two factors. Firstly the plug is a very tight fit, necessitating the user to try to slip his fingers under the plug so as to exert sufficient force to remove it. Secondly the plug top pulls off easily, which provides very little on the side of the plug for the user to grip. Therefore it would be dangerous for the user to attempt to remove the plug while the power supply is energized. You are advised to fix a label to the apparatus warning of this.

Reference

1. IEC 479-2 : 1987 *Guide to effects of current on human beings and livestock. Part 2 : Special aspects relating to human beings* British Standards Institution (BSI) or see *PD 6519 : Part 2*. 1988. BSI.

SAFETY NOTES

False economies

The provision of too few technicians may have an adverse effect on health and safety

We are increasingly getting reports about unsatisfactory levels of technician support in Scottish secondary schools. It may be that there is a link with devolved management arrangements. There are a number of employment issues which such reports might raise between employers, employees and their trades unions or other professional bodies. None of these are the direct concern of SSERC. Rather we would indicate the health and safety implications of any such trend and of which some senior management teams both within and outwith schools seem to be insufficiently aware.

It would appear that there are two main strands to this problem. On the one hand there is a simple under-provision in terms of the overall numbers of technical support staff. This may have come about through what is euphemistically termed *wastage*. Technician posts become vacant and for reasons of apparent economy are left unfilled. More worringly, a support post may indeed be filled but by an additional member of the administrative staff or by a school librarian. In a few cases the shortfall occurs because the school is 'favoured' and is growing. Technical support provision doesn't keep pace with increases in class numbers, or science and technology teaching staff. Thus it fails to match facilities.

These are the very factors which the Association for Science Education utilises in its established and well respected formulae for objectively estimating reasonable levels of technician staffing [1, 2]. In some cases technician numbers have fallen below less than half of the ASE minimal levels and in some schools may be only a quarter or fifth of the recommended levels. This mismatch between likely demand and actual provision has potentially serious implications for the management of health and safety in such schools. Should health and safety related tasks be given to a technician in such a school the HSE might well judge the delegation to be illegitimate on the grounds that it was unreasonable given the time and resources available. In the event of anything going wrong the management team which made the decision on staffing levels may be held responsible.

Another possible trend is the use of largely or partly untrained, inexperienced auxilliaries rather than of trained and qualified technicians. Such staff may be told to take on technical tasks for which they are not in practice competent. Obvious examples would include handling hazardous chemicals, doing electrical work or microbiological preparation or disposal.

In the event of an accident, such persons are not likely to be held individually liable. It is more probable that responsibility will be traced back up the management system to persons who should appoint competent staff or at least identify necessary skill levels, look at training needs and arrange for that training to be given.

Similar concerns are raised by the trend in some areas toward part-time, term-time only or sessional working. These patterns of employment raise questions as to matters such as arrangements for equipment maintenance and testing, keeping adequate stock records of hazardous substances etc. Sessional working can cause serious difficulties in all these areas and others besides. There may be other difficulties in the provision of adequate information, instruction and training when such employment patterns are adopted, The HSC is sufficiently concerned about the effects on health and safety of such shifting patterns of employment for it to have issued a discussion paper on the matter [3].

It is as well to note that our assertions as to managerial responsibilities are based upon the legislation. Should anyone doubt them, they are advised to examine closely the relevant sections of the COSHH Regulations, the Electricity at Work Regulations, the Management of Health and Safety at Work Regulations, the Provision and Use of Work Equipment Regulations and the HSE or HSC Guidance thereon [4]. All of these indicate that, although the primary duty of care rests always with the employer, the day to day responsibility may be that of those who control the funds and premises and take the decisions.

It is accepted that times are extremely difficult. Funds are in shorter supply than ever. Nonetheless, some senior management teams, who see technician support levels as soft targets for savings, may yet learn the hard way and too late. Devolved management brings with it, in addition to financial decision making, other heavy responsibilities of which some, apparently, have never even imagined.

References

1. *Technical Support for School Science*, Revell, M. Editor, ASE, December 1990, ISBN 0 86357 142 5.
2. *School Technicians : An Invaluable Asset*, Laboratory Technicians' Task Group, ASE, April 1994.
3. *The health and safety implications of changing patterns of employment : A discussion document*, Health and Safety Commission, HSE Books 1996.
4. *Managing Health and Safety in Schools*, Education Service Advisory Committee of the Health and Safety Commission, HSE Books, 1995, ISBN 0 7176 0770 4.

Mercury exposure

There have been some recent reports in the British, so-called *Popular Press* which, whilst not as sensational as we have come to expect, may have overstated the effects of exposure to mercury and its vapour. The latest reports referred to a domestic incident where mercury was spilled from a barometer. This then led to some journalistic sniffing into the possible risks from mercury in school laboratories. It has been somewhat reassuring therefore to read of an up-to-date study into possible mercury exposure in school chemistry teachers in Ohio in the USA [1]. In order to assess whether high school chemistry teachers had higher urinary mercury concentrations than did other non-science teaching staff a group of twenty four high school teachers from nine different Ohio schools were studied.

First morning voided urine samples were taken as were air samples from the teachers' laboratories or classrooms. These samples were analysed for total mercury by atomic absorption spectrometry (AAS). The results of the urinary analyses[1] showed no significant difference between the concentrations of mercury found in 12 chemistry teachers and those in a control group of 12 other teachers. In all of the air samples taken mercury was below detection limits.

The researchers conducting the study thus concluded that they had found no evidence that high school chemistry teachers were at increased risk of chronic effects from exposure to mercury as a result of their teaching activities when compared to colleagues who did not teach chemistry.

Reference

1. Crump, C. et al reported in the *Laboratory Hazards Bulletin*, January 1997, Item 51, p.11, Royal Society of Chemistry.

Footnote [1] Median adjusted urinary Hg concentration in the chemistry teacher group = 4.6 μg per gramme of creatinine (range 2.2 - 8.2 μg g^{-1}). In the control group the median was 6.3 μg g^{-1}.

Lack of training - a cause of accidents

As most readers will know, a number of key pieces of health and safety legislation place a duty on employers to inform, instruct and train. The Management of Health and Safety at Work Regulations even spell out a duty to retrain if circumstances change as well as indicating a need for refresher training. Just two recent incidents reported to us underline the key preventive role of sound, practical training. Time after time a lack of training, knowledge or experience emerges as the root cause of accidents and near misses. Both of these involved physics teachers acting outwith their specialism. We would not however single out physicists here. For example, such problems might as easily crop up where biologists or chemists get involved in electrical work. Ironically, one of these incidents was reported to us orally whilst we were running a health and safety course.

Both also illustrate that old sore that a little learning is a dangerous thing. The first incident involved confusion between two "*p*"s - potassium and phosphorus - one being handled as though it were the other. The end result of such confusion was that the teacher involved received a nasty phosphorus burn which, as is often the case, proved extremely slow to heal and required hospital treatment.

The second shows how what would be a simple risk assessment for an experienced and knowledgeable person may be much more demanding when a substance is handled by a relative novice. On our COSHH courses we have always stressed three key elements of any risk assessment :

- *what is to be used?*
- *how will it be used?*
- *<u>who</u> will use it?*

An example we frequently employ is the dilution of concentrated sulphuric acid. For an experienced and properly trained technician or teacher, this would require only the simplest of risk assessments - reading a label and following its instructions or recalling what is already in one's head should suffice. For the inexperienced and untrained this is a much more serious operation. They may need to be shown how to add acid to water and how to allow for the dissipation of the heat of dilution. They would need advice on suitable levels of personal protective equipment, which would depend on the scale of operation - the volume of acid to be handled.

This need was reinforced at a recent training course for technicians where an incident was reported to us and which had actually happened only that same week. A technician had been making up battery acid by diluting concentrated sulphuric acid. A physics teacher spotted two Winchester bottles - both apparently only half full. Being helpful he poured the contents of one into the other so as to tidy things up and save space in the store. Being unlucky as well as willing - you guessed - he poured a half bottle of diluted acid into a half full bottle of the concentrate. He wasn't wearing any eye protection nor any other protective equipment. Fortunately for him his luck changed for the better when the returning senior technician immediately spotted what had been done. The now full bottle was already very hot. An orderly retreat was organised to allow time for the heat to dissipate before anyone attempted to handle the bottle which, by yet more good fortune, had remained intact.

It's a wonderful thing to be born lucky. In science and technology teaching it's a far better thing to be trained and properly informed. The correct procedures are by now well documented. Despite any governmental claims to the contrary, most of us educationalists and scientists can still read.

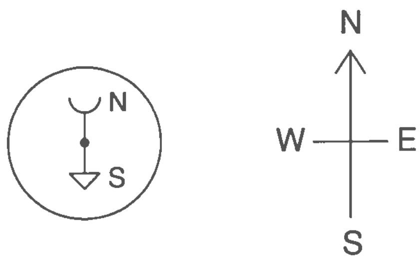
Some of us may just need telling where to look.

TECHNICAL TIPS

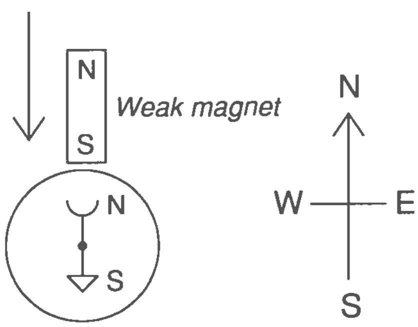
Wrongly polarised plotting compasses

It is commonplace for the polarity of a plotting compass to become reversed. So far as we understand, the usual means of correcting this condition is to bring up a permanent magnet to the compass so as to attract the needle, then rapidly polepitch this magnet, which, if you are nimble, reverses the needle's polarity.

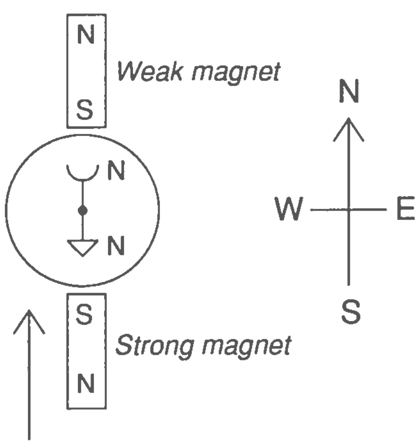
We are indebted to Andrew Barclay of Moray House Institute for suggesting the following variation to the usual method. His has the advantage of not requiring the same agility of finger flicking.



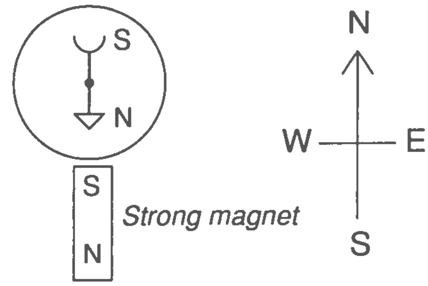
1 Starting with a compass whose needle points southwards



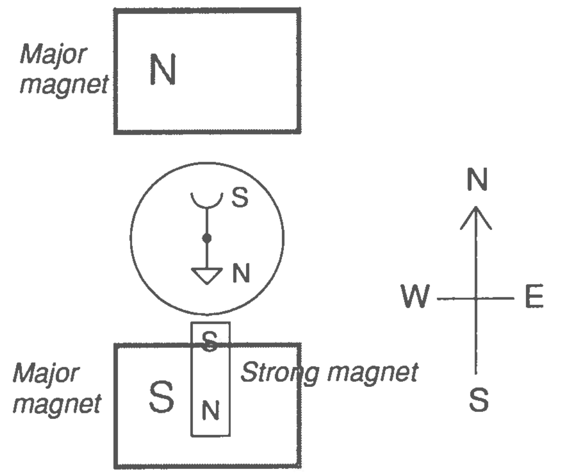
2 Hold it in position using a weak magnet



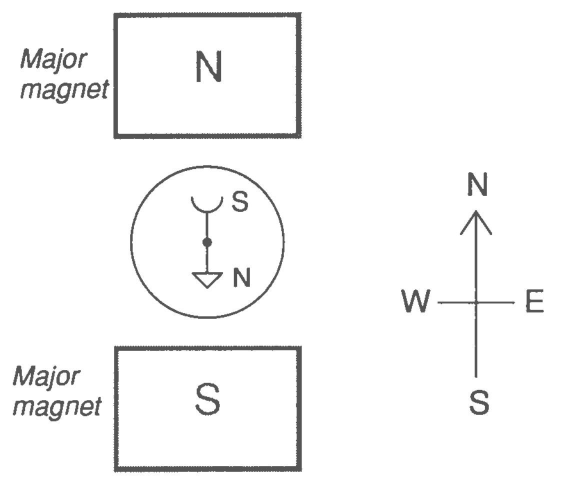
3 Keeping this weak magnet in position, introduce a stronger magnet to induce the correct polarity on the needle's arrowhead



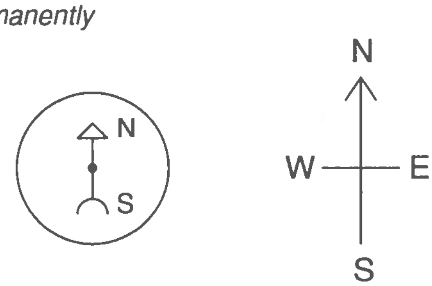
4 Now remove the weaker magnet maintaining the stronger magnet in position



5 Slip the compass into the gap between the poles of a Major magnet maintaining the strong magnet in position



6 Remove the strong magnet and knock the compass case a few times against the Major magnet to help magnetize the needle more permanently



7 On removing the compass from the Major magnet's field you should find that it points north

TECHNICAL ARTICLE

Laser radiation

What is laser radiation like, how do you show it, what use can you make of it? These are perhaps the first questions a teacher faces when introducing the laser to a class for the first time. This article describes ways of tackling them.

One of the purposes of Circular 7/95 on laser safety [1] issued recently by the Scottish Office was encouragement to make greater use of lasers than hitherto. We are responding by publishing a series of articles on laser experiments. The first in the series, on ways of using laser radiation with ray and spherical optics, appeared two issues ago [2].

The themes underlying the experiments described here are ways of showing the tightly collimated nature of laser radiation and making use of this. Beginning with viewing radiation in air and liquids, the article describes ways of showing refraction, internal reflection and properties of optical fibres. It includes a method to look at the intensity profile across the beam.

All of the practical work must comply with the guidance on laser safety in Circular 7/95. Further specific safety advice is given where appropriate.

Showing radiation in air

The usual trick of knocking chalk out of a duster has the merit of being simple and taking no time to prepare. However it gives only a transitory view of the beam, is messy, and because chalk dust is respirable, may be harmful to health. Products which produce fume, such as smoke pellets, should not be used outwith a fume cupboard because fume is respirable. Products which produce an oil mist are not recommended either - again because of risk to health.

The preferred method is a mist of supercooled water droplets using either liquid nitrogen or dry ice to do the chilling. Liquid nitrogen is more effective [3].

A sketch of a fog machine is shown below (Fig. 1). The main part is a clear plastic tank, such as an animal cage. Drill holes in either end to accept flexible hosing. One piece of hosing connects to an air blower. The other piece should be sufficiently long to reach the laser demonstration area.

The rate of flow of air from the blower should be controllable. Quite a low flow rate is required. If the blower does not itself have a speed controller, then the air inlet should have a variable vent to release some of the air from the pipe before it reaches the tank.

The heater element should be low voltage for safety reasons. 100 W may not be powerful enough. Some experimentation is called for. Several 12 V immersion heaters may be needed. Pairs of 4 mm sockets should be wired back to back. The internal one connects to a 4 mm plug on a heater lead. The external one should be fixed to the tank wall for connecting to an external supply.

Many materials become brittle and crack in the extreme cold produced by contact with liquid nitrogen. Don't use a plastic tray for liquid nitrogen. Aluminium, stainless steel, polycarbonate or Pyrex should be satisfactory. Some polystyrene insulation should be inserted between the base of the tray and the tank floor.

The procedure is as follows. Fill the beaker with water from a boiling kettle. Switch on the heater(s) and wait for a copious production of steam. Add about 1 litre of liquid nitrogen or dry ice to the tray, close the tank lid and start the air blower. Direct the fog on the laser demonstration. The room should be blacked out otherwise.

If you wish to work with liquid nitrogen please refer to the safety precautions on pages 6 to 8 of this issue.

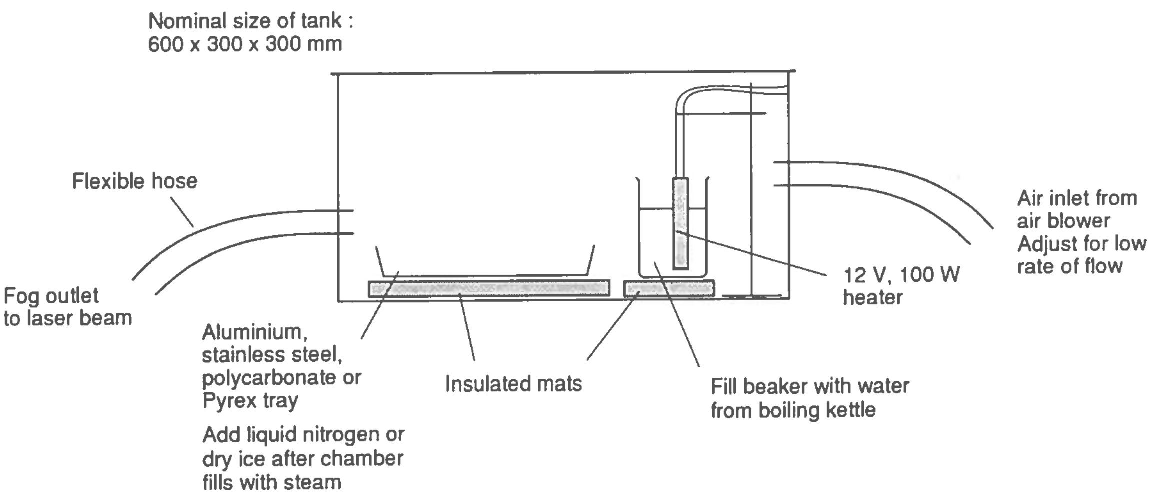


Figure 1. Apparatus to generate supercooled water droplet fog.

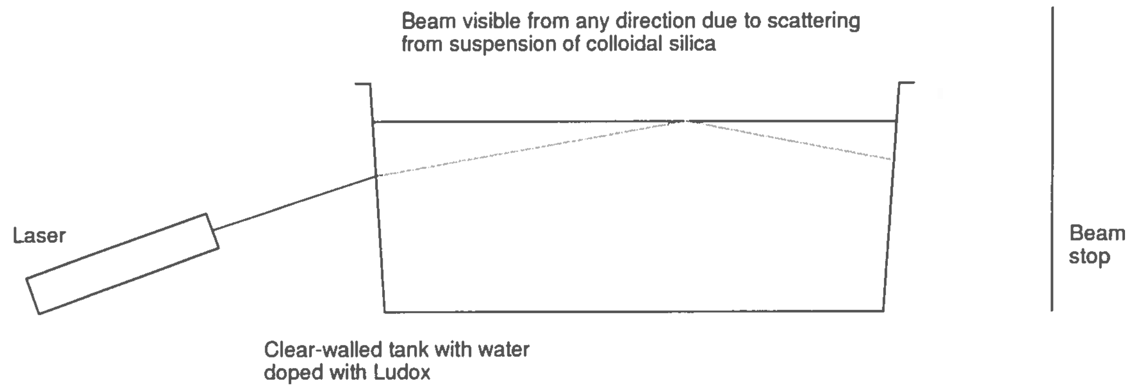


Figure 2. Seeing a laser beam in water.

Showing radiation in water

If a laser beam is directed into a transparent tank of pure water, the beam is largely invisible. However if the water is viewed carefully in a darkened room, tiny pinpricks of light indicate the beam's position. These scintillations illuminate at random. They are caused by particles or bubbles in suspension scattering light. The best viewing direction is from behind the laser because most of the scattering takes place in forward and backwards directions. (Looking towards the laser is best avoided for fear of direct viewing, but preferential forward scattering implies that in principle this should be a 'good' viewing direction also.)

Scattering can be enhanced by doping the water with a suspension of sub-microscopic particles of about 10 nm in diameter (Fig. 2). A tiny quantity of either liquid or dried milk may be used wherein the protein molecules act as scattering sites. Fatty milk may not work as well. Milk should only be used in a short-term experiment because it quickly goes off, causing a bacteriological hazard. Any surfaces contaminated should be well cleaned afterwards. Starch is another ready-to-hand substance which forms a colloid in water and scatters light.

A better substance is Ludox [4]. This is the proprietary name for a Du Pont product, being colloidal silica. Different particle sizes are available. The demonstration suggested here uses 14 nm particles. The optimum particle size is reputedly 12 nm. Only a few millilitres need to be added to 10 litres of water to be effective.

Because Ludox is commonly used in the manufacture of white emulsion paint, this may be used in substitution for Ludox. Add a few drops per tankful of water.

The demonstration should be viewed under blackout conditions.

Brownian motion

The scintillations which take place in the laser beam is evidence of Brownian motion. Particles in suspension in the water move continually at random in and out of the beam causing the scintillations.

Optical fibre model

If a transparent tube is filled with water doped with Ludox and a laser is directed into the water through a clear tube end, then the beam can be seen to proceed down the tube by a series of total internal reflections. It models an optical fibre. The tube may be either rigid, such as a glass measuring cylinder, or flexible, such as PVC tubing.

However the model is a poor one. The core of an optical fibre has a higher refractive index than the cladding. Total internal reflection occurs at the core-cladding boundary. In this model total internal reflection takes place at the outer wall of the tube, glass and perspex having refractive indices of around 1.5 and water having a refractive index of 1.3.

Risk assessment

Ludox is irritating to the eyes, respiratory system and skin. It has a pH of 9. Avoid skin contact. Wash with copious amount of water in the event of skin contact. In case of eye contact flush eyes continuously for at least 15 minutes with copious amounts of water.

The main risk of harm comes from inhaling silica particles after the fluid has evaporated. Do not therefore allow Ludox to dry out. Dispose of to drain after use and sine out thoroughly both the vessel and sink.

Materials

Ludox is obtainable from the Aldrich Chemical Company
Product name : Silica (Colloidal), 50 wt. % suspension in water (Ludox TM-50)
Product order number : 420778
Price : £9.60 for 1 litre

Total internal reflection at a graded index

This demonstration [5] may be set up either in front of the class for immediate use, or prepared some days in advance.

1. You need a transparent tank which is at least 450 mm long. Raise the tank on a firm support about 50 mm high. Place a sheet of white paper beneath the tank. Half fill the tank with water. Dope the water with Ludox and leave to settle.
2. Prepare the sugar solution using 500 g of sugar (sucrose) in 1 litre water doped with Ludox. Using a magnetic stirrer, this takes about 15 minutes to dissolve.
3. Slowly pour the sugar solution into the water tank (Fig. 3) using a large funnel. The sugar solution will be seen to sink to the bottom of the tank and a fairly well defined boundary will form between the two liquids.
4. If you want to use the tank immediately, gently disturb the boundary with a glass rod to produce a continuous optical density gradient. Otherwise leave alone and a graded index will develop naturally over a period of several days.
5. When ready to use direct a laser beam into the tank as illustrated (Fig. 4). The effect is best viewed in a darkened room.

Risk assessment

Because the apparatus may be left set up over a long period of time there is a risk of bacteriological contamination. The growth of a mould may be visible after perhaps one week. If this appears, immediately dispose of the contents to drain and wash the tank with soap and hot water.

Apparatus

If you do not have a tank with which to use then a long, narrow, tall, rectangular tank measuring 600 mm x 75 mm x 200 mm is stocked by Eagle (P32-965, £54.29) and Harris (Q48250/1, £74.17).

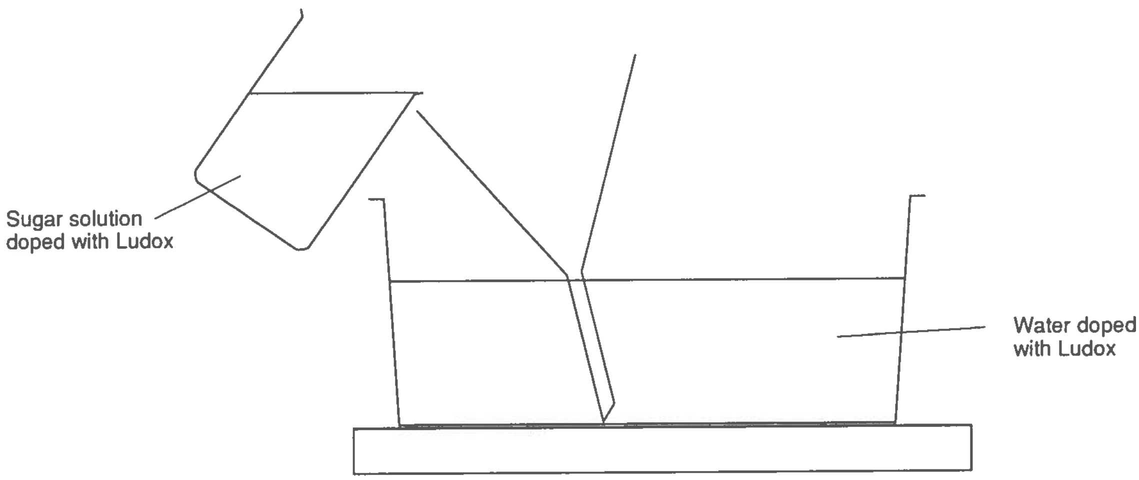


Figure 3. Adding sugar solution to water through a funnel.

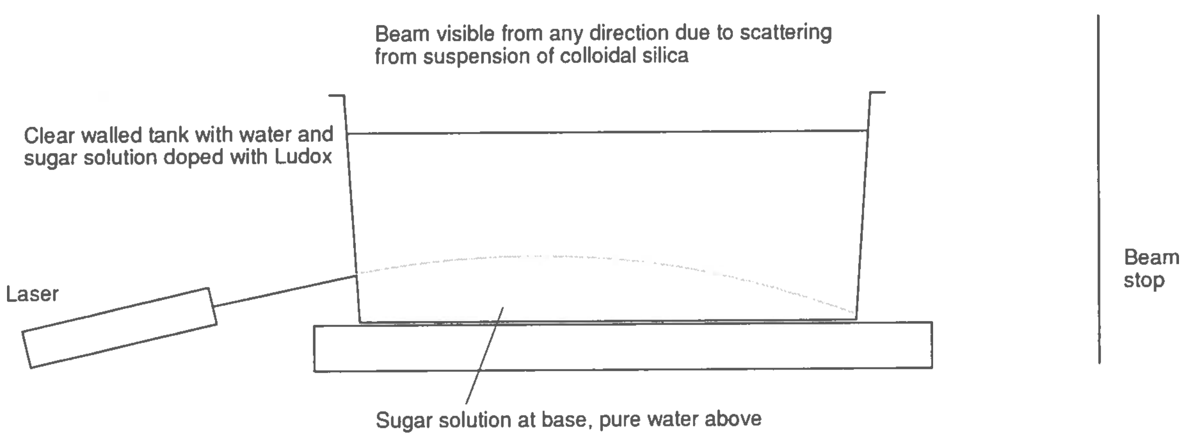


Figure 4. Graded refractive index between sugar layer and water causes beam to bend.

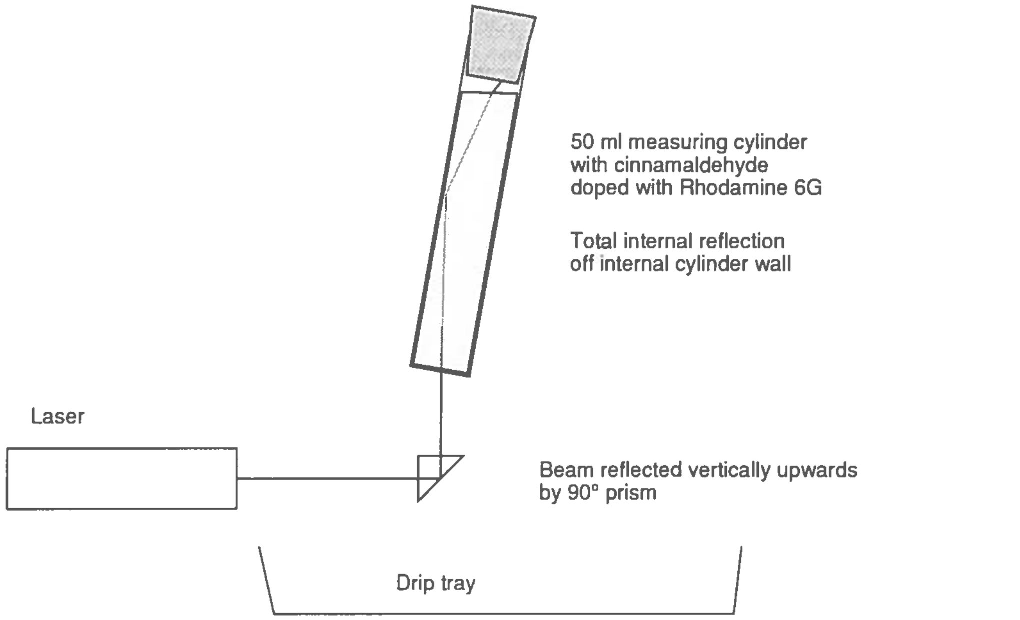


Figure 5. Total internal reflection at boundary between cinnamaldehyde and glass. Rhodamine fluoresces in laser beam.

Optical fibre analogue

Cinnamaldehyde is an oily aromatic liquid with an unusually high refractive index of 1.62. Because this value is higher than the index for glass, light can undergo total internal reflection at the liquid-glass boundary. This is the analogue of refraction of light at a core-cladding boundary of a step-index optical fibre [6].

If a few flecks of Rhodamine are added to cinnamaldehyde, a laser beam passing through the liquid is made visible by the fluorescence caused.

It is suggested that the apparatus is set up as shown (Fig. 5). Because cinnamaldehyde is an irritant to the skin, this arrangement ensures that the container is upright so that the contents are not able to escape. It also ensures that no reliance is placed on the stopper to contain the substance. Being an organic substance, cinnamaldehyde may attack materials used as stoppers. The container is a 50 ml glass measuring cylinder temporarily removed from its plastic base. The measuring cylinder should be hand held in the beam and aligned to show multiple refractions. The work should be done over a drip tray to contain spillage in the event of an accident. Good blackout conditions are required.

Risk assessment

Cinnamaldehyde :

1. Cinnamaldehyde is irritating to the eyes, respiratory system and skin. It has been reported to be a skin sensitiser. Wear eye protection and rubber gloves - even when handling a sealed container.

   If it contacts the eyes immediately flush eyes with copious amounts of water for at least 15 minutes and seek medical advice.

   If it contacts the skin immediately wash the affected skin with soap and copious amounts of water.

   Avoid breathing the vapour. Dispense in a fume-cupboard.

2. Cinnamaldehyde is combustible. Keep away from flames.
3. Incompatibles : strong oxidising agents, strong bases.

Rhodamine 6G :

Rhodamine is harmful by inhalation, in contact with the skin and if swallowed. It is a possible carcinogen.

Wear gloves and eye protection when using. Take care not to raise dust.

Laser beam :

Because the laser beam is directed upwards, take care not to look down into it.

When positioning the glass cylinder into the beam, prevent stray reflections hitting other persons. Use screening if necessary.

Materials

Cinnamaldehyde is obtainable from the Aldrich Chemical Company.
Product name : trans-Cinnamaldehyde, 99%
Product order number : C80687, Price : £7.90 for 500 g

Rhodamine 6G is obtainable from the Aldrich Chemical Company.
Product name : Rhodamine 6G
Product order number : 201324, Price : £7.60 for 25 g

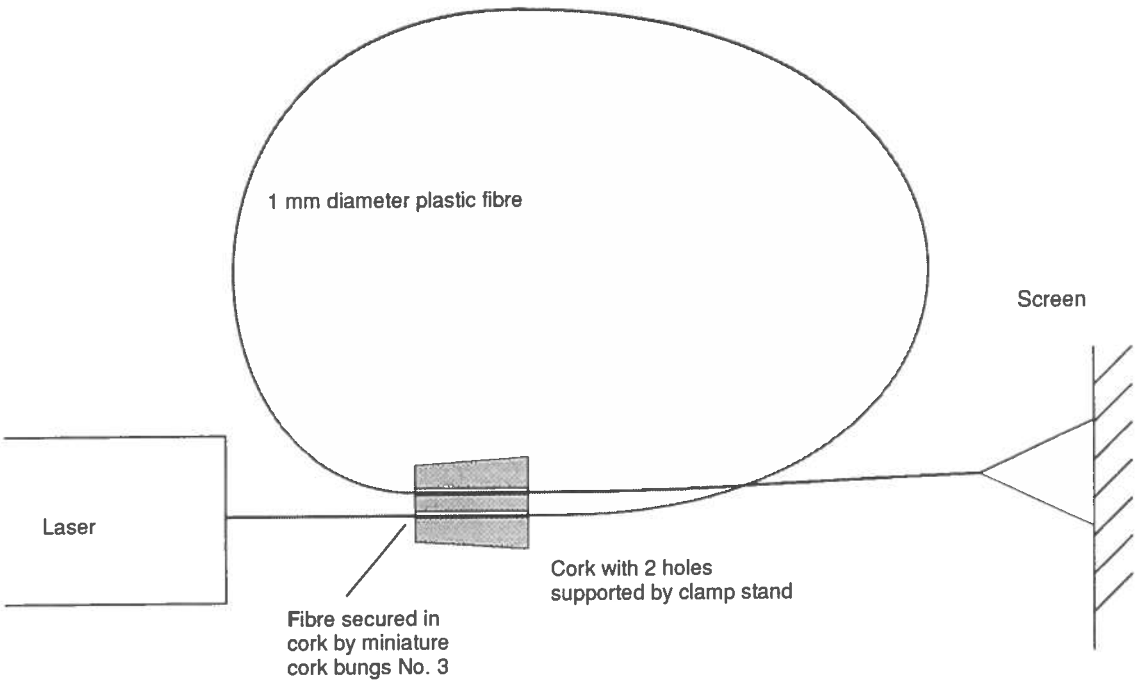


Figure 6. Simple jig to secure optical fibre for transmission of laser radiation. Length of fibre between fibre-end and bung should not exceed 10 cm.

Radiation and optical fibres

When radiation is directed through an optical fibre, not all the radiation travels the whole length of the fibre. Some emerges along the way. If laser radiation is used, then because of its great intensity, significant amounts of radiation spill out to be readily seen. This activity amounts to observing what happens, noting where on the fibre radiation is being emitted, asking why and drawing inferences on the physical processes.

Cover the workbench with a large sheet of white paper. Bend the fibre into a wide loop and thread twice through a cork or rubber bung (Fig. 6). Because it is probably rather loosely secured like this it will be necessary to secure it more soundly by gently pressing miniature bungs into the holes in the cork. Size number 3 has been found suitable.

The cork or bung is then held in a clamp at the height of the laser aperture. A white screen is placed about 5 cm from the other end of the fibre. Blackout conditions are needed.

The following effects should be apparent :

1. *Bends* : Light is emitted from the fibre at bends, especially tight bends.
2. *Straights* : Relatively little light is emitted from straight sections of fibre.
3. *Distance* : Less light is emitted with distance because divergent modes get lost.
4. *Sites of damage* : Bright spots indicate sites of mechanical damage. Light is scattered out of the fibre at these sites.
5. *End* : Because the beam emerging from the end of the fibre is seen to diverge, this is evidence that light within the fibre is angled with respect to the fibre's longitudinal axis.

Risk assessment

The ends of the optical fibre must be effectively clamped to prevent a person viewing directly emerging radiation. A beam stop must be placed at the end where light emerges. The screen serves this function.

Intensity profile across a laser beam

If a laser beam is swept repeatedly across a photodiode, the signal on the oscilloscope corresponds to the intensity profile across the laser beam [7].

Laser radiation is swept across the photodiode by reflection off a small mirror attached to the paper cone of a loudspeaker (Fig. 7). This mirror consists of a fragment of glass broken off a microscope slide cover slip and attached to the loudspeaker cone with double sided Sellotape. By driving the speaker with a triangular waveform, the beam should sweep to and fro with constant angular velocity. The photodiode should be placed centrally within this sweep to ensure that the angular velocity is reasonably constant. Initially set the frequency at some arbitrary value between 100 Hz and 200 Hz. It should be adjusted later for best performance.

Use a photodiode such as BPX65 (RS 304-346) or BPX65RT (RS 846-755), both of which have small surface areas. Because its reverse leakage current is proportional to intensity, so will be the voltage developed across the 10 kΩ resistor. The oscilloscope displays this transient, repeated voltage (Fig. 8). Adjust the frequency and amplitude of the signal generator's output for optimum performance. By triggering directly from the signal generator, the trace should be quite stable. The oscilloscope signal therefore represents the intensity profile across the laser beam. This profile resembles a Gaussian distribution.

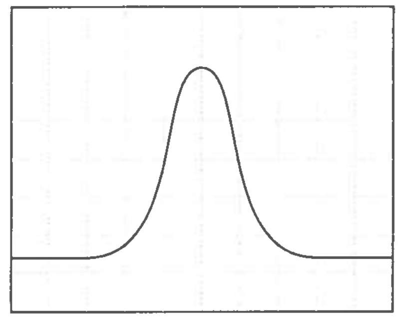


Figure 8. Signal on CRO. It is a Gaussian curve and represents the variation in intensity in a cross section through a laser beam.

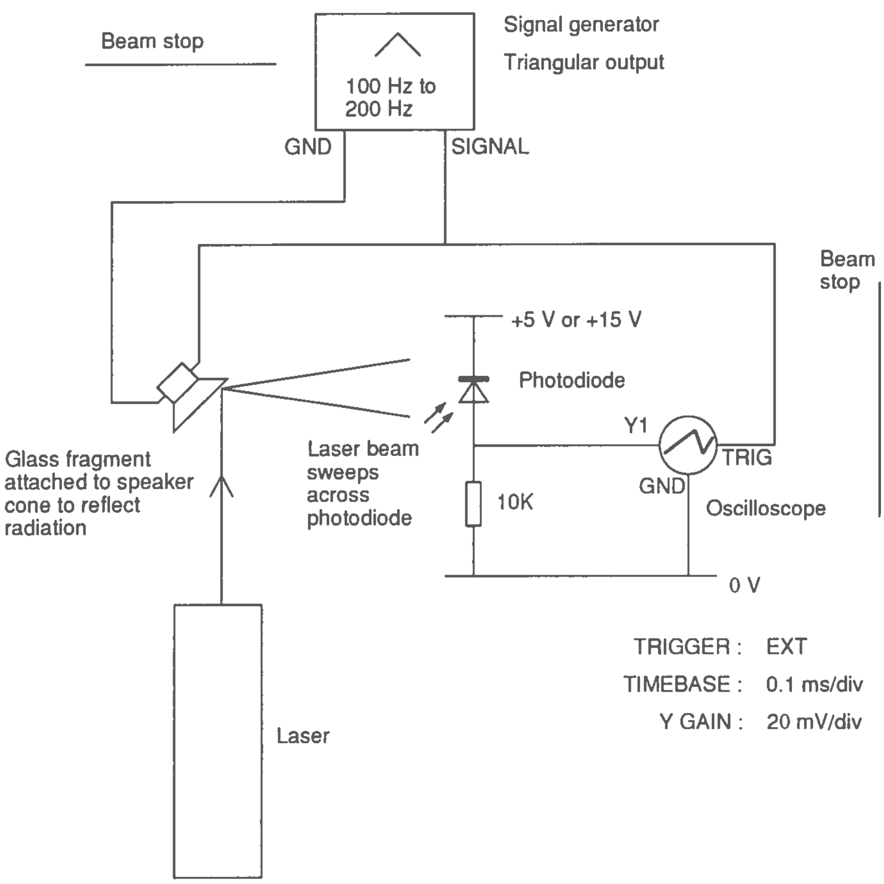


Figure 7. Apparatus for plotting an intensity profile across a laser beam.

Total internal reflection

In the standard experiment, light from a raybox is directed radially on the plane surface of a semi-circular glass or perspex block. Another effective method was shown in Figure 2 of this article. There, radiation was directed upwards through a trough of water at the surface and was seen to be reflected. This method is effective only because the fluid had been doped with particles that scatter the radiation. It can either be set up as a teacher demonstration, or pupil experiment. By contrast the following experiment is small scale, for work by small numbers of pupils. In this arrangement [8], the raybox of the standard pupil experiment is replaced by laser radiation transmitted through water in a small tank. The laser radiation in water is clearly visible due to scattering from colloidal silica.

The apparatus consists of a laser, a clear, perspex sandwich box measuring about 180 mm x 120 mm x 80 mm and a hollow perspex 50 mm cube (Griffin, XBX-660-D, set of 4). Water doped with Ludox is added to the sandwich box, which is placed on a white paper sheet on a low platform so that the box base is about 1 cm lower than the laser aperture.

The hollow perspex cube should be used to show refraction at the water-perspex-air boundaries (external and internal cube walls) (Fig. 9) and total internal reflection at the perspex-air boundary (internal cube wall) (Fig. 10).

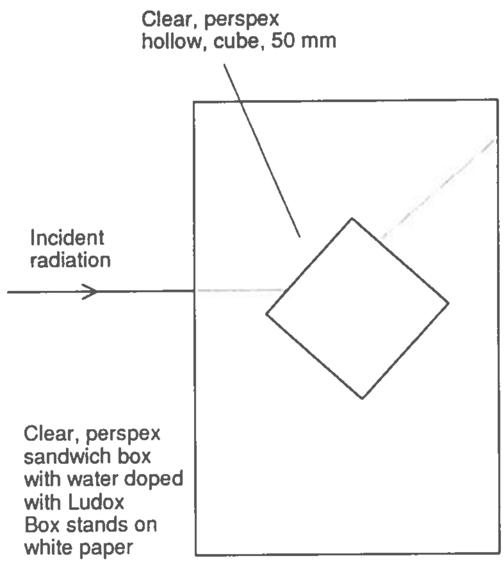


Figure 9. Laser radiation visible in water. Shows refraction at water-perspex-air boundaries.

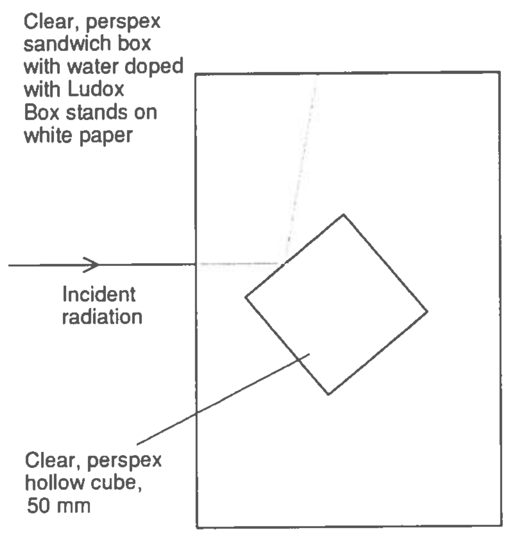


Figure 10. Laser radiation visible in water. Shows total internal reflection at perspex-air boundary.

Risk assessment

Ludox is irritating to the eyes, respiratory system and skin. It has a pH of 9. Avoid skin contact. Wash with copious amount of water in the event of skin contact. In case of eye contact flush eyes continuously for at least 15 minutes with copious amounts of water.

The main risk of harm comes from inhaling silica particles after the fluid has evaporated. Do not therefore allow Ludox to dry out. Dispose of to drain after use and sine out thoroughly both the little tank and hollow cube.

Acknowledgements

The method for making laser beams visible in air with a mist of supercooled water droplets was devised by M E Knotts and appeared in *The Physics Teacher* (1993). The method for making beams visible in water with Ludox was described by M G Cornwall and G J Williams in their book *Lase* (1991), as were the optical fibre analogue with cinnamaldehyde doped with Rhodamine and the intensity profile demonstration.

Training

The Centre has prepared in-service training so as to help broaden the scope of practical work with lasers and show how the work can be done safely. If interested, please contact the Director.

References

1. Circular No: 7/95 *Guidance on the use of lasers in laboratory work in schools and colleges of education, and in non-advanced work in further education establishments* SOEID 1995
2. *Optics with lasers* Bulletin 188 SSERC 1996
3. M E Knotts *Making laser beams visible* The Physics Teacher 1993 31 402
4. M G Cornwall and G J Williams *Lase* 1991 ISBN 0 9517357 0 5 *Visualising a laser beam* 13
5. *Ibid. Producing a GRIN - the sugar tank* 53
6. *Ibid. Simulating a step-index fibre* 52
7. *Ibid. Scanning a Gaussian* 67
8. *Ibid. Total internal reflection* 21

Extraction solvents for plant and animal lipids

Separation, isolation and analysis of mixtures of lipids by thin layer chromatography (TLC) is a popular practical activity in senior school biology. Until recently, a mixture of 1,1,1 trichloroethane and methanol (2:1 v:v) was commonly used in school procedures as a solvent to extract oils. Such extractions were commonly made from animal products - such as butter - or from plant tissues, especially those such as sunflower seeds or ground nuts (peanuts). Because 1,1,1, trichloroethane is harmful to the ozone layer, its manufacture and sale (but not the use of existing stocks) were effectively ended by the Montreal Accord. Recently we were asked by a school to suggest suitable substitute extraction solvents for this activity.

In early empirical trials of other potential solvents, we substituted for the 1,1,1 trichloroethane : methanol mixture with a number of variants based on hexane or cyclohexane and propanone. The relatively expensive, silicone based solvent, Volasil 244, was also trialled (all as mixtures with propanone, in the ratio 3:1 v:v). A fairly recent publication by Unilever called *Fats and Oils* [1] was then obtained at the UK, ASE Annual Meeting. This describes two investigations which, in combination, provide a much simpler answer to the problem. One of the basic experiments described therein uses basic thin layer techniques to analyse the polar content of an oil. The suggestion here is to use a purchased sample of an edible oil with the standard hexane : ethoxyethane : ethanoic acid mix as the running solvent and iodine vapour as the detecting agent. In a separate investigation, described earlier in the booklet, hexane is suggested as the extraction solvent to obtain oil from crushed sunflower seeds. We took the rather obvious hint and combined the two activities. We found that either hexane or the somewhat safer cyclohexane were adequate extraction solvents on their own. We then wondered if we weren't still being too clever by half and tried industrial methylated spirits (IMS).

All of these substitutes proved effective in extracting lipids from butter and peanuts. The resultant mixtures were successfully separated by ascending chromatography on t.l.c. plates in a saturated atmosphere of hexane : ethoxyethane : glacial ethanoic acid in the ratios 80 : 20 : 2 (v:v). The results with most of these substitutes (Fig. 1) seemed at least as good as those obtained with the 1,1,1 trichlorethane : methanol mix. Those with IMS were a little different in that although the separation on the t.l.c. plate was well-defined - and all or most of the components were present - the lipid mixture was apparently not as concentrated as that obtained with the same volume of cyclohexane or hexane.

The final choice between these various substitutes has to be a balance between safety, effectiveness and cost. On such grounds - for the extraction - we would choose cyclohexane on its own. On the grounds of simplicity, but at a push, industrial methylated spirits (IMS) would do the job. We also tried substituting cyclohexane for the hexane in the t.l.c. running solvent. The results with a cyclohexane : ethoxyethane : ethanoic acid : 80 : 20 : 2 (v:v) ratio mix were apparently better than those obtained with hexane.

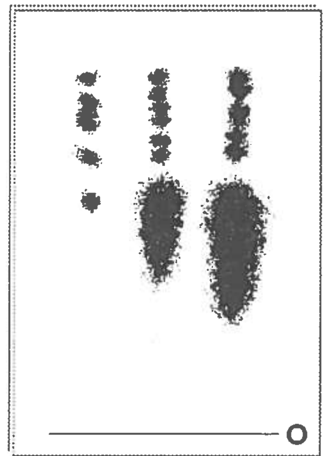


Figure 1. Sample results - from a photocopy of actual thin layer chromatogram run in cyclohexane : ethoxyethane : ethanoic acid mix and developed in iodine vapour.

The original spots at the origin O were : reader's left - extract from peanuts using IMS; middle - peanut extract using cyclohexane at 10 cm^3 of the solvent to 5 g of nuts, and right - olive oil as a relative standard.

Risk assessment results

Eye protection must be worn. The solvent mixes are all highly flammable, as well as harmful and irritant. Remove any sources of ignition. After separation, the solvent should be allowed to evaporate, and the plates to dry, in a fume cupboard. The iodine solid is corrosive to the skin and harmful. It should not be handled directly (wear nitrile gloves, eye protection and use a spatula). The iodine vapour is harmful to the respiratory system and irritates the eyes. The t.l.c. plates should be exposed to the iodine vapour within a closed vessel such as a large beaker with a cover and placed in a fume cupboard. Note that some individuals are sensitised to ground nut (peanut) and other oils. They may exhibit extremely serious allergic reactions (*anaphylaxis*). If at all possible, use alternative sources of lipids. Some pupils may be allergic also to certain other seeds and fruits (eg sunflower, maize, or to more expensive nuts such as Brazils, hazelnuts, walnuts etc) as well as to peanuts and peanut oil. Look out for further discussion of this problem in the Safety Notes section of the next issue.

Reference

1. *Fats and Oils, Unilever Educational Booklet : Advanced Series*, Unilever, January 1994 (1995 reprint).

TECHNICAL TIPS

Ice hangers

In the conventional Scottish S1/S2 science course, part of unit nine (Convection, conduction and radiation) is a set of activities called *Heat on the Move*. This usually includes a simple investigation of what happens to water when it is cooled. A typical set-up is shown in Figure 1 below. The idea is to pick up the temperature differences as the water at the surface cools and sinks. One major snag with this arrangement is that the floating ice cube tends to skite about the surface bringing in its wake results which may be difficult or impossible for youngsters to interpret. This is especially so if the pupils chase the cube about with the thermometers so agitating and mixing the whole body of water.

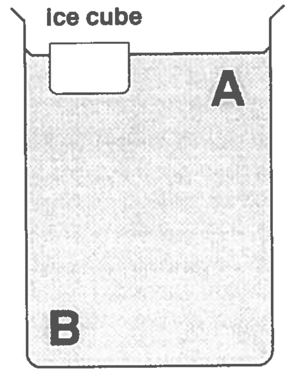


Figure 1. "*As water cools it will sink*". The idea is to measure the temperature at each of points A and B over one minute.

Pauline Anderson of Earlston High School has sent us details of a neat wee trick to curcumvent this problem. She uses modified paper clips as 'ice hangers'. The basic idea is illustrated in Figure 2. Paper clips are opened up so that the two wire loops are at right angles to one another. The larger loop is then rotated so that it can be hung on the side of a cell of an ice cube tray with the smaller loop near the bottom of the cell. Put one such clip in each section of a tray (sufficient for a class set), fill with water and freeze. When they are required for use, remove the ice cubes complete with their wire loop hangers. The cubes can then be hung on the lips of the beakers at the water surface and will remain tethered in one place. So long as the pupils do not swish their thermometers about, there will be little or no agitation of the water and much clearer results should then emerge.

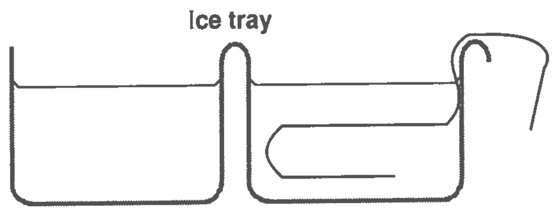


Figure 2. Modified paper clip in position in an ice tray compartment.

MICROBIOLOGICAL TIP

Chromobacteria

We have received enquiries on suitable media for the culture of the coloured bacterium *Chromobacterium lividum*. This is listed in most of the 'approved' lists for educational work at Level 2 and is a useful substitute for *Serratia marcescens* which although once popular for educational use some years ago was identified as an opportunist pathogen in humans. Note that *C. lividum* is also known as *Janthinobacterium lividum* and may be assigned this synonym in some texts or culture catalogues. It will actually grow quite happily on ordinary nutrient agar. The addition of a touch of glycerol, however, at 0.5% by volume, seems to perk it up significantly. Inoculated plates should be left to 'age' for about four days whereafter the typically coloured colonies should be evident.

MORE COMMENT

At the time of writing the SOEID and SCCC initiative on Scottish History was announced. Most indigenous readers will be aware, too, of the consultative exercise which has begun on the place of culture and cultural values in the curriculum. Serendipitiously I stumbled then on some of the poems of Tom Leonard and fell over this double edged message for Messrs Forsyth and Robertson:

Parokial

thahts no whurrits aht
thahts no cool man
jiss paroakial
aw theez sporran heads
tahty scoan vibes
thi haggis trip
bad buzz man dead seen
goahty learna new langwij
sumhm ihnturnashnl

Noah Glasgow hangup
bunnit husslin

gitinty elektroniks man
really blow yir mine
real good blast
no whuhta mean

mawn
turn yirself awn

bunnit husslin - deliberately portraying an image of, or for, the 'common' man

Tom Leonard Intimate Voices : Selected Work 1965-1983. Galloping Dog Press 1985, ISBN : 0904837 68 8.

EQUIPMENT NOTES

Oscilloscopes

Four single trace oscilloscopes and one inexpensive dual trace model have been tested. The report cross references with advice on oscilloscopes given in Bulletin 176.

When we last published Equipment Notes on oscilloscopes in 1993 [1], we reported on five single trace and twelve dual trace models. We noted then the lack of the so-called *pupil oscilloscope*. Indeed only two of the five single trace models were so designated. Since then Irwin have withdrawn their pupil 'scope, which leaves only the Unilab model remaining. Moreover two other single trace models have been withdrawn from the UK market - the Hameg *103-2*, which had been given an *A* assessment in our report, and the Harris *Super 5*. We are therefore pleased to note the appearance on the market of four single trace models - the *Didascope* from Metrix in France, the *Harris Super 10*, which is made by Intel Instruments & Systems of India, a company associated with Crotech, the *Good Will GOS-935* from Taiwan and the Kenwood *CO 1305*, which is a product of the Japanese company of that name. Of these four newcomers, the *Didascope* has been designed specifically for the schools' market. It is a genuine pupil oscilloscope of modern design. The other three are also for beginners and may too have been designed specifically for educational use.

This report also includes one new dual trace model from Crotech, made in India by Intel. For its specification it is so unbelievably cheap we just had to test it too.

Information on the remaining single trace models (*Crotech 3036* and Unilab *Student Oscilloscope*) and best buy dual trace model (*ISO-TECH ISR 620*) has been included in the tables given here. This will allow cross referencing with our best buys in 1993. Please refer to the previous report for a technical description of oscilloscope features and the tests we apply.

Safety

All the instruments have been tested for compliance with the relevant safety standard IEC 1010. We also applied a more stringent aperture test on single channel 'scopes because these may be used by junior pupils.

Although in most respects well engineered, all had one or more serious defects. However we are pleased to report that Intel, Kenwood and Metrix have acted to put right faults found in their products. Final assessments (Table 5) and recommendations take account of these changes.

Regarding the other product, the Good Will oscilloscope has been withdrawn from the market by the supplier after consideration of our test report. We hope that this is only a temporary measure until it too can be improved adequately.

This evaluation is a useful exercise in the duties of respective parties. Manufacturers and suppliers have a duty of care to ensure that goods they supply are in reasonably safe condition. The responses to our test reports indicates that this is generally the case. Duties of employers include that of providing work equipment in safe condition. It follows that it would be wrong of an employer to purchase an oscilloscope with a *C* rating for safety (Table 5).

Performance

Further to the summary in Table 5, some additional comment on each instrument is given here.

Good Will GOS-935 : The fault condition referred to in the preceding section is the aperture sizes on the rear and base panels of the enclosure. Some of these would admit a 4 mm diameter test pin giving access to hazardous internal conductors.

If these deficiencies were to be put right, the *GOS-935* would be well suited to the early stages of secondary education. Its minimal controls are simple to operate for someone learning to use an oscilloscope. Standard waveforms are triggered satisfactorily and clearly displayed. XY performance is very good. The trace quality is good. However it is of little use at making measurements, a function for which it has not been designed.

In summary the *GOS-935* is simple to operate. is good for qualitative work, but not for quantitative. Also its price is low at around £217, but until Good Will remove the apertures, it would not be not adequately safe. You should not buy it in its present condition.

Harris Super 10 : This instrument may be used for quantitative as well as qualitative work. It uses push-button instead of rotary switches to set amplitude and timebase. These controls are unorthodox, but relatively simple. The sample we looked at performed well in every respect. It has been given an *A* assessment and could be used throughout all secondary stages from inspecting waveforms in junior classes to measurement in senior.

Kenwood CO-1305 : This oscilloscope has the minimalist features that may be desirable with classes at early stages of secondary education. It can be used for qualitative work, not quantitative.

The timebase is synchronised rather than triggered, which is a low cost, unconventional method. However we find that standard, regular signals are displayed effectively, being well focused and stable. Thus the timebase is reasonably adequate.

Amplitude and sweep ranges are selected by slide switches. The latter is marked in units of frequency rather than time. The former is marked :

V.ATT GND 1/100 1/10 1=10mV/DIV

This gobbledegook destroys the simplicity of the Kenwood's minimalist features. A machine for Star Trekkies ? - perhaps! But not for school children. It therefore gets a *B* assessment.

Metrix Didascope OX71 : This instrument features the minimalist controls one would hope to find on a school oscilloscope (see front cover illustration). Both Y-gain and timebase are set by rotary switches with conventional 1-2-5 settings. Because of the many settings, almost any signal can be displayed to optimum advantage against a calibrated scale. It is thus a measuring instrument.

The sample we tested performed well in every respect. It triggers easily on any regular waveform. For most applications auto-triggering is sufficient. The trace is well focused and stable. Accuracy was excellent and easily within specification.

Note that the *Didascope* cannot be triggered from an external source. This limits its use with other equipment from which a synchronising pulse may be required for waveform stability.

The enclosure is broken by 3 mm wide slotted apertures. This complies with IEC 1010 for electrical safety. However some councils or schools may not want to provide such an instrument for use with junior classes because of the risk of insertion of foreign objects. Because of the aperture positions relative to internal hazardous parts, we do not think that the risk is great.

The *Didascope* has been awarded an *A* assessment. It would find a place at any stage in secondary - displaying waveforms in junior classwork, or as a measuring instrument in senior classwork.

Crotech 3305 : This is the only dual trace oscilloscope in the batch tested. Its controls are thus necessarily much more complex. It would not be suitable for use with junior classes, finding its main application in work with years S5 and S6, but might also be used with Standard Grade pupils with a bent towards things technical.

Operationally, the front panel layout is typical of most similar dual trace oscilloscopes in recent years. It is reasonably user friendly.

The sample we tested performed well in every respect. All its test parameters were within specification - indeed more or less spot on! However we found that timebase measurements drifted by up to 1% over a period of time. Although still well within specification, if you were planning to measure to this precision, then this slight drift would need to be reckoned with. Our one other grouch is that the trace is not quite as sharply focused as on some other, more expensive, oscilloscopes. However, despite saying that, the trace sharpness is reasonably adequate and acceptable.

Summing up, every category assessed merits an *A* (Table 5) and the whole package merits an *A*. At only £265 before discount, it's got to be a winner!

Triggering restriction

Excepting the *Crotech 3305*, none of the other oscilloscopes can be triggered on the falling edge of a signal. This restriction limits the range of equipment with which these oscilloscopes can be interfaced. Many instruments, such as the Thandar digital storage unit, apply the falling edge of a synchronising signal to the measuring oscilloscope.

Best buys - Single trace CROs

At this point we need to cross refer to the oscilloscope report in Bulletin 176. Best buys in that report have been included in all of the following tables. Three single trace models have been given an *A* assessment :

Harris Super 10	£309
Metrix Didascope OX71	£299
Crotech 3036	£278

If you are after a pupil oscilloscope for use from S1 upwards, then the *Didascope* has the simplest set of controls, but watch the apertures and be aware that it cannot be triggered from an external source.

If these two weaknesses put you off the *Didascope*, then consider the *Super 10*. It does have unorthodox controls, but then some people prefer lots of pushbuttons to multi-set rotary switches.

Because the *Crotech 3036* has the style of a professional oscilloscope - albeit at the minimalist end of that market - it would not be everyone's preference for junior classwork, but remains an excellent choice for Standard and Higher Grade coursework. Furthermore it is the cheapest of the three best buys.

Best buy - dual trace CROs

There are two best buys. The *Crotech 3305* is significantly cheaper while the *ISO-TECH ISR 620* may have the edge, technically - but just by a whisker.

Crotech 3305	£265
ISO-TECH ISR 620	£302

Oscilloscope model	Supplier	Stock number	Price (£)	Discount	Screen shape	Screen size (mm)	Graticule	Other suppliers
Single trace								
Good Will GOS-935	[2]		217.35		rectangular	75	10 x 8	
Harris Super 10	Harris	Y34010/0	309.00 [1]	10%	rectangular	130	10 x 8	
Kenwood CO 1305	Harris	Y33990/0	292.56 [1]	10%	rectangular	75	10 x 8	
Metrix Didascope OX71	S J Electronics	Metrix OX71	299.00	10%	rectangular	130	10 x 8	Unilab 881.007
Crotech 3036	RMR Measurements	3036	278.00 [1]	6%	rectangular	130	10 x 8	
Unilab Student O'scope	Unilab	032.603	287.68	8%	circular	70	10 x 10	
Dual trace								
Crotech 3305	RMR Measurements	3305	265.00 [1]	4%	rectangular	130	10 x 8	Harris Y34050/1
ISO - TECH ISR 620	RS Components	497-561	302.00 [1]		rectangular	130	10 x 8	

NOTE :

1. BNC test lead(s) supplied inclusive with quoted price.
2. Withdrawn from market by supplier because of SSERC test report.

Table 1. Oscilloscope suppliers, prices and screen detail.

Oscilloscope model	Band-width (Hz)	Calibrated Y settings (V/division)	No. of Y settings	Switch sequence	Y accuracy (%)	Calibrated sweep speed (s/division)	No. of sweep settings	Switch sequence	Sweep accuracy (%)	Max. calibr. sweep rate (s/div.)
Single trace										
Good Will GOS-935	5 M	Uncalibrated	3	1,10,100	(3)	Uncalibrated	4	1,10,100	NS	100 kHz
Harris Super 10	10 M	5 mV to 20 V	12	1,2,5 [1]	5	0.1 μs to 100 ms	6	1,10,100 [1]	5	100 ns
Kenwood CO 1305	5 M	10 mV to 1 V	3 [2]	1,10,100	5	10 Hz to 100 kHz [3]	4	1,10,100	5	430 ns[4]
Metrix Didascope OX71	5 M	50 mV to 5 V	7	1,2,5	5	0.5 μs to 500 ms	19	1,2,5	5	500 ns
Crotech 3036	20 M	2 mV to 10 V	12	1,2,5	3	0.5 μs to 200 ms	18	1,2,5	5	100 ns
Unilab Student O'scope	100 k	50 mV to 10 V	8	1,2,5	NS	100 μs to 100 ms	4	1,10,100	NS	10 μs
Dual trace										
Crotech 3305	25 M	5 mV to 20 V	12	1,2,5	3	0.5 μs to 200 ms	18	1,2,5	5	100 ns
ISO-TECH ISR 620	20 M	5 mV to 5 V	10	1,2,5	3	0.2 μs to 500 ms	20	1,2,5	3	20 ns

NOTES :

1. The Harris Super 10 uses pushbutton switches rather than rotary switches to select amplifier and sweep sensitivities.
2. Vertical control varies attenuation continuously from ÷1 to ÷20.
3. Timebase marked in hertz, but is uncalibrated. Markings are confusing; e.g. a sweep range of 100 kHz displays one cycle of a 100 kHz signal on the screen - not one cycle per division.
4. Timebase uncalibrated. Fastest sweep rate is 430 ns/div.

NS Not specified.

Table 2. Oscilloscope specifications.

Oscilloscope features	A	B	C	D	E	F	G	H	J	K	L	M	O	X	Z
Single trace															
Good Will GOS-935					E		G			K				X	
Harris Super 10							G			K				X	
Kenwood CO 1035					E		G			K				X	Z
Metrix Didascope OX71										K				X	Z
Crotech 3036						F	G		J	K				X	
Unilab Student Oscilloscope							G							X	
Dual trace															
Crotech 3305	A	B	C			F	G		J	K				X	Z
ISO-TECH ISR 620	A	B	C	D	E	F	G		J	K	L		O	X	Z

Table 3. Oscilloscope features.

Key to features :

A Alternate and chopped operation
B Algebraic addition of traces
C Inversion of one or both traces
D Y amplifier switched magnifier or attenuator
E Y amplifier variable gain or attenuator control
F Sweep rate switched magnifier
G Sweep rate variable magnifier or attenuator control
H Component testing facility
J Calibrator output provided
K Trace rotation adjustable
L Illuminated graticule
M Trace locate function
O Amplifier output
X X - Y facility
Z Z modulation facility

Oscilloscope triggering	A	B	C	D	E	G	H	J	K	L	S	T
Single trace												
Good Will GOS-935	A				E							
Harris Super 10	A	B	C		E							
Kenwood CO 1035	A				E							
Metrix Didascope OX71	A	B	C									
Crotech 3036	A	B	C	D	E							
Unilab Student Oscilloscope	A											
Dual trace												
Crotech 3305	A	B	C	D	E		H	J		L		T
ISO-TECH ISR 620	A	B	C	D	E	G	H	J		L	S	T

Table 4. Oscilloscope trigger features.

Key to trigger features :

A Automatic triggering
B Normal triggering
C Manual level control
D Selection of trigger slope polarity (+ / -)
E External triggering
G Alternate (ALT) or vertical mode triggering
H Sweep hold-off facility
J LF triggering, or HF rejection
K HF triggering
L Supply line triggering (50 Hz)
S Single shot triggering
T TV sync pulse separator facility

KEY TO PERFORMANCE RATINGS :

In general,

A Good   B Fair   C Poor

Specifically,

Electrical safety :

A Complies fully with IEC 1010-1 as far as our tests are able to indicate, except for some very minor infringements; has no appreciable points of weakness for use in schools.

B Complies in general with IEC 1010-1, but has one or more features where there is a very small risk of harm.

C One or more features present an unacceptable risk of harm.

Y amplifier, bandwidth and sweep performances :

A Performs to specification.

B Performs slightly poorer than specification.

C Performs considerably worse than specification.

Assessment :

A Most suitable for use in Scottish schools and non-advanced FE.

B Satisfactory for use in above.

C Unsatisfactory.

Oscilloscope model	Electrical safety	Standard of construction	Y amplifier performance	Bandwidth performance	Sweep performance	X-Y mode performance	Layout of controls	Assessment
Single trace								
Good Will GOS-935	C [1]	C [1]	- [2]	B	- [2]	A	A	C [3]
Harris Super 10	A	A	A	A	A	A	A [1]	A
Kenwood CO 1305	A	A	A	A	B	C	C [1]	B
Metrix Didascope OX71	A	A	A	A	A	A	A	A
Crotech 3036	A	A	A	A	A	B [1]	A	A
Unilab Student O'scope	A	A	A [1]	C [2]	B [3]	B	A	B [4]
Dual trace								
Crotech 3305	A	A	A	A	A	A	B	A
ISO-TECH ISR 620	A	A	A [1]	A [1]	A [1]	A	A	A

Table 5. Oscilloscope performance.

NOTES :

Good Will GOS-935

1. There are many apertures on the rear and base of the enclosure. Some admit a 4 mm diameter test pin, which is dangerous. In other respects the GOS-935 is adequately safe.
2. Not suitable for measurements.
3. If Good Will were to put right the aperture problem, then the assessment would improve to *A*.

Harris Super 10

1. Ranges are selected by pushbuttons - unorthodox, but clear.

Kenwood CO 1305

1. The markings are unsatisfactory. This oscilloscope is designed for qualitative rather than quantitative work. The Y-scale is marked *V.ATT GND 1/100 1/10 1=10mV/DIV*. This is gobblegook. Children would not be expected to work with the concept of *attenuation*. Either the scale should be marked *VOLTAGE GND 1 V/DIV 100 mV/DIV 10 mV/DIV* or *INPUT SIGNAL GND LARGE MEDIUM SMALL*. The time base markings are in units of frequency, which is unusual. Confusingly, the markings relate to one cycle per screen width rather than per graticule division.

Crotech 3036

1. X - Y operation : Rather unusually the sensitivity of the horizontal amplifier is 400 mV/div., whereas the vertical amplifier is 500 mV/div. Because of this quirk, a 1 : 1 x : y signal ratio gives a corner to corner trace on the 10 x 8 screen.

Unilab Student Oscilloscope

1. The Y amplifier accuracy is not specified. We reckon on the sample we tested that it is about ±6%, which is as good as could be expected for a screen of this size.
2. The bandwidth was only 35 kHz, much lower than the 100 kHz specified.
3. It proved impossible to recalibrate the timebase such that all four calibrated settings were spot on. The best we could achieve were errors on the three fastest ranges of less than 3%, but an error on the slow range of 10%. This is reasonably fair.
4. Signals above 10 kHz are almost impossible to trigger. The trace is very sharp for a screen of this size. However the trace is skew at the top and bottom of the screen, but horizontal through the centre.

ISO-TECH ISR 620

1. These features perform better than specified.

Reference

1. *Oscilloscopes* Equipment Notes Bulletin 176 SSERC 1993.

Equipment Offers

Items are arranged by similarity of application, or for other reasons, and not by stock number sequence. Often the item number serves only for stock identification by us in making up orders. Newer stock items are underlined, so as to be more easily seen.

Since the publication of Bulletin 189 and the 5-14 Newsletter No. 10 the following changes to the listings have become necessary :

Withdrawals from stock : Regrettably several of our listed items are subject to uncertainty of supply. A number of items have to be dropped when stock runs out etc. The relevant items this time are :

329 33 ohm pot.; 419, humidity switch; 501, screened kynar film (see below); 751, hacksaw blade with strain gauges (withdrawn meantime due to pressure of other work);753, submersible pump; 791, Propellor (but see substitute item 801 at a lower price).

Other changes : Screened Kynar film (items 501 and 502) is no longer made in pieces 18 x 100 mm (item 501) the nearest equivalent now being only 12 x 30 mm which is a screened version of our item 503. The base cost of the new sensor is still £20 but 4 mm plug terminations are no longer included. By the time we add these the total cost is likely to be of order of £22. The new screened assembly has yet to be bench tested for its suitability in the various curricular applications and thus item 501 has been withdrawn meantime.

The unscreened version (Item 503) is still available but the manufacturer has significantly increased the price and we have had to follow suit.

Item 640 - disk thermistor - also is now no longer available at the 15 kilohm value at the size previously supplied. It has proved possible to stock a smaller version with the same characteristics and a superior tolerance. Its reduced power rating will have no appreciable effect in low voltage circuits.

VAT and postage : The prices quoted do not include VAT. However it is added to every customer's order. Local authority establishments will be able to reclaim this input VAT.

Postage and, where necessary, packing, will be charged for. It is therefore best not to send cash with an order, but wait for us to bill you. Official orders may be used. Please try and ask for at least £10 worth of goods because the administrative costs of handling orders are significant.

Don't send cash with orders

We repeat, please do not send payment with your order. Wait until you receive our advice note upon which payment may be made. This saves unnecessary complications e.g. when items are out of stock, failure to make provision for VAT, or if a delivery charge needs to be made. Items of equivalent value may be deducted from your order to balance any shortfall.

Motors

778 Stepper motor, Philips MB11, been stored in damp conditions but unused and retested. 4 phase, 12 V d.c., 100 mA per coil, 120 Ω coil per phase, step angle 7.5°, with 7 mm x 2 mm dia. output shaft. Dimensions 21 mm x 46 mm dia. on oval mounting plate with 2 fixing holes, diam. 3 mm, pitch 42 mm, at 56 mm centres. Circuit diagram supplied. £2.50

755 Pulley wheel kit comprising:
- plastic pulley wheel, 30 mm dia., with deep V-notch to fit 4 mm dia. shaft,
- two M4 grub screws to secure pulley wheel,
- Allen key for grub screws, and
- 3 mm to 4 mm axle adaptor.

The whole making up a kit devised for SSERC tacho-generators with 3 mm shafts.
Specially supplied to SSERC by Unilab. £1.25

614 Miniature motor, 3 V to 6 V d.c., no load current 220 mA at 9600 r.p.m. and 3 V, stall torque 110 mN m, dims. 30 mm x 24 mm dia., shaft 10 mm x 2 mm dia. 45p

593 Miniature motor, 1.5 V to 3 V d.c., no load current 350 mA at 14800 r.p.m. and 3 V, stall torque 50 mN m, dims. 25 mm x 21 mm dia., shaft 8 mm x 2 mm dia. 30p

621 Miniature motor, 1.5 V to 3 V d.c., open construction, ideal for demonstration, dimensions 19 x 9 x 18 mm, eight tooth pinion on output shaft. 25p

739 Miniature motor, 1.5 V d.c., dimensions 23 mm x 15 mm dia., shaft 8 mm x 1.7 mm dia. 25p

732 Motor with gear box, high torque, 1.5 V to 12 V d.c., 125 r.p.m. at 12 V, dimensions 40 x 40 x 28 mm, shaft 10 mm x 3 mm dia. with key. Suitable for driving buggies, conveyor belt, or any other mechanism requiring a slow drive £6.00

773 Tachometer (ex equipment) £2.25

811 Worm and gear for use with miniature motors, 34 : 1 reduction ratio plastic worm and gear wheel. 35p

378 Encoder disk, 15 slots, stainless steel, 30 mm dia. with 4 mm dia. fixing hole. 80p

642 Encoder disk, 30 slots, stainless steel, 30 mm dia. with 4 mm dia. fixing hole. 80p

772 Encoder disk, 4-bit Gray code, stainless steel, 81.28 mm dia., 3 mm fixing hole, slots sized to register with components mounted on 0.1" stripboard. Applications: shaft position sensing, wind direction indicator.
For related electronic circuitry see Bulletin 146. £3.00

Precision motor stock

785 Precision motor with optical shaft encoder, 0.25 to 24 V d.c., no load current and speed 9 mA and 6,600 r.p.m. at 24 V, stall torque 23 mNm, 9 segments. Overall body length including shaft encoder 59 mm, dia. 23 mm with output shaft 20 x 3 mm dia. Back EMF constant 3.6 V/1000 r.p.m. Suggested application - tachogenerator. Data on shaft encoder section available on application. £15

787 Precision motor with attached gearbox, 0.15 to 12 V d.c. With a supply of 3 V, the no load current is 25 mA and the output shaft turns at ca. 20 r.p.m. Gearbox ratio 1 : 365. Overall body length including gearbox 43.5 mm and diameter 16 mm. Output shaft 6 x 3 mm dia. with flat side to maximum depth of 0.3 mm along outer 5 mm length of shaft. Application - any system where a very slow angular velocity is required. £15

836 Motor mounts, plastic push-fit with self adhesive base pad, suitable for SSERC motors 593 & 614, pk of 10 £1.95

Miscellaneous items

801 Propeller, 3 blade, to fit 2 mm shaft, 62 long. (Replaces Item 791at lower cost). 35p

792 Propeller kit with 10 hubs and 20 blades for making 2 or 3 bladed propellers. 130 mm diameter. Accepts either 2 mm or 3 mm shafts. £3.40

790 Buzzer, 3 V. 55p

827 Buzzer, 6 V. 55p

629 Dual tone buzzer with flashing light, mounted on small p.c.b. The unit has a PP3 battery clip and two flying leads for switch applications. 55p

710 Sonic switch and motor assembly. First sound starts the motor, a second reverses the direction of rotation, a third sound stops the motor. Driven by 4 AA cells (not supplied). 60p

715 Pressure gauge, ca. 40 mm o.d. case, 25 mm deep and 33 mm dia. dial reading 0 to 4 bar (i.e. above atmospheric). With rear fitting for $^{1}/_{8}$" BSP. Suitable for use as indicator for pneumatic circuits in Technological Studies. 75p

165 Bimetallic strip, length 10 cm;
high expansivity metal: Ni/Cr/Fe - 22/3/75
low expansivity metal: Ni/Fe - 36/64 (invar) 15p

166 Ditto, but 30 cm length. 40p

385 Pressure switch, operable by water or air pressure. Rated 15 A, 250 V (low voltage operation therefore possible). Dimensions 2" x 3" dia. 65p

758 Loudspeaker, 8 Ω, 0.5 W, 66 mm dia. 50p

771 Neodymium magnet, 13.5 mm dia. x 3.5 mm thick. £1.30

814 Ring magnet, 24 mm o.d., 6 mm i.d. 20p

837 Ring magnet, 40 mm o.d., 22 mm i.d. 35p

815 Ceramic block magnets, random polarisation, 19 x 19 x 5 mm. 15p

823 Ceramic block magnets, poles at ends, 10 x 6 x 22 mm. 12p

824 Ceramic block magnets, poles on faces, 25 x 19 x 6 mm. 35p

825 Forehead temperature measuring strips 50p

745 Sub-miniature microphone insert (ex James Bond?), dia. 9 mm, overall depth 5 mm, solder pad connections. 40p

723 Microswitch, miniature, SPDT, lever operated. 40p

354 Reed switch, SPST, 46 mm long overall, fits RS reed operating coil Type 3. 10p

738 Relay, 6 V coil, DPDT, contacts rated 3 A, 24 V d.c. or 110 V a.c. 75p

774 Solenoid, 12 V, stroke length 30 mm, spring not provided. £2.25

742 Key switch, 8 pole changeover. 40p

382 Wafer switch, rotary, 6 pole, 8 way. 70p

688 Croc clip, miniature, insulated, red. 5p

759 Ditto, black. 5p

788 Crocodile clip leads, assorted colours, insulated croc. clip at each end, 360 mm long. £1.35

809 Wire ended lamp, 3 V 10p

741 LES lamp, 6 V. 15p
770 ditto, but 12 V. 15p
789 MES lamp, 3.5 V, 0.3 A 9p
690 MES lamp, 6 V, 150 mA. 9p
691 MES battenholder. 20p

692 Battery holder, C-type cell, holds 4 cells, PP3 outlet. 20p

730 Battery holder, AA-type cell, holds 4 cells, PP3 outlet. 20p

835 Battery holder, AA-type cell, holds 2 cells, PP3 outlet. 15p

729 Battery connector, PP3 type, snap-on press-stud, also suitable for items 692 and 730. 5p

724 Dual in line (DIL) sockets, 8 way. 5p

760 DIL sockets, 14 way. 7p

826 DIL sockets, 16 way. 8p

808 Electrodes for making lemon or other fruit cells etc. 1 pair, comprising 1 of copper, 1 of zinc, each approx. 60 mm square, per pair 50p

716 3-core cable with heat resisting silicone rubber insulation, 0.75 mm² conductors, can be used to re-wire soldering irons as per Safety Notes, Bulletin 166. Per metre. £1.35

756 Silicone coated, braided glass sleeving, yellow, 2.5 mm dia., gives both heat and electrical insulation to conductors (e.g. for autoclave rewiring). Price per metre. 55p

714 Sign "Radioactive substance" to BS spec., 145 x 105 mm, semi-rigid plastic material. Suitable for labelling a radioactive materials store. With pictogram and legend. £2.70

763 Sign "DANGER, Electric shock risk" to BS spec., rigid plastic, 200 x 150 mm. £2.70

764 Sign "DANGER, Laser hazard" to BS spec., rigid plastic, 200 x 150 mm. £2.70

727 Hose clamp, clamping diameter from 8 mm to 90 mm, 101 uses - securing hose to metal pipe, tree to stake, joining wooden battens for blueing, etc. 30p

731 Re-usable cable ties, length 90 mm, width 2 mm, 50 per pack. 12p

752 Shandon chromatography solvent trough. £1.00

805 Condenser lens, bi-convex, 200 mm focal length, 75 mm dia. Crown glass. £12.50

806 Condenser lens, plano-convex, 150 mm focal length, 75 mm dia. Crown glass. £12.50

Components - resistors

420 resistors, 5% tolerance, ¼ W : 1R5, 4R7, 5R6, 6R8, 8R2, 10R, 15R, 22R, 33R, 47R, 56R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R, 1K0, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 150K, 220K, 330K, 390K, 470K, 680K, 1M0, 1M5, 2M2, 4M7, 10M. Per 10. 6p

421 DIL resistor networks, following values available: 62R. 1K0, 6K8, 10K, 20K, 150K. Per 10. 30p

BP100 Precision Helipots, Beckman, mainly 10 turn. 10p-50p

Components - capacitors

813 Capacitors, polystyrene: 180 pF, 220 pF, 330 pF, 560 pF, 1000 pF, 2400 pF, 3000 pF, 3300 pF, 3900 pF & 4700 pF 4p

695 Capacitors, tantalum, 15 µF 10 V, 47 µF 6.3 V. 1p

696 Capacitors, polycarbonate, 10 nF, 220 nF, 1 µF, 2.2 µF. 2p

697 Capacitor, polyester, 15 nF 63 V. 1p

698 Capacitors, electrolytic, 1 µF 25 V, 2.2 µF 63 V, 10 µF 35 V. 1p

358 Capacitor, electrolytic, 28 µF, 400 V. £1.00

Components - semiconductors

807 Schools' Chip Set, designed by Edinburgh University, comprises the 4 chips and prototype board. £4.00

Edinburgh University support material :
Volume 1 : Teaching Support Material (+£2 p&p). £4.50
Volume 2 : Laboratory Work (+£2 p&p). £5.00

322 Germanium diodes 8p

701 Transistor, BC184, NPN Si, low power. 4p

702 Transistor, BC214, PNP Si, low power. 4p

717 Triac, Z0105DT, 0.8 A, low power. 5p

725 MC74HC139N dual 2 to 4 line decoders/multiplexers 5p

699 MC14015BCP dual 4-stage shift register. 5p

711 Voltage regulator, 6.2 V, 100 mA, pre-cut leads. 10p

Sensors

615 Thermocouple wire, Type K, 0.5 mm dia., 1 m of each type supplied: Chromel (Ni Cr) and Alumel (Ni Al); for making thermocouples, see Bulletins 158 and 165. £2.20

640 Disk thermistor, (substitute type) resistance of 15 kΩ at 25°C, β = 4200 K. Means of accurate usage described in Bulletin 162. 30p

641 Precision R-T curve matched thermistor, resistance of 3000 Ω at 25°C, tolerance ±0.2°C, R-T characteristics supplied. Means of accurate usage described in Bulletin 162. £3.00

718 Pyroelectric infrared sensor, single element, Philips RPY101, spectral response 6.5 µm to >14 µm, recommended blanking frequency range of 0.1 Hz to 20 Hz. The sensor is sealed in a low profile TO39 can with a window optically coated to filter out wavelengths below 6.5 µm. Data sheet supplied. For application see SG Physics Technical Guide, Vol.2, pp 34-5. 50p

503 Kynar film, unscreened, 28 µm thick, surface area 12 x 30 mm, no connecting leads. £1.00p

504 Copper foil with conductive adhesive backing, makes pads for unscreened Kynar film to which connecting leads may be soldered. Priced per inch. 15p

506 Resistor, 1 gigohm, ¼ W. £1.40

Opto-electronic devices

507 Optical fibre, plastic, single strand, 1 mm dia. Applications described in Bulletin 140 and SG Physics Technical Guide Vol.1. Priced per metre. 50p
508 LEDs, 3 mm, red. Price per 10. 50p
761 Ditto, yellow. Per 10. 60p
762 Ditto, green. Per 10. 60p

Items not for posting

All of the following items are only available to callers because of our difficulties in packing and posting glassware and chemicals. We will of course hold items for a reasonable period of time to enable you to arrange an uplift.

Glassware

664 Flat bottom round flask, 500 ml. 50p

768 Sodium lamp, low pressure, 35 W. Notes on method of control available on application. 85p

810 Watch glasses, assorted sizes 20p

Chemicals etc.

712 Smoke pellets. For testing local exhaust ventilation (LEV) - fume cupboards and extractor fans, etc. large, 50p, small 35p

We have a range of other chemicals surplus to our needs. These are in reasonable condition and quantities and are not just our old stock of which we would otherwise dispose via a contractor.

Please send a SAE for a complete listing.

Index to Bulletins 180 - 189

Institute of Biology : Scottish Branch 2nd Stirling Biology Meeting 15th May 1997

Programme of Events

09.15-10.00	**Registration and Coffee :** (Foyer of MacRobert Arts Centre)
10.00-10.05	**Welcoming Remarks** Prof.A. Miller, Principal, Stirling University

MORNING SESSION
Chairperson : Dr J. Jackson HMI

10.05-10.30	**Some Glimpses in the Crystal Ball :** Mr Brian Arnold Northern College
10.30-11.00	**Higher Still Biology Arrangements :** Mr J.Stafford, D.O.
11.00-11.45	**Practical Biotechnology :** Mrs Marjorie Smith, D.O. Scottish Biotechnology Education Project.
11.45-12.30	**Tomorrow's Doctors :** Stuart G. Macpherson, University of Glasgow.

LUNCH
AFTERNOON SESSION
Chair : Prof. C.Bryce, Napier University

14.00-14.50	**A Window on the Plant World :** Prof. David Ingram, Regius Keeper, RBGE.
14.50-15.30	**Making Eyes - A Miracle in Design and Development:** Prof. Veronica Van Heyningen, MRC Human Genetics Unit.
15.30	Coffee : Foyer of MacRobert Arts Centre

The meeting will be held in the Logie Lecture Theatre, University of Stirling.

The meeting fee is £20.00 *which includes morning coffee, lunch (£9.50) and afternoon tea.* ***Members of the Institute of Biology, of whatever category, and teachers from Affiliated Schools, may reduce their overall fee to £16.00.***

Those wishing to attend should return a copy of the form in the next column to Dr Arthur Mitchell - either directly or via their appropriate authorising body not later than Thursday, 24th April 1997.

So as to save on administration costs, no acknowledgements will be sent.

No registration form will be accepted unless it is accompanied by the appropriate fee, or by clear indication of an acceptable form of payment (eg Local Authority, School etc.).
You may photocopy the registration form - next column - as required. *If you need one a receipt will be issued at the meeting.*

Lunch arrangements must be confirmed well in advance and thus lunch cannot be guaranteed for late applicants. Participants do not wish to take the arranged lunch may deduct £9.50 from the fee.

Participants arriving by car may park in the visitors' area of the main Cottrell Building car park. If requested you should show a photocopy of this programme page to security personnel on arrival.

Institute of Biology : Scottish Branch 2nd Stirling Biology Meeting Thursday15th May 1997

REGISTRATION FORM/ PRO-FORMA INVOICE

Name ____________________

School/College etc. ____________________

Address ____________________

____

Tel. ____________________

Fee (see notes) £ *Lunch : YES* *NO*

Any special dietary requirements :

This Registration Form must be accompanied the appropriate fee or by a clear statement below of your Authorising Body's method of payment, ***no later than Thursday 24th April 1997.*** *It would save adminstration costs if this form were used as a pro-forma invoice. A* ***surcharge of £10.00 will be added to any payment reminders which have to be issued after 1st July 1997.*** Cheques should be made payable to : "Institute of Biology Scottish Branch".

Please return completed forms to :
Dr Arthur Mitchell,
Human Genetics Unit,
Western General Hospital,
Crewe Road,
Edinburgh EH4 2XU

Tel. 0131 467 8419 Fax. 0131 343 2620
E-mail : arthur@bgu.mrc.ac.uk

SSERC, St Mary's Building, 23 Holyrood Road, Edinburgh, EH8 8AE; Tel. 0131 558 8180, Fax. 0131 558 8191.

Aldrich - see Sigma-Aldrich.

BOC Cryospeed, 150 Polmadie Road, Glasgow, G5 0HN; Tel. 0141 424 4477.

Nigel Botting, Chemistry Department, St. Andrews University, St.Andrews, Fife; Tel. 01334 463856.

Eagle Scientific Limited, Regent House, Lenton Street, Sandiacre, Nottingham, NG10 5DJ; Tel. 0115 949 1111, Fax. 01159 391144.

Griffin & George Limited, Bishop Meadow Road, Loughborough, Leicestershire, LE11 0RG; Tel. 01509 233344, Fax. 01509 231893.

Philip Harris Education :
2 North Avenue, Clydebank Business Park, Clydebank, Glasgow, G51 2DR; Tel. 0141 952 9538.
Lynn Lane, Shenstone, Lichfield, Staffordshire, WS14 0EE; Tel. 01543 480077, Fax. 01543 480068.

PASCO Scientific, Admail 394, Cambridge, CB1 1YY; Tel. 0345 626055, Fax. 0181 232 8669.

RMR Measurements, 2 MacTaggart Road, Seafar, Cumbernauld, G67 1JL; Tel. 01236 728170.

RS Components Limited, PO Box 99, Corby, Northants., NN17 9RS; Tel. 01536 201201; Fax. 01536 201501.

Scottish Biotechnology Education Project (SBEP), SCCC (see below) :
Marjorie Smith, Development Officer, c/o Dollar Academy, Dollar, Clackmannanshire, FK14 7DU; Tel. 01259 743753.

SCCC, Gardyne Road, Dundee, DD5 1NY; Tel. 01382 455053, Fax. 01382 455046.

Sigma-Aldrich Company Limited, Fancy Road, Poole, Dorset, BH12 4QH; Freefone (orders) 0800 373731 Freefax 0800 378785, Freefone Customer Services (first order etc) 0800 447788.

SJ Electronics Limited, 27 Priors Way, Coggeshall Industrial Estate, Coggeshall, Essex, CO6 1TW; Tel. 01376 562004, Fax. 01376 562215.

Unilab Limited, The Science Park, Hutton Street, Blackburn, Lancashire, BB1 3BT; Tel. 01254 681222, Fax. 01254 681777.

Unilever, Education Liaison, UK National Management, Unilever House, London, EC4P 4BQ.

Sarah O'Donoghue, The Wellcome Trust, 210 Euston Road, London, NW1 2BE; Tel. 0171 611 8230, Fax. 0171 611 8237.

Whatman International Limited, St Leonard's Road, 20/20 Maidstone, Kent, ME16 0LS; Tel. 01622 674821, Fax. 01622 682288.