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SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No. 156

March 1987

Surplus Offer
Electrolysis

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O P I N I O N - on learning outcomes

A learning outcome in one draft of one of the planned Standard Grade science courses is:

> pupils should be able to state that normal body temperature is 37°C.

Now just before I sat down at the keyboard I took the temperature of one part of my body, the left pinkie actually, and found that this part of me is at 20°C only, which shows, since I am today as normal as I ever am, that the assertion in this learning outcome is wrong. Perhaps it should be modified to read:

> pupils should be able to state that the temperature of parts of the human body is normally 37°C, but that the temperature of the pinkie is only 20°C?

Before we collapse in mirth over this and other possible variants of this learning outcome let me express my opinion which is that I do not like learning outcomes. They are a tosh and an abomination; they trivialise our prime function, which is to educate. Now I appreciate why learning outcomes have been introduced - not just to Standard Grade courses, but to Ordinary Grade courses over the last few years. The learning outcome is a logical necessity. If we have a public examination of candidates from all parts of the country it is only fair that what is being examined is precisely known by all schools. But it is my contention that this atomistic approach to syllabuses and knowledge results in a poor filleted thing - more a corpse than a core, or should it be corps, of knowledge. To hang with logicality and fairness! What I want are loosely specified syllabuses, like the 1960s versions of the O and H Grades, brimful and overflowing with ideas; vague, salacious, indulgent and wanton.

Am I whistling in the dark? I am not sanguine that this puny outcry will overturn events and lead to the destruction of learning outcomes. But if I do have any supporters this then is what I suggest: use the power of ridicule to force the Exam Board to change its policy. If learning outcomes are as fragile as I suspect it should be possible to make fun of them one by one and droun the haill clanjamfrie in a sea of mirth. And the temperature of the tip of my nose is 24°C. What's yours?

* * * * *

I N T R O D U C T I O N

Easter closure

Staff will be taking some leave over the Easter long weekend. We therefore give notice that the Centre will be closed on Friday 17th and Monday the 20th of April 1987.

Comment

Big bids from little acorns?

Some of the material in our "Equipment Offer" was recently bought at auction. It was under the hammer at the behest of those spectres of business - the liquidators. Interestingly we saw there others from education. However, having played before at auctions, we apparently were not so far out of our depth.

We shouldn't mock the afflicted but have to admit to amusement at their response when anything surfaced which was to do with the BBC microcomputer. Not only were folk bidding up some lots to near the price as new, some from the same establishment were bidding against each other. One chap bid himself up! Even the auctioneer, with smile wreathed face, took pity on this innocent. He pointed out the error, something I have rarely seen from a hard faced hammerer.

The first time I had to attend a sale on SSSERC's behalf, I was given some sound advice. Perhaps it deserves to be more widely known. It was: "Remember - one fool will always find another at an auction".

AIDS and school science

In Bulletin 149 and again in number 151 we mentioned the possibility of our giving advice and information, in the context of science education, on AIDS (Acquired Immune Deficiency Syndrome) and its causative agent. That agent is a virus which has become known as the HIV (human immuno-deficiency virus) previously known as HTLVIII/LAV. We also wrote that we were aware of the preparation of "considered, national, medical guidance on this complex subject" [1]. That guidance was published very recently (in early February, 1987) as a blue, A5 booklet of a dozen or so pages. By the time this bulletin is printed, copies of that Scottish Office publication should be available in every Scottish school and college. It is entitled:

"AIDS: Guidance for Educational Establishments in Scotland" [2].

We think it gives an excellent, balanced overview. It provides information on the risks and means of infection, as well as on the efficacy of hygiene measures. That is all based on advice provided by the Government's Expert Advisory Group on AIDS. We would recommend a close study of the whole of the booklet.

It raises the important matter of a cohesive, whole school policy. The best context for pupil questioning and discussion is undoubtedly within a positive, health education programme ([2] para.12, page 7). We would endorse the suggestion that where the issue is raised in other subject areas, including the sciences, staff should ensure, through consultation, that they approach the topic in a way consistent with its treatment in social and health education programmes elsewhere in the school.

Only one specific aspect of practical work in science is mentioned. This is the practice of taking small samples of human blood for microscopic examination or investigations of blood grouping. The guidance states that this practice should be discontinued ([2] Annex 2). Other parts of the document reinforce just how small is the risk of infection from this practice. Indeed, the earlier advice of at least one member of the Expert Advisory Group had been that the practice could continue, providing the procedures in ASE 'Topics in Safety' were used.

For reasons we fully understand there has been a shift of opinion. No doubt the over-riding consideration was that, no matter how remote the risk, should infection occur the only prognosis at present is eventual death. The view was taken that the risk was completely avoidable, the consequences of infection were unacceptable and that abandonment incurred little curricular penalty.

At first reluctantly, but now willingly, we agree with that advice. We endorse the recommendation that blood sampling in school science be discontinued. Equally we would agree with the warnings against the sharing of implements which could be significantly contaminated with blood. One obvious example is that of toothbrushes used in investigations on dental hygiene. However, even pre-AIDS, common sense practice would have been for pupils to use their own brushes (assuming they all have them). Another possibility is the use of disposable brushes of the type sold to travellers in stations and airports.

An important need now is constructive advice in a curricular and teaching context. We are at present looking at practical activities in the science curriculum. As we do so, we hope to formulate sound positive advice on safety for all activities and not only for the relatively small number where there may be risks of infection, from HIV or any other agent.

Still contentious is the status of other practical activities which involve the use of human body fluids. These include the taking of cheek cell scrapes and the use of saliva as a source of the enzyme amylase. Other issues include that of equipment which may become contaminated with body fluids. All current indications are that existing good practice should contain the risk. With that proviso we see no reason yet to discontinue these activities. However it is, more than ever, imperative that good practice is embraced. (The other article in these "Safety Notes" is instructive in this respect).

It is certain that for many activities we will be able to suggest positive measures to reduce still further any risk. The obvious need is for simple, practical precautions which do not make procedures so onerous that they are abandoned by teachers. Common sense measures include the use of disinfection where appropriate and of disposable items where it is not. Other precautions would include the examination or use by pupils only of material taken from their own body.

It is as well to note that a pre-requisite for sound health education is some knowledge of the biology of our own bodies. The ways of best imparting such knowledge involve practical work. It is also worth remembering that only a tiny proportion of the current school age population is likely to be sero-positive for AIDS (latest figures suggest about 180 young people below the age of 19 in the whole of Scotland).

Clearly, when detailed advice is given it must be based on sound evidence. It must also be consistent with reliable information which pupils will receive from other educational sources. We have decided therefore not to immediately publish detailed advice here in the 'Bulletin'. We will instead try to ensure that suitable information is provided along with support material for the sciences. To that end we will consult with SED, SCDS and the Scottish Health Education Group (SHEG) in order that we avoid, as far as possible, the issuing of conflicting advice from different agencies. Myth and rumour have caused enough confusion in the minds of the public. There is every need to avoid adding to that confusion.

* * *

"Science teacher fined"

Our readers' attention is drawn to a recent piece from the ASE Laboratory Safeguards Sub-committee [3]. This gives a fuller account than for which we have space on a recent prosecution, in the English courts, of a science teacher by the Health and Safety Executive. The teacher pleaded guilty and was fined £500.

This was the first time, to our knowledge, that an individual teacher has been subject to criminal prosecution under the provisions of the Health and Safety at Work Act. The relevant incident involved an explosion during a demonstration of the reduction of copper oxide by hydrogen. The gas was being prepared by the standard zinc and dilute sulphuric method with a little copper sulphate as catalyst. Concentrated sulphuric acid was in use as a drying agent. However no safety screens were in use nor was eye protection issued although both were available in the laboratory.

The hazards of this type of preparation and the means to avoid or contain them are well documented in readily accessible references, including ASE's "Safeguards in the School Laboratory", "Topics in Safety", in various back issues of the SSSERC "Bulletin", in CLEAPSE/SSSERC "Hazcards", and in the SSSERC manual on hazardous chemicals. There is an abundance of information on both hazards and good practice.

The teacher had seven years experience. He was not prosecuted for having an accident. He was prosecuted because even knowing that there was a risk, he failed to make proper use of available safety equipment. In so acting he also ignored guidelines laid down by his employer, a local education authority. The HSE does not seek to inhibit practical work in school science. It is obviously willing to act against bad practice which leads to dangerous incidents which could have been avoided.

There is a lesson for us all here. All the safety files and policy documents in the world are useless unless folk act on that advice. It is not enough to describe good practice. It may have to be monitored and, in the last resort, enforced.

References

1. "Safety Notes: AIDS and school science", SSSERC Bulletin 149, February 1986.

2. "AIDS: Guidance for Educational Establishments in Scotland", Scottish Office, HMSO, 1987.

3. "From the Laboratory Safeguards Sub-committee", "Education in Science", ASE, January 1987.

* * * * *

Sizing cells

- a follow up

In Bulletin 155 we described an idea for a pupil investigation and set a simple problem. This was to use basic techniques in microscopy to estimate the average length and width of onion epidermal cells. We hinted at some solutions and promised to give more detail in this issue. Are you sitting comfortably?

Our no-fuss method, suitable for junior forms, used a plastic ruler with fine millimetre markings as a poor man's stage micrometer. We employed an '0' grade specification microscope, its x10 objective, and a typical widefield (Ramsden type) x10 eyepiece.

When one millimetre scale division of the ruler was centred in the field of view the edges of its two adjacent markings were just visible at the periphery. The field diameter with this particular objective and eyepiece combination was thus approximately 2 mm.

Estimating cell length was then easy. A temporary wet mount of a piece of onion epidermis was prepared in the usual way and examined with the same objective/eyepiece combination. If desired the preparation could be stained with iodine in KI to give a little more contrast. We found that adjustments of the field stop on the understage disc diaphragm, with slight tilting of the mirror for oblique illumination, gave all the contrast enhancement we needed.

The aim is to keep the slide still so that the same batch of cells is held in the field of view and counts carried out along diameters. Typical counts along the relevant field diameter gave 4 or 5 cells to a longitudinal row. We already know the dimension of that diameter - 2 mm. An onion epidermal cell is therefore about two-fifths to one half of a millimetre long. For some pupils the width estimates may prove tricky. There are a lot of cell widths to count remembering all the while just to where you have got. They may find it more practicable to use a radius, counting only to the centre and doubling. Our counts gave about 24 cell widths to a diameter. A typical onion epidermal cell is therefore about one-twelfth of a millimetre wide.

At this stage such rough figures, even expressed in vulgar fractions, should not offend. Remember we only asked for estimates. Training in the art of estimation should be one spin-off from this simple exercise. (Another might be identification of pupils needing help in the use of a microscope). It should be noted that the field of view with a x10 objective and x10 eyepiece is only roughly 2 mm. The actual diameter will vary about that figure depending on the type of eyepiece, and to some extent on the size of any diaphragm stop within it.

Where does the rotatory leather punch come in [Fig.2, p.3, Bulletin 155] ? That was a typical bit of lateral thinking from one, Dennis Belford. It so happens that a common hole size on these punches is ca. 2 mm. Cut a piece of onion skin with such a punch and it almost exactly fits the field of view. The pupils can either be told the diameter of the punch or be asked to measure it using mm graph paper or some other ruse (another problem we will leave with you).

Cutting onion epidermis with a leather punch is a potentially masochistic pursuit. The trick is to have handy some thin card and a bowl of water. Peel the onion skin onto damp card. With the 2 mm punch, numbers of epidermal discs can be cut. Using the bowl of water they are then floated off onto microscope slides to be wet mounted with a coverslip in the usual way. Whether teacher or pupils struggle with the floating-off bit is optional.

Sticking with the optional: we suggested an extension exercise in the first article. Hesitating to insult any reader's intelligence, we give the answer. The total number of cells visible in the field of view probably lies somewhere between 96 and 125.

Which raises another question. Sorry, I can't resist it! On the onion you used, about how many cells in total are there in the whole epidermis ? How would you go about estimating that?

Electrolysis with lead electrodes

Abstract

Lead electrodes have an advantage over the commonly used graphite electrodes in that the expected oxygen is indeed formed at the anode. Methods of making these and fitting them into cells of several designs are described.

Introduction

Most of us are too poor to afford platinum electrodes on a class scale! One result of using the more reasonably priced graphite rods is the lack of oxygen evolved, and many pupils become a little confused. Then the large Hoffman voltameter, fitted with real platinum electrodes, is pulled out of the cupboard by Sir in order to dispel such doubts. This is usually filled with dilute sulphuric acid and, being large and cumbersome to empty and refill, is unlikely to be used for other electrolytes. A small cell will be more flexible in use and will require smaller electrodes and less platinum. Alternatively, lead electrodes will be much cheaper and will fill most of the bill.

Construction of cells

The idea of using DIY lead electrodes, made by casting, was given to us by Liberton High School, Edinburgh. Small holes drilled in the base of the electrodes will accept a self-tapping screw. The screw is also tapped through the base of the plastic beaker used as the cell. In order to prevent a leak there is a leather or paper fibre washer as depicted in Fig.1(a). The same screw can also carry a tag for the electrical connector. One slight variation tried out by ourselves is to use discarded empty plastic pill containers. It is worth having an arrangement with your local pharmacist to keep these for you. Dimensions are not critical, but we found the Securitainer 75 mm x 106 mm size very suitable. A small notch cut out of the rim of the lid allows the two leads to pass out the side leaving the cell with a flat base (Fig.1(b)). Thus it sits on the bench and does not have to be held in a clamp. It is better to attach this base with stout PVC tape rather than to permanently glue it, leaving access to the screw heads should the need arise. One extra refinement is to make two permanent marks on the outside of the cell showing the polarity of each electrode.

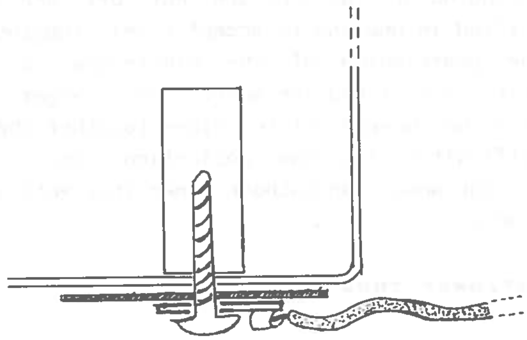

Fig.1(a) - Initial design of electrodr

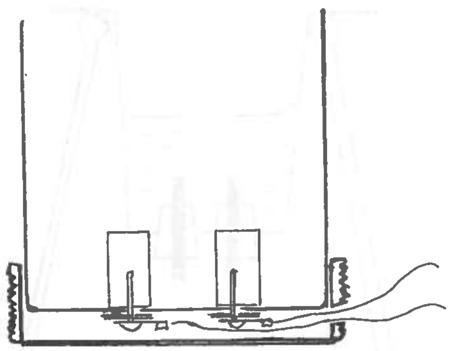

Fig.1(b) - Initial design of cell

Casting the electrodes

The lead was cast by gently heating some scrap lead in a crucible to just above its melting point and pouring it into lengths of ½ inch (oops 15 mm!) copper pipe previously coated lightly on the inside with candle grease. There is some hazard in this process and due care must be taken to avoid:

(i) lead fumes, by not overheating the melted lead and ensuring adequate ventilation, ideally using a fume cupboard;

(ii) burns from molten lead. Tongs must be strong, and the weight of lead should be kept to a minimum. Both hands should be kept clear of the mould while the lead is being poured; a tray will prevent any accidental spillage from running onto the feet. Leather heat resistant gloves should be worn.

Lengths of 2 or 3 cm are cut off and a hole drilled in one end to accept a self-tapping screw. The positioning of the electrodes is not too critical - if too far apart then a larger voltage will be needed; if too close together then it is difficult to fit gas collection tubes, and to prevent anode and cathode gases from entering both tubes.

Narrower rods of lead

A number of variations in the design of cells is possible using much narrower rods of lead.

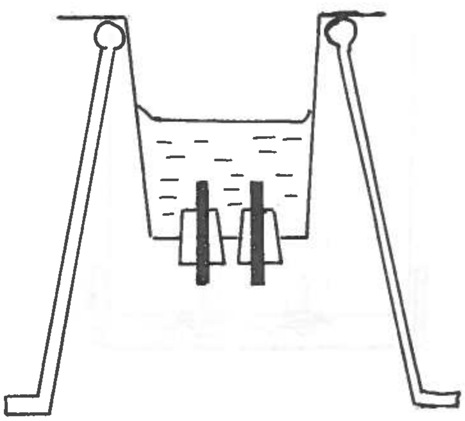

Fig.2 - The 'Traditional' on legs

(a) One of the old favourites (see Fig.2) must be to replace the graphite electrodes by two lead rods which are about 5 mm in diameter. The rubber bungs carrying them are fitted into the base of a 250 cm plastic 'Tripour' beaker. These are available from Philip Harris (Cat. no. C17564/2, price £2.55 for 10). Two clean holes can be made by a warmed cork-borer (No.8 for No.13 bungs or No.5 for No.10 bungs). A suggested spacing is with centres about 25 mm apart. The beauty of the Tripour beaker, apart from its price, is that the three lugs on the top rest very nicely on a tripod. The spacing of the electrodes will help to prevent accidental shorting by the touching of the two croc-clips. Alternatively, the wires can be soldered directly onto the lead electrodes. It is also possible to embed the end of the wire in the lead before it solidifies.

These electrodes were cast by pouring molten lead into a hole (5.5 mm drill bit) made through a piece of scrap wood at least 7 mm to 10 mm in thickness. With a softwood mould a slightly rougher, though satisfactory, finish was obtained than was found for hardwood. Two tips are:

(i) to countersink the top of the hole in the mould to act as a funnel for pouring; and

(ii) to pour just a little lead into the block and wait till it forms a plug before the main pouring. Once solidified the rod can be driven out with a punch. Safety precautions as described above should be observed.

(b) A variation on this is to mount the plastic beaker or pill-box on a base board with two holes drilled out to accommodate the two protruding outer or rather 'under' parts of the electrodes (Fig.3). Two channels cut to the side can carry the leads, or 4 mm sockets can be mounted at the edge of the base.

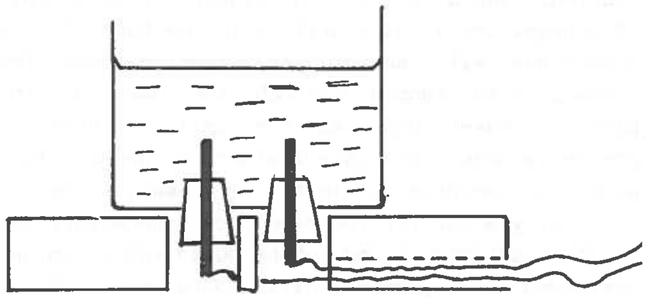

Fig.3 - The 'Traditional' brought down to earth

(c) A totally different concept is that of a **mounted pair of electrodes** which can be dunked into any standard sized laboratory beaker. With this design, gas collection tubes can be placed above the electrodes. The mount is essentially a slice of two holed bung carrying the electrodes in the holes. A third hole allows a handle to be fitted, by which it is easily lifted in and out of different solutions without even getting your hands wet. If a hollow plastic tube, or better still the barrel of a 'dead' Bic pen, is used the conductors can be tidied inside it [Figs.4(a) and (b)].

A 100 cm^3 squat form beaker might be a suitabl size of beaker. We found the narrow end of a twc holed No.45 bung fitted loosely into such a beaker. But a No.41 is a preferable fit. Going down to smaller sizes will result in the two holes for carrying the electrodes being brought closer together. A slice of about 1½ cm thickness is about right. You might get three slices from a No.41 bung. It is difficult to slice a large bung cleanly using a hacksaw and vice - not that a slight slope on the face affects its functioning. Various ploys such as holding it in a tube or lathe chuck do help.

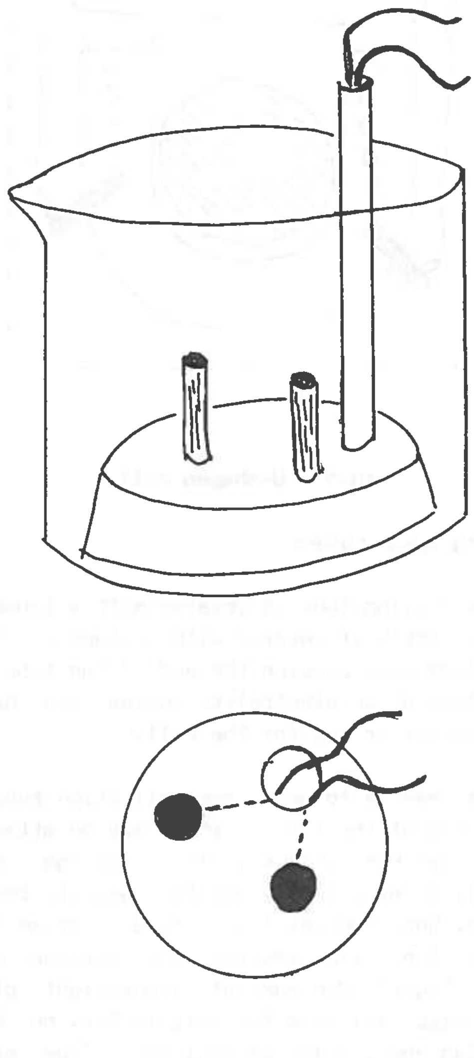

Fig.4(a) - Mounted pair of electrodes

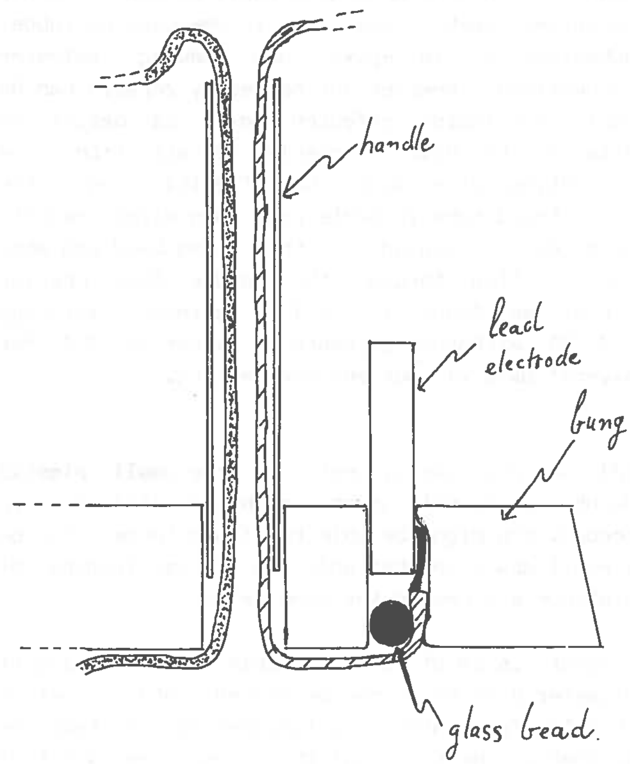

Fig.4(b) - Detail of electrode

The connecting wires are threaded upwards with sufficient of the conductor bared, and then the lead rod pushed down from the top. It is important to ensure that none of the bared part of the wire protrudes from either end of the hole. Then a 6 mm diameter glass bead of the type used for packing fractional distillation columns or a short length of solid glass rod is pushed home to seal the bottom of the hole (Griffin DPR-530-070T, £4.05 for 250 cm).

This simple arrangement relying on pressure contact for electrical continuity seems to work well. There is a chance of the bared part of the wire to the anode dissolving, should the glass bead fail to provide a good seal. We did consider embedding each connection in Dow-Corning rubber adhesives or in epoxy and making soldered connections. However any necessary repairs can be easily and rapidly effected and it is better on balance to have a simple construction. The connecting wire must be flexible and the multistrand type is preferred. Thin wires are both more easily sealed by the glass bead and more easily fitted through the handle than heavier types. We found 10 x 0.1 mm stranded wire (RS 357-334) withstood currents in excess of 2 A for several days without any overheating.

(d) Another useful cell is the **small plastic** U-tube, since only short lengths of metal wire are needed. You might be able to afford these cells on a pupil scale in that only two 1½ cm lengths of platinum are needed for each cell.

About 16 cm of clear flexible plastic tubing of diameter 8 mm or so can be shaped into a U-tube (Fig.5). The centre of a finished roll of tape can be used as the former of the U-shape, and a bit of the tape does the rest. To fit the electrodes a small hole is first pierced with nichrome wire and then replaced by the platinum. This technique results in reasonably leakfree joints.

The liberated gases can be collected in two 2 cm or 5 cm glass syringes. (Plastic disposable types have too much friction.) Some slight adjustment of the syringes may be needed to keep the electrolyte at the same level in the two tubes. One beauty of this method is that the awkward filling of gas collection tubes is avoided.

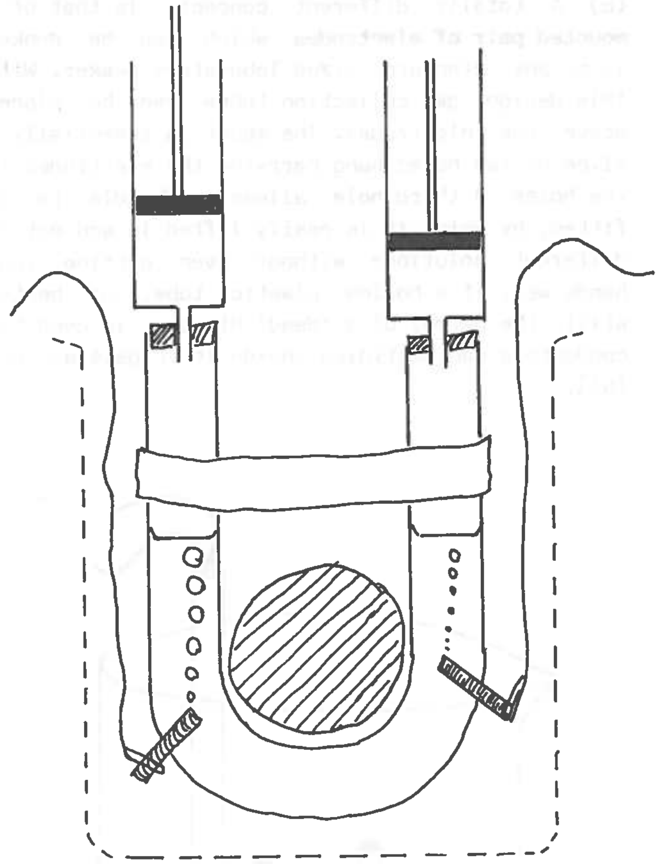

Fig.5 - U-shaped cell

Filling gas tubes

If the filling tube is covered with a thumb, or more correctly if covered with a stopper, then it is far from easy placing the end of the tube under the surface of an electrolyte unless you have a veritable vat or tub for the cell.

Another way is to use a gas collection tube with an opening at the top, to which may be attached a plastic syringe (Fig.6). The syringe should obviously be of slightly greater capacity than the gas tube. Once the level of liquid is drawn to the top and the clip secured the syringe can be removed (Fig.6). One make of lightweight plastic rachet clip suitable for this is Cat. no. CP103, priced 24p each, which is available from several suppliers including Mackay and Lynn, Beveridge, McQuilkin, and R & J Wood.

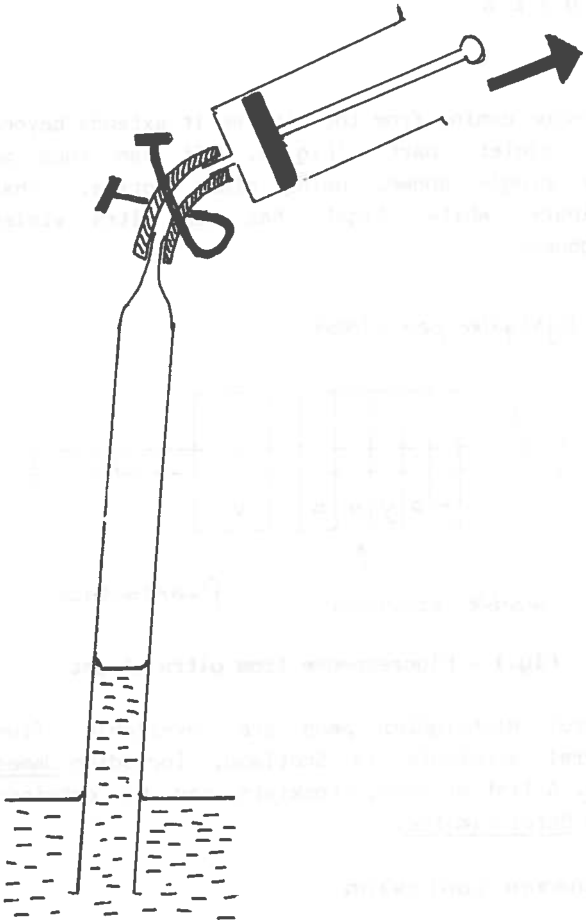

Fig.6 - Filling gas collection tubes

Four ways of providing gas collection tubes are:

(i) disposable plastic syringes;

(ii) cannibalised old burettes which have lost their taps;

(iii) disposable plastic 25 cm pipettes with the mouthpiece sawn off;

(iv) two lengths of tubing about 16 mm in diameter, fitted at the top with a one hole bung carrying a short length of 6 mm o.d. glass tubing for making connections. Rigid acrylic tubes, though more expensive, are also useful.

The disposable plastic pipettes mentioned above (iii), being easily sawn, drilled, or glued, are a useful source of DIY material for many jobs. The fact that they are graduated adds to their value in this application. Unfortunately they are only sold in fairly large minimum quantities, 200 for £70. Becton Dickinson pipettes are available from Beveridge; the J. Bibby Science products from Griffin, Harris, Mackay and Lynn, McQuilkin, and R. & J. Wood. At present these suppliers seem reluctant to break down the case size of 200, though we hope they may do so in the future. SSSERC can supply a pair of graduated 25 cm^3 (x 0.2 cm^3) pipettes at £1 per pair inclusive of post and packing. Other applications spring to mind: gas analysis experiments in biology, DIY cheap burettes - and they might even be used just as pipettes!

Other electrode materials

The lead electrode gives off hydrogen and oxygen in the expected ratio of 2:1 by volume. The only snag is the oxidation of lead to lead ions in solution by copper(II). A similar snag occurs with other metal salts which have a more positive potential than that of lead. With the exception of copper virtually all of the other electrolytes likely to be used will not cause such problems.

If it is to be platinum and you are looking for a source of supply, one firm whose platinum prices are lower than most is Hogg Laboratory Supplies. Their price for 300 mm of 28 swg (0.37 mm) wire is £22.20.

One means which is cheaper than platinum, apart from lead, is to put a thin coating of platinum on a cheaper metal substrate, e.g. nichrome. Readers are referred to Bulletin 93 for details. Whilst this approach works, the coating is not mechanically strong and is easily damaged by contact with gas collection tubes. At present our search for an acceptable ersatz platinum continues. We will be pleased to hear of any better substitute.

*   *   *   *   *

To show that ordinary white light has an ultra violet component

The transition between ultra violet and visible violet radiation occurs at a wavelength of 380 nm. Because many types of glass will transmit down to 320 nm it is possible to work with the ultra violet waveband which lies immediately below 380 nm using glass optics. Therefore if using an ordinary, broadband, white light source and conventional optics it is highly probable that the radiation coming from the source and transmitted through the optics will have a near ultra violet component. We have recently tested this hypothesis and have found a simple means of demonstrating that this is so.

The source we used was a quartz halide lamp mounted in a unit known as the compact light source (Philip Harris P36120/9). A spectrum was produced by conventional means using a slit, converging lens and prism. The slit should be just wide enough to produce a bright spectrum, but not so wide that too much overlapping of colours takes place. Another suitable arrangement would be with the collimator of a spectrometer. This can be adjusted to provide the slit and lens part of the set-up.

The near ultra violet is detected by fluorescence using a highlighter pen. There are many such pens, but of the twelve or so we have tested only two are suitable: they are the orange and yellow Berol Highlighter Pens, type E52. Tests with an ultra violet fluoroscope have confirmed that these two dyes do fluoresce strongly when excited by near ultra violet radiation. They also fluoresce if excited by short wave visible radiation. The Berol Detective Pen D58, which also fluoresces under ultra violet, does not emit strongly enough in contrast to the brilliant visible spectrum to be clearly discernible.

The demonstration should be conducted in a darkened room. If the spectrum is cast on a sheet of white paper across which a line has been drawn with a Berol pen there will be a prominent emission coming from the line as it extends beyond the violet part (Fig.1). It can thus be convincingly shown, using glass optics, that ordinary white light has an ultra violet component.

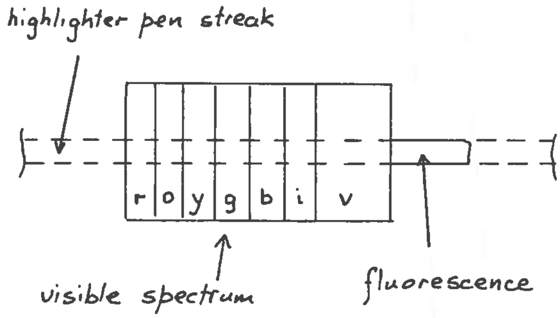

Fig.1 - Fluorescence from ultra violet

Berol Highlighter pens are available from several stockists in Scotland, including James Thin. A list of local stockists can be obtained from Berol Limited.

A common confusion

One final tip. The detection of ultraviolet by fluorescence can be stunningly shown by irradiating matt black paper which has been streaked with Berol markings. If the source is an ultraviolet lamp then the Berol ink will fluoresce brightly whereas the black surround will absorb whatever light strikes it - and remain black. This overcomes the common confusion which arises when soap powder is irradiated. Because the powder is white it reflects the visible violet part as well as emitting fluorescent light. Ultra violet is then believed to appear as visible violet.

However black paper cannot be used in the demonstration that white light has an ultra violet component. The visible spectrum would just not be seen.

Acknowledgement

The author wishes to thank Ken Campbell of the Biology Department in Napier College for providing the facilities for carrying out the fluoroscopy, and for assisting with the analysis of pen dyes.

Resolution, and the human senses

Resolution is the process of being able to discriminate between two parts, or between two different objects. The concept is often extended to mean the smallest difference that can be distinguished - this is still sometimes called resolution, but is more correctly, I think, called resolving power. In physics the concept is normally associated with optical instruments, but here is a way of relating the concept to the human senses. The premise is that mans' senses of seeing, hearing and feeling are logarithmic in nature, and that in general man can just distinguish between fractional differences of around 10%. This article is an adaptation of an idea seen in 'The Physics Teacher' [1].

A pupil is presented with a number of small canisters of similar size but different weights and asked to arrange them in order of weight. The canisters should all look the same; plastic cans which hold 35 mm film are just right (Fig.1). Each should be loaded with lead shot to a precisely set weight, sealed, and given a codemark. The teacher should reference this code against a record of the weights. A length of thread should be fixed through the lid so that comparisons can be made either by gripping or holding the cans, or by suspending the cans by thread. Pupils should be allowed to experience the static force of holding a can at rest, and the dynamic forces of accelerating and decelerating.

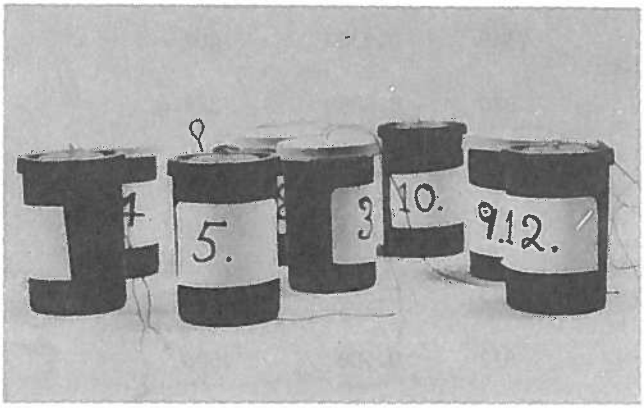

Fig.1 - Weighted cans

The initial exercise might use just four cans, each 10 g apart, the series being 70 g, 80 g, 90 g and 100 g. There should be little trouble in discriminating between these. This should then be replaced by a series which are 5 g apart: 70 g, 75 g, 80 g, 85 g, 90 g, 95 g and 100 g - which is quite hard to sort. Then there should be a series which is impossible to sort: 70 g, 75 g, 79 g, 80 g, 85 g, 89 g, 90 g, 95 g, 99 g and 100 g.

One variation might be to compare sets of pairs, one pair at a time. Such a set might comprise five pairs such as 90 and 100 g, 91 and 99 g, 92 and 98 g, 93 and 97 g, and 94 and 96 g.

A further variation might be to arrange in order a long series of weights which starts at 100 g. The values are then sequentially decimated: 90 g, 81 g, 73 g, 66 g, 59 g, 53 g, 48 g, etc. If the logarithmic nature of human sensing holds, and if the resolving power of 10% holds, then the entire series will be correctly sorted every time.

Reference

[1] "DOING Physics", 'The Physics Teacher', No.6 Vol.24, September 1986, pp.358-359.

* * *

Graphical symbols

The British Standards Institution (BSI) have recently revised their special publication on graphical symbols. The title is "Electrical and electronic graphical symbols for schools and colleges", catalogue number PP 7303: 1986; it costs £7.50 and is obtainable from BSI direct. The publication comprises a 20 page A4 sized booklet on the graphical symbols which are at present most likely to be used in schools, together with an A1 sized wall chart depicting many of the commoner symbols.

* * *

Thermistor circuits

In Bulletin 150 we published an article on bridge circuits, which explained how to linearise the response of an out of balance bridge. The example of a sensor used in that article was a thermistor; it was shown how to design a bridge which gave a linear output across the range 20°C to 40°C. We are having another look at this thermistor bridge because we think it is an extremely useful little circuit.

In the original article it was shown that, by specifying the temperature range and output sensitivity, values of the resistors in the bridge and the voltage of the supply were all obtained by solving a set of simultaneous equations. As this mathematical process is offputting we have written software which performs the calculation. This is available for two models of computer, the Spectrum and the BBC Model B. If you wish a copy of the program please send either a cassette (Spectrum) or a formatted 40-track disk (BBC); but do pack your disk properly - some which we receive are floppy beyond use!

In Table 1 there are values for eight different sets of range and sensitivity. The thermistor is the type specified in Bulletin 150, which is RS stock number 151-215. The symbols R4, R3/R2 and V_s are all as defined before, but for convenience the circuit is redrawn below (Fig.1).

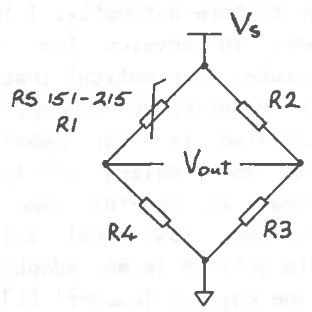

Fig.1 - Thermistor bridge circuit

The output voltage should be monitored on a high impedance meter, such as a digital voltmeter. A circuit for interfacing the bridge to the Analogue Port of the BBC Microcomputer was given in the original article.

temperature range (°C)	V_{out} (mV)	R4 (Ω)	R3/R2	V_s (mV)
-20 to +20	0 to 200	7811	0.267	431
-20 to +20	-250 to +250	7811	0.797	1077
0 to 50	0 to 200	2348	0.2397	407
0 to 100	0 to 200	870	0.0888	274.4
20 to 40	0 to 200	1846	0.493	971
20 to 40	-100 to +100	1846	0.764	971
20 to 60	0 to 200	1223	0.326	533
40 to 60	0 to 200	812	0.508	1086

Table 1 - Circuit specifications for different temperature ranges and sensitivities

*   *   *   *   *

SURPLUS EQUIPMENT OFFERS

Through the generosity of Philip Harris we are able to offer a range of unused equipment and materials. These are all 'ends of lines' which Harris cleared out of their warehouse towards the end of last year. They are all items which have been removed from the catalogue either because Harris no longer stock them or because they have been replaced by updated versions.

Because the items have been donated the prices shown are largely nominal and reflect only our handling and sorting costs. "N.C." denotes "no charge".

Please note: Once they had written off these goods and passed them to SSSERC, Philip Harris ceased to be responsible for any faults or any required repairs. Should you be lucky in the ballot we will ask you to identify the equipment in your stock or inventory list as SSSERC supplied. Please direct any subsequent complaints or queries to us and not to Philip Harris Ltd.

In general this offer is subject to the conditions laid down in Bulletin 116. All items are **subject to our ballot procedures.** Entries should preferably be submitted on a postcard and with an indicated order of priority.

In addition to a short description, wherever possible we give a reference for catalogue number and date. This may be helpful to hoarders like us who hang on to old catalogues.

"Chemistry and General" items

Item 524	Filter flask, 1 litre, 'Pyrex' (C37320/8, 1980-82 catalogue).	50p
Item 525	Electrolysis investigation unit (C33870/1, 1980-82 cat.), as for Nuffield 'O' Chemistry (revised).	£3
Item 526	Gas generator, Kipp's type by Exelo, (C41740/6, 1980-82).	£5
Item 527	Bunsen burner, natural gas, with pilot, (C23142/6, 1980-82).	£2
Item 528	Ribbon burner head attachment, for combustion tube work, (C23400/2, 1980-82 catalogue).	£2
Item 529	Gas ring, cast iron, domestic pattern, (C23460/9, 1980-82).	£2
Item 530	High temperature gas burner, heavy brass construction (no Cat.No. available).	£1
Item 531	Crystal lattice grid, to show cubic structure of MgO, needs polystyrene spheres (C50520/4, 1983-85 catalogue).	£1
Item 532	Hydrometer, for crude oil testing calibrated in API units, length overall 300 mm, no other details.	50p
Item 533	Glass syphon, with suction tube and safety bulb, 450 mm long, (C74800/9, 1980-82).	50p
Item 534	Stirring rods, soda glass, per 10 ca.5 mm diameter, 300 mm long fused ends.	20p
Item 535	Hand-driven centrifuge, (C24640/5)	£3
Item 536	Sample tubes, clear glass, per 100 straight sides, flat bottom with corks, 10 mm diameter.	50p

"Biological Apparatus"

Item 537	Disposable micropipettes, per 100	N.C.
Item 538	Slide staining kit, polyacetal slide carrier, (B37420/5, 1980-82 catalogue).	£1
Item 539	Reaction time switches, set of 3 for use with a 'Digitimer' (B73300/9, 1980-82 catalogue).	£2
Item 540	Pond net, square frame and handle aluminium, 1.5 m long, without net.	£2

Item 541 Transpiration apparatus, one only (B63680/7, 1983-85 catalogue). £2

Item 542 Animal weighing box attachment for Ohaus balance (C13885/2, 1983-85 catalogue) £3

Item 543 Incubator thermometer, 32°C to 44°C by 1°C, (B52090/8, 1980-82) 50p

Item 544 Aquarium under-gravel filters 292 x 165 mm, (B54460/3, 1983-85 catalogue). 20p

Item 545 'Whalehide' plant pots, per 10 bitumenised paper, top dia. 225 mm (B6680/3, 1983-85 catalogue). 30p

Physics related apparatus

Item 546 Green filter, mounted, believed to be 'Cinemoid', no other details. 10p

Item 547 Resistance coil, "unknown value" alphabetic codes, A,C and J, 1% tolerance, (P59220/7, 260/8 & 320/0 1980-82 catalogue). £1

Item 548 As above but not "unknowns", 4 values available: 0.2 Ω, 50 Ω, 100 Ω, 200 Ω please state value(s) required (P59380/7 etc., 1980-82) £1

Item 549 Desoldering wick, 1.5 m reel (Similar to C83570/8, 1980-82). 10p

Item 550 Receiver for modulated light (P43882/6, 1983-85 catalogue). £3

Item 551 Fresnel's double mirror for determining wavelength of light by interference (P37101/9, 1983 -85 catalogue). £5

Item 552 Capacitance unit, 11 capacitor values, mounted with independent 4 mm connectors (P60280/8, 1980-82) £1

Item 553 Electronic temperature probes voltage output type for use with multimeters (P81400/9, 1983-85). £6

Item 554 As above but current output type (P81405/8, 1983-85). £6

Item 555 Decade capacitance box, ten values selected by rotary switch, (P60304/7, 1983-85 catalogue). £3

Item 556 Experimental resistance set, 3 values on a single plastic base, with double 4 mm connections (P59020, 1983-85 catalogue). £2

Item 557 Adaptor for 'Edspot' galvanometer, by WPA, turns galvo' into a three range demonstration meter, (P57900/8, 1983-85 catalogue). £2

Item 558 Flywheel unit accessories, per set includes Savart's wheels (pitch v. frequency); siren disc and a set of stroboscope cards (P29770/2, 1983-85) £5

Item 559 'Worcester' current balance kit quarter kit, components for use of 8 students (P54330/0, 1980-82 cat.). £2

Item 560 Model astronomical telescope one only, (P36530/6, 1980-82) £3

Item 561 Model periscope, plastic tube type, 3 available, (P36590/2, 1980-82). £2

Item 562 Dry cell holder, 'SP2'/'HP2' 4 cell type, 2 only available, (P69460/0, 1980-82 catalogue). £1

Computer related items

Item 563 BBC Analogue to digital converter module, original 'Mk.I' fast A-D, with 0-5 V mono- or bipolar range only. Complete with cassette software (P89250/1 1983-85 catalogue). £5

Item 564 PET interface unit, originally intended for connection to PET user port via an edge connector and multi-way cable. Built-in diode and resistor network for reverse polarity and over-voltage protection. Looks adaptable for use with other computers with a £4

6522 VIA chip. Recommended only to those with some experience. Worth £4 for the box! (P87220/4, 1983-85 catalogue). We will throw in cassette software (PET) for control, an instruction booklet and if need be, technical advice.

Item 565 Dual input A-D converter for PET. £4
Goes with last item as part of a control and data gathering package. (P87230/7, 1983-85 catalogue). Can be used as a general purpose (PET) A-D or the box adapted for use with other microcomputers. Again some experience will be necessary.

Item 566 'Bedfordshire' interface module by £4
Educational Electronics. For use in computer control of motors, valves solenoids etc. Needs nominal 12 V, d.c., smoothed. Connects to BBC 'B' user port as input port and to the printer port as an output port. Has some protection circuitry and Darlington driver i.c.s to switch relay outputs. With instruction book but without software or leads.

Item 567 Analogue Interface Tutor (AIT) by £4
Educational Electronics. For use with any computer with a user port. Uses a systems approach with building blocks consisting of D-A converter, comparator, voltage to frequency convertor and an audio-amplifier. LEDs indicate states input lines and the bit pattern on the D-A input. With a set of notes and instructions.

Item 568 Ribbon cable with 'D'-plug and 50p
connector for Beeb or Apple to some Educational Electronics items.

Item 569 "Creative Graphics" software for £2
BBC 'B'. Cassette and book with 36 programs and listings for a "spectacular" range of pictures and patterns including animations recursively defined curves and rotating 3-D shapes. (4 sets only but 3 spare books with listings).

Item 570 "Graphs and charts". Cassette £2
with a range of graphics routines for inclusion in other programs. Includes automatic scaling, labelling of axes and use of colours. Only 6 in stock and regrettably no books.

Item 571 FORTH language for the Beeb £2
on cassette. 4 packages with book 3 with software only, distributed in ballot order.

Item 572 "Timer" or "Meter" software by N.C.
Cambridge Educational Computing. Needs C.E.C. "Timer" or "Meter" boxes. These we are not supplying.

END OF HARRIS ITEMS

The following items are all new SSSERC lines mostly bought at recent auctions or withdrawn from sales through our private treaty arrangements. Note that they also **are subject to the ballot procedure.**

Equipment

Item 573 Polaroid Super Swinger colour £4
camera. Uses type 88 colour or type 87 black & white film. Complete with instructions.

Item 574 Polaroid Colorpack 80 with case £4
and instruction book. Film types 88 colour and 87 black & white.

Item 575 BX3 35 mm camera by Bentley £4
simple model of the type suitable for pupil use.

Item 576 Monochrome TV, 12" screen, by £5
'Videologic',ex-SSSERC stock. Only two available, to be collected.

Firmware and software/

Firmware and software

Most of the following items were bought at auction. All are sold without any facility for exchange if faulty. However in cases of any real faults, rather than operator errors, a 'money-back' system will operate.

Item 577	"Intersheet" ROM chips for BBC B, B plus and Master (normally ca. £50).As new in original packaging. Only 4 sets of 2 in stock.	£20
Item 578	"Interchart" ROM compatible as above (normally ca. £30). 2 only.	£15
Item 579	"Printmaster" ROM, 'Star' dot-matrix printer compatible (ca. £28 normally). 2 only.	£10

Note: Items 580 to 584 inclusive are 'one-offs'. First out the hat gets them!

Item 580	"Printmaster" ROM 'Epson' dot-matrix printer compatible.	£10
Item 581	"Caretaker" BASIC utility ROM (normally £28).	£10
Item 582	"Communicator" ROM, a VT100/VT52 terminal emulation ROM for Beeb. (normally £55).	£25
Item 583	"Termi II" communications ROM for the Beeb (normally ca. £30).	£15
Item 584	Speech ROM for BBC microcomputer (normally ca. £28).	£10
Item 585	"Wordwise" ROM, with manual and typing tutor cassette, ex-SSSERC.	£10

Books and manuals

Item 586	BBC "Advanced User Guide" (normally ca. £16). 2 only, 1 shop soiled - haggle!	£5
Item 587	"Amstrad Companion" for PCW8256 and 8512 (normally ca. £8).	£3
Item 588	"User Manual" for Juki 5500 printers (colour dot-matrix).	Any offers?

No comment

"To feed applied science by starving basic science is to misunderstand both. The case seems so obvious that I would hesitate to put it here, were it not for the fact that I have heard senior government servants say recently that there is too much science."

Sir George Porter, in his presidential anniversary address to the Royal Society, December 1986.

S.S.S.E.R.C.

BULLETIN 156

CONTENTS

March 1987