SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

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RECO (Laboratory Products) Ltd., 5 Armitage Gardens, Luton, Bedfordshire LU4 8RD.

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R.S. Components Ltd., P.O. Box 427, 13-17 Epworth Street, London EC2P 2HA.

Technomatic Ltd., 17 Burnley Road, London, NW10 1ED.

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Introduction

Bulletin Distribution

This bulletin is being distributed using the 'finished' version of our new distribution scheme. We have completely changed, and we hope rationalised, our addressing system. This is to take account of the bulk distribution arrangements we have with most Scottish Regional Authorities which started with the distribution of Bulletin 128. This also gave us the opportunity to rationalise our mailings to 'non-regional' readers and to schools in Highland Region and Orkney. With the latter we now address bulletins not to named posts but to the 'Science Department'. This will help us to use the same system when mailing out items other than bulletins, for example equipment lists. The other change is that we no longer send direct mail copies in twos to Scottish Education Authority schools. The number of copies sent is now a sort of 'Ford's choice'. You can have any number of copies you wish, as long as its one or three! If anyone is aggrieved we will be happy to consider their complaints. We have tried very hard to remove anomalies from the system and to make it cost-effective. We now have our fingers crossed in the hope that complaints will trickle and not flood in.

Bulletin Format

This bulletin also sees the final touches put to the changes in format suggested by our Planning Committee after considering the replies to the questionnaire in Bulletin 122. Officianados of reprography will notice that the bulletin is now typeset instead of being offset printed from camera ready copy. In these hard times we feel we should explain this apparently extravagant change. In fact the bulletin costs about the same to print in this better quality format as it did when produced by normal offset-litho techniques. This is merely tangible evidence of the effects of the micro-electronic revolution. Find a printer with the latest technology and you can obtain a better result for the same or less money. Typesetting has further advantages. It frees the staff at the Centre from the time consuming business of producing camera ready copy. In addition we are now able to include photographs at little extra cost.

'Hazcards'

Over the past months SSSERC has been co-operating with our sister organisation *CLEAPSE* (Consortium of Local Education Authorities for the Provision of Science Equipment) in the preparation of a new set of 'Hazcards'. This new publication is a logical development from the CLEAPSE chemical 'Hazcards' issued to their member authorities in 1979. The 1981 'Hazcards' have been extended to cover biology topics and to include additional chemicals mainly used in biology. The opportunity was also taken by CLEAPSE to revise several of the original chemical cards.

The cards are a different type of publication from the SSSERC 'Hazardous Chemicals — A Manual for Schools and Colleges'. They give information and advice for teachers and technicians about hazards in school biology and chemistry. They may be used in several ways. For example, an experienced teacher or technician can alert other members of staff to particular hazards by removing the appropriate card from the set and leaving it with apparatus; the set may be consulted like any other reference; or a Principal Teacher could cross reference items on a suitably annotated syllabus to particular cards. One great advantage of the cards is that they gather together information previously only to be found scattered amongst a large number of publications.

Co-operation with CLEAPSE, who have used a very competitive modern printing/collating service, has meant that the price of a set of 139 cards plus 7 index cards has been kept low. A set of '1981 Hazcards' consists of three sections plus an index:

Section 1 81 white cards — particular chemicals used in school biology or chemistry.
Index 7 blue cards — covers all 3 sections.
Section 2 22 white cards — processes experiments, groups of chemicals.
Section 3 36 yellow cards — biology topics.

The front of each card carries hazard information, the back advice on safe experimental methods. At the top right hand corner of each card in Section 1 is a list of all the index entries that refer to the card. This is so that a person reading one card can quickly verify that the information on the card is relevant to the chemical he or she is checking on. Cards are extensively cross referenced. They are A5 size and thus will fit in a standard A5 file card box.

We are attempting to distribute these cards to Scottish Education Authority Schools (and to Colleges and private schools in Scotland who are

SSERC subscribers) in the most economic manner possible. The aim is to cover our costs rather than make any huge profit. Heavy postage charges mean that individual sets sent out by post will have to be charged at £3 per set including p. and p. A number of Education Authorities are buying sets in bulk for distribution to their schools. Prices for these sets and for sets collected from SSSERC or SSSERC exhibitions, will be heavily discounted.

Ordering

1. **Please wait until it is clear what your Regional Education Department is issuing before ordering a set.** We would find it extremely difficult to handle cancellations.
2. We shall not handle any orders for individual sets before 20th November, so expect delays.
3. Orders will be restricted to one set per school initially.
4. If you are a teacher ordering privately and so not using an official order form, please order on a separate sheet from any request for surplus equipment etc. Enclose a crossed cheque or postal order payable to SSSERC.
5. This offer is only open to those in Scottish establishments, which are run by the Regional Councils or who otherwise subscribe to SSSERC.

Atomic Absorption Spectroscopy (AAS)

The 'Chemistry Notes' section of this bulletin contains articles on methods of producing flame coloration and on a model atomic absorption spectrometer for sodium. The 'Workshop' section contains constructional details for the AAS model. This is not entirely fortuitous. Recent proposals for changes in the CSYS chemistry syllabus included work on AAS. It struck us that this could easily become yet another topic on modern analytical technique dealt with, at best, by a visit to see equipment in a university or, at worst, by 'chalk and talk' theory teaching. Our hope is that the technique described in this bulletin could mean that there will be some school-based practical element.

Saturday mornings

Readers are reminded that, because of staff shortages, we are restricting Saturday morning opening to the **FIRST TWO** Saturdays of the month.

— and finally!

'Bumper Issue'

Readers will notice that even with the reduction due to typesetting this issue contains a lot more material than a normal bulletin. This is unavoidable. The last issue which reached schools in September was a Physics and Safety Abstracts publication. The issue following this present one will be Chemistry and Safety Abstracts. Thus this is the only 'proper' bulletin which will reach the schools this term. Many items which are news now, will be stale if kept until next term.

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Microelectronics Notes

Regular readers will know that in recent years SSSERC has published a great deal on the use of micro-electronic circuitry in science teaching, particularly for physics instrumentation. Nearly all of this work has concentrated on the use of low density i.c.'s usually in the shape of t.t.l. circuitry of the 'System 74' type. Joe Stewart, the late Director of SSSERC, was convinced that teaching on the theory and use of logic circuitry had a legitimate place somewhere in school science and technical courses. At times he must have felt like the proverbial prophet crying in the wilderness.

Now things have moved on apace and what was once thought a little zany has suddenly become very respectable. With the development of new agencies and initiatives SSSERC staff and the Centre's Planning Committee have had to carefully examine what role, if any, we can now play on the microelectronics stage in Scotland.

One area which seems relatively neglected, and suited to the SSSERC background of expertise, is interfacing scientific equipment to microcomputers. Such interfacing will allow the micro to control external equipment, to gather data from it and to process and present the gathered information. Here the microcomputer becomes an aid to practical work instead of a mere substitute for it. Our Planning Committee has suggested that this area of work should become one of our major priorities for the next year or so at least.

In the long term we see SSSERC evaluating available interfacing and data logging equipment and publishing practical details of d-i-y circuits. These circuits may be developed in SSSERC but in many cases this would be tantamount to re-inventing the wheel. A more effective arrangement would be for us to evaluate, 'referee' and publish details of circuitry developed in schools or elsewhere. Where interfacing 'packages', involving hardware and experimental techniques plus software, have been developed SSSERC could evaluate and publish practical details of the hardware and techniques. Evaluation of the software its categorisation and documentation could be carried out by SMDP (Scottish Microelectronics Development Project) who could also take responsibility for the dissemination of software associated with science interfacing. Thus each organisation will complement the role of the other with SSSERC operating in a specific area with a finer focus than SMDP.

The SMDP 'Phase 1' and 'Phase 2' centres involved with interfacing science apparatus are relatively easily identified. What is not so easily determined is the number of science teachers developing interfacing techniques, or interested in so doing, in schools outwith the SMDP scheme. It would be helpful to everyone involved if they were all known to each other so that experience and information can be pooled. With this aim in mind we would like to compile a 'Science Interfacing Register' with the names and school or college addresses of all those with an interest in interfacing science hardware to 'micros'.

We invite anyone who wishes to be included on such a register to send the following details to SSSERC:

a) Name
b) Post in school/college or subject/department
c) School/College address and telephone number
d) Model(s) of microcomputer involved with interfacing
e) Type of apparatus interfaced
f) Interfacing already being actively pursued or initial interest only
g) Any other relevant details.

For our part we undertake to compile the register and send a copy to everyone named on it. Then at least we will all know each other, which is a start!

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CLEAPSE Reports

We have recently received the following reports from our sister organisation. Copies of these reports may be borrowed for up to one month by writing to the Acting Director of SSSERC.

L44 "Domestic dishwashers for laboratory use: some notes". An edited version of reports from schools on the use of four models.

L122 "Simple electrical circuits with lamps and batteries".

L150 "Equipment List 1 : Measuring equipment".

L156 "Equipment List 2 : for work with light".

L169 "Environmental Equipment" (like the two previous 'reports', L150 and L156, L169 was prepared mainly with primary and middle school science in mind).

L168 "Temperature Stabilised Equipment".

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Safety Notes

Accident Reports

We have received reports of two recent laboratory accidents. The first of these involved the use of the 'Arculus' method for generating oxygen and heating zinc metal in a stream of the gas. An explosion occurred blowing a hole in the base of a 'Pyrex' test-tube. The zinc had melted and run down past the ceramic wool plug, making direct contact with the hot, solid potassium manganate (VI) crystals. This produced a classically incompatible mixture of a powerful oxidising agent and reducing agent being heated together. The problem will only arise with the use of metals of low melting point, e.g. lead, zinc and tin. It is recommended that the test-tube is kept horizontal in order to prevent run-back of any molten metal and any repetition of this accident.

The second incident involved a plastic 'dropping bottle' of the type designed to deliver a few drops of reagent upon inversion and gentle squeezing. Such bottles are very useful but, in inexperienced hands, can be hazardous. The accident reported to us occurred when a pupil applied great pressure to one of these dispensers the small orifice of which had become blocked. The stopper suddenly came off and reagent sprayed over the pupil. Certain reagents do tend to dry out or form other deposits that block the small holes in these droppers. Occasionally the hole may not have been cleanly cut and a core of plastic remains acting as a plug. It is important to check these bottles for blockages and to explain to pupils that only gentle pressure should be used.

Thoron 'Cows'

Some concern has been expressed of late over the use of so-called 'thoron cows' in schools. These are used as a convenient source of the radioactive gas, radon 220 (formerly called thoron). These radon generators commonly take the form of a polythene squeeze bottle fitted with a tube closed by a clip and a fabric filter to prevent the egress of particles of solid thorium carbonate. The bottle usually contains about 20g of this compound in powder form.

Some of these bottles have been in use for 15 years or more. Recently reports have been made that, not surprisingly, some of these ancient bottles have been splitting in use, resulting in spillage of the powder. Thorium compounds are of low radio-toxicity and in equilibrium with solid decay products are only very weakly radioactive. However, Thorium salts are very toxic in the ordinary sense. They should not be ingested nor inhaled nor should long-term contamination of bench or other surfaces from a spillage be tolerated.

Should a spillage occur, the area should be vacated until the dust has settled. The area should then be GENTLY ventilated to remove any radon gas. A member of the science department staff, wearing a lab. coat, eye-protection, disposable gloves and a disposable dust filter mask, can then using two sheets of paper carefully collect up the bulk of the powder and transfer it to a screw top, wide mouth bottle for future reuse. The remaining powder can be wiped up with tissue or filter paper moistened with a detergent solution. The area should be checked for activity and, if necessary, repeatedly swabbed and checked until a count close to background is obtained. The contaminated sheets of paper, disposable gloves and mask and, if applicable, the old 'thoron cow' bottle should be sealed in a stout plastic bag.
This may then be safely placed in with the normal laboratory waste.

Any school possessing 'cows' over ten years old should transfer the powder to a new squeeze bottle. As with any chemical, reasonable precautions should be taken in handling the powder to prevent the raising of dust and subsequent ingestion or inhalation.

References
1. 'Education in Science', No. 92, April 1981.
2. *AID Scientific Ltd.* — leaflet on the SK308 and SK107 B radio-activity kits, dated March 1981.
3. Radioactive Substances (Uranium and Thorium) Exemption Order, 1962, Statutory Instrument 2710, HMSO.

Oscilloscope earth fault

We have received a note from the Principal Teacher of Physics, Perth Academy about a potentially hazardous fault in the casings of some Telequipment Serviscope Minor CRO's. During routine safety checks the technician noticed that on some instruments one part of the metal case was earthed while the other was not. This occurs because the case has two metal parts which do not touch and the earth continuity is thus broken. It would be advisable for schools possessing Serviscope Minors to check for this fault and, if necessary, to connect the two parts of the cases with a suitable earthing wire.

'EiS' Accident Reports

The attention of readers is drawn to a report of an accident involving the thermit reaction, in 'Education in Science', No. 92, April, 1981. 'Education in Science', No. 93, June 1981 carried reports of a further three accidents. The first of these involved the oxidation of ethanal (acetaldehyde) by a potassium manganate (VII)/sulphuric acid mixture The method, from 'Advanced Practical Chemistry' by Clark and Clynes, suggests that $3cm^3$ of the potassium manganate (VII) solution should be added to $0.5cm^3$ of the aldehyde or ketone. This is then followed by a few drops of concentrated sulphuric acid, and the mixture gently warmed. In the reported incidents a very vigorous reaction occurred shooting liquid out of test-tubes. The most likely explanation is over-addition of the acid, a few drops becoming a few cm^3. It is pointed out that the experiment works satisfactorily and with less attendant hazard, if dilute sulphuric acid is employed. Teachers are advised to amend any copies of the book they may have. Future editions of the book will be so modified.

The second accident involved a hydrogen/oxygen explosion during pupil experiments where various elements were burned in boiling tubes of oxygen. The oxygen had been collected over water and small amounts of the liquid remained in the tubes. A pupil tried to ignite a small sample of calcium on a combustion spoon and to plunge it into the oxygen. The calcium fell off into the water, generating hydrogen. When the pupil put a fresh piece of hot calcium into the tube there was an oxygen/hydrogen explosion. There is an obvious risk here in inexperienced hands and this burning of calcium in oxygen is probably more appropriate as a teacher demonstration.

Lastly there is a report of an accident involving a demonstration of a model Contact process, the catalytic oxidation of sulphur dioxide. Here crystals of the product blocked a tube causing a build-up of pressure. Concentrated sulphuric acid, being used as a drying agent, was sprayed out of the apparatus when the oxygen delivery tube was disconnected. Several recommendations are made which will help teachers avoid similar incidents. The use of narrow tubes which can be blocked by a solid product should be avoided and the condition of the apparatus be checked at regular intervals. The main damage was caused by the acid being sprayed about. Where gases are delivered from a cylinder, there is no need to use a drying agent at all. An inert liquid can be used to monitor flow rates (e.g. the less hazardous phosphoric (V) acid could have been used). Where the use of concentrated sulphuric acid is essential as a drying agent, the volume should be kept as small as possible. It is suggested that a drying tower with glass beads and concentrated acid may be safer than a conventional wash bottle.

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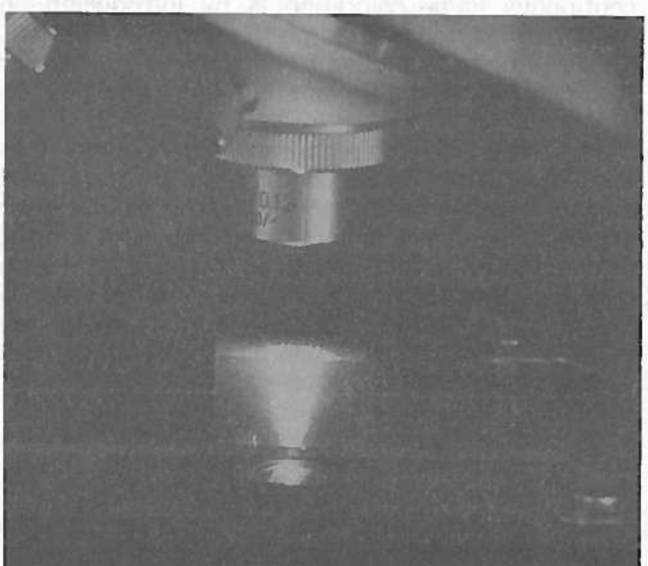
Biology Notes

'Turbid cubes'

In earlier bulletin articles on microscopy (e.g. Bulletin 113) much emphasis was placed on the need for careful illumination if one is to obtain the best performance from an optical microscope. Unfortunately there may be major difficulties in teaching this aspect of microscope usage. For many explanations of why things are done in a certain way, direct demonstration of what is actually happening to the light is apparently impossible. Usually the teacher is reduced to sketching simple ray diagrams or waving his hands in the air in attempts at explanation.



This need not always be the case. With 'turbid cubes', ray paths can be made visible at various points in the microscope. In this way the uses of the condenser controls can be directly illustrated. In addition the mode of operation of a number of techniques of contrast enhancement can be readily demonstrated. A turbid cube is a block of transparent material such as glass or perspex set on the microscope stage where the ray paths are made visible by scattering of light by tiny particles suspended in the material of the block.

In 1967 Haselmann[1] described the used of glass 'turbid cubes' in demonstrating ray paths in microscopy. Shortly afterwards Thomson[2] described the simpler techniques needed to make such cubes by substituting methyl methacrylate ('Perspex') for glass.

Having seen turbid cubes being used most effectively at a Royal Microscopical Society course, we decided to attempt an even simpler technique using a polyester embedding resin rather than castings of 'Perspex' cement (Tensol No 7 from ICI Ltd) as in Thomson's method. Some schools already use polyester resins for embedding biological specimens and for making jewellery or paper-weights.

A number of polyester resins are sold by various suppliers for embedding work. We used 'liquid plastic' Cat no. KC525 from *E.J. Arnold*. However the same material is available from *Trylon* who describe it as embedding resin EM306PA. Trylon also have a technical leaflet T15 for their polyester resins and will supply a 'Safety Data Sheet' on request. Some care is needed in handling this material to keep the resin off the skin and to avoid fire hazards. In particular the MEKP catalyst used is an organic peroxide and thus entails a high fire risk. It is also very dangerous to the eyes. Eye protection should be worn. In working with the polymerised resin, care should be taken to avoid raising, inhaling or digesting any dust.

Thomson used zinc oxide powder for the suspension of particles giving turbidity. However almost any finely divided powder which is insoluble in, and not reactive with, the plastic material would serve. We used magnesium carbonate (light) powder. A very small amount of this powder is needed to produce the desired degree of turbidity. (A rough guide is to use about 0.05g per 100cm^3 of liquid resin). It should therefore be added carefully in stages to the liquid resin before adding the catalyst (hardener). Each time an addition is made the resulting suspension should be stirred with a glass rod. The performace of the turbid suspension can be checked at this stage by projecting a focussed beam of light through the mixture in a glass container. Containers and utensils used for mixing and testing the resin may have to be treated as disposable, because of the difficulty of cleaning them. However it was found that the plastic tray used for the actual casting (see below) could be re-used.

When the required turbidity has been achieved the correct amount of catalyst is added, following the resin manufacturer's instructions. This mixture is then cast by pouring it into the depressions in a plastic tray of the type used for making ice cubes in a domestic refrigerator. The mixture is allowed to stand in a warm room for at least 48 hours to allow it to set and harden.

At the end of this time the cast blocks can be removed from the tray. The now solid blocks can be cut with a hacksaw and reduced to conveniently sized cubes or rectangular blocks which will sit on the microscope stage. The roughly shaped block is then lapped with successively finer grades of 'wet and dry' paper laid wet on a sheet of glass. Alternatively coarse and then fine grades of carborundum powder followed by ceric oxide as used in lapidary may be employed for the lapping operation. As with the paper, these powders are used wet on a sheet of glass. Final polishing is carried out by repeated rubbing on a soft cloth, impregnated with 'Brasso' or chrome cleaner and stretched over a glass plate.

The shaping of the blocks can be done more quickly if a milling maching is available. However the hand shaping operations are efficient and give acceptable results. The processes are not quite as laborious as their description would suggest!

Use of the 'cubes' makes simple the demonstration of a number of important points concerning microscope illumination. The effect on the ray paths of focussing the condenser and of operating the iris diaphragm controls can be readily demonstrated. The change in the apparent size of the source when first the plane and then the concave side of the mirror is used can be shown. This explains why some workers use the concave mirror to illuminate the large field of view of a very low power (x4 or x5) objective. Other uses include revealing the whereabouts of the exit pupil or Ramsden disc above the eyepiece and demonstrating the effect of stops, Rheinberg filters etc in contrast enhancement methods.

All of these effects are best seen with a light source of relatively high intensity. Most schools do not possess high intensity microscope lamps. Thus we suggest the use of a slide projector as a source of illumination. (See Bulletins 35, 73). The photograph shown in this article was taken using such a source. Whilst this is acceptable for these demonstrations, such a source is far too powerful for ordinary visual microscopy. Teachers should ensure that no one looks down the eyepiece of the microscope when such a source is used.

References

1. Haselmann, H., 1967, 'Didactic Methods in Teaching Microscopy', Proc. Roy. micr. Soc., 2, 344-355.
2. Thomson, D.J.M., 1968, 'A simply constructed Turbid Cube for Ray Path Demonstrations', Proc. Roy. micr. Soc., 3 12-13.

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Chemistry Notes

Methods for producing flame coloration.

Coloured flames produced by heating a nichrome wire dipped in a solution of an appropriate metal halide may be satisfactory for qualitative analysis, but are usually short-lived. They are often useless for longer term examination as needed in say, spectroscopy. One satisfactory way of producing a continuous flame coloration is by introducing an aerosol of the halide salt into the flame of a burner. Three simple methods, not involving any major modificiation of the burner, are shown below (Fig. 1)

The aerosol may be produced simply by adding to a solution of the halide salt a piece of granulated zinc (previously treated with a few drops of copper sulphate solution) and some 2M hydrochloric acid. For the method shown in 1(a) a 90 x 10mm borosilicate test-tube is the correct size to match a *Flamefast* semi-micro Bunsen burner. With the method in Fig. 1(b) the use of a home-made rack for the small test-tubes enables a series of different solutions, producing a range of colours, to be rapidly and conveniently introduced into the flame. The rack we used was simply a hardwood block of the correct height drilled out to take the tubes. The coloration produced by these first two methods is seen on one side only of the flame and gives some degree of

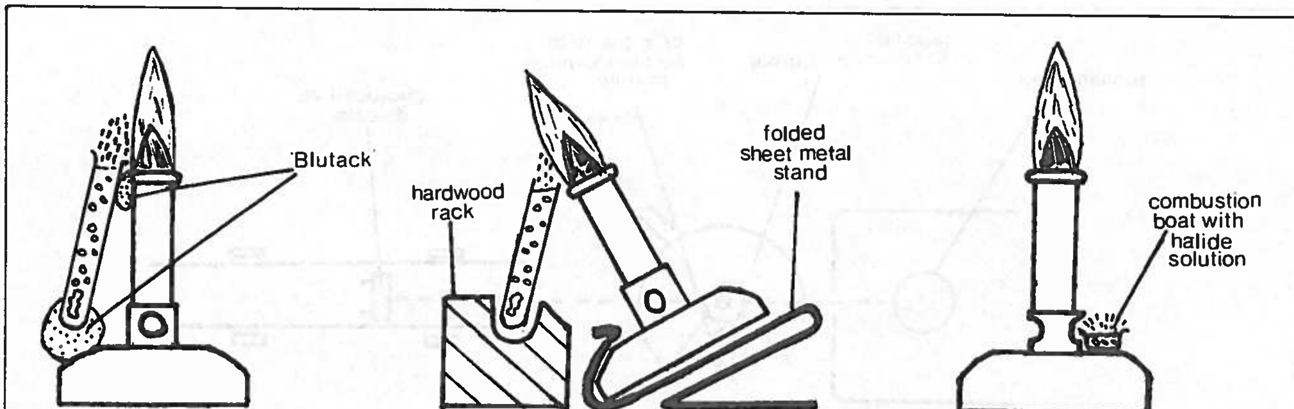


Fig. 1(a) Fig. 1(b) Fig. 1(c)

erratic flickering. This flickering is largely caused by the bursting of the bigger bubbles of hydrogen directly into the flame.

The method shown in Fig. 1(c) does not suffer from these disadvantages because here the aerosol is drawn in through the air regulator. A small combustion boat containing the aerosol producing mixture will just rest beside the air opening, on the burner base.

If one is willing to 'mutilate' a burner an even better, longer-lasting coloration can be obtained. This method is shown in Fig. 2.

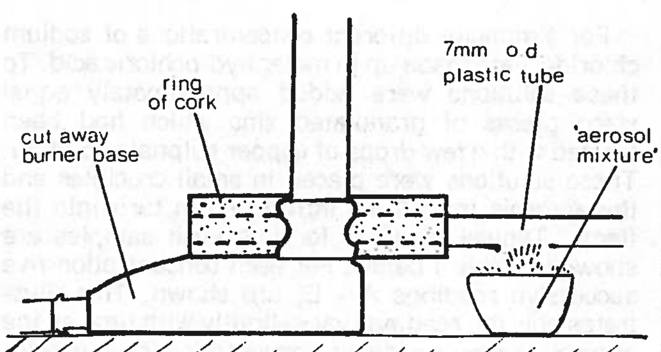


Fig 2.

Here a sector of approximately 120° is cut out of the base, allowing a crucible to be placed very close to the air inlet of the burner. With the 'Flamefast' microburner we found a medium type, 25mm depth Royal Worcester pattern (e.g. *Philip Harris* Cat. No. C30440/05) to be very suitable. A stronger colour can be obtained if an inlet tube is used to draw the aerosol into the air regulator. A piece of 7mm o.d. plastic tubing with a hole cut in the underside proved to be very satisfactory. The shorter the distance between this hole and the Bunsen air regulator collar, the more of the aerosol will be incorporated into the flame. A T-piece with the vertical leg cut short is an effective substitute. For those not wishing to permanently modify a burner, a less intense flame coloration can be obtained by using a longer piece of plastic tubing, without a hole in its underside, to draw in the aerosol from a crucible set clear of the burner base. Whichever method is chosen, the tubing can be held in place by a ring of cork with two holes in opposite sides, one to admit air the other to hold the inlet tube in place (see Fig. 2).

When, after some five or more minutes, the aerosol begins to die down and the flame colour to fade the addition of a few drops of concentrated hydrochloric acid will soon start it up again.

Atomic Absorption Spectroscopy model

A coloured flame produced using the methods described above can be used to build an inexpensive

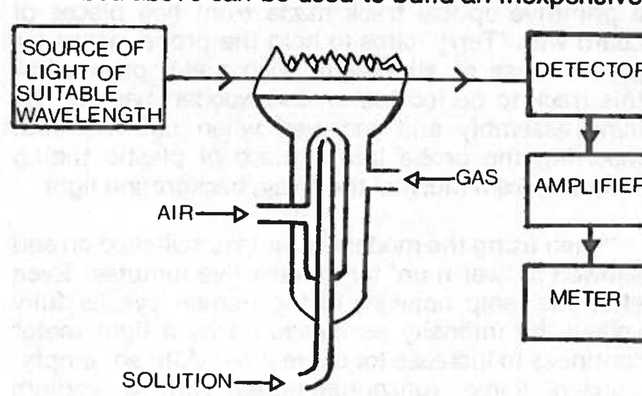


Fig. 3.

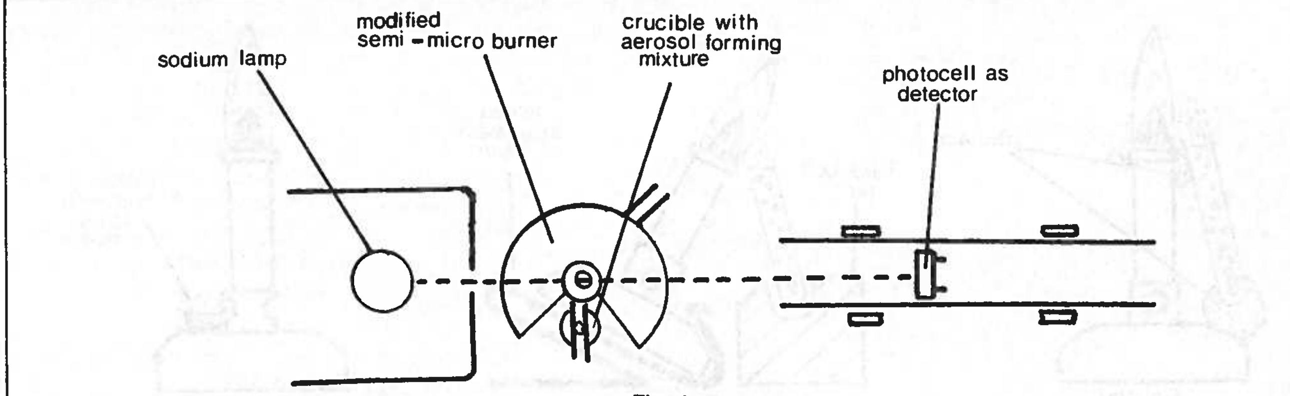


Fig. 4.

working model of an atomic absorption spectrophotometer. In Bulletin 90 we described the simple demonstration of a shadow produced when a sodium flame is placed in the path of a beam of light from a sodium lamp. The principle of atomic absorption spectroscopy (AAS) is outlined schematically in Fig. 3. Here the amount of light of the relevant wavelength which is absorbed is measured. The proportion of light so absorbed is related to the concentration of the particular element in solution.

In our working model a sodium street lamp, driven by a ballast transformer as described in Bulletin 122 was used as the source of sodium light. A micro-burner modified as described above and illustrated in Fig. 2., was used as the 'atomiser'. A light probe borrowed from a friendly biologist's environmental kit was used as the detector. The apparatus is shown in plan view in Fig. 4. Constructional details, including measurements, are to be found in the 'Workshop' section of this bulletin.

The light probe may simply be held in a clamp, but a primitive optical track made from two pieces of board with 'Terry' clips to hold the probe makes for greater ease of alignment. Two metal pegs allow this track to be located on the wooden base of the lamp assembly and removed when not required. Inserting the probe into a piece of plastic tubing shields it from much of the stray, background light.

When using the model the lamp is switched on and allowed to 'warm up' for at least five minutes. Even after the lamp appears to the human eye as fully yellow the intensity as measured by a light meter continues to increase for some time. With an 'empty' Bunsen flame (uncontaminated with a sodium aerosol) set in the light path, the meter reading is adjusted to read 100% transmission by applying the inverse square law, adjusting the distance between probe and lamp.

The flame then has introduced into it an aerosol containing a known concentration of sodium chloride and the decreased meter reading is read off. The position of the burner in the optical path is not fixed so its correct alignment has to be achieved by moving it across the path (but not along it) until the shadow from the flame falls on the light sensitive cell. Such a position corresponds with the largest decrease in photocell current. Thereafter the burner should not be moved for the duration of the demonstration.

For simplicity different concentrations of sodium chloride were made up in molar hydrochloric acid. To these solutions were added approximately equal sized pieces of granulated zinc which had been treated with a few drops of copper sulphate solution. These solutions were placed in small crucibles and the aerosols from them introduced in turn into the flame. Typical readings for five such samples are shown in Table 1 below. For each concentration five successive readings A - E, are shown. This illustrates how the readings vary slightly with time as the aerosol wanes, owing to consumption of the acid, and the amount of light absorbed gradually decreases.

As the absorption of light falls away and the meter reading begins to increase significantly, after five minutes or so, the crucibles can be 'rejuvenated' by adding two drops of concentrated hydrochloric acid to each.

The simpler methods for coloring a flame described earlier in these 'Notes' were also tried in

TABLE 1

Molarity of sodium chloride (in 1M hydrochloric acid).	Successive sets of readings (≡ % Transmission).				
	A	B	C	D	E
1.0	36	35	36	37	38/39
0.25	40	39	43	44	48
0.10	53	54	60	67	70
0.025	79	87	86	85	88
0.005	92	92	93	94	95

the AAS model. They were reasonably satisfactory, but produced significant fluctuations in the readings. These were caused by the one-sided coloration of the flame and the production of larger bubbles of hydrogen, at the smaller surface of a tube, than were formed in a crucible. These bubbles burst in the flame disturbing it, causing flickering. A further variation is the use of small pieces of marble instead of zinc in generating the aerosol. Any slight coloration due to calcium in the flame will not cause absorption of the sodium light. This is perhaps in itself a useful teaching point.

For those who might not have the use of an environmental kit's light probe a simple d-i-y detector is described in the 'Workshop' section. In our experiments this home-made detector, based on an ORP12 cell, was mounted in the same position as the WPA probe. Full scale deflection on a milliammeter was obtained by varying the voltage tapped off using a potentiometer in the circuit shown below. (Fig. 5). Fine control was obtained by small movements of the tube in which the detector was mounted.

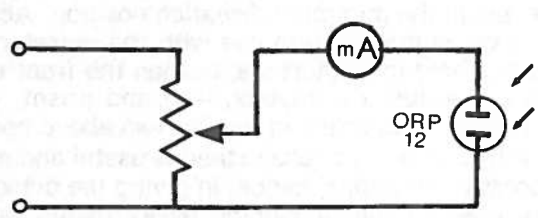


Fig. 5.

Alternatively, f.s.d. could be obtained over a range of applied voltages by varying the distance between flame and detector. Our experiments showed a range varying from a reading of 2mA using 1.4V at a detector/flame distance of 26cm to a 5mA reading with 16V at 21cm. Variable resistors from 250 Ω up to 10k Ω were found to be suitable as voltage dividers. Such combinations, matching available meters and power supplies, are easily found by trial and error. The maximum rate of heat dissipation from the ORP12 is given as 200mW at 25°C. Even using a current of 10mA this rate is unlikely to be exceeded. Table 2 below shows typical results using the ORP12 as detector.

Results for two different circuit conditions are shown.

TABLE 2

(≡ % Transmission)

Molarity of sodium chloride (in 1m hydrochloric acid).	f.s.d. = 100 units (2mA)	f.s.d. = 100 units (5mA)
1.0	40	38
0.25	51	54
0.10	65	64
0.25	78	88
0.005	92	92

The results obtained with the d-i-y detector are thus as satisfactory as those for the commercial probé and meter.

The working performance of the SSSERC A.A.S. model could be greatly improved by:

(i) reducing the amount of stray light entering the detector. (This would mean using a darkroom or 'boxing-in' the light path. However these improvements would be at the expense of the model's great simplicity. Also it is worth pointing out that by covering the sodium lamp it can be shown that only 15 to 20% of the meter reading can be attributed to the normal room lighting. In other words, switching off or covering the lamp brings about a decrease in the reading of 80-85%).

(ii) collimating the light before it enters the flame and the photocell.

(iii) using a flame spreader giving a longer path length of absorbing flame. (This would increase the sensitivity but would require more precise optics because such a flame is very thin).
(iv) using an amplifier to boost the signal so allowing lower concentrations of sodium to be measured.
(v) modulation of the incident illumination (by a 'chopper' or other means) and of the detector, at the same frequency so that the characteristic emissions of the flame itself will not be detected.

The simple model, without these improvements, will detect 100 ppm of sodium. We feel that, with a model for teaching the principles, there is much to be said for simplicity. In such a simple model the three main parts, incident radiation source, excitation of the sample and the detector can be readily seen.

* * * * * *

Physics Notes

One or two teachers have asked us if it is possible to construct an infra-red radiation detector which would be cheap enough to be made in pupil quantity for class use. Photo-transistors for reading punched paper tape have maximum light sensitivity in the infra-red, and hence are suitable for detecting i.r. They are also cheap; the present cost of the TIL78 which this design uses is 55p from *Technomatic.* It is an npn transistor in which the base is not connected externally, and of the two leads that which is nearer the flat position of the body is the collector (see Fig 1.). The light sensitive position is at the top, so that the transistor can be mounted inside the hole of a one hole stopper with the leads protruding through the far end.

The transistor must be proof against ambient light, and we plug it into the end of a plastic can used to hold 35mm film, using a no 27 rubber stopper. Opaque adhesive tape is used to cover the exit hole. In the centre of the other end of the can we made a 2mm dia. hole, and that end of the can is painted white on the outside. An alternative is to glue white paper or card over the end of the can, and then to drill the 2mm dia. hole in the centre.

The electrical circuit is shown below. (Fig. 1). When illuminated the transistor is practically a short circuit so that the series resistor should be such that the current will not overload the milliammeter.

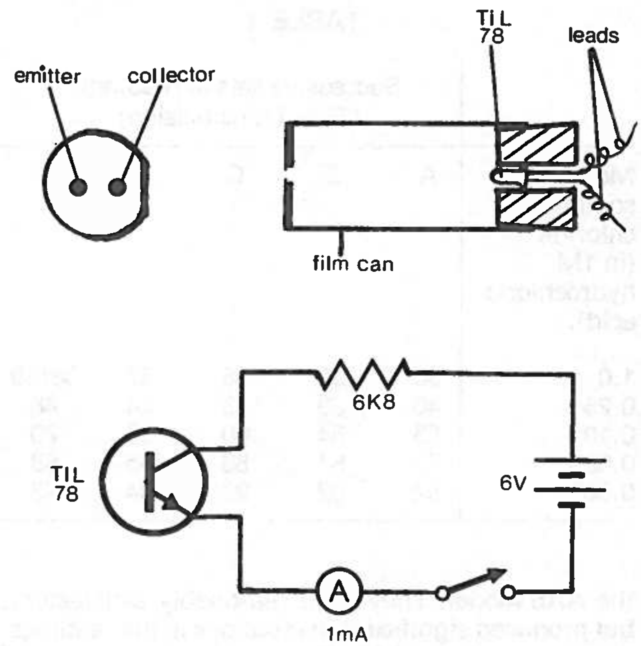


Fig. 1

If the battery is reduced to 4.5V, the series resistor can be 4.7k Ω. A 10mA ammeter can also be used, with the resistors reduced to 680 Ω or 470 Ω, but it is then not so easy for pupils to see the residual current when the beam is in the infra-red. Also, although the characteristics of the TIL78 do not say so specifically, we think that 10mA may shorten the life of the transistor. The circuit diagram of Fig. 1 has been made on the assumption that pupils would be using battery power, but labpacks or similar will do as well. The photo-transistor has an absolute maximum of 50V between collector and emitter, and a maximum dissipation of 50mW.

The mechanical details of the experiment are in Fig. 2. A pupil raybox is used without the slit, and with a bi-convex lens, 10 or 15cm focal length, strapped over the hole by means of two strips of sellotape, one at each side. This will give an approximately parallel beam of light from the raybox. Close to the lens is an equilateral glass prism, set in the minimum deviation position. About 35cm away is put the film can with the detector. If the can is held in a retort stand, then the front end of the apparatus, i.e. raybox, lens and prism, will require to be supported an inch or two above bench level with a book. The retort stand is useful and may be necessary in pupils' hands, in giving the detector a firm base so that it can be easily manipulated across the beam.

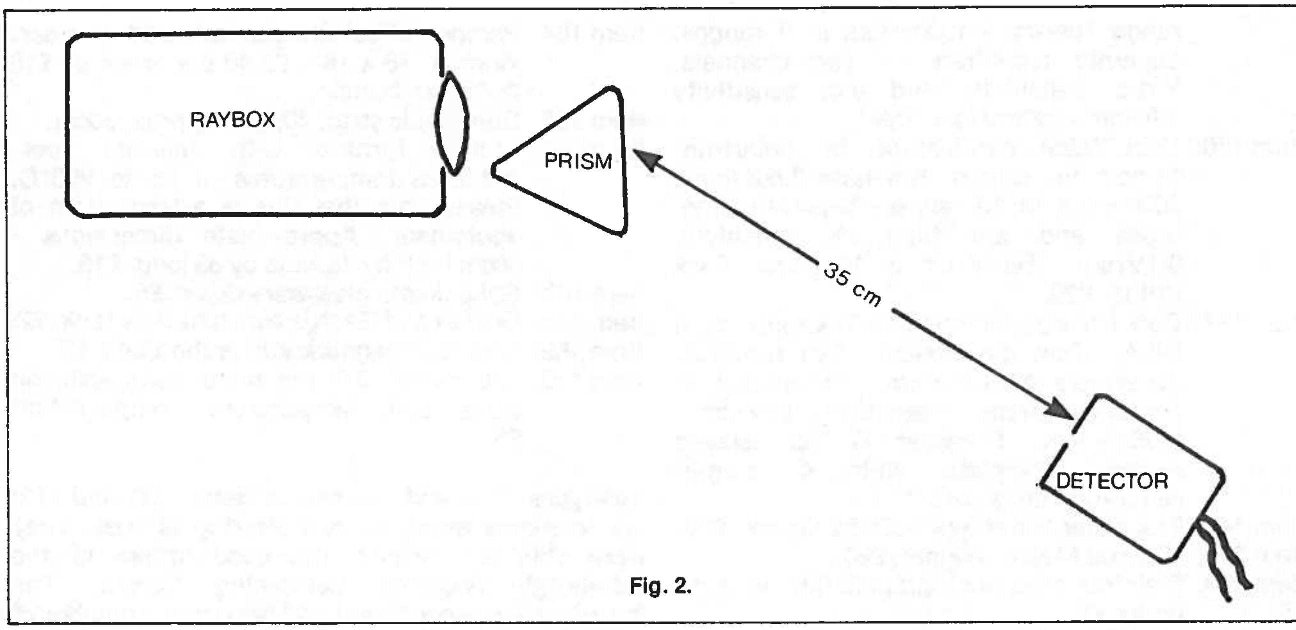


Fig. 2.

With the circuit of Fig. 1 we got a maximum current of 800uA at the red end of the spectrum which persisted until the hole was 5mm beyond the visible. Interrupting the beam with the hand reduced the current to zero, even in a sunlight room.

* * * * * *

Surplus Equipment Offer

The following items of equipment are offered for sale, subject to the conditions laid out in Bulletin 116. We would entreat prospective buyers to read these conditions so that unnecessary paper and telephone work may be avoided. Items with numbers less than 145 have already appeared in bulletins 116; 122; 125 or 128. These are **not** now subject to the ballot. Items with numbers greater than 144 are those included in this present ballot.

As with the Bulletin 128 ballot we will allow for delay in bulletin distribution caused by the new bulk distribution system. The ballot will not take place until three weeks after we judge that bulletins have reached the schools.

Item 1.	Bulletin 116.	Photographic film b/w, 35mm, 125ASA, ca. 3m. length, 25p.
Item 3.	Bulletin 116.	Film b/w, Kodak, TXP120 400ASA, 15p.
Item 6.	Bulletin 116.	Polaroid film, 15p.
Item 20.	Bulletin 116.	Silicone grease, £1.
Item 44.	Bulletin 116.	Head and breast sets, 75p
Item 50.	Bulletin 116.	Bottle brushes, 3p.
Item 64.	Bulletin 122.	Display units, £5.
Item 84.	Bulletin 125.	Photographic fixer, 30p.
Item 88.	Bulletin 125.	Dry cells, 3V, 15p.
Item 89.	Bulletin 125.	Dry cells, 1.5V, per pair 15p, 24 - £1-50 and per gross £8.
Item 95.	Bulletin 125.	Battery charger, £3.
Item 112.	Bulletin 128.	Valve voltmeter, £10.
Item 118.	Bulletin 128.	Multimeter, £15.
Item 122.	Bulletin 128.	Mains heaters, £3.
Item 127.	Bulletin 128.	Griffin and George ionisation chambers, 50p.
Item 135.	Bulletin 128.	Electrolytic capacitors, 5p - 40p.
Item 136.	Bulletin 128.	Mains suppressors, 25p.
Item 137.	Bulletin 128.	Nixie tubes, 25p.
Item 138.	Bulletin 128.	Glass cartridge fuses, 1A, 2p.
Item 139.	Bulletin 128.	Low power transistors, 2p.
Item 142.	Bulletin 128.	Silica gel dessicant, 1p.
Item 143.	Bulletin 128.	Rubber bungs, ½p.

The following items are those included in the present ballot:

Item 145. Dual trace oscilloscope type CD 1014-2 by Solartron. 8cm. dia. screen, timebase range 1us/cm - 100ms/cm in 6 ranges. Separate amplifiers on two channels. Y.d.c. sensitivity and a.c. sensitivity 10V/cm - 100mV/cm. £30.

Item 146. Dual trace oscilloscope by Solartron. 11.5cm dia. screen. Timebase 0.5us/cm - 200ms/cm in 18 ranges. Separate timebases and amplifiers. Y sensitivity 0.1V/cm - 50mV/cm in 12 steps. Rack fitting. £20.

Item 147. Dual trace oscilloscope by Tektronix, type 545A. 12cm dia. screen. Two timebase generators A: 0.1us/cm - 5s/cm and B: 2us/cm - 1s/cm. Y sensitivity 20V/cm - 0.05mV/cm. Timebase B has delayed sweep. Complete with 4 plug-in calibration units. £45.

Item 148. Transistor tester type 1325 by Cossor. £10.

Item 149. 'Eclipse Major' magnet. £20.

Item 150. Stainless steel photographic film washing tanks. £5.

Item 151. Photographic print trimmers/guillotines. These have had guards fitted by us to comply with safety requirements. £5.

Item 152. Photographic enlarging base/easel. 54 x 45cm approx. £8.

Item 153. Large compound lenses, ex. aircraft cameras. Complete with iris. f5.6 or f6.3. £5.

Item 154. Darkroom safelight filters by Ilford. Dark brown, approx. 25 x 20cm. 10p.

Item 155. Photographic print lacquer by Kodak. 425g aerosol pack. £1.

Item 156. Kodak DC developer, 4.51 bottle. £1.

Item 157. Kodak DX80 developer, 2.71 bottle. £1.

Item 158. Ilford ID82 developer, 1 l bottle. 10p.

Item 159. Ilford IF18 fixer, 1l bottle. 30p.

Item 160. Ilford photographic paper. Bromide grade 1, 10 x 10", glossy. Box of 100 sheets. £1.

Note re Item 160. We have tested samples of this paper and found that it produces acceptable prints, certainly good enough for pupil work with beginners. however it is long out-of-date. This explains the ridiculously low price of 1p per sheet.

Item 161. Kodak photographic paper WSG2D. Double weight bromide, grade 2. 30.5 x 40.6cm. Glossy, 100 sheets/box. £10.

Item 162. Kodak paper WFL2D. Bromesko double weight. 30.5 x 40.6cm. White, fine lustre. 100 sheets/box. £15.

Item 163. Kodak paper, Veribrom F2, grade 2. Resin-coated, glossy. 40.6 x 50.8cm. 100 sheets/box. £20.

Item 164. Perspex offcut sheets, coloured or clear. Approx. 48 x 18". £2-40 per sheet or £18 per 25kg. bundle.

Item 165. Bi-metallic strip. 40p per approx. 30cm.

Item 166. Muffle furnace with thermal fuse. Achieves temperatures of up to 950°C. Please note that this is a large item of equipment. Approximate dimensions - 60cm high by 45 wide by 83 long. £15.

Item 167. Gallenkamp glassware dryer. £5.

Item 168 Griffen and George constant flow tank. £2.

Item 169. Chandos magnetic stirrer/hotplate. £5.

Item 170. EIL model 388 pH meter with millivolt scale and temperature compensation £5.

Teletypes The next two sets of items (171 and 172) are teletypes which we are offering at cost. They were obtained through the good offices of the Edinburgh Regional Computing Centre. The machines are secondhand and have had a number of hours of use as teletypes. We think that they should still make useful printers/remote keyboards for a number of models of microcomputer held in schools. The simplest and cheapest interfacing of these devices will be with those micro's having serial interfacing (RS232 etc.). With models using IEE type parallel data transmission, a serial parallel interface will have to be acquired or built probably using a UART as the central component. Alternatively interfacing with the PET etc. could be by software but, of course, such a programme would have to be loaded everytime the teletype was to be used as a printer.

We can give information on the basic circuitry for interfacing the machines to most types of micro. However there may be slight differences of detail for some models. At the time of writing we are not able to dot every i and cross all the t's. In the circumstances it would be best if those balloting for teletypes had some initial experience of micro-electronics. Absolute beginners may experience a little difficulty in getting the system to work first time.

Item 171. Teletypes with D200 interfaces (operationally identical with the American EIA RS232 interface). Interfacing straightforwardly with Apples, UK 101's etc. Appear fully operational as keyboard/printers. £50. (6 machines) There are a further 3 machines which are out of adjustment but otherwise operational as keyboard/printers. For these we are asking £40 each.

Item 172. Teletypes with 20mA loop interfaces, where data is transmitted by switching on and off a current flow. We have 4 of these machines for sale. All appear fully operational as keyboard/printers. £50 each.

* * * * * *

In the Workshop

The A.A.S. model described in the 'Chemistry Notes' consists essentially of two main parts, the sodium lamp assembly and the optical 'bench'. The construction of the lamp assembly is shown in Fig. 1. In our version the lamp control gear as fitted in street lamps was used. (Details of this G.E.C. 'Sox' control gear were given in the Trade News Section of Bulletin 122). This control gear, suitably enclosed switched and fused, was mounted on the base of the lamp assembly as shown. Alternatively control of the lamp can be by the type of 'auto-leak' transformers sold by *Philip Harris* or *Griffin and George.*

This lamp assembly will be useful for a number of other experiments particularly in physics. There is a considerable advantage in not permanently fixing it to the other half of the model. This consists of a simple optical track made from wood or faced chipboard and which supports and aligns lamp burner and detector (Fig. 2). Two nails fastened through the end of the baseboard, and with their points then sawn off, can be used to locate the optical track on the lamp assembly when required. At the opposite end of the baseboard a block, of the same thickness as the lamp assembly base, screwed to the underside acts as a foot keeping the track horizontal.

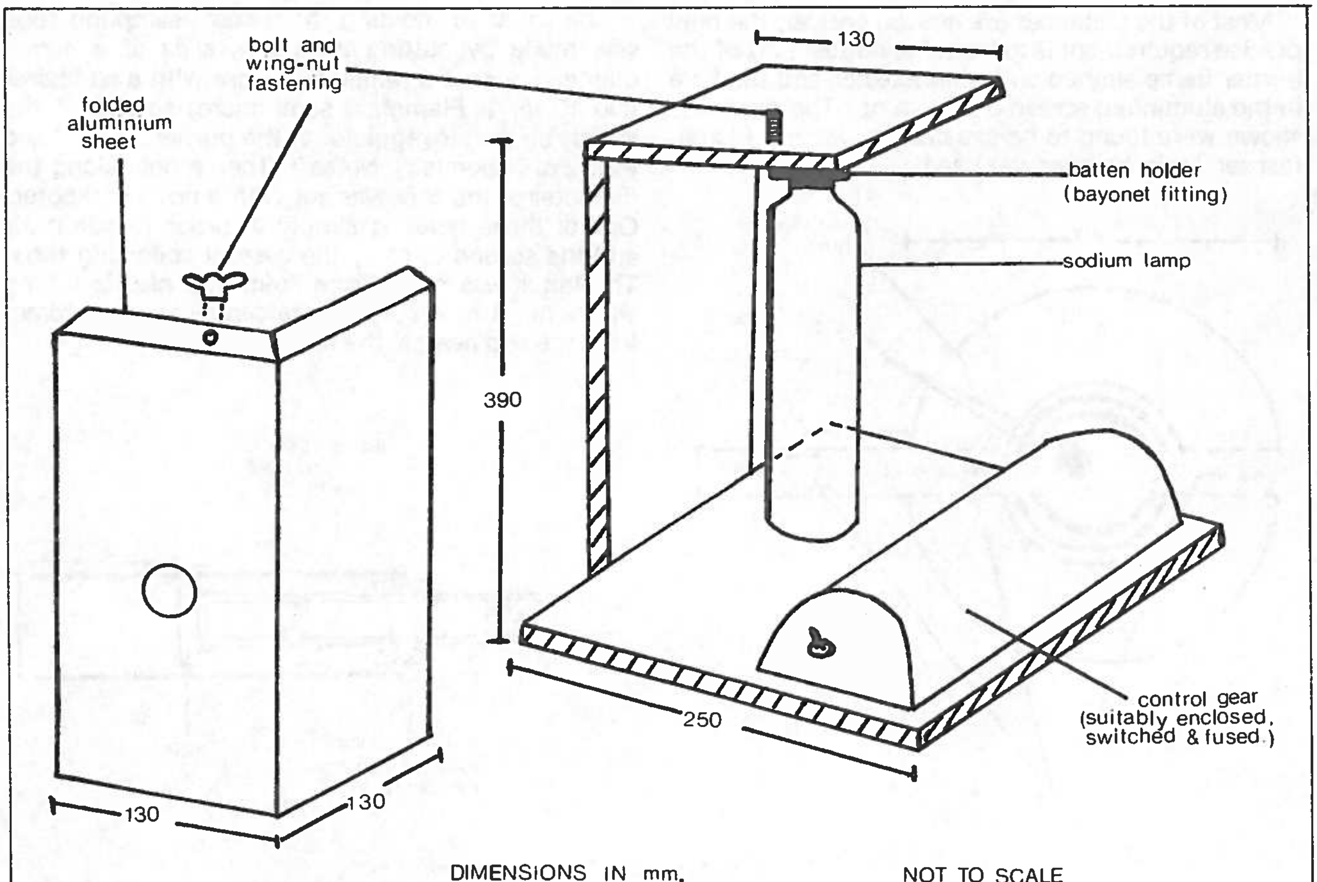


Fig. 1.

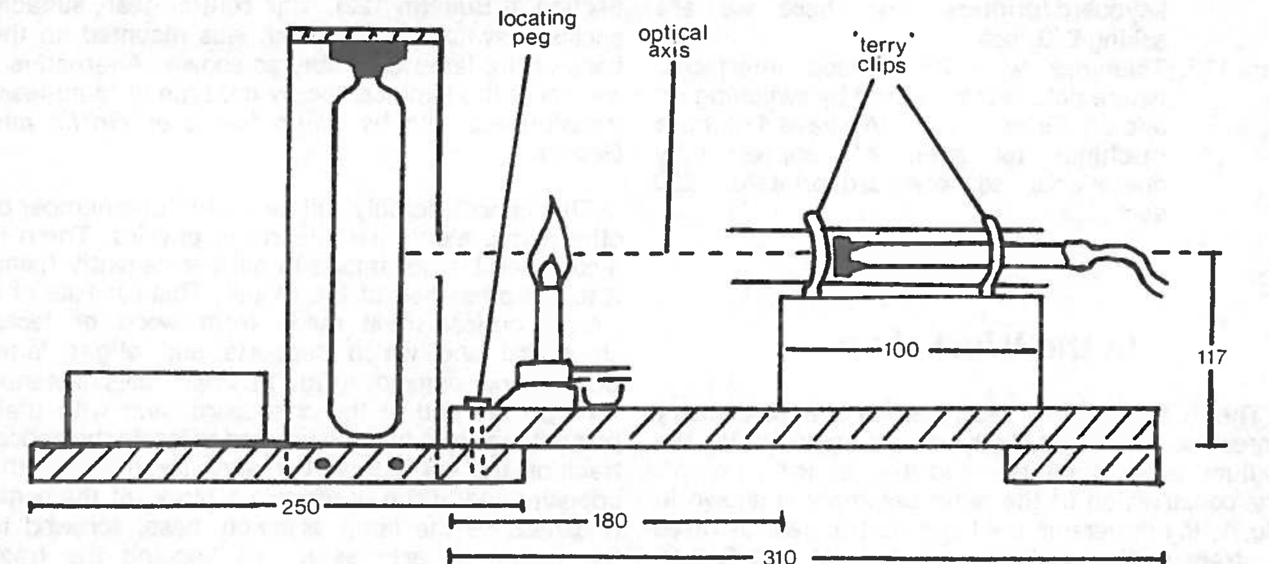
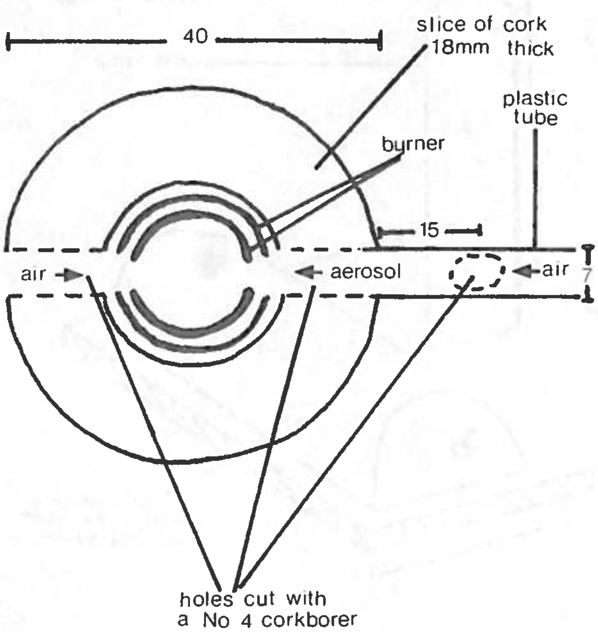
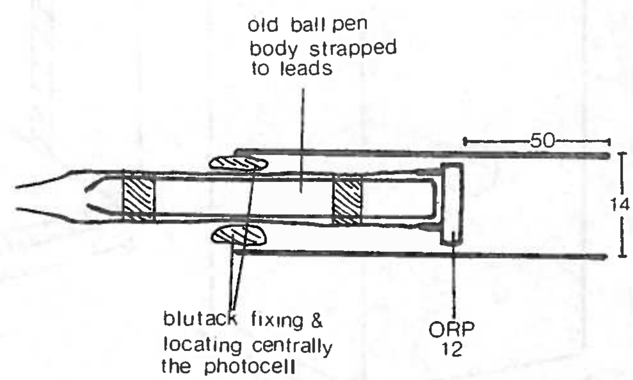


Fig. 2

Most of the distances are not too critical; the only precise requirement is to have the hottest part of the burner flame aligned with the detector and the hole in the aluminium screen on the lamp. The distances shown were found to be satisfactory when a Flamefast semi microburner was used.

The collar for holding the aerosol sampling tube was made by cutting an 18mm slice of a 40mm diameter cork and removing a core with a corkborer (No 10 for a Flamefast semi-micro) so that it fits snugly on the air regulator of the burner. (Fig. 3 and Fig. 2 of 'Chemistry Notes'). Then a hole along the diameter of the cork was cut with a no. 4 corkborer. One of these holes is simply in order to admit air and the second to carry the aerosol collecting tube. The latter was made from 7mm o.d. plastic tubing with a no. 4 hole cut with its centre approx. 15mm from the end nearest the burner.





NOT TO SCALE DIMENSIONS IN mm.

Fig. 3.

Fig. 4.

For those without access to a light probe from an 'environmental' kit a simple d-i-y design is shown in Fig. 4. An ORP12 photocell (*R.S. Components Cat.* No. 305-620) is strapped onto a plastic ball pen body with insulating tape. This assembly is then mounted inside a short length of metal or plastic tubing of approximate internal diameter 14mm. A suitable circuit for this detector is described in the 'Chemistry Notes' section of this bulletin.

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Trade News

Changes at 'Griffins'

Schools in Scotland should have by now received a letter from *Griffin and George* advising them of new centralised arrangements for obtaining information and placing orders. A sales desk will not be maintained at East Kilbride after 1st October 1981. Instead orders and written enquiries should be sent directly to the Manchester branch of Griffin and George (address on inside front cover of this Bulletin). A direct telephone link with the Manchester branch has been established. The number to obtain this connection is:

GLASGOW (041) 248 5680

Griffin and George technical representation and sales management organisation remain intact (see address list for details).

'Labpacks'

We have received a number of enquiries as to the present address of *Radford Electronics* makers of 'Labpacks' and this is given in the address list for this bulletin (inside front cover). We also received one complaint that this firm are no longer selling replacements for the ordinary cut-outs fitted in the earlier 'Labpacks'. We have been told by the firm that they are now fitting electronic cut-outs to their power supplies. Demand for replacement cut-outs for the older models did not justify their buying the large minimum order quantity demanded by their own supplier. Therefore, they have stopped stocking the older type of cut-out and instead recommend a *R.S. Components* cut-out (Cat. No. 339-954). However our complainant says that this cut-out is unsuitable, failing to trip before the 2A mains fuse blows. If this is the case then clearly the cut-out might as well not be there. We would like to hear from anyone else who might have experienced the same problem.

Microscope Repairs

The firm of *RECO (Laboratory Products) Ltd.* will carry out the servicing and repair of school microscopes. Travelling charges will probably rule out on-site servicing for Scottish schools. However repairs are usually done in their workshops in Luton and instruments can be sent by post/carrier. If RECO find repair impossible they will return the instrument free of charge. The firm is also willing to carry out complete overhaul and reconditioning. With both repairs and reconditioning it is claimed that an estimate will always be supplied before work is begun. RECO are interested in purchasing old, unwanted or broken microscopes and also claim they will buy "almost anything".

Oscilloscopes

We have recently had yet another single beam 'pupil' oscilloscope on evaluation loan. This instrument, the SBO 31058, is made by BPL India and sold by *Universal Engineers Consultants*. Sensitivity is from 10mVcm^{-1} in twelve steps and the time base 0.5us cm^{-1} in twelve steps and to 0.1s cm^{-1} through variable control. Triggering is automatic, internal only. The screen has an 8x10cm graticule on a blue filter. This instrument retails at £140 but educational discount will bring the price down to "around £100".

The OSC 3C oscilloscope which we mentioned in this section of Bulletin 125 is now available from *Rakestar* at £85.68. The larger Elmac 4810 at £108.50 is available from the same firm. A more sophisticated and slightly bigger 'scope, the 5810, has 10mV/division sensitivity and a 12.5cm wide screen. It costs £156. Unlike the other instruments mentioned here, which have 4mm input terminals, the 5810 uses a co-axial socket input, and a probe lead is included in the price.

Multimeters

Universal Engineers Consultants, mentioned above as a source for the SB0 31058 oscilloscope, sell a wide range of other electronic equipment, including analogue multi-meters. Of particular interest is the UM 049 pocket multi-meter at £10 including p and p. We have had a sample and were sufficiently impressed by the value it offered to have bought the evaluation sample.

Stereomicroscopes

Prior Scientific Instruments Ltd have recently launched a new range of stereomicroscopes, the S2000 range. These instruments are based on a completely new design of a unit or modular system so that a wide range of stands, magnifications etc can be selected from to put together the exact model required. Prices start at around £120.

'Safe-break' bottles

Baird and Tatlock are now selling bottles for chemicals, with a coating of adherent plastic claimed to withstand strong acids and corrosives. The bottles are claimed to be considerably more resistant to shock and, in the event of breakage to normally contain both shattered glass and liquid. Thus they should prevent flying glass and splashing and ensure minimal spillages. The bottles are available in two sizes 250 and 500 ml and can be supplied in clear or amber glass. Details from 'B and T' at the address on the inside front cover of this Bulletin or from their Scottish agents *Macfarlane Robson*.

'Oxoid' materials

Philip Harris Biological have now been appointed the official Oxoid agents for schools, taking over the work which was formerly done by Astell Hearson. The Oxoid products already listed in the Harris catalogue will continue to be available from stock and the range of these products will be increased in due course in line with demand. All other items from the Oxoid range will also be available through Harris to special order. An up-to-date product list is available on request.

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CONTENTS

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