SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

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Harwood Products, 15 Little Thistle, Welwyn Garden City, Herts AL7 4AB. Tel. (070 73) 34258.

Industrial and Biological Electronics Limited, 12 Royal Terrace, Glasgow G3 7NY. Tel. 041-332-1077.

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ITT Electronic Services, 52A High Street, Paisley, Renfrewshire. Tel. 041-889-1711.

Macfarlane Robson, Burnfield Avenue, Thornliebank G46 7TP. Tel. 041-637-2333.

Johnson Matthey Chemicals Limited, Orchard Road, Royson, Herts SG8 5HE. Tel. (0763) 44161.

Salter's Institute of Industrial Chemistry, Professor R.O.C. Norman, Director, c/o Dept. of Chemistry, University of York, Heslington, York YO1 5DD. Tel. (0904) 59861.

SSI Ltd., Dawson House, 128/130 Carshalton Road, Sutton, Surrey SM1 4RS. Tel. 01-643-1126.

Andrew Stephens and Company, (Medical Electronics), 41/EE Dickson Road, Blackpool. Tel (0253) 23755.

INTRODUCTION

Surplus Equipment

This bulletin contains a list of equipment offered for sale subject to the conditions set out in Bulletin 116. We would entreat prospective customers to read carefully these conditions so that unnecessary paper and telephone work may be avoided.

'Foundation' Science Notes

The Munn/Dunning Development Programme in Science has now reached the stage where first line pilot schools and certain 'interested bodies' have been issued with a set of 'Specifications of Compulsory Topics'. This means that we now have a very clear idea of the types of practical activities that will be needed.

To mark this development we have decided to open a 'Foundation Science' column in the Bulletin. In this column we will pass on some of the more relevant 'products' and designs which have arisen from our work with the trial schools. It is our medium term aim to have a collection of foundation science items large enough for us to be able to mount specialised 'foundation' exhibitions in centres throughout Scotland. To this end we would ask teachers and technicians to send us designs, or possibly just ideas, for items they judge would be useful for these new courses.

Salters' Institute Fund

The **Salters' Institute** of Industrial Chemistry has established a fund for supporting the development of innovations which are designed to improve any aspect of chemistry teaching for pupils in the age range 11-18. A total of £1,500 will be available in 1983, and applications from individuals or groups for sums up to £750 should be made to the Director, Professor R.O.C. Norman at the address in the address list by 31st October, 1982.

Science Interfacing Register

Details of the aims of SIR and the information required for registration were given in the 'Microelectronics Notes' sections of Bulletins 129 and 130. Issue number 2 of SIR was issued in April but we are now looking to the compiling of the third issue. If anyone else active in the field of interfacing science apparatus to micro-computers wishes to be included on the register would they please send the information requested on page 3 of Bulletin 129 to SSSERC as soon as possible.

Cost Index

Our cost index of consumable items of equipment is sampled twice yearly, in May and again in November. In May 1974 the base line was set at 100. In May 1982 the index stood at 307.5. Put in 'money' terms our shopping basket, of glassware, chemicals, crocodile clips and preserved rats etc. cost £192.69 (≡100) in May 1974. Those same goods were priced at £592.49 in May of this year.

Calculation of the percentage increase since last May gives an increase of approximately 10.6% for the year May '81 - May '82. A similar calculation for the change since last November gives an increase of only 3.7% over the six month period. This may mean that the economic pundits were correct when they predicted a marked fall in the inflation rate in 1982 - seems strange doesn't it?

Silver nitrate

The 'Bunker-Hunts' of this world have a lot to answer for! Few would make the link between a family of Texan billionaires and school chemistry practicals but such a link exists. The Hunts' attempt to gain a 'corner' in the world silver market affected greatly the price of the metal and in turn of its compounds, to such an extent that the use of silver nitrate in school chemistry has been questioned because of the expense. Hence in the 'Chemistry Notes' section of this bulletin we examine the extent of usage of this compound and suggest some ways of reducing the costs.

* * * *

Opinion

"Precautions have to be taken in order to obviate problems caused by glitching* on the signal line" is an impersonal way of saying "you will have to cope with glitching on the signal line". The former sentence would hide inoccuously in scientific prose. The latter sentence would hit you between the eyeballs. It is not the done thing to address the reader as "you". It could be said that scientific writers eschew emotive prose. It might be truer to say they cherish impersonal prose. The first sentence is a typical example of style, with use of the passive rather than the active leading to writing that is bland and anodyne.

Once upon a time everyone accepted that scientific thinking was objective. This was maybe a case of the scientists believing what the philosophers told them and the philosophers believing what the scientists told them. However faith in objectivity has weakened since Popper pointed out that a scientific theory is not proven true by a logical process called induction, and since Watson described his double helix work. Science is a very human activity. It is subject to hints, hunches and inspired guesswork. It is affected by feelings such as pride, jealousy, envy and sloth. An impersonal writing style is a convention for covering up those human feelings. We believe this convention should be less rigidly adhered to. For a start it should be OK** to use "we", "I", "one" and "you" in scientific prose. Descriptive passages may well be better in the passive, but where the writer wants to catch the reader's attention he should use the word "you" and write plainly and directly. Scientific prose should be emotive in that it should be a conspiracy between the writer and the reader, his collaborator.

What sparked off this opinion article was our dipping into a copy of "The Art of Electronics" (1). It's title sets it's style. Electronics is an art, isn't it? Then lets call it that! The authors don't cherish impersonal prose and the book is well worth examining for it's language. (We could rave about it's content too.)

We, ourselves, find that when our Bulletin articles are sent off to other publications for reprinting they are returned for proof reading with all the "we"s slashed out. This sort of stuffiness should be held up for ridicule and jeered off the stage.

Reference:

1. Horowitz, P. and Hill, W., "The Art of Electronics" (Cambridge University Press, 1980).

Glossary:

* "glitching" - an American electronics term, new to Britain, coming from the verb "to glitch", meaning to form spikes on a signal.

** "OK" - An American expression, now acceptable in Britain, meaning "acceptable".

* * * *

Safety Notes

Fume cupboards

The standards of design and performance required of fume cupboards has been a contentious area for some time now. The degree of controversy has not been lessened by the failure of the British Standards Committee, which was then drawing it up, to agree on a recently formulated new standard. As we understand it this committee has gone off to think again.

However some light has now been shed on this difficult area as far as schools are concerned. The Department of Education and Science has very recently issued 'Design Note Number 29 - Fume Cupboards in Schools'. Prepared by the Architects and Building Group of DES, it incorporates the results of an investigation by the development group of our sister organisation in England and Wales, CLEAPSE. This investigation was commissioned by HM Inspectorate (DES) and involved research into the quantities of toxic gases and vapours released in school chemistry and into the performance of fume cupboards currently found in schools.

This present design note covers the standards required for a school fume cupboard, recommended provision, recommended specifications, installation, extraction system, 'make-up air', and performance testing.

Copies of Design Note 29 are available from the **Publications Despatch Centre** of the **DES** at the address given on the inside front cover of this Bulletin.

Of course DES publications have no mandatory nor even official 'advisory' status here in Scotland. However 'Design Note 29' is highly relevant to the debate on the fume cupboard provision in Scottish schools. We are hopeful that our own current research project commissioned by the HSE and involving a survey on the use of hazardous materials in schools will enable SSSERC to provide further relevant information on this topic.

Air-rifle hazard

We have received a report on a potentially hazardous use of an air rifle from Mr. Iain MacInnes, Head of Physics at Jordanhill College of Education. Mr. MacInnes wrote to us after observing an incident on a visit to a school physics department. This involved the use of an air rifle in the well known experiment to determine the velocity of an air rifle pellet.

The precautions required to minimise the hazards in this particular experiment are, one would think, well known. Firstly the rifle or pistol used must be bolted to a baseboard or track with the barrel pointing straight down the track. Reputable school science equipment suppliers sell rifles or pistols with a hole drilled to take such a bolt or fitted with some other arrangement for firm, clamped alignment. Secondly a suitable safety screen(s) should be set up with pupils and teacher in 'safe' positions.

What Mr. MacInnes actually witnessed caused him and us great concern. The air rifle he saw in use was not bolted down nor did it have a hole in the stock to take a bolt because it had been supplied, on loan, by a pupil. Mr. MacInnes made a number of suggestions for the avoidance of such, potentially very hazardous, practices.

Firstly he suggested that the precautions outlined above should be requirements rather than recommendations. There is little we can do directly on this one except to suggest to regional authorities and/or individual schools that here is something for a mandatory note in any codes of practice. Secondly he asks that we give the incident and the necessary precautions proper publicity. This we are attempting to do with this safety note. Principal Teachers can assist us in this by drawing the attention of their colleagues to what is written here. Lastly, and we would heartily endorse this also, he states that in texts including this experiment, schematic diagrams or sketches which are a mixture of experimental detail and mere pretty illustration should not be published. A clear photograph or proper diagram showing the correct set up and separately, with due emphasis, a list of the precautions should be provided. Some of the suppliers' catalogues have set an excellent example here. Authors and publishers of science texts - take note.

Bell-jar implosion

We have received notice from a school physics department of a 'near-miss' in an experiment involving the evacuation of a bell jar. The experiment involved the well known (but theoretically dubious!) 'sound in a vacuum' exercise, using a bell suspended inside a bell jar on a pump plate with evacuation by a vacuum pump. In a routine demonstration the bell jar imploded suddenly without warning. Fortunately there was a clean collapse without any richochets of glass and no one was hurt.

This incident should serve as a timely reminder of the forseeable risk of implosion whenever such vessels are evacuated. In such demonstrations eye protection should be worn by the demonstrator. Two safety screens should be employed, one to protect the teacher and a second one to protect the pupils!

- and another 'near-miss'

This incident was reported by another school, this time it was a chemist's heart that missed a beat or two. The incident occurred during the disposal of an old sample of phosphorus pentachloride. Practically all the contents had been removed and safely disposed of, leaving only a small amount of a 'mushy' material (presumably phosphorus trichloride oxide) in the bottom of the bottle. Some water was added to this deposit and after some little time had passed, a delayed but then violent reaction occurred ejecting the contents of the bottle.

School texts lead us to expect the oxychloride to be much less reactive with water than the pentachloride; after all hydrolysis of the latter can stop at the oxychloride stage. Bretherick(1) reports that the initiation of the reaction between phosphorus trichloride oxide and water may well be delayed especially if:

(i) there is a lack of stirring or (ii) only limited amounts of water are used or
(iii) the mixture is kept too cold or (iv) is in a closed or virtually closed container.

It is also reported that a layer of the denser oxychloride can survive for several minutes under a layer of water before violent instantaneous hydrolysis occurs. One other possibility in this case is that the lower layer may have contained some dissolved phosphorus pentachloride.

We would thus draw attention to this potential hazard in the disposal of older samples of phosphorus pentachloride. One answer to the problem might be to rinse the residue from the confined space of a bottle by placing that bottle in a large bucket or basin and running warm water continually into it through a length of rubber tubing attached to a tap. This should ensure adequate agitation of the two phases. Clearly it would be most inadvisable to run any unhydrolysed phosphorus oxychloride into the relatively confined space of a drain.

With regard to the general problem of dealing with chemicals having a limited safe shelf life, we would point out that many such materials are available in small pack quantities. For example **Philip Harris** offer phosphorus pentachloride in either 100g or 4 x 25g containers.

Reference:

1. Bretherick, L., 'Handbook of Reactive Chemical Hazards' 2nd Edition (Butterworths, 1979) IS BN O 408 709278.

'Blazing Goggles'

No not a sequel to the well known movie! Our apologies for the flippancy of this heading (meant to draw your attention to an important and serious note, dear reader). **Griffin and George** wrote to us recently on an incident involving their safety goggles, catalogue number SAP-420. The incident happened when safety goggles were being used in a science lesson. We can't improve on Griffin's Technical Marketing Manager's prose and thus we quote:

"A smaller pupil had adjusted the headband of the goggles to fit and this left free strap protruding at the sides. During the lesson this free strap came into contact with a bunsen flame and it caught fire. Fortunately the pupil was not harmed but it does highlight a potential danger when goggles are being used by younger pupils.

To help prevent a similar incident occurring in the future we are arranging to make available packs of clips which will hold any loose strap close to the head after adjustment for head size of younger or older pupils.

I will send you details of the clips as soon as they are available - but in the mean time it would be advisable for teachers to check that any loose strap is tucked tidily away inside the headband, particularly with younger pupils".

Thanks!

We are grateful to the correspondents who took the time and trouble to write to us reporting these incidents. Often near misses are just as, or more, informative (and much less painful) than an actual accident. They also have the advantage that they indicate the need for action or precautions before the real thing happens and in less fortunate circumstances, someone gets hurt. We are always interested in receiving these reports and are quite happy to respect a school or teacher's wish to remain anonymous. The main thing is that others should benefit and be forewarned by someone else's nasty experience. As several speakers at a recent Scottish safety seminar pointed out, the three main ingredients of safety in science are common sense, awareness and information. We can't do very much to instil the first of these but we can encourage the second and disseminate the third.

'Safety in School Science' articles

By the time this Bulletin reaches the schools the **ASE** should have published a collection in one volume of the articles which have appeared in "Education in Science" over the last four years. Most of these have been reprinted in this bulletin, the last occasion being the article on disposal in Bulletin 131. SSSERC staff were closely involved in the ASE-convened group responsible for these articles. The articles have now been up-dated and amended in the light of comments received and ASE has produced them as an A4 size booklet some 60 pages in length. This is available from ASE headquarters at a price of £2.50 (with the usual 10% discount for members).

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Foundation Science Notes

The aim of this new section of the Bulletin is to assist teachers and technicians prepare for some of the more novel practical activities suggested for new courses at this level. Many of the currently suggested practical activities are well known and tried and tested. However some are less well known. Even with many of the familiar activities the background and characteristics of the pupils or the teaching methods adopted mean that a new approach may be required. Much of the material in this, and we hope in future issues, has arisen from work with and for pilot schools.

Pulse rate measurement

This is a suggested activity in the sub-topic of 'Your Heart and Blood' in the proposed compulsory topic 'Healthy Bodies'. There is nothing novel in making this measurement in schools but if it is to be made easier for the pupils, or if fairly rapid measurement is dictated by its inclusion as only one of a series of measurements in a 'fitness assessment' circus, then a new approach is needed.

The difficulty that some pupils have in finding, never mind counting, their own radial pulse is well known to experienced teachers. The fundamental mistake of using the thumb to monitor the pulse in the wrist is difficult to eradicate. Other difficulties such as in concentrating on a count over sixty seconds are also frequently met with. Some teachers are driven to the dubious expedient of letting pupils count for fifteen seconds only and multiplying by four (thereby jumping out of the cardinal frying pan into the ordinal fire!)

Whilst not suggesting for a minute that direct tactile monitoring of the pulse be completely abandoned, we do think that in certain circumstances an aid to rapid, reasonably accurate measurement could be very useful.

As far back as Bulletin 20 we described an elementary mechanical aid for demonstrating human pulse beat using a milk straw pointer on a drawing pin. In Bulletin 111 we published notes on a modification to this method whereby the milk straw was replaced by an optical pointer in the form of a chip of mirror. This method was shown to us by Dennis Belford, P.T. Biology at Liberton High, and originator also of the milk straw idea. These mechanical aids were fine for demonstration but were not entirely satisfactory in helping pupils having difficulty counting their pulse beats.

Fortunately an increasing interest in 'jogging' and other aspects of personal fitness has lead to the development of a number of instruments for the direct measurement of pulse rate. In Bulletin 108 we gave some information on the d-i-y pulse rate meter design published by the National Centre for School Technology (NCST). For a time we were also supplying schools with cyclostyled notes on our own modified version of this design. In our experience the design was intermittently unreliable due, we think, to problems in the integrator circuit. It was a bit like the girl with the curl, "when it was good it was very, very good but when it was bad it was horrid!"

Now some commercial items have come to our attention which, from our own assessment, appear reliable and at the time of writing are in the school price range. The first of these is a pulse monitor, catalogue number YTH-630-U at £30.00 from Griffin and George (see Fig. 1.).

Fig.1. Griffin Pulse Monitor

The second is a pulse rate meter PU-102 (see Fig. 2) from the specialist medical electronics firm of **Andrew Stephens and Co**. at £35.00 including VAT, post and packing.

The sensors of both of these commercial designs, and of the NCST d-i-y device, use the same basic principle. A light source such as a small bulb or light emitting diode (l.e.d.) and a photocell are so placed in a box, or a finger pickup device, that direct light cannot reach the sensor. However when a forefinger is held against both source and cell, light passing into the finger is reflected back by the bone and/or fingernail onto the cell. The

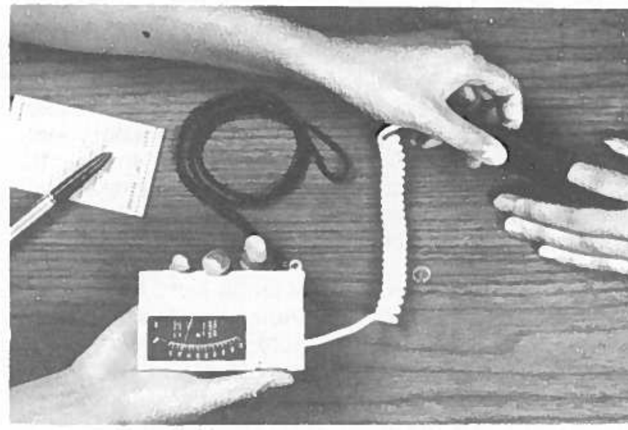

Fig. 2. PU−102 Pulse Rate Meter

light intensity reaching the cell changes each time the pulse beats because of the dilation of the small blood vessels in the light path. (An alterntive design of transducer uses an ear clip, with light source and photocell on either side of an ear lobe). (See Fig. 3).

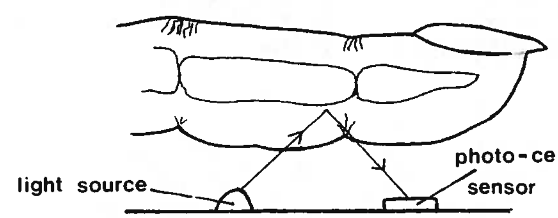

Fig. 3.

Because of the absorption spectrum of human tissue, it is largely infra-red radiation which penetrates and is reflected. The selection of a suitable light source and photocell takes this fact into account. There are a number of different ways in which the basic signal from the transducer may be treated and displayed.

In the Griffin pulse monitor the signal is used to trigger an audio circuit, the passage of each pulse beat producing a 'bleep' from an oscillator. It is then a simple matter to count 'bleeps' over a known period and if necessary calculate a rate in beats per minute. The slightly more expensive PU-102 from Stephens has a microlamp (or very small l.e.d.) which flashes with each pulse beat and also displays the rate in beats per minute on an analogue scale of range 40-200. Stephens also sell a more expensive pulse meter, the Bosco II monitor, which uses an ear lobe transducer. This gives a very sophisticated digital display with a microprocessor calculated average of rate based on the rate of the previous eight beats. It can also be switched to display the time for which measurements have been taken with the last pulse rate held in memory etc. Obviously this sophistication has its price and at the time of writing the Bosco II was ca. £70. For nearly all school based work the PU-102 from Stephens or the Griffin monitor would suffice.

We should perhaps sound one small word of warning about some of the pseudo-medical material in the booklets sold with meters also sold to the public. Much of this is inevitably grossly simplified and could just cause needless alarm in some of our more nervous or gullible pupils. By the same token the limitations of the meters themselves should be pointed out to pupils and any attempts at self diagnosis of conditions, real or imagined, be discouraged.

Petrol / Oxygen Explosion

In the core topic 'Energy' the sub-topic specification 'Sources of Energy' puts great emphasis on fossil fuels, their finite supply, alternatives etc. A very dramatic introduction to fossil fuels and the energy available from them is given by a demonstration of a petrol/oxygen explosion. We first described a safe method for such a demonstration in Bulletin 22. Work for a trial school has given rise to the simpler, more convenient set up illustrated in Fig. 4 below.

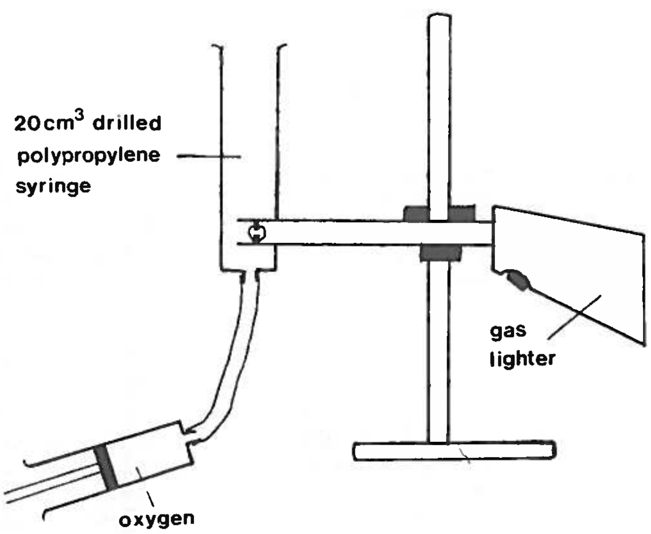

Fig. 4.

The original design involved heat sealing electrodes into the walls of a plastic syringe. This new version only requires the drilling of one hole in a 20cm³ polypropylene syringe. This hole should be slightly smaller than the diameter of the nozzle of the gas lighter used. In our current version we use a 10mm diameter hole to take the nozzle of a Plessey 'Magispark'. Obviously this dimension may be altered to suit the models of piezo-electric lighter available to the school. The mode of use is very simple. The 20cm³ syringe is placed in position on the clamped lighter. The 10cm³ syringe is filled with oxygen from a cylinder with a fine control valve using the short length of rubber tubing shown. This tubing is then coupled to the nozzle of the larger syringe. One or two **drops** of petroleum ether are then added to this syringe. 2cm³ or so of oxygen is then injected into the larger syringe and the gas lighter trigger operated. A very loud crack should result. Too much petroleum ether or too little oxygen will obviously give too 'rich' a mixture and consequently a poor bang. This is in itself a useful safety demonstration, illustrating just how little solvent vapour is needed for an explosive mixture. The parallels with the internal combustion engine are too obvious for further amplification here.

In our view the method described here is a very good example of a potentially hazardous demonstration made acceptably safe. The scale is small and plastic vessels minimise any possibilities and consequences of breakage. We have been careful in the design not to contain the energy of the explosion. Explosion demonstrations using closed vessels such as tins with tightly sealed lids etc. are in our view unnecessarily hazardous.

In a very large number of operations with the demonstration described here, we have never experienced any shattering of syringes. However, it may be wise to wear belt and braces and employ safety screens. Although they are only translucent, rather than transparent, polypropylene syringes (eg. **Macfarlane Robson** Cat. No. D41-580, state size when ordering) are preferable to polystyrene ones.

Polystyrene, should it shatter, forms more small jagged fragments. It should be obvious that no part of the apparatus described should use glass in its construction.

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Chemistry Notes

Silver nitrate

Because of recent high price levels for silver nitrate the reduction of the costs of using this compound has

become a topical subject. Discussion has tended to focus on three main possibilities: (a) reducing the scale of operations, (b) substituting other compounds for certain applications, (c) purchasing from the most inexpensive sources.
Obviously these actions are not mutually exclusive. A sensible policy would involve maximal exploitation of all three possibilities.

(a) **Reducing the scale**

Those parts of SEB syllabuses requiring the use of silver nitrate are readily identifiable. The quantities needed for each are amenable to estimation. Our own analysis suggests that the quantity required in a school year is not large and that this can be further reduced without any great difficulty.

In 'O', 'H' grade and CSYS chemistry courses we identified eleven topics where silver nitrate would normally be used. We also calculated the quantities required in an imaginary school with 12 'science' 4'O' grade and 2'H' grade groups (all with 20 pupils) with 12 CSYS students. The total quantity needed ranged from 60g to 90g the variation largely depending on the scale of one titration (see below).

One very obvious use of the reagent is in spot testing for halides. However many of these require no more than a few drops of reagent. Many pupils find the pouring from reagent bottles of small quantities very difficult. The use of dropping bottles can ease this difficulty considerably. A great variety of types of reagent dropping bottle is now available. Such bottles can be made up into small scale test kits. This aid to small scale work is not a new idea but it is perhaps not as widely used as it should be.

Several of the other identified uses of silver nitrate would lend themselves to some reduction of scale. However by far the largest use of the reagent will be for the estimation of iodide concentrations in supernatants in the investigation of the equilibrium between lead sulphate and sodium iodide solution. This use would consume the bulk of the 60 to 90g of silver nitrate needed in our imaginary school (as much as 50 per cent when 10cm^3 burettes are used). Whether 60 or 90g or some intermediate quantity is needed depends mostly on assumptions on the size of burette used in this one titration. Clearly there is scope here for a reduction of scale to make a significant saving in reagent costs. At the end of these 'Chemistry Notes' and in the 'Workshop' section details are given on the use and/or construction of micro-burettes which will allow a significant reduction of scale without undue loss of precision.

(b) **Substituting other compounds or reagents**

Some other applications apparently could lend themselves to substitution. For example, silver nitrate is sometimes used to make Tollen's reagent for test tube identification of reducing sugars or for distinguishing between aldehydes and ketones. The same reagent may also be used as a chromatographic locating agent for sugars. Only in the case of the tests for sugars are substitutes readily available (for example Fehling's, Benedict's or Barfoed's reagents). These reagents can each at a pinch be used as locating agents if dabbed (wear gloves and eye protection), rather than sprayed, onto the chromatogram and developed in an oven maintained at just over 100°C.

However both for use as a locating agent and as a aldehyde/ketone test, ammoniacal silver nitrate is hard to beat. It is a potentially hazardous reagent, explosions having occurred when it was handled carelessly or allowed to dry out. This however is an argument for educating people to handle it properly, not one for withdrawing it! The silver mirror test is a memorable and aesthetically pleasing exercise. Reliable substitutes as locating agents for sugars are themselves not without hazard. One, ammonium oxalate is not available as such and preparing it means mixing up a nasty brew of ammonium hydroxide and oxalic acid. The other convenient substitute, anisidine hydrochloride, is an aromatic amine and would need careful and restricted handling.

For yet other applications lead nitrate has been suggested as a useful substitute. It will certainly be suitable for distinguishing between chloride, bromide and iodide but only if both the lead nitrate and the halide solutions are sufficiently concentrated. (Lead chloride and bromide being reasonably soluble. Solubility products are 2×10^{-5} and 8×10^{-5} mol dm^{-3} respectively at 298°K). Generally, molar lead nitrate solutions are needed as against decimolar silver nitrate. This higher required concentration would offset any savings made by this substitution and since the amounts of silver nitrate needed for halide tests are very small, it is hardly worth replacing it for this purpose. Higher concentrations in this context involving lead, must add to the toxicity hazard and the pollution problems in final disposal. In any case, if at a later time a lead nitrate test was to be used in less controlled conditions, for example in the examination of some natural waters, it would probably fail (eg. chloride is not detected at less than 0.2M with molar lead nitrate). In addition, in such conditions sulphate ions might well be mistaken, by the unwary, for a chloride or a chromate (VIII) taken as an iodide.

(c) **Relatively cheaper sources**

At the time of writing purchasing from a less expensive source will effect a very significant saving. Two such sources, **Johnson Matthey** and **A. and J. Beveridge** identified in 'Trade News', Bulletin 130 are offering silver nitrate at very attractive prices.

Our imaginary school, would use just under 100g of silver nitrate in a year. At Johnson Matthey's June 1982 price 100g would cost the school £11.42 and a Region or school buying in bulk could buy a kilogram for £83.60. (No minimum order nor handling charge, and price includes delivery). For comparison prices quoted at the same time by two of the more usual suppliers, for 100g of a similar grade were £58.45 and £53.66. Against this is must be said that prices charged by these less expensive sources do fluctuate with movements in the precious metals market. Therefore any prospective buyer should check prices before ordering. Happily, at the time of writing Matthey's prices were still coming down (£11.42 per 100g at the end of June as against £21 in February). Clearly there is a chance here for some carefully timed buying and for a little sensible 'hoarding'. Certainly this kind of hoard would be more justified than many we have seen! Should the market again turn upward there obviously will be greater pressure to reduce scale or look to the use of substitutes.

Microburettes

By far the greatest expenditure on silver nitrate falls in titrations for CSYS work. The feasability of reducing the scale of these operations by the use of much smaller burettes was thus closely examined. One possible snag was the increasing percentage error due to readability alone with decreasing titration volumes. e.g.:

scale	readability error
50 x 0.1cm³	0.2%
10 x 0.1cm³	1%
5 x 0.02cm³	0.4%
2 x 0.02cm³	1%
1 x 0.01cm³	1%

Also for small titres it must be remembered that 'blanks', if not allowed for, will give rise to a larger percentage error.

As a first step, samples of commercial 1cm³ and 2cm³ microburettes were purchased and examined. Apart from their cost (£4.35 each) which was greater than the standard burettes normally used, they had other disadvantages. Even though the models tested were fitted with filler cups they developed airlocks and proved difficult to fill. D-i-y microburettes, based on graduated pipettes fitted with a rubber teat or a syringe, were then made. These proved much easier to fill and operate than the commercial versions.

The 'MkI' d-i-y microburette is simply a standard Class A or B, 1cm³ graduated pipette fitted with a rubber teat (Fig. 1).

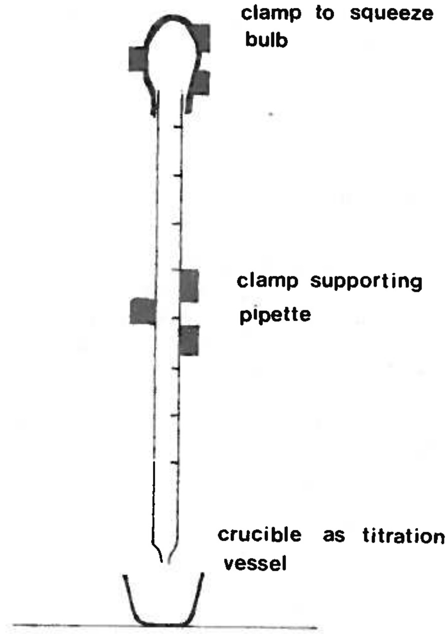


Fig. 1.

This is set up with the teat bulb held in the jaws of a laboratory clamp. It can then be filled by squeezing the bulb by tightening the clamp, whilst the pipette tip is below the surface of titrant, and then releasing. Slowly squeezing the bulb with the clamp gives a fine control and each 0.01cm³ could, with practice, be delivered in four or five portions.

The size of a drop is large compared with the graduations and problems caused by this are overcome by having the tip dipping below the surface of the solution which is stirred, or by washing off each portion expelled. In the MkII version the titrant level is controlled by a modified 1cm³ syringe attached to the top of the pipette. (Fig. 2).

Turning the screw thread slowly depresses the syringe plunger which in turn displaces the liquid. Constructional details are given in the 'Workshop' section of this bulletin.

The accuracy of this home made version and the two commercial burettes were compared by weighing 0.50

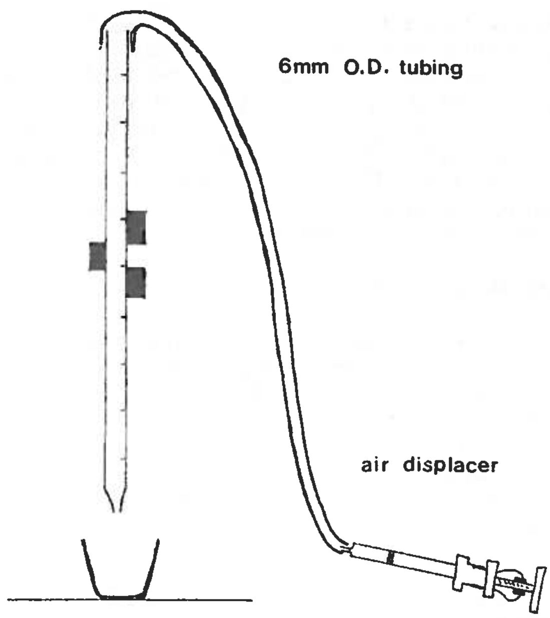


Fig. 2.

± 0.005cm³ water at 20°C. The averages for six readings are shown in Table 1 below:

Apparatus	Calibrated	Average value(g)	Range(g)
Commercial burette 'B' grade	1x0.01cm³	0.4968	0.4964-0.4978
	2x0.01cm³	0.4969	0.4936-0.5020
D-i-y from 'B' grade pipette	1x0.01cm³	0.4979	0.4928-0.5006

Note: Given the density of water at 20°C as 0.99821cm ³ the expected weight of water was 0.4991g.

TABLE 1

The two homemade burettes were also compared with a commercial 50cm³ burette for titration of acid against alkali and silver nitrate against chloride using (i) potassium chromate (VI) indicator (Mohr's method) and (ii) using an absorption indicator. Twenty six readings of each were taken. The results of the silver nitrate against chloride titrations are shown in Table 2 below. Mean and standard deviation are given for each of the two methods, for each type of titration apparatus.

0.1M $KCl/AgNO_3$				
Method	'Chromate' indicator (Mohr's method)		fluorescein indicator	
	Mean(cm³)	Standard deviation	Mean	Standard deviation
Large scale. 50x0.1cm³ burette	9.99*	0.07986	9.93	0.03059
Small scale. MkI d-i-y microburette/pipette 1x0.01cm³	0.522*	0.002891	0.509	0.00833
Small scale. MkII d-i-y microburette/pipette 1x0.01cm³	0.519*	0.005295	0.507	0.003249

TABLE 2 (*Figures adjusted to allow for 'blanks').

Interfacing Notes

Titration Curves

In our view experimentation in school science should serve the following functions:

a) to display with clarity the physical principles involved,

b) to actively encourage the pupil to experiment further,

c) to allow the pupil to put to the test his understanding of concepts,

(these are listed in a hierarchical order).

It is often in the nature of the game that experimentation doesn't get beyond, or even reach, the first level. We believe that computer interfacing can make all three levels more readily attainable. We seek here to illustrate this point by describing an interfaced experiment on drawing titration curves (pH versus time). It should perhaps be stressed at the outset that the purpose of this article is not to teach chemists to suck eggs! Little is said about the more technical points that can be drawn from the titration curves themselves. These are already well known to chemistry teachers.

Some experiments lend themselves readily to interfacing, others may not. We seek here merely to illustrate some of the general features of experimental work that may make rewarding the insertion of a computer into the experimental system.

Recording system

The principle of operation is that the pH of a liquid is converted to a voltage, this voltage is changed into a digital signal and that digital signal is read by the microcomputer at its I/O port (Fig.1). The pH meter used should be one which has a voltage output for chart recorder use. We used a WPA C14 meter.

D-i-y analogue to digital converters (ADC) and the programming are described in detail in an MCC publication prepared at SSSERC and at the time of writing in the press (1). Any model of micro-computer which has an I/O port can be used. The BBC model B has an on-board ADC and so will not need the device referred to above. The model B looks to be very handy for experimental work of this nature always providing you can get your hands on one!

Experimental details

The microcomputer should be programmed to record data at a regular rate. We program ours to record a series of 40 readings. The success of the experiment depends on the rate of data capture chosen, which itself depends on the rate at which the reaction occurs, the concentration of reactants, the properties of the burette and the rate of response of the probe to changes in pH. (Tables 1 and 2).

The data gathering and display part of the program is relatively short. Altering the sampling rate involves changing only one line. This core of the program is thus general purpose. Data capture rates can readily be altered to suit other applications. Further tailoring is open to the individual teacher by the addition of the necessary 'print' statements.

In our arrangement the base is titrated into the acid (Fig.2). One can therefore conveniently change the acid being titrated. A magnetic stirrer is used and the pH combination electrode should be carefully positioned to avoid damage to its sensitive end from the stirrer bar.

One of the recurrent problems in 'automating' the plotting of titration curves has been the variation of flow rate from the burette as the liquid level falls and the 'head' diminishes. In the past, often this led to the use of various constant-flow devices. These took the form of d-i-y syringe drives or a second burette emptying into the first. In our experiments, data capture and production were tuned. The duration of each titration was usually such that only the top third of the burette was used each time. Since the experiments were also essentially qualitative, topping up the burette between titrations was thought sufficient.

Date capture should begin immediately on opening

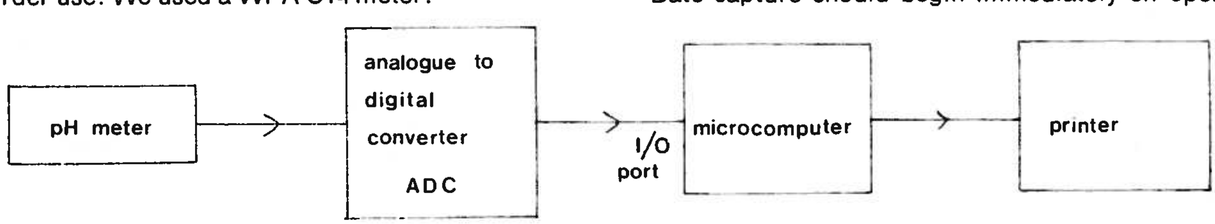


Fig. 1

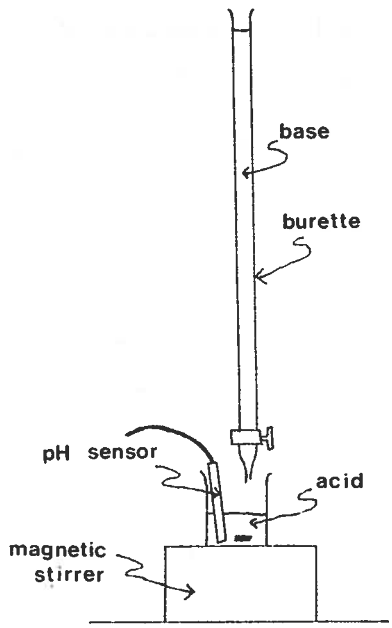


Fig. 2.

the burette tap. When this is over the gathered data is displayed and then the titration graph is drawn on the screen. A printer, if available, is used to enable pupils to obtain a hard copy. Screen display is ephemeral. Data recalled from memory is transitory. It is valuable to provide a hard copy so that pupils can take away a record to mull over later. Some computer systems have a mechanism for dumping screen contents onto a printer. The method consists of reading screen memory and printing out, address by address, whatever is stored therein (1). Three titration curves, reduced copies of print-outs produced by this method, are shown in Fig.3. The horizontal axis is time and the vertical pH units. Curves (a) and (b) have the same time scale. Curve (c) took approximately twice as long.

Discussion

Further sophistication could have been introduced of course, by using the control facilities offered by the computer. A device using a stepper motor or peristaltic pump controlled via the computer could solve the constant flow problem. However at present we are not sure that such extra sophistication is warranted here. It may be pointless to remove one relatively simple

CHEMICAL		CONCENTRATION (M)	SAMPLE VOLUME (cm^3)
'TYPE'	NAME		
strong base	sodium hydroxide	0.5	-
strong acid	hydrochloric acid	0.1	25
weak acid	ethanoic acid (acetic)	0.1	25
tribasic acid	orthophosphoric acid	0.1	25

TABLE 1.

TYPE OF TITRATION	DURATION OF DATA CAPTURE (s)
strong base - strong acid	16
strong base - weak acid	16
strong base - tribasic acid	24-36

TABLE 2.

technical difficulty by introducing what may be undue complication. Whilst it may seem bizarre to some to combine burette and computer, the burette at least has the virtues of familiarity and a clear mode of operation. (We are still thinking about this one!).

Some might also argue that, as it stands, the experiment could just as easily be carried out using a suitable chart recorder. However, the chart recorder is not an 'intelligent' terminal and cannot present instructions nor questions to the pupil nor can it carry out an analysis of results. Particular models of chart recorder may be needed to suit signal levels or rates of data production. The analogue to digital techniques used here can be used to capture, process and display data in a very wide range of applictions. They are general purpose. The point which emerges is that the power of the computer lies not so much in its ability to perform any one particular function, as in its ability to perform such a wide variety of tasks at any one time.

Some important features of computer interfacing to science apparatus are clearly shown by this experiment:

a) the experimentation is relatively easy. Obtaining titration curves by other means is not, at school level.

b) the time taken in obtaining a titration curve is relatively short. In all it takes about three minutes per titration. There is ample time for many such titrations in one lesson.

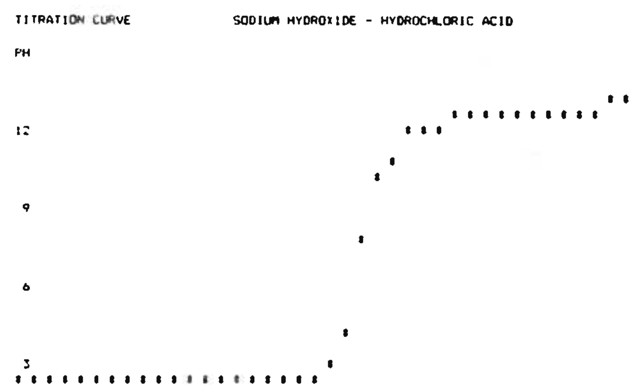
c) the 'noise' factor is slight. At one end of the process the pupil is titrating chemicals. At the other end he obtains a printout of his data. There is little in-between which takes away the immediacy of the data from the titration.

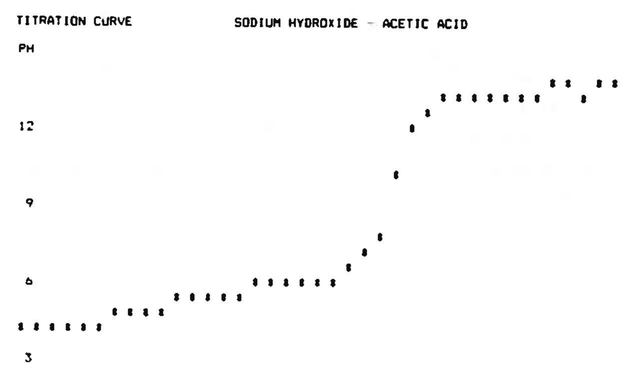
d) data is presented in a form which is immediately ready for analysis. Indeed the data handling capacity of the computer could easily be further exploited. For example plots of the differential, change in pH against change in time, could easily be added. It doesn't take much imagination to see how useful these plots might be, yet they would be exceedingly tedious if prepared manually.

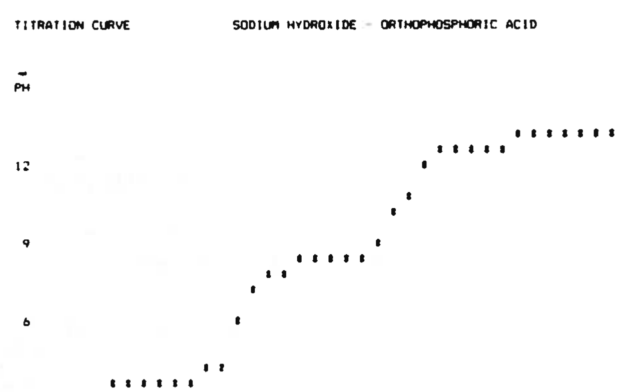
The naive experimenter might initially expect when a base is titrated with an acid that the pH would creep up gradually. That this is not so (Fig.3(a)) is an immediate confrontation between poorly conceived concepts on the one hand and reality on the other. Experimentation should be provocative. It should make the pupil seek to understand. It should also prompt the pupil to experiment further in order to put to the test his understanding of concepts. This experiment is of that nature. The ease and slickness of the procedure coupled with the clarity of results encourage further work. What happens if we dilute the acid? What happens if we dilute the base? What happens if we change the titration volume? What, exactly, do we mean by strong, weak, concentrated, dilute? The essence of knowledge lies in asking questions. The essence of experimentation lies in prompting those questions.

Reference:

1. "Interfacing techniques", MCC publication. In the press, publication due Autumn, 1982.







Surplus Equipment Offer

The following items of equipment are offered for sale, subject to the conditions laid out in Bulletin 116. We would ask prospective buyers to read and note these conditions so that unnecessary paper and telephone work may be avoided. Items with numbers less than 173 have already appeared in previous bulletin issues and details of them can be found in the relevant issue (number given in list). These items are not now subject to the ballot procedure. Items with numbers greater than 172 are those inlcuded in this present ballot. As with the last ballot in Bulletin 129 we will allow for delay in bulletin distribution. The ballot will not be held until three weeks after we judge that bulletins have reached the schools.

Item 1.	Bulletin 116.	B/w photographic film 35mm 3m lengths, 25p.
Item 6.	Bulletin 116.	Polaroid film, 15p.
Item 50.	Bulletin 116.	Bottle brushes, 3p.
Item 84.	Bulletin 125.	Photographic fixer, 30p.
Item 88.	Bulletin 125.	Dry cells 3V, 15p.
Item 89.	Bulletin 126.	Dry cells 1½V, 2 for 15p, 4 for £1.50, Gross £8.00
Item 122.	Bulletin 128.	Mains heater, £3.00.
Item 127.	Bulletin 128.	Griffin and George ionisation chambers, 50p.
Item 135.	Bulletin 128.	Electrolytic capacitors, 5-50p.
Item 136.	Bulletin 128.	Mains suppressors, 25p.
Item 137.	Bulletin 128.	Nixie tubes, 25p.
Item 138.	Bulletin 128.	Glass cartridge fuses 2A, 2p.
Item 150.	Bulletin 129.	S/S film washing tanks, £5.00.
Item 151.	Bulletin 129.	Photo print trimmers, £5.00
Item 155.	Bulletin 129.	Photo print lacquer, £1.00.
Item 158.	Bulletin 129.	Ilford developer, 10p.
Item 159.	Bulletin 129.	Ilford fixer, 30p.
Item 165.	Bulletin 129.	Bimetallic strip 30cm, 40p.

The following equipment is included in the ballot:

Item 173. Moving coil microphones (new in boxes). 50p.

Item 174. Hand communication sets with built in amplifiers and buzzers (each set requires a 4½V battery i.e. Duracell px21 Alkaline or TR-133N Mercury). Set of 2, £5.00.

Item 175. Megger insulation tester. £5.00.

Item 176. Impact adhesive by Dunlop, Semtex LRD (non-flammable - low toxicity) ½l tins. 75p.

Item 177. Photographic paper Veribrom 30.5cmx40.6cm, box of 100 sheets. £18.00.

Item 178. Photographic paper Bromide WSG4 6½x8½''. £5.00.

Item 179. Photographic paper Bromide WSG 2 20.3x25.4cm (10x8). £6.00.

Item 180. Photographic paper Bromide WSG 1 20.3x25.4 (10x8). £6.00.

Item 181. Photographic paper Bromide WSG 2 18.5x21.6 (6½x8½). £5.00.

Item 182. Photographic paper Bromide WSG 1 5½x5½''. £3.00.

Item 183. 35mm b/w film ca. 60-80 (ASA) 1000ft. reels. £5.00.

Item 184. 16mm Ektachrome video news film 125 ASA 122m. £5.00.

Item 185. 35mm Eastman colour negative 121 film 100ASA 61m. £10.00.

Item 186. 35mm Kodak Ektachrome slide duplicating film, process E6,100ft. £5.00.

Item 187. 120 b/w film H.P.4 400ASA Ilford. £0.25p.

Item 188. Weston exposure meters. These meters are in need of repair and calibration. We give below the name of a firm who will repair and calibrate and give a guarantee for £16.90.* £5.00.

Item 189. Kodak, DX80 film developer 2.7l. £2.50.

Item 190. Kodak D19 developer (powder) (To make 5l). £2.00.

Item 191. Super Amfix highspeed fixer (5l). £2.00.

Item 192 Veribrom R.C. fixer (5l). £1.50.

Item 193. Speed dry marking ink (Black). 50p.

Item 194. Oscilloscope double beam Tectronix 535A, time base A: 0.1 μs-5s/cm in 24 calibrated steps, uncalibrated sweep 0.1 μs-12s/cm, timebase B: 2 μs-1s/cm in 18 calibrated steps. Vertical sweep, bandpass DC to 15MHz (3db at 15MHz + 0.5db). Rise time 0.012 μs. £45.00.

Item 195(a) Signal generators advance J1A. £20.00.

Item 195(b). Signal generators advance J1A as above but cases need some repainting work. £15.00.

Item 196. Electronic calculators (desk type). £5.00.

Item 197. Electronic calculators (desk type). £3.00.

Item 198. Typewriters - manual. £8.00.

Item 199. Teleprinters (Creed) in working order £10.00.

Item 200. Right angled torches complete with batteries and bulb. £1.00.

Item 201. Perspex offcuts clear or coloured ca. 48x18'' £2.50 per sheet or £20.00 per 25kg

Item 202. Stereo headsets with microphone by Air-lite. £2.00.

Item 203. Headsets with microphone and built in amplifier. £2.00.

Item 204. Small Chart recorder by Elliot in original boxes unused. Approx. 275x137x237mm. Calibrated width of chart scale 75mm. Synchronous clockwork motor (therefore portable and independent of mains supply) driving paper at relatively slow speeds (chart speed on samples tested was $30cmh^{-1}$). Recording mechanism is a d.c. moving coil device with a f.s.d. of 1mA driving a syphon pen. Capacity of ink trough - 30 days use. Complete with 6 chart rolls, bottle of ink, ink filler and spare pens. Looks ideal for long term recording, especially in the field. £10.00.

Item 205. Kodak, b/w multipurpose paper developer for bromide and veribrom papers. 51 bottle. £3.00.

Note: Items 206 and 207 below are fresh stock and are 'in-date'.

Item 206. Ilfospeed b/w paper developer 51 bottle. £3.50.

Item 207. Ilfospeed fixer 51 bottle. £2.50.

Item 208. Kodak E6 (current process) Ektachrome colour transparency processing kit. £2.50.

*Weston meter repairs - including parts, recalibration, carriage and guarantee £16.90 (cheque with order) from **Instrument Services Co (London) Limited**. This means that a virtually new meter will cost the school ca. £22 against the normal £35-£40 retail price.

* * * *

In the Workshop

Microburettes

Construction of the MkI d-i-y microburette involves nothing more elaborate than the fitting of a rubber pipette teat to a graduated $1cm^3$ pipette costing approximately 60p. The MkII with its 'air displacer' is more complicated and its construction is thus described below. A diagramatic section of the complete 'displacer' is given in Fig.1.

The device is based on a disposable syringe with a screw thread driven piston replacing the original plastic one, so giving a finer control. The piston assembly is removed from a $1cm^3$ disposable syringe and the 'rubber' piston on the end carefully detached. One end of an 120mm length of 2BA threaded brass studding was then machined to accommodate this rubber piston and the other end fitted with a circular control knob. This knob is a disc approximately 5mm thick and 25mm in diameter and can be in brass, wood or plastic.

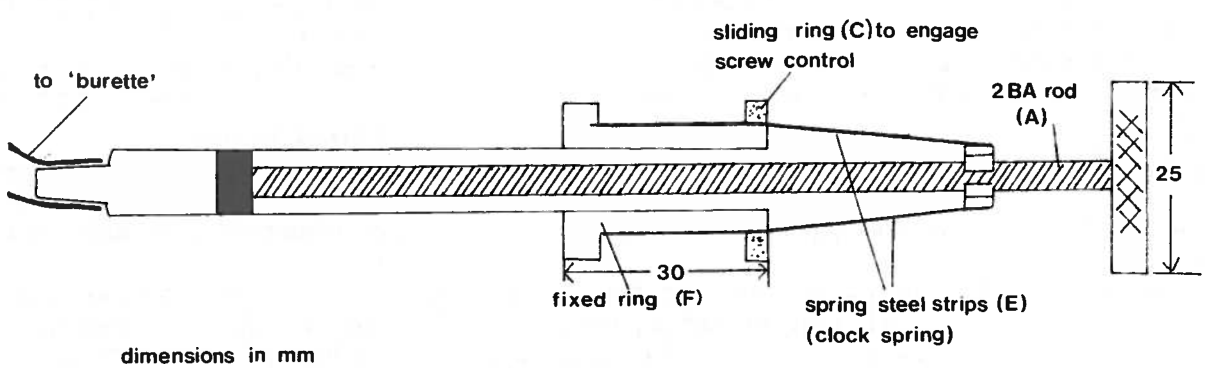


Fig.1.

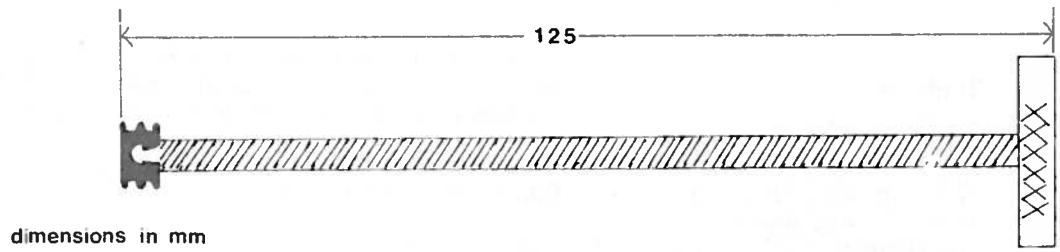


Fig.2.

Syringes do vary slightly in their internal dimensions. We found it necessary with one make, to slightly file down the threaded rod at the end nearest the plunger so that it could move freely inside the syringe barrel. (Alternatively a thinner rod, 4BA, could be used but would be less robust).

Rotating the control knob drives the rod (A In Figs. 1-3) in a 2BA nut so moving the piston in or out of the syringe barrel. Filling the burette by this means would be painfully slow so a mechanism for disengaging the plunger is provided for rapid filling. The 2BA nut (B) is in two halves so that it can be made to close or open, and so engage or disengage the threads on the rod, by sliding the brass ring (C) away or towards the nozzle end of the syringe. This is shown in more detail in Fig. 3.

The sliding ring moves up and down on a piece of 12.5mm brass rod (D) drilled out to fit the syringe used. The diameter of hole required varies, not only with the model of syringe. Particular syringes may be somewhat tapered along their length. A slightly undersize hole should therefore be drilled to ensure a tight fit. Two 'flats' are then made on opposing sides of this rod, of such a size as to permit the brass ring (C), of internal diameter 12.5mm, to slide over two spring steel strips (E) resting on top of the flats. The dimensions of these flats clearly depend on the spring steel used. This latter is not critical but that used in our models was 5mm wide and approximately 0.4mm thick. The spring strips are held under a second brass ring (F) soldered in position at the nozzle end of the assembly. The 2BA nut can be split down its centre by screwing it onto a spare piece of 2BA studding. Rod and nut can then be clamped in the vice and both cut with a small hacksaw. Each half of the nut is then soldered to the ends of the spring strips which are bent to the shape required to allow the action of the ring(C) to engage or disengage the nut on the threaded rod (A).

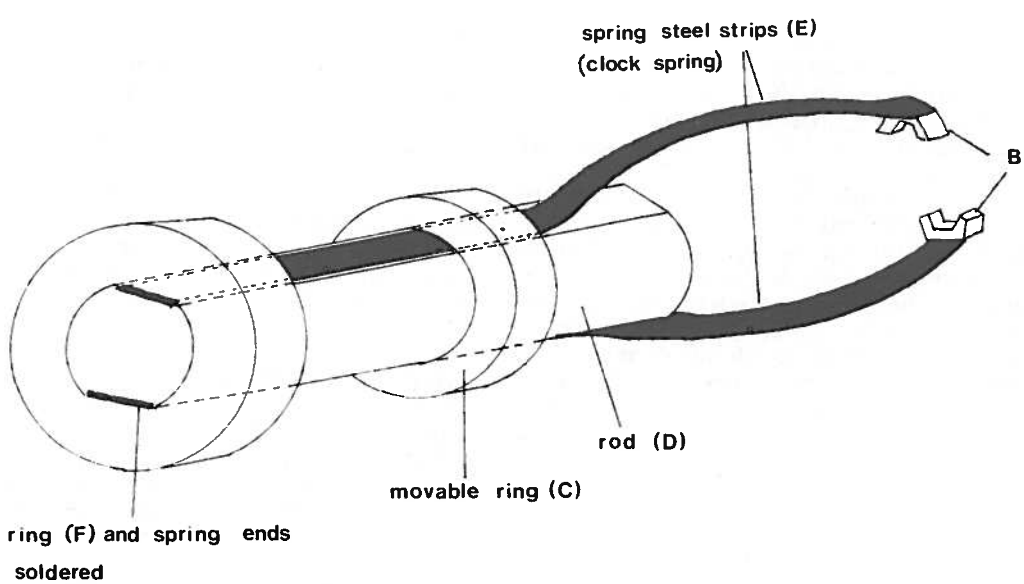


Fig.3.

Trade News

M.L.I.

Over the last year or so we have had a number of requests for information on the whereabouts of M.L.I. (Morris Laboratory Instruments). Unfortunately we have to inform any of our readership who are seeking spares for, or repairs to, M.L.I. equipment that this firm has ceased trading. They were taken over by another firm named Hanovia who now trade out of the last address occupied by M.L.I. However this address will be of little use to teachers since **Hanovia** informed us that, they were "only trading with hospitals at the moment".

I.T.T.

I.T.T. Electronic Services, a source of unmounted panel meters and a wide range of components and instruments, have recently moved to the address given on the inside front cover of this Bulletin.

Inexpensive sources

A number of these have come to our attention recently. For example **Balmain Instruments** are selling two highly competitive ranges of ovens, incubators and incubator/sterilisers at prices of ca. £100-£160 depending on size and lining materials etc. Most of these units have a 2 year guarantee on the elements with one or two having a 3 year warranty.

SSI (Semiconductor Supplies International) Ltd

'Special Products Division' are a source of inexpensive meters. For example analogue multi-range meters are offered at ca. £5.00 for a simple 'pocket' model up to £30 or so for a bench sized model with a very full specification. In all, 20 different models are available within the price range of £5 to £30. Two l.c.d. digital models (3½ digits) are also available. The DM6011A has a total of sixteen ranges and includes an HFE test facility, for distinguishing PNP/NPN transistors, and a diode check facility. It has automatic polarity indication and zero adjustment. This model costs £41 for one off or £31 each for five or more. A simpler but similar model is the DD601 at £34.50 one off and £26 for 5 or more. We bought the same model of meter as the DM6011A some time ago and are well pleased with it. However ours cost £43.50 for one off and was called a model 3T! For those who prefer to buy close to home we give the address of our Glasgow supplier in the address list. They were **Industrial and Biological Electronics** as agents for a firm called Centemp.

SSI's unmounted panel meters also appear to offer excellent value. Small (32x32mm) 'Quick-Fit' meters in a variety of ranges from 0-50µA up to 0-5 amp are priced at £2-£4 one off with other models in larger sizes available at £4.30 to £6.00 (these versions are 82x109x32mm and are available in micro-amp ranges only).

Fume cupboard monitor

We have recently received an evaluation sample of a relatively inexpensive monitor from **Harwood Products Limited**. At £33, including post and packing this may be of interest to science advisers or teachers' centres or even individual schools. The monitor is an anemometer of the hot-wire type with the wire mounted in the end of a short aluminium tube. The read out is a novel and somewhat ingenious l.e.d. bar graph display. This reads in steps from 0.1 to 0.9ms . The monitor comes complete with a mains adaptor fitted with a lightweight 2 metre lead. Alternatively it may be powered by a PP9 cell, the leads and connectors for this being available as an extra at £1.

We compared readings from this Harwood monitor with those of our own more expensive air-flow meter and found close agreement in a variety of air speeds at ambient temperature. However increasing the air temperature by 4°C caused a significant decrease in the reading (fell from 0.8-0.9ms^{-1} to 0.6-0.5ms^{-1}) of the Harwood model with that from our own model remaining largely unchanged.

If our own sample was typical, then some care would have to be exercised in the use of the monitor and the interpretation of results. The other limitation of this monitor stems in a way from one of its virtues. The instrument has a relatively slow response which provides some 'damping' of the display so that the readings lack a lot of the jerkiness of more responsive (and more expensive) meters. This makes for ease of use, but limits the monitor's applications. For example it may be inadequate for detailed analysis of air flow rates at different points across the face of a cupboard.

Against these limitations must be set the relatively low cost of the monitor and its ease of use. As a device for a quick check on fume cupboard performance, which can be afforded in greater numbers than meters for more detailed analyses, at £33 it is probably a 'good buy'.

Biological 'Special offer'

John S Galbraith, Marine Biological Supplies have available a large quantity of starfish (**Asteria** sp., average 10-15cm diameter) water vascular system latex injected (red). These are grade 'B' quality, perfectly preserved but some have broken arms or insufficient latex to fully extend the tube feet, and cannot therefore be sold as perfect. These are being offered at 10 for £1.00 (plus post and packing) and should provide very useful but inexpensive dissection specimens.

THE BRITISH COUNCIL

Specialist Course

Technical Education at Secondary Level:
Strategies and Trends in Curriculum Development

20-31 March 1983 in Dundee

Technical Education in this context is the study and practice of craftwork in wood, metal and plastics; technology (eg applied mechanics, electrical and electronic devices, heat engines) and drawing as a means of communication. Secondary level means children aged between 11 and 17 or 18 years.

The course will be under the direction of **Mr John A R Hughes OBE** and **Mr Donald C Fraser**, respectively Director and Assistant Director of the Dundee Centre of the Scottish Curriculum Development Service. The Centre is located on the campus of Dundee College of Education where most of the course will be held. The Centre has been associated with a number of successful development projects in mathematics, science and technical education, such as Modular Mathematics, Mathematics for General Education, Scottish Integrated Science and Scottish Technical Education Modules.

The course is designed for those involved in various aspects of curriculum development in technical education (as defined above) such as officers of curriculum branches of ministries or departments of education; staff of curriculum development centres; inspectors and advisers; staff in colleges of education, technical colleges, university departments of education; senior teachers. The over-riding qualification is that they should be engaged in planning and decision-making in the field of curriculum development in technical education.

There are vacancies for 30 members.

Fee: £447 (Residential): £260 (Non-residential)

Residential members will be accommodated in a hall of residence.

Applicants are advised to apply before 30 November 1982.

Further information and application forms for this, and other British Council specialist courses, can be obtained from your local British Council office or from the Director, Courses Department. The British Council, 65 Davies Street, London W1Y 2AA.

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

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August 1982.