SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No. 89. June, 1976.

Contents

Introduction

We have recently sent to biologists and a number of other subscribers in the U.K. a copy of our revised biology equipment list. We have tried to reduce our costs by restricting circulation to principal teachers of biology, regional education offices and manufacturers. However, anyone from abroad who wishes to have a copy of the list should send us 15p (or the equivalent in their own currency) with, please, a clearly printed address in BLOCK CAPITALS, and the list will be sent to them. The same charge, which includes postage, will apply to anyone who is not on our circulation list, or requires additional copies.

The list purports to cover the needs of a biology laboratory up to 'H' grade. All prices were current in January, 1976 which is why the list carries that date. We have usually tried to quote at least two suppliers to give some idea of the price differences which are possible. When the arithmetic is done, multiplying the pupil scale apparatus by 10, (i.e. assuming a class of 20 working in pairs), always taking the lower of the two costs for an item, and the smallest number of items where numbers are given, we find that an approximate minimum figure for equipping up to 'H' grade is £2,750. However, like the trade figures, there are some "invisibles" which require explanation.

The total includes many items which are also required for Integrated Science, for example 10 '0' grade microscopes. An approximate figure for these I.S. elements in the list, computed as described above, is £900. Therefore in schools where integrated science is taught the additional cost of equipping a laboratory for '0' and 'H' grade biology, i.e. for years 3 - 5 would be in the region of £1,850. This total would be lower if the three science departments can co-operate fully in sharing arrangements. The cost of basic equipment has also to be taken into account. We have excluded from the biology list items of equipment which are common to any laboratory whatever its function, such as burners, retort stands, test-tubes etc. A revised basic equipment list, which includes such expensive items as top-pan balances was issued in May, 1975.

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In our last bulletin we offered a number of chemicals, and these have now been allocated. Over 100 requests were received and only 15 were wholly unsuccessful in the ballot. These people have been notified but we have not informed those who have been allocated chemicals; it is assumed that they will get in touch with us to learn how much of their order has been fulfilled and to arrange for its collection. We are at the moment very short of boxes and we would appeal to anyone who still has material here awaiting collection to bring some kind of container for it.

It was noticeable that despite the recommendation in the bulletin, nearly a third of those applying did not endorse their envelope on the outside with the word 'Chemicals'. We point this out because this bulletin also offers surplus equipment in its Physics Notes section. This will also be disposed of by ballot, and we warn those who wish to apply for any items that if the

numbers of these items are not written on the outside of the envelope they may be overlooked and not included in the ballot.

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Our cost index of items of consumable apparatus (= 100 in may, 1974) now stands (5/5/76) at 144.1. This is an increase of 3.8% over the past half year.

Opinion

A recent radio news magazine programme raised the question of whether children in school laboratories are more at risk now than they were a few years ago. Two reasons were put forward; firstly that with mixed ability learning becoming more common, less able children, including the illiterate, were placed in contact with hazardous substances in conditions of less strict supervision. Doubtless there is some truth in this assertion, as it appears to be part of the ethos of mixed ability learning that the strong, who are not necessarily the best informed, should help the weak. Secondly, that with the trend to comprehensive education - by which I think the author meant integrated science teaching - teachers were less well qualified in the subjects they were asked to teach and therefore less knowledgeable on safety procedures.

In the programme I heard, a teacher from an English school had written refuting these allegations, claiming that the D.E.S. and the A.S.E. kept him up to date on safety techniques, and that the shortage of science teachers was the reason for employing poorly qualified or non-specialist teachers. However valid these assertions may be in the English situation, one should be wary of applying them to Scotland. I wish I could feel as secure as he does that my knowledge of safety procedures was up to date, and being kept up to date by the organisations referred to. For Scotland at least, his argument about non-specialist teachers might seem to have been stood on its head. A chat with one or two College of Education lecturers will soon show that there is evidence for the belief that if there is a shortage of science teachers, or of the right calibre of science teacher, one of the reasons is that these people know they will be expected to teach integrated science for which their university training has not fitted them.

One aspect of this non-specialisation is particularly alarming to a non-biologist. This is the extent to which microbiology is seen as a fitting project for non-certificate pupils in SIII and SIV. Human nature being what it is, it is often the less experienced teacher who is given these pupils to teach, and even although he/she may be a biologist, it is doubtful if they are sufficiently aware of the need for stringent safety procedures. The Microbiology in Schools Advisory Committee is concerned about the situation, and will shortly publish a document which, amongst other things will attempt to classify organisms into three groups:

A Those organisms which can be used in schools with little if any risk, e.g. algae, non-pathogenic yeasts and protozoa.

B Those organisms for which the risk in use is acceptable, assuming elementary precautions.

C Those organisms unacceptable for school use, including all pathogens.

Obviously there is a blurred area between groups B and C, which will extend although it can never clear, as our knowledge of the effects of these organisms grows. For example, S. marcescens is a bacterium with coloured strains which have proved useful as 'markers' in a number of school microbiology experiments. Some time ago it was reported that S. marcescens had been implicated in human disease in the United States and that it has a high propensity for producing antibiotic resistant strains. This caused the withdrawal of S. marcescens from some suppliers' catalogues, and the suggestion from some quarters that Chromobacterium violaceum would be a suitable substitute. This was quickly followed by reports that C. violaceum is also suspected of pathogenicity. The present position can be summarised by these extracts from our recent correspondence.

"... in the HMSO pamphlet "The Use of Micro-organisms in School Courses" (to be published later this year), Serratia marcescens, Chromobacterium violaceum, and Pseudomonas aeruginosa appear in a list as unsuitable for use with pupils of compulsory school age. The MISAC advice is, therefore, that they are not used at all. Chromobacterium lividum has been suggested as a suitable replacement for S. marcescens, but whether this is to be included in the HMSO pamphlet we do not know." It is perhaps worth noting in passing that Pseudomonas aeruginosa was included in the CSYS Biology syllabus (Unit 4), when this was finalised as recently as last year.

This kind of situation is not new in schools. It is some years since a code of practice for the use of radio-active substances was set up. This classifies sources according to type and level of activity, and requires that teachers wishing to work at certain levels qualify through attending courses in which safety procedures are prominent. The S.E.D. has issued one circular on the use of carcinogenic substances in schools and this will doubtless be followed by others as our knowledge of carcinogenic effects grows. Is it not time that we considered adopting a similar procedure in the case of microbiology? I would like to see the situation in which every teacher wishing to work with MISAC groups B or C was required to attend a qualifying course, in the same way as for radio-active substances. Otherwise, the conjunction of inexperienced teacher, ill-disciplined class, and possible pathogenic organisms is a recipe leading to a disaster of epidemic proportions. Some school courses encourage teachers to culture unknown bacteria from soil or mammalian excreta. We know of one case where a pathogenic strain of Salmonella was cultured to highly infective levels, being discovered when the culture was taken to a pathology laboratory for identification; this occurred in a primary school!

If the radio-active source handlers require qualification through an in-service safety course, surely so do teachers culturing unknown bacteria. Even with known organisms the risk is greater, due to the possibility of mutation. If a mutant gene occurs once in every 10^n generations, then schools culturing colonies of 10^{n-1} individuals must sooner or later throw up a mutant. The more mutants we produce, the greater the chance of an escape due to inadequate safety procedures. One wonders how many biologists, let alone other

teachers, know that current authoritative advice is against the use of the popular Escherichia coli in any experiment involving antibiotics, because of the risk of selecting the resistant strains. One might question whether in some classes microbiology should be taught at all, even with experienced and qualified teachers. Lifting the lid of a petri dish must seem a very harmless act to a pupil, or to those who have resisted the smoking/lung cancer campaign, it may seem to be an acceptable risk.

Biology Notes

Under new consumer legislation it is now illegal to sell the glass envelope type of aquarium heater, although it is still permissible to use those already in schools. This is because they are classed as immersion heaters, which they are, and as such they have to meet the appropriate British Standard which requires double insulation. The glass envelope and air layer do not qualify as double insulation. Manufacturers are working on new designs which will meet the requirements but as far as we are aware these have yet to be finalised.

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We have a note from Thurso Technical College intimating a source of 100 ml containers. These are "disposable baby bottles collected from our local maternity hospital. These bottles we have found to be ideal for Drosophila culture as the medium can be sterilised with the teat top as a seal and the plug sterilised separately. It is then possible to store large numbers of prepared bottles without having to make large numbers of cotton wool plugs - only the bottles in use being plugged. The bottles can also be used for water culture experiments quite easily".

"We have managed to arrange with our local maternity unit that we collect the washed bottles from them at regular intervals and I am sure this must be possible in other areas. I must warn you, however, that one can accumulate a vast number in a short space of time - one baby uses about 40 bottles per week!"

Physics Notes

Those teachers who have obtained a sodium street lamp for use as a spectrum source may already know of this very simple method of determining the wavelength, brought to us from St. Aloysius College, Glasgow. Apart from the lamp and diffraction grating, it requires only a metre stick and measuring tape, and the experiment can be done in daylight.

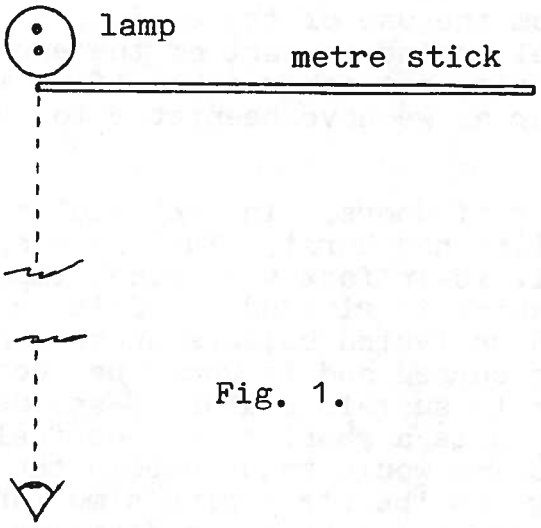

Fig. 1.

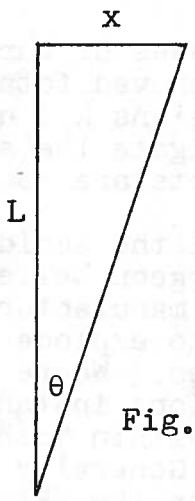

Fig. 2.

The lamp is mounted vertically, with both legs of the U containing the sodium vapour in the line of sight. At right angles to this line a metre stick is clamped, the end being level with the middle of the U limb. At a distance of several metres, the student views the lamp through the diffraction grating, held close to the eye. First and second, perhaps even third order spectra will be visible. Keeping the images in view, the student moves towards or away from the lamp until the first order yellow image coincides with the far end of the metre stick. A colleague then measures the distance from the grating to the lamp, using the measuring tape.

Sample result :-

Referring to Fig. 2.

$x = 1$ m

$L = 5.54$ m

$$\tan \theta = \frac{x}{L} = 0.181$$

$$\theta = 10^{\circ}\ 16'$$

$$\sin \theta = 0.178$$

Grating constant = 7500 lines/inch

Grating separation, $d = \dfrac{2.54 \times 10^{-2}}{7500} = 3.39\ \mu m$

$$\lambda = d \sin \theta$$

$$= 3.39 \times 0.178 = 0.603\ \mu m$$

$$= 603\ nm$$

Other techniques readily suggest themselves; if the laboratory is such that distances of 5 - 6 m are not easily obtainable, the student may approach closer and a paper rider be used on the metre stick to mark the position of the first order yellow image, or one may move so as to locate the second or third order image at the far end of the stick.

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In October last year, the BBC Nationwide programme featured a series of accidents involving the Mamod model steam engine, manufactured by Malins. In the programme, a surgeon reported that he had treated

five cases of burns resulting from the use of the engine, one of which proved fatal. As this model engine is part of the energy conversions kit used in many schools, a teacher asked if we would investigate the situation. As far as we have been able to ascertain, the facts are as follows.

All the accidents occurred out of doors. In the fatal case, the surgeon believed that the boiler had burst. This is disputed by the manufacturers, who say, "It is in fact a physical impossibility to explode such as boiler which is riveted in addition to being soldered. Where we have exploded unriveted boilers under controlled conditions instant condensation occurred and it would be necessary to be within inches of the boiler to sustain scalds of any description. Generally speaking within quite a short range one feels cold water on the skin. Such as explosion would require both the failure of the safety valve and a blockage in the steam pipe simultaneously, and in our experience this just does not happen accidentally."

The remaining accidents are all believed to have occurred when more fuel was added and it might be supposed that the children had mistakenly assumed that the flame was out when they added fuel. Malins, who have investigated the accidents, claim that each was caused by the explosion of the fuel dispenser, and not of the engine. They suspect that a squeeze pack type of polythene dispenser was being used, in which there is a suck back effect when the dispenser is released and that this will cause an explosion if a flame is present. They state that it is impossible to cause an explosion even where fuel is poured on to a naked flame from a glass or metal container.

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The following new items of surplus equipment are offered for sale. Customers are asked to note that these items in the first instance will be supplied only against a written request, which need not have an official order number or form, and that these requests will be ballotted approximately ten days after the issue of this bulletin. These arrangements were described in detail in Bulletin 88. Items remaining after the ballot will be supplied without reservation to personal callers or against a phone call, etc. There are many items still available from earlier lists; customers should consult Bulletins 85, 83 and 77 for details. Orders for these may be placed along with an order for the new equipment detailed below.

Item 629. Barograph, clockwork, in mahogany case, £30.

Item 630. Suunto orienteering compass, clear plastic, liquid filled, £1.

Item 631. Dictaphone, disc type by Olympia, operates off mains or rechargeable battery. With operating instructions, £2.

Item 632. Banda spirit duplicator, hand operated, £5.

Item 633. Stopwatch, x0.2 s £2.50; x0.1 s £3.

Item 634. Incubator, water jacketed and thermostatically controlled; external dimensions 68 x 71 x 92 cm, £20.

Item 635. 'Minus Seventy' thermostat bath by Townson and Mercer. This consists of two large vacuum jars, one of which is filled with solid carbon dioxide, the other with the specimen under test. A circulatory system then

keeps the specimen at a thermostatically controlled low temperature; for 110 V operation, £5.

Item 636. Transformer to drive above (Item 518), £1.

Item 637. Stirred water bath 32 x 27 cm, depth x dia. 8 position rotating holder for samples etc. with fluorescent lighting and separate pipe system for circulating cooling water. For 110 V operation, £3.

Item 638. Stirred water bath by Grant, type SB2. With framework and motor to provide agitation of specimens. Dimensions 21 x 45 x 18 cm, £5.

Item 639. Hot water urn, 6 gallon capacity, 2.2 kW with 3 position heating switch, £5.

Item 640. Wide range oven by Baird and Tatlock, 30 to 300°C. Dimensions, internal 46 x 51 x 45 cm; external 88 x 61 x 26 cm, £10.

Item 641. Deioniser, Mark 17JS by Permutit. In working order, but exchange resin requires renewal, £3.

Item 642. Extraction unit type ME437 by Electrothermal, This has two 150 W heating mantles with simmerstat control, £3.

Item 643. Steriliser with 3 position heating switch; inside dimensions 165 x 335 x 130 mm, £3.

Item 644. Dissolved oxygen meter. This has been constructed to measure the oxygen content of marine boiler water, and is too sensitive for ecological work. Complete with test cell, instructions and circuit diagram, £6.

Item 645. Electromechanical calculator, 20 digit capacity on main register, 10 digit on two auxiliary registers, 10 entry keys for each digit, £3.

Item 646. Avo valve tester, without operating instructions but appears to be in working order, £3.

Item 647. Decade potentiometer type 202B by Dawe Instruments, input 10 kΩ, output variable on 3 decade switches 0 - 10 kΩ, 50p.

Item 648. Valve voltmeter type V200A by Furzehill, large scale meter reading 1 - 5 x 0.1 and 5 - 10 x 0.2; ranges 10 mV to 1 kV f.s.d., and decibel range 0 - 20 x 0.5 db, £5.

Item 649. Decade oscillator type D-134-A by Muirhead. Frequency range 1 Hz - 111 kHz x 1 Hz steps on four decade frequency dials. Output 0 - 150 V into 8 kΩ, shown on output voltmeter. Milliameter for monitoring anode and screen currents. Dimensions 64 x 54 x 34 cm; mass 48 kg. With operating instructions and circuit diagram, £5.

Item 650. Electrically maintained tuning fork, 50 Hz; requires 6 V a.c. input, £1.

Item 651. Thermocouple thermometer, 0 - 300°C. Edge-wise large scale (ca. 200 mm radius) mirror-backed pointer; thermocouple probe length 43 cm, £3.

Item 652. Photo-electric relay; heavy duty contacts; complete with lamp, £1.

Item 653. Moving coil meters, 240 or 270° scale, 40 mm radius. These are ex-marine meters with heavy metal clad casing and all have an r.p.m. scale. Type (a) centre zero 20-0-20 mA, 25-0-25 V d.c.; type (b) 0-20 mA, 0-15 V d.c.; type (c) 70 mm radius scale with 230 V lamp to illuminate the scale, 11.5 mA, 23 V d.c.; type (d) as type (c) but 15 mA, 30 V d.c., £1.

Item 654. Telephone handsets, G.P.O. type, 30p.

Item 655. Headset comprising single earphone (50 Ω) and microphone, 50p.

Item 656. Stereo earphones (50 Ω) and microphone set, 50p.

Item 657. Throat microphones, 180 Ω impedance, 30p.

Item 658. Earphones amplified; one earphone contains a battery, the other a 3-transistor amplifier, supplied without battery, £1.

Item 659. Intercom set, consisting of two handsets and battery operated amplifier, £1.

Item 660. Hour meter, by Smiths. For use on 200/250 V a.c. mains; capacity 9999 x 0.1 h, non-resettable, £1.50.

Item 661. Hour meter, similar to above but two scales 999 x 0.1 h resettable, and 99999 x 0.1 h fixed, £2. Items 660 and 661 in series with mains powered equipment will register the total time for which that equipment has been switched on. We have had a suggestion that they could be used to monitor the life of overhead projector lamps.

Item 662. Pressure gauge, 0 - 200 lb/in^2 linear 270° scale. Pipe thread inlet connection, 50p.

Item 663. Moving coil meter, f.s.d. 30 μA, 1500 Ω. This has been scaled as a replacement in a multi-meter and has linear scales 0 - 25 and 0 - 100 for V and A, 0 - 200 Ω forward and 0 - 100 MΩ reverse scales, 0.05 - 5 mW and +7 to -13 db non-linear scales, £2.

Item 664. Moving coil meter, f.s.d. 1 mA, edge-scale. As the meter is in clear plastic, it could be used on the overhead projector, £1.50.

Item 665. Moving coil micro-ammeter, edge scale. F.S.D. values from 50 to 100 μA. These meters have various non-linear temperature scales. Scales are mirror backed and large enough to act as demonstration meters, £3.

Item 666. Electronic testmeter, type FTM4 by Avo. A.C. volt ranges 250, 100, 25, 10, 2.5 and 1 V; d.c. as for a.c. but in addition 1 kV and 250 mV. D.C. amperes 25, 100, 250 μA, 1, 2.5, 10, 25, 100, 250 mA and 1 A. Forward resistance scales 0 - 100 kΩ x 100, x 1 and ÷ 100. Reverse resistance scale 0 - 1000 MΩ. Capacity 0.0001 - 2.5 μF x 1 and x 100. A.C. power ranges 0.5 and 5 W into a choice of 5, 10, 25, 600 Ω, 2 kΩ or 5 kΩ. Probe to extend direct volts ranges x 10, £10.

Item 667. Three channel thermocouple chart recorder. The cycle time to record all three channels is 18 s. Chart speeds of 3 in/min and 1 in/h. Other speed may be possible by interchanging gear wheels. Chart width 5 in; 100 division scale marked 0 - 10. Sensitivity on all channels

ca. 10 mV; a copper-eureka thermocouple gives half scale deflection for a temperature difference of 100°C, £3.

Item 668. Six channel chart recorder; style etc. as for the previous item but each channel sensitivity is 10 mV f.s.d. 50 division scale marked 0 - 10. The cycle time to record all six channels is 30 s; single chart speed of 6 in/h, £3.

Item 669. Scalamp galvanometer type 7904/S by Pye. Scaled 0 - 14 x 0.1 and 7-0-7 x 1.1; 2 s period; resistance 1400 Ω. Basic sensitivity 190 mm/μA; ranges direct, x1, x.05, x.01 and x.001, £5.

Item 670. Scalamp microammeter type 7906/S by Pye. Style as above but single range f.s.d. 1 μA. Scaled 0 - 10 x 0.1 and 0 - 3 x 0.02, £3.

Item 671. 3 standard capacitors 0.001 μF (2) and 0.00025 μF accurate to ± 1 part in 1000. In wooden case, £1.

Item 672. Camera lens, Wray Lustrar 7 in, f 5.2; damaged iris diaphragm, £2.

Item 673. Camera lens, Cooke Aviar Anastigmat 7 in, f 4.5; damaged iris diaphragm, £2.

Item 674. Camera lens, Leitz Wetzlar Summar f = 5 cm 1:2, £2.

Item 675. Measuring magnifier, magnification ca. x4. Scaled -5 - 0 - +15 mm x 0.1 mm and 0 - 180° x 2° angular, £1.

Item 676. Load cell calibration equipment. This is highly specialised and has a hydraulic pump for applying tension or compression to a material rod specimen ca. 1 in diameter. There are no gauges attached to the equipment, £5.

Trade News

Griffin and George are now offering a new single phase outfit, L07-386, containing a x40 (N.A. 0.65) retractable phase objective, phase condenser assembly with an iris diaphragm, swing out annulus and swing out filter holder, all at £66.00. This outfit will convert either the Olympus K1 or HSC to x40 phase.

Prior are now marketing a simple 'short arm' version of the well-known 'Stereomaster' stereomicroscope. This is known as the 'Stereomaster 250' (under the new act should this be 'Stereoperson'?) and sells at £53.00. Also available is a newly developed transmitted light base for the 'Stereomaster' at £6.20.

Taylor Halliday Developments have launched a compact filmstrip-slide projector known as the 'Halight'. This comes in 300 and 150 W versions at £41.00 and £39.50 respectively. The filmstrip carrier costs £4.50 and the slide attachement £3.75. Also available is a microfiche/microscope attachement which will project microfilm or microscopic material (including living organisms). This last attachment costs £18.90. Because of a strong back draught through the instrument, living material can be observed for up to 4 hours.

Pyser are now selling a long-arm version of the Swift M20E stereomicroscope. This has a heavy cast base with a transformer

for a low voltage illuminator and a knuckle joint for head adjustment. The instrument costs £89.00 with a x1 or x2 objective. The additional objective costs £6.00.

The Philip Harris 'digitimer', P10253, is intended to replace stopclocks and the timing facility of scaler/timers. It has a three digit 7-segment display read-out which is large enough to be read by a group of pupils gathered round the demonstration bench. Counting can be x1, x0.1, or x0.01 s, and the timer uses mains frequency as its timing standard. Terminals are provided for mechanically starting and stopping the count, and these are also used for single photo-diode timing by interruption of a light beam. A section labelled triggered timing is for use with two photo-diodes, and there are two pairs of terminals giving 2.2 V a.c. to operate lamps. One pleasing feature is the operating instructions printed on the back of the instrument. The digitimer costs £48.

A number of schools have enquired recently about the supply of Oxoid materials. Oxoid have ceased supplying schools directly and have appointed Astell Laboratory Services as educational agents. Astell charge Oxoid list prices but have a handling charge of £1.50 on all orders under £25. Oxoid materials are also available from the Scottish firm of Mackay and Lynn. This firm sells at prices about 10% above the Oxoid list prices, which is to cover a handling charge made by Oxoid which Mackay and Lynn then spread out over all the items. Therefore anyone wanting less than £15 worth of Oxoid items should be in pocket ordering from Mackay and Lynn.

The Scottish Scientific Instrument Centre have again extended their range of products by becoming agents for SRI (Scientific and Research Instruments). SRI make a large range of physiological apparatus including spirometers, stethographs and tambours etc.

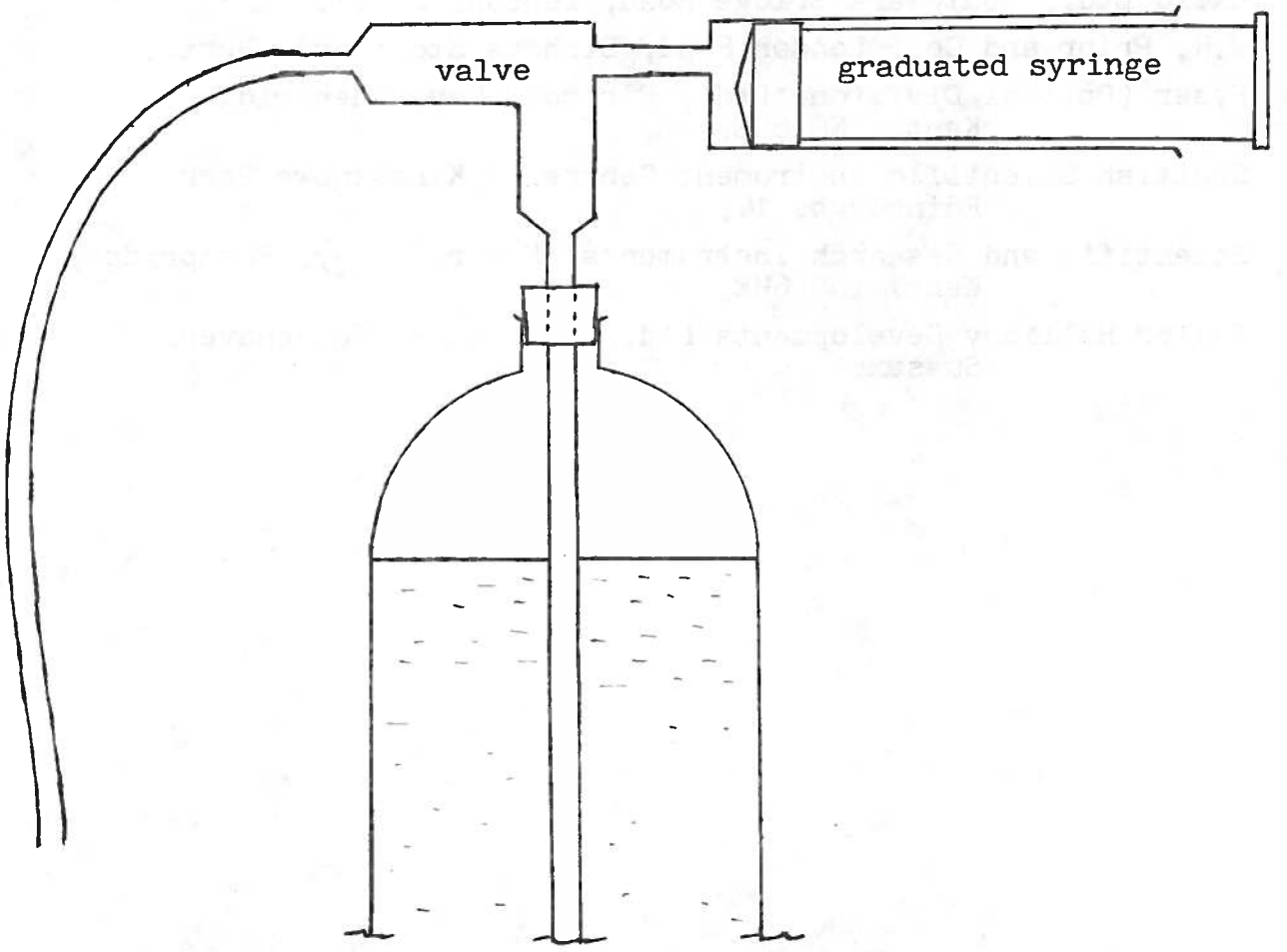
The Microscope Sales and Servicing Company of Glasgow are now offering a microscope maintenance service to schools. All the usual school instruments can be dealt with and servicing can be done on an individual or contract basis. The servicing charge is usually between £4 to £5 per hour depending on the number of instruments and the amount of travelling time involved.

One solution to the difficult problem of fume extraction vs visibility in demonstration experiments may have been solved by the introduction of portable fume hoods. These have a fan which draws the contaminants through a molecular seive, so that no ventilation system is necessary. Although only recently introduced to this country they have been used industrially on the continent for over 5 years, where the life of the molecular seive is between 18 months and 2 years. In school, their expected life is up to 5 years. The Erlab 2004C has internal dimensions 730 x 481 x 398 mm, length x depth x height and costs £290. A larger version, Erlab 2005CD measures 781 x 574 x 720 mm internally, is fitted with fluorescent lighting and costs £505. The replacement filter for both those models costs £69. Both models are portable, although only in the sense that they easily separate into three parts, top, filter and base, each of which can be carried or wheeled on a trolley. But being free of any ducting they can be placed on any laboratory bench, and pupils will have as good a view of the experiment as the demonstrator. Erlab fume hoods are marketed in this country by Bigneat Ltd.

In The Workshop

This dispenser not only allows liquids to be dispensed into test tubes, flasks or beakers without spillage, but will deliver the selected volume accurate to within 0.1 ml. When one hears teachers discussing the difficulties which pupils experience in attempting to pour from a reagent bottle, and when we have already published constructional details for two other types of dispenser (Bulletins 29 and 73), it is disappointing to see in the newest worksheets diagrams of tilting reagent bottles. Perhaps this is a psycho-motor skill which it is thought good that the whole populace, and not merely intending bar-persons, should require.

The dispenser is based on the syringe valve type GK SVC by Gordon Keeble costing £1.75 and the sketch below should be largely self-explanatory. Any size of syringe with a Luer fitting will connect directly to the right hand opening on the valve. However, the standard rubber stopper has holes which are too wide for connection between the valve and reagent bottle, and a solid stopper must be selected and a smaller hole bored out. A useful tip when taking out this hole is to heat the shaft of the cork-borer immediately above the stopper by playing a bunsen flame on it. This prevents the rubber from twisting and gives a clean hole. A short length of rubber tubing should be joined to the delivery end of the syringe so that containers may be filled when resting on the bench. Pupils will need both hands to operate the syringe, which means that containers should be free-standing when being filled, and a rack for test tubes should be kept alongside the dispenser for this purpose.



S.S.S.E.R.C., 103 Broughton Street, Edinburgh, EH1 3RZ.
Tel. 031 556 2184.

Astell Laboratory Service Co., 172 Brownhill Road, Catford, London, SE6 2DL.

Bigneat Ltd., 4 Solent Road, Havant, Hants.

Gordon Keeble Laboratory Products, 8a Chapel Street, Duxford, Cambridge, CB2 4RJ.

Griffin and George Ltd., Braeview Place, Nerston, East Kilbride, Glasgow, G74 3XJ.

Philip Harris Ltd., 30 Carron Place, Kelvin Industrial Estate, East Kilbride, Glasgow, G75 OTL.

Mackay and Lynn, 30 Marchmont Crescent, Edinburgh.

Malins Ltd., 206 Thorns Road, Quarry Bank, Brierley Hill, Staffs., DY5 2JZ.

Microscope Sales and Servicing Co., 50 Glasgow Road, Milngavie, Glasgow, G62 6HY.

Oxoid Ltd., Southwark Bridge Road, London, S.E.1.

W.R. Prior and Co., London Road, Bishops Stortford, Herts.

Pyser (Optical Division) Ltd., Fircroft Way, Edenbridge, Kent, TN8 6HE.

Scottish Scientific Instrument Centre, 5 Kingsknowe Park, Edinburgh. 14.

Scientific and Research Instruments, Fircroft Way, Edenbridge, Kent, TN8 6HE.

Taylor Halliday Developments Ltd., THD House, Peacehaven, Sussex.