SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No. 101. December, 1977.

Contents

Introduction

This bulletin contains an item 'Display Laboratory' which may be strange to the majority of our readers. It used to be a regular feature in the bulletin, although you will have to go back a number of years to find it, and its revival can be looked upon as an aberration produced, in the same way as New Year resolutions, by our recent embarkation on our second century. The section is intended to indicate to readers new items of equipment which we have recently received from the manufacturers, or have made ourselves, which they can see if they visit the Centre. While the number of visitors to the Centre shows little variation over the years, we find that more are coming for the benefits of our bargain basement, where the surplus material is kept, and fewer are seeing what finished equipment is available.

We are anxious to remedy this situation, not because we want to stop people visiting the basement, but because teachers may not be sufficiently aware of the opportunities there are for seeing and handling manufacturers' equipment before ordering it. Manufacturers also have had cause to feel aggrieved because we have not given their apparatus as much publicity as we could have done.

The Display Laboratory section was dropped for no good reason other than that there were always other items competing for publication. We are often asked if we are ever at a loss for bulletin material: in fact the reverse is the case, and it is much more difficult to achieve a balance in each issue, as we try to do, between the interests of biologists, chemists and physicists. Of late the articles have tended to be longer and yet of a nature which made it undesirable to split them between two issues, something we are averse to doing in any case, so that they have tended to monopolise a bulletin. When this happens we try to compensate by 'majoring' a different discipline in the next issue. This does not always work, and we get subjective judgements of the kind: "I never read the bulletin because there is never anything in it for .....ists".

If chemists have felt this way lately, and there could be some justification for it, then it is because Allen Cochrane has spent most of his time on our hazardous chemicals manual which may soon be published. Our Governing Body has agreed to send one copy to each region, so that they may reproduce it for their schools if they wish, but negotiations to have it published in loose-leaf form by a commercial firm are in an advanced stage. To try to compensate for the relative dearth of chemistry material in recent bulletin issues, and to give chemists an indication of what they can expect from the manual we have reproduced a sample page on page 5 of this bulletin.

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Our cost index of items of consumable apparatus (= 100 in May, 1974) now stands (15/11/77) at 175.6. This is an increase of 3.7% over the past six months, and 11.2% over the year. There has been a noticeable, and welcome, slowing down in the rate of increase. When the index was last published (June, 1977) the figures were 7.3% and 17.6% respectively.

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We remind readers that the Centre will be closed on Saturdays 21st and 28th January, 1978.

Opinion

On the first of July this year the transitional period of our E.E.C. membership made further 'progress' towards its termination. On that momentous day, which went unnoticed by most of us, E.E.C. Regulation Number 1798/75 became fully binding on the United Kingdom. This deals with the duty free importation of educational, scientific and cultural materials. The science teacher's only experience of these matters will have been in completing the mysterious DFA3 form in order to claim duty remission on certain pieces of equipment such as microscopes. This exercise was even occasionally fruitful. If the replies were skilful and it could be shown that there were no competitively priced 'native' instruments of comparable performance, a refund of duty could be obtained. This was in the heady days when only the Import Duties Act 1958 (Section 6 and Para 3 of the Fourth Schedule thereto) was applied.

Admittedly some of the decisions of the Duty Remission Branch of the Department of Trade and Industry had seemed to us somewhat arbitrary. Remission was sometimes refused on one model of imported microscope and allowed on another which seemed to us inferior and more expensive. I began to doubt the technical competence of some D.T.I. staff when one of them tried to ensnare me with the bureaucratic riddle - "Is a microscope a scientific instrument?". There was also the notable instance when an authority submitted and obtained duty remission on a single instrument, only to have the duty slapped on again when they attempted to place a bulk order. Nevertheless some money was occasionally clawed back out of the tenacious hands of H.M. Customs and Excise. Alas, it now looks as though even these hard won gains are to disappear. It will still be possible to obtain a DFA3 form, but the fun has gone out of the whole exercise. DFA3 completion will no longer be the joy it was. Form DFA is being revised in the light of E.E.C. Regulation 1798/75. Competitiveness of price will no longer be taken into account. The main consideration, under Article 3 of the regulation, is that "instruments or apparatus of equivalent scientific value are not being manufactured in the Community". Nothing is said about price or value for money.

This has already given rise to one ludicrous situation that we know of and doubtless others equally bizarre will occur. We heard of one school which was refused remission on a batch of Japanese microscopes. The duty per instrument was approximately £3. The D.T.I. letter of refusal quoted two British equivalents which the school could have purchased. Both were more expensive, even when duty had been paid on the imported model, by £16 and £22 respectively. In these circumstances few schools would take the trouble to consider the British alternatives.

So, at a time when educational budgets are under severe pressure, the school paid £3 per item to one government agency with money they had mostly obtained, via the Rate Support Grant, from another while an official in a third government department was paid more public money to see that they did. It often embarasses me to have to recommend foreign instruments because of

their value for money. It would give me great pleasure to see a strong British microscope industry fighting off competition from Japan and elsewhere. In certain areas both within and outwith the educational market there are signs that this is happening. However I have a strong belief that the revitalisation will be brought about not by ineffective deterrents like Regulation 1798/75, but by investment in new designs and equipment.

Equipment Offer

The following items of equipment are offered for sale, subject to the ballot procedure outlined in Bulletin 91. We apologise for having to include this when the previous bulletin also devoted considerable space to surplus equipment. This material was offered to us by Reynolds and Branson after Bulletin 100 had gone to the printers. The firm is rationalising stocks and the items below are 'clearance' lines which have been heavily discounted. Unless otherwise stated the goods are new and unused. The final figures in brackets are intended to be rough guides to normal current prices for similar goods. All the glassware offered here is 'Pyrex' brand. All magnets offered are 'Eclipse'.

Item 819. (32) 100 ml grad. Erlenmyer conical flask, 25p (37p).

Item 820. (144) 22 x 150 mm test tube, light wall, 5p (7½p).

Item 821. (288) 12 x 75 mm rimless test tube, standard wall, 2p (3½p).

Item 822. (12) 150 ml flat bottom flask, 45p (60p).

Item 823. (23) 150 ml grad. unspouted, tall form beaker, 26p (38p).

Item 824. (24) 100 ml grad. spouted, tall form beaker, 25p (36p).

Item 825. (36) 60 x 25 mm evap. basin, flat bottom, 38p (60p).

Item 826. (7) 100 ml cylindrical separating funnel, £2.95 (£3.50).

Item 827. (5) 50 ml pear shaped separating funnel, £3.00 (£3.50).

Item 828. (2) Reel of 12.5 cm x 100 m Whatman No. 1 chromatography paper, 35p (77p).

Item 829. (40) Pack of 200 discs 9 cm Whatman G.P. filter paper, 10p (40p).

Item 830. Grey 540 Stereomicroscope, x1, x2, swing-change, protected objectives, x10 W.F. eyepieces, built in transformer and adjustable light source, £80 (£143.46).

Item 831. (3) Meopta AZ2 '0' grade microscope x3.3, x6.7, x20; x10 orthoscopic eyepiece, cases slightly scratched, £26 (£45.86).

Item 832. As above, but some corrosion on stage movement guide rod, £17.50.

Item 833. (3) Vernier microscope (travelling microscope) with wooden case, metric scales, 'shop soiled', £40.00 (ca. £80 - £90).

Item 834. As above, but damaged and rebuilt by us, £30.00.

Item 835. (4) Prior microscope lamps with special heavy base, long lamp arm with ball and socket joint, lamp house with cover, filter holder and blue filter, £12.00 (ca. £20.00).

Item 836. (12) Gowlands 1067(a) x8 achromat folding magnifier in metal, £1.25 (£8.00).

Item 837. (100) Gowlands 215 x8 folding magnifier in plastic. The plastic bearing on which the lens rotates had seized on many of these magnifiers and we have modified them so as to recondition them - hence the very low price, 20p (95p).

Item 838. (2) Glass diffraction grating, 600 lines/mm, by Patton and Hawksley, £2.00 (ca. £11.00).

Item 839. (4) Horseshoe 'power' magnet 19 mm high 14 mm pole gap, 50p (£1.00).

Item 840. (6 prs) Rectangular bar magnet 40 x 12.5 x 5 mm, 30p/pr (64p).

Item 841. (3 prs) Rectangular bar magnet 20 x 10 x 5 mm, 30p/pr (66p).

Item 842. (4 prs) Rectangular bar magnet 60 x 15 x 5 mm, 70p/pr (£1.40).

Item 843. (2 prs) Cylindrical bar magnet 50 x 10 mm, 50p/pr (£1.00).

Item 844. (5 prs) Cylindrical bar magnet 25 x 8 mm, 35p/pr (70p).

Item 845. (1 pr) Cylindrical bar magnet 30 x 10 mm, 50p/pr (£1.00).

Item 846. (5) Small horseshoe pocket magnet with keeper, 40p (75p).

Item 847. (13) Reel of P.V.C. insulating tape ½" x 25 yd, 25p.

Item 848. (5) Reel of 'cloth' type insulating tape ½" x 10 yd. 10p.

Item 849. (4) Reel of 'cloth' type insulating tape 20 mm x 20 m, 25p.

Item 850. (5) Metre bridge, four gap type on hardwood base, scale graduated 0 - 100 cm x 1 mm. Not standard 4 mm terminals but these could be easily fitted, £8.00 (ca. £20.00).

Chemistry Notes

One sample entry of our hazardous chemicals manual is reproduced below. The manual will deal similarly with over 200 chemicals, which is not large, but is thought to be all those that might be encountered in the school situation. An introductory section will give general advice on such things as storage, types of fire extinguisher and respirator etc. A most important section of each entry is at the foot of the page, labelled Local Conditions. Here it is hoped the principal teacher of chemistry will insert information which is specific to his department, such as the maximum quantity he will permit on open laboratory shelves, where the bulk will be stored etc. While we hope it will be so used by all who are concerned for the safe running of their department, we would contend that anyone who does not supply this type of written information to his technicians may be in breach of the Health and Safety at Work Act.

METHYLPHENOLS
(CRESOLS)

METHYLPHENOLS	$C_6H_4(OH)CH_3$ Solids MPs 11 - 355.5°C.
HAZARDS	Harmful vapours, irritate nose etc., corrosive to mucous membranes. Poisonous by swallowing, skin absorption, or by inhalation. Flammable. Produces very toxic fumes when heated to decomposition. Exposure to small amounts over a long period may damage kidneys and liver and may cause dermatitis. TLV (skin) 5 ppm (22 mg m^{-3}). Flash point 95°C. Autoignition temperature 559°C.
INCOMPATIBILITY	Oxidising materials.
HANDLING	Wear gloves and eye protection.
STORAGE	Flammables.
DISPOSAL	Emulsify small quantities with water and detergent and wash to waste with water.
SPILLAGE	Apply water and detergent, brush to emulsifty and proceed as for disposal. Consult Local Authority if spillage is large.

FIRST AID

EYES	LUNGS	MOUTH	SKIN
Irrigate with water. Seek medical attention.	Remove patient from exposure, rest and keep warm. Seek medical advice.	Give water to drink. Seek medical attention.	Wash with water and gently rub glycerol on affected area. Remove and wash contaminated clothing. Seek medical attention.

LOCAL CONDITIONS

Physics Notes

As described in Bulletins 86 and 87, our timer/frequency meter will measure any frequency up to 55 kHz by counting the input cycles over a time interval which can be selected to be 1 s, 100 or 10 ms, and in conjunction with a signal generator of known frequency it will measure the time interval during which a light beam is blanked off e.g. by a blanking card on a moving dynamics trolley or linear air track vehicle. It is also readily adapted for other timing and counting requirements, so that it becomes possible for example to dispense with a scaler/timer, at a considerable saving of money.

Some applications, involving mechanical switching can quickly be obtained from the unit. The method used for the photo-resistor input to the timer is that a low resistance - or a short circuit - connected across the terminals will cause the timer to count cycles fed in from the signal generator, until the low resistance is increased, or the circuit broken. Hence impact times can be measured directly by connecting foil electrodes attached to the impacting surfacrs to the photo-resistor input. The method may be used for any type of ball and striker such as golf or billiards. The technology needed for hitting a moving ball as in tennis, football or squash may need a little more ingenuity. With the signal generator set to 1 kHz the display will show the impact time in milliseconds, but if the impact time is less than 100 ms one may still get 3 digit accuracy by increasing the frequency to 10 kHz, when each unit digit will represent 100 μs. Even greater accuracy will be got for very short times by stepping up the input frequency to 50 kHz i.e. 20 μs per digit.

One slight technical difficulty requires to be overcome. The photo-resistor input goes to a SN7413 Schmitt trigger, which is normally kept low by a 330 Ω resistor connected between it and ground. When the impact switch closes, the input is made high by being directly connected to V_{cc}, and at the end of the impact the contacts open and the input returns to logic 0. In an ideal situation, a square, positive pulse would be applied to the input and the duration time of the pulse would be accurately measured. Because of contact bounce, which means that mechanical contacts never open or close cleanly, both the rise and fall of the pulse are liable to have jagged edges, as in Fig. 1a below. This may result in a train of pulses, Fig. 1b, passing into the timer to be counted. Because of the way in which the SN7490 resets are connected, the positive going edge of each pulse resets the count to zero. Thus only the last pulse of the train will be timed, and if as usually happens this time is less than a cycle of the input frequency, the counter registers zero.

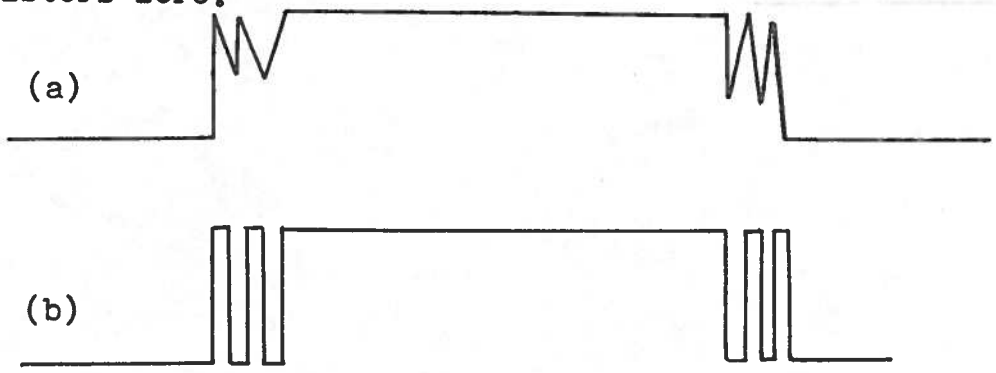

Fig. 1. Effect of contact bounce.

Fortunately, the SN7413 is a level-operated device, i.e. it does not require pulses with fast edges, so that the jagged peaks due to contact bounce can be smoothed out by a capacitance connected between the input terminal and ground. If the capacitance is too large, it will delay both the start and finish of the count beyond the periods when contact bounce occurs, and this may give rise to a false result. Hence one should find by trial and error the minimum capacitance which will still allow counting of the main pulse to proceed. For a snap-action toggle switch, or a push button switch, we found that 5 μF was suitable.

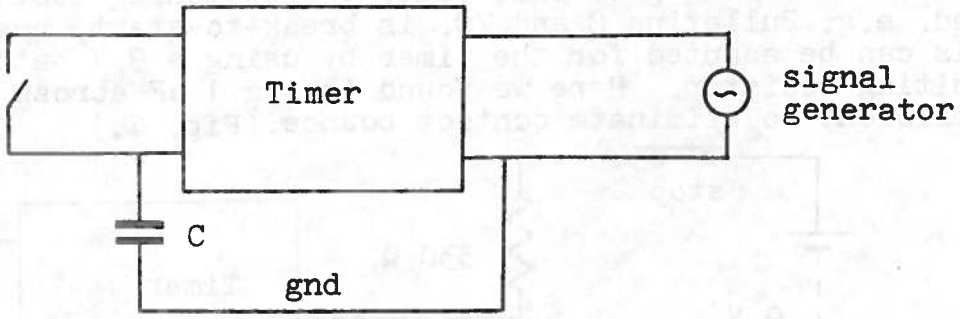

Fig. 2. Impact switch timing.

For example, in Bulletin 49 we described two methods for calculating the velocity of sound in a metal rod by measuring the impact time between a freely suspended rod and a hammer. Both methods were indirect, because the times involved were less than 1 ms and could not be measured by commercial scaler/timers. Using the SSSERC timer in the circuit of Fig. 2 we were able to measure the velocity of sound in a copper rod to an accuracy of 5%. No capacitance C is required in this instance, because what we wish to measure is in fact the contact bounce time. Accuracy is limited by the upper frequency limit of the timer which is about 50 kHz. If greater than 5% accuracy were required, this could be obtained by reducing the value of the 10 nF capacitance (Fig. 4, Bulletin 87). With a signal input frequency of 49.7 kHz, we counted 28 cycles in 7 trials out of 10, the other three giving counts of 29, so that the true time must lie between 28 and 29. Using the mean value, 28.3, this gives an impact time of 569 μs, during which the compression wave travels to the far end of the rod and back. The rod was one metre long, giving a value for the velocity of the compression wave of $(3.51 \pm 0.14) \times 10^3$ m/s.

A second application involving only mechanical switching is the measurement of reaction times. A two-pole push-button switch with normally open contacts (R.S. Components 337-920) is used. One pair of contacts goes to the photo-resistor input of the timer, the other pair to a power supply and lamp or other indicating device to be observed by the subject. The subject has a normally closed switch (337-936) which he/she presses immediately the indicating device is noticed, stopping the timer.

The experimenter is required to press and hold his switch, thus keeping the lamp on, until the subject has pressed his switch, thus stopping the count. For reaction time measurements an input frequency of 100 Hz is probably sufficiently accurate so that a display of 024 would be recorded as 0.24 s.

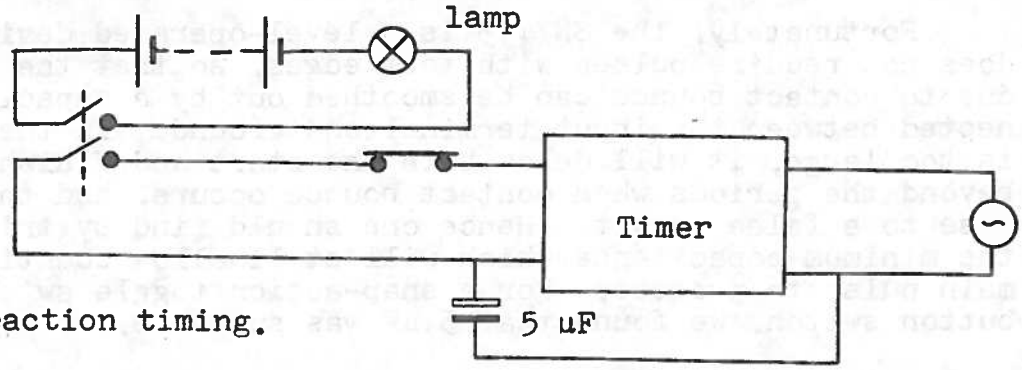

Fig. 3. Reaction timing.

In measuring g by free fall, the switching most frequently used, e.g. Bulletins 8 and 70, is break-to-start, break-to-stop. This can be adapted for the timer by using a 9 V battery and current limiting resistor. Here we found that a 1 μF across the input was sufficient to eliminate contact bounce. (Fig. 4.)

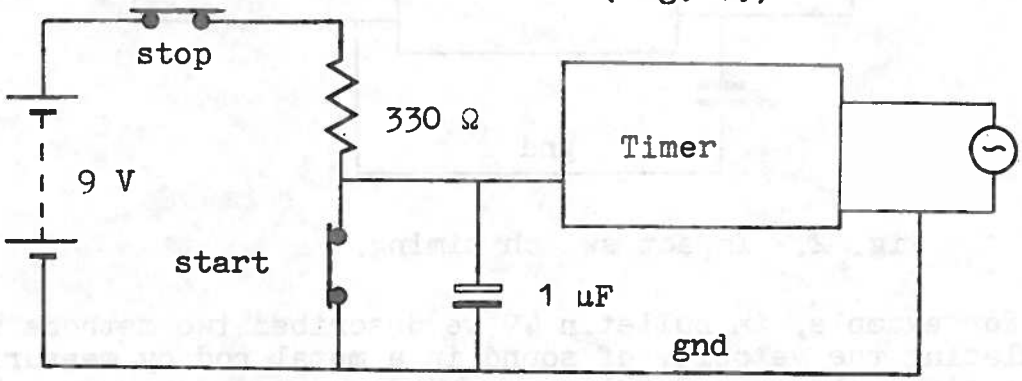

Fig. 4.

The normally closed start switch holds the input terminal low, inhibiting the count. When the start switch opens the 9 V battery applies about 4.5 V to the input, so that counting starts. The stop switch isolates the supply and the input resistor in the timer brings the input down to ground, thus stopping the count.

If the experiment is extended beyond the usual single measurement, by varying the distance through which free fall occurs, one advantage of the timer becomes apparent. The input signal frequency can always be set so that the display reads between 900 and 999, with an accuracy of ± 1. The frequency can be measured simply by switching the timer to the frequency mode. If one counts m cycles of a signal of frequency n, the time interval t is given by $t = m/n$. By making both m and n large, we increase the accuracy with which both can be measured, hence increasing the accuracy of t. This facility is not available on commercial timers operating on a fixed frequency, usually 1 kHz. The accuracy of all these measurements depends on how accurately one has been able to set the timing intervals of 10 ms, 100 ms and 1 s when the timer was constructed. Sample results are shown below.

Distance s (m)	Count m (cycles)	Frequency n (kHz)	Time t=m/n (ms)	Acceleration g (m/s^2)
0.545	932	2.77	337	9.61
0.727	819	2.11	388	9.66
0.897	908	2.11	430	9.70
1.184	893	1.81	493	9.73
1.400	(1) 852	3.45	538	9.69
1.628	(1) 708	2.95	579	9.71

In the final two readings the distance is such that the frequency needed to give under 1000 counts is quite low, thereby increasing the error. So, having found approximately what this frequency was, it was doubled to 3.45 and 2.95 kHz respectively. This means that the count will now be greater than 1000 but less than 2000 so that although the most significant digit does not appear on the display we can assume it to be a 1. The error in the final reading is about 1%, most of it contributed by the measurement of t. This would give $g = 9.71 \pm 0.10$, bringing it just within the normally accepted value. The reason for the consistently low figure is probably due in part to air friction, and in part to the magnetically held stop switch not releasing immediately upon the impact of the falling ball (a steel ball bearing 10 mm dia.). To isolate the former, if one wished to investigate it more thoroughly in a SYS project for example, would require a photo-electric method of stopping the clock.

Trade News

We have recently received a number of new CLEAPSE reports. These can be borrowed for up to one month by writing to the Director at the Centre.

L57 Colorimeters
L85B Electrical and Electronic Kits for Nuffield Secondary Science
L94a Conductivity Apparatus
L124 Aquaria - Electrical Safety
L133 Replacements for Asbestos Products
L134 Bio Gas Plant
L135 Eye Protection
L140 Pollen/Particle Collector.

Some time ago we were approached by a teacher who wanted a mechanical make-to-start switch on the school's Panax 402ST scaler. Those who have this model will know that the contacts are break-to-start. As a result of correspondence with the firm, they have produced a modification allowing this to be done, which requires the use of an additional change-over switch on the back panel. Panax will supply a leaflet explaining the modification with the necessary switch and leads, for £1.75. Alternatively the school may return their scaler to the firm, who will carry out the modification at a cost of £5 plus carriage. The modification is applicable only to scalers having a 'Gate In/Out' switch on the back panel. Others are advised to contact the firm.

T.H. Goldschmidt Ltd., suppliers of the ampholytic surfactant disinfectant TEGO MHG, have changed their address to that given on page 12.

J.S. Galbraith, Marine Biological Supplies, collectors for a number of biological supply houses south of the border, is now offering to supply directly to schools and colleges in Scotland. A catalogue is available from the address given on page 12.

One firm whose catalogue shows prices which are very competitive with those of other suppliers is Comber and Son. Some examples are:

	Comber	Other Suppliers	
Pyrex beakers squat form 250 ml	£24.02(96) 0.29 (1)	31.75 0.40	33.18 0.47
Pyrex Erlenmyer flasks, narrow neck grad.	18.20(72)	25.90	27.08
Flamefast Nat. Gas burner 701	1.20 (1)	1.50	1.49

Available for laboratory glassware protection is 'Polynet' from Owens Polyscience Ltd. This plastic netting is available in a range of sizes from 1/4" to 14" and can easily be snugggly fitted over all types of glassware from pipettes to round bottom flasks and Buchner flasks. Thus it can help reduce breakages and retain large pieces of broken glass (mesh size is approx. 7 mm) in the event of an implosion. It can be folded round on itself to make a ruff or collar at the neck of the vessel.

We have been informed by Vickers Instruments Ltd. that they have ceased production of their M10A microscope. Philip Harris Ltd. will have stocks of M10As sufficient to meet the usual levels of demand over the next 6 to 12 months. Vickers themselves have exhausted their stocks of stands but have enough optical components and accessories to meet the anticipated demand for at least the next year or so.

The capital of Townson and Mercer Ltd. has been acquired by Plantation Holdings through their subsidiary Southern Instruments Holdings who are also the parent company of the Aberdeen firm Glass Appliances. Agencies of these two firms will be pooled from 1st January, 1978. Customers south of a line between Oban and Dundee will be able to obtain Shandon equipment previously handled only by Glass Appliances direct from Townson and Mercer. Customers north of this line will be able to obtain Townson and Mercer equipment from Glass Appliances. Townson and Mercer stocks are being rationalised and they have for sale a large quantity of laboratory goods and equipment at generous discounts. A new Townson and Mercer catalogue is nearing completion and should be available at the turn of the year.

Griffin and George Ltd. have announced that they are now offering a range of the British Prior microscopes. Full descriptions and specifications are given in product bulletin P3017 which is free on request from Sybil Martin at the address given on page 12.

Corning disposable glassware, mentioned in Bulletin 95 and our 'Beat the Budget' leaflet, are being withdrawn from the U.K. market.

Display Laboratory

The items listed below are some of those which we have recently acquired or made ourselves, and may be seen by anyone visiting the Centre. Most of these will be in the display laboratory: the others will be demonstrated on demand.

Item	Manufacturer or Agent
Cleapse pattern aquarium safety panel	SSSERC
Dissolved oxygen water sampler	SSSERC
Dissolved oxygen measurement	SSSERC
Decimal to binary converter	SSSERC
Self-maintained tuning fork	SSSERC
Ticker timer drive	SSSERC
Air table molecular motion model	SSSERC
Hydrogen electrode	SSSERC
L.T. power supplies	Philip Harris
H.T. power supply	Philip Harris
E.H.T. power supply	Philip Harris
Power signal generator	Philip Harris
Single beam oscilloscope	Philip Harris
Conductivity meter	Philip Harris
Spirometer	Philip Harris
Oxygen meter	Griffin and George
Digital centisecond timer	Griffin and George
D.C. Amplifier and electrometer	Griffin and George
Transfer chamber	Griffin and George
Electrophoresis apparatus	Griffin and George
Mk2 colorimeter	W.P.A.
O2 oxygen meter	W.P.A.
Colorimeter	Irwin-Desman
TP46 balance	Oertling
Single beam oscilloscope	Unilab
Environmental kit	Unilab
Waveform generator	R.S. Components
Parat 1 respirator	Draeger
Craigie Kit	Oliver and Boyd

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

Cleapse Development Group, Brunel University, Kingston Lane, Uxbridge, Middlesex.

Comber and Son, Portland House, Portland Grove, Heaton Moor, Stockport, Cheshire, SK4 4AA.

Corning Ltd., Laboratory Division, Stone, Staffs, ST15 OBG.

J.S. Galbraith, Marine Biological Supplies, Tobernochy, Isle of Luing, Oban, Argyll, PA34 4UF.

Glass Appliances Ltd., 488 Holburn Street, Aberdeen.

T.H. Goldschmidt Ltd., Initial House, 150 Field End Road, Eastcote, Middlesex, HA5 1RY.

Griffin and George Ltd., 285 Ealing Road, Wembley. Middlesex, HAO 1HJ.

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

Owens Polyscience Ltd., 2 Hibel Road, Macclesfield, Cheshire.

W.R. Prior and Co. Ltd., London Road, Bishop's Stortford, Herts.

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

Townson and Mercer Ltd., 4 Teviot Place, Edinburgh, 1.

Vickers Instruments Ltd., Haxby Road, York, YO3 7SD.