# SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No. 122. August, 1980.

# Contents

# Introduction

Our Planning Committee, mentioned in Bulletin 120, has been formed and has held its first meeting. The members of the committee are:

Chairman: Mr I Young, Science Adviser, Renfrew Division, Strathclyde.
Secretary: Mr S Robertson, Principal Teacher of Physics, St Augustine's High School, Edinburgh.

Members:

Mr D Glen, Principal Teacher of Physics, Clydebank High School, Clydebank.
Mr A Mackenzie, Principal Teacher of Chemistry, Peterhead Academy, Aberdeenshire.
Miss C Mathieson, Principal Teacher of Biology, Dumfries Academy, Dumfries.
Mr J Pickering, Principal Teacher of Biology, Wallace High School, Stirling.
Mr R Robertson, Principal Teacher of Chemistry, Blairgowrie High School.
Mr A H Sloss, Secretary, Scottish Central Committee on Science.
Mr J R Stewart, Director, SSSERC.
Mr D Tawney, Director, Cleapse Development Group.
Mr J Watson, Senior Technician, Bell Baxter High School, Cupar.

There is one vacancy still to be filled, owing to the death of Mr Reid, HMI.

At the inaugural meeting, the Planning Committee decided that a first step in determining whether the pattern of SSSERC work should be changed, and the directions in which it should be changed, would be to ask for the views of the Scottish school teachers, which inevitably means another questionnaire. One way of cajoling people to reply to questionnaires is to circulate a slip with ready made spaces for replies, sometimes even to give the replies with boxes to be ticked. Unfortunately this would mean one reply per department in a school, and we would like to think that more than one member of staff reads the bulletin, or makes use of the SSSERC service. We want as many members as want to have their views aired, be they principal or assistant teachers, or technicians, to answer the questionnaire. It would be helpful if the person to whom this bulletin is addressed would arrange a system for the replies to be collected and sent within a reasonable time, say within three weeks of receiving the bulletin, to the Centre (address on page 12). Thank you.

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## THIS CONCERNS YOU

As a reader of this bulletin, we hope you will complete and return the enclosed questionnaire, aimed at providing you with a better SSSERC service. On a slip of paper, number the questions 1-15. Questions 1,3,4,5,7,8,10,12,13 and 14 only require a yes/no answer: if both halves of a question answer no it is assumed that you are reasonably satisfied with present coverage. Questions 2, 6,9,11,15 should only need a one phrase, or at most a one sentence answer, for each part. When answering the questionnaire, remember

that there are only 8 hours in a working day, and that if you have asked for a number of aspects of SSSERC work to be increased without a corresponding reduction somewhere else, your answer loses much of its value. When completed your answer should be returned to the principal teacher for return to SSSERC. We do not need to know the person or the school from which the questionnaires come.

Bulletin

1. For most teachers, their main contact with SSSERC is via the bulletin, which is sent out every six weeks, and which we try to see contains something of interest to every science teacher. Would you prefer us to send out the bulletin (a) more frequently but containing less information per bulletin, (b) less frequently and containing more information?

2. Would you like to see the format of the bulletin changed? If so how? (One sentence answer, e.g. by giving an example).

3. Would you like to see the number of do-it-yourself designs in the bulletin (a) increased, (b) decreased?

Exhibitions

4. At present we mount 10-15 apparatus exhibitions per year. An exhibition in a region is arranged only if asked for, e.g. by a science adviser. Would you like to have this changed so that a SSSERC visit (for an exhibition or lecture/demonstration) was made regularly in your region?

5. Would you like to see the number of apparatus exhibitions (a) increased, (b) decreased?

6. If increased, would you name one aspect of the science syllabuses which you think has been under-exposed by SSSERC?

Safety

7. Do you think that our safety lecture/demonstrations, of which we hold 8-10 annually, provide useful information?

8. Would you like to see the number of safety lectures (a) increased, (b) decreased?

9. If increased, would you name one aspect of safety you would like to see as a subject for a lecture/demonstration?

Evaluating equipment

10. At present we spend 25-30% of our time evaluating manufacturers' apparatus. Some of this appears in our reports and equipment lists, and much of it forms the basis of our expertise when answering individual callers by letter and telephone. Would you like to have this allocation (a) increased, (b) reduced?

11. At present we have a standing remit to test monocular and stereomicroscopes, balances, centrifuges, pH meters, spectrophotometers, colorimeters, conductivity meters, power units and transformers. If you think our testing programme should be increased, would you name up to three pieces of apparatus, in order of priority, in any or each of (a) biology, (b) chemistry, (c) physics/engineering that you would like us to test?

Technician Workshops

12. We have recently held a number of technician workshops, covering for example maintenance and repair of microscopes, and integrated circuit wiring. Would you like to see this facility (a) increased, (b) reduced?

Surplus equipment

13. At present we spend about £3000 per year acquiring surplus equipment for sale in our bargain basement, and the majority of visitors to the Centre come for this purpose. Would you like the volume of surplus equipment (a) increased, (b) decreased?

14. If we maintained sub-depots of surplus equipment in other centres, e.g. Glasgow, Dundee, Aberdeen, would this make a marked increase in your use of this service? (This could be costly to establish and maintain, so don't agree with the question unless you think it would make a marked difference).

15. Would you name one area not covered above which you would like to see added to the functions of SSSERC? (One sentence answer).

# Opinion

While doing tests on electronic balances, we were struck by one obvious incongruity, compared with other pieces of equipment.

| | Weight | Value | Handle | Cable clip |
|---|---|---|---|---|
| Oscilloscope | 7.3kg | £200 | Yes | Maybe |
| Power unit | 8.3kg | £100 | Yes | Yes |
| Balance | 12.8kg | £900 | No | No |

Balances are evidently not pieces of equipment which are to be moved from lab to lab. Despite their weight, and the loss if they get dropped, some do not have adequate feet to allow a hand to be easily inserted under them to move them along the bench. In the ideal world, the school would have one on every floor, if not every lab. We know that you can't put a handle on the top because the pan gets in the way. But I have seen equipment which had a recessed handle along the top front edge, which would pull out to allow the case to be carried. This would not have done the mechanical balance much good, because its delicate nature required it to be kept level. But electronic balances should carry without harm in any position, as long as they are approximately level when put to use. One of the advantages offered for the electronic balance is its speed of use. This should lead to an economy of scale, so that fewer balances are needed in the school. This cannot be realised if the balance must stay in the one position.

On another subject, as long ago as Bulletin 4, we highlighted the problem of battery operated equipment which had no warning system to tell whether it was on or off. In those days batteries cost pence - old pence - and the light emitting diode had not been thought of. We returned to the subject in Bulletin 69 (February 1974) when the l.e.d. and the liquid crystal were both in use. Yet six years later we still find on the portable pH meters we have been testing, no visible indication of the state of the equipment, other than the switch position itself. Recently Philip Harris have produced

ammeters and voltmeters where the indicator is a flashing l.e.d., and the price does not appear to have risen very much, although this may not necessarily be due to the cheapness of the alarm system. But when batteries are costing nearer pounds than pence, a flashing l.e.d. added to battery powered equipment would seem to make conservation, if not economic sense. I reckon we could build a flasher circuit, excluding labour costs for the cost of one PP9. Are these both examples of vertical, as opposed to lateral thinking?

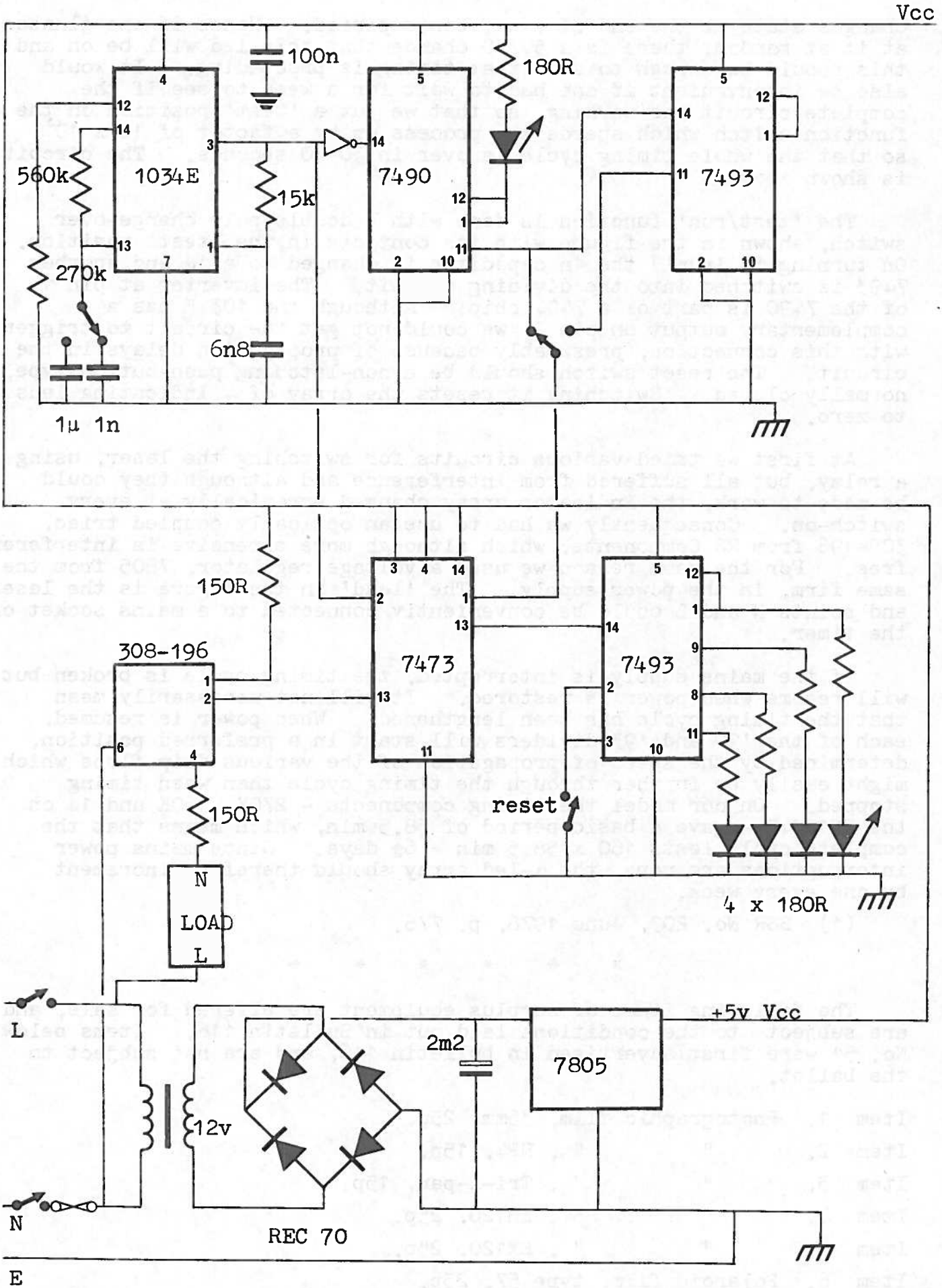
# Physics Notes

Most schools will by now be aware that lasers suffer if kept unused for long periods. What happens is that the tube glows but does not laze when switched on. A method of rejuvenating a laser was described in the School Science Review (1), but it did not work with us. Another, which we heard of through a manufacturer, was to remove the tube from its power supply, and to connect it to two or more e.h.t. power units in parallel, until the current in the laser had risen to 3-4mA. This did not work either, probably because the tube had not been used for a long time. We do know of two schools where this has worked, using two e.h.t. units plus the laser's own power supply in parallel, but with most schools possessing only one e.h.t. power supply, it is a method which needs some organising.

We believe the trouble is due to slow curing of the seals between the metal and glass, and although Philip Harris state in their catalogue that their lasers do not need preventive treatment, Griffin and George suggest that the laser should be switched on for an hour each week. As this is a chore which can easily be forgotten (to say nothing of the summer holidays) we constructed the following timer to do the job.

A week has 168 hours, so that if we design a timer with a basic one hour period, and divide its output frequency by 16 and then by 10, the output period will be approximately one week. None of the times needs to be exact, so that any near approximation to a basic period of one hour will do. Hence although we have used a precision timer, 305-850 from RS Components, to produce the one hour period, it is not because of its precision but because it can generate this length of delay without resorting to electrolytic capacitors in the time constant. This occurs because the timer, which is equivalent to ZN1034E has an internal oscillator and 12 stage binary divider which changes the state of the output after 4095 oscillator cycles. The reason for avoiding electrolytic capacitors if possible is their relatively large leakage current. The capacitor in the time constant of the ZN1034E is a 1uF, which means that either a polyester or a polycarbonate type can be used.

Apart from the basic timing process, two refinements to the circuit were made. If the circuit is to be left unattended for weeks or months, it helps to be able to glance at it occasionally to see if it is still working, and secondly, it may be a help to know how many times the laser has come on, presumably for a one hour basic period, since it was last set. For the second we provide a 7493 counter with outputs to four leds so that they count in 4-bit binary and increment by one each time the laser switches on. Another led has been set so that it


Vcc
100n
180R
560k
1034E
15k
7490
7493
270k
6n8
1µ 1n
150R
308-196
7473
7493
reset
4 x 180R
150R
N
LOAD
L
L
2m2
7805
+5v Vcc
12v
N
REC 70
E

changes state at the end of every basic period. Hence if one glances at it at random, there is a 50/50 chance that this led will be on and this should be enough to show that timing is proceeding. It would also be inconvenient if one had to wait for a week to see if the complete circuit was working, so that we put a 'test' position on the function switch which speeds the process up by a factor of $16 \times 10^3$, so that the whole timing cycle is over in 30-40 seconds. The circuit is shown above.

The 'test/run' function is done with a double pole change-over switch, shown in the figure with its contacts in the 'test' position. On turning to 'run', the 1n capacitor is changed to a 1µ and another 7493 is switched into the dividing circuit. The inverter at pin 14 of the 7490 is part of a 7404 chip. Although the 1034E has a complementary output on pin 2, we could not get the circuit to trigger with this connection, presumably because of propagation delays in the circuit. The reset switch should be a non-latching push-button type, normally closed. Switching it resets the array of 4 indicating leds to zero.

At first we tried various circuits for switching the laser, using a relay, but all suffered from interference and although they could be made to work, the indicator array changed erratically at every switch-on. Consequently we had to use an optically coupled triac, 308-196 from RS Components, which although more expensive is interference free. For the same reason we used a voltage regulator, 7805 from the same firm, in the power supply. The 'load' in the figure is the laser, and points N and L could be conveniently connected to a mains socket on the timer.

If the mains supply is interrupted, the timing cycle is broken but will resume when power is restored. It will not necessarily mean that the timing cycle has been lengthened. When power is resumed, each of the '90 and '93 dividers will start in a preferred position, determined by the speed of propagation of the various flip-flops which might easily be further through the timing cycle than when timing stopped. On our model the timing components - 270K, 560K and 1µ on the ZN1034E - gave a basic period of 58.5 min, which means that the complete cycle lasts 160 x 58.5 min = 6½ days. Since mains power interruptions are rare, the 4-led array should therefore increment by one every week.

(1) SSR No. 209, June 1978, p. 776.

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The following items of surplus equipment are offered for sale, and are subject to the conditions laid out in Bulletin 116. Items below No. 51 were first advertised in bulletin 116, and are not subject to the ballot.

Item 1. Photographic film, 35mm, 25p.
Item 2. " " , HP4, 15p.
Item 3. " " , Tri-X-pan, 15p.
Item 4. " " , EH120, 25p.
Item 5. " " , EX120, 25p.
Item 6. Polaroid film, type 57, 25p.
Item 12. Universal developer PRNQ, (this is new stock), £1.

Item 18. Exposure meter, £4.

Item 20. Silicon grease, £1.

Item 21. Silica gel, 50p.

Item 37. Rheostat, £2, (not all values still available).

Item 39. Helipots, £1.

Item 44. Head and breast set, £1.50.

Item 45. Electrolytic capacitor, 3mF, 30p.

Item 51. Measuring cylinder, glass, 100 x 1ml, 60p.

Item 52. Mercury in glass thermometer, 80-340 x 2°F, £1.

Item 53. Max. and Min. thermometer, -10 to +140°F, £2.50.

Item 54. Wet and dry bulb hygrometer, £2.50.

Item 55. Aneroid barometer, 80 min. dia. circular scale, 860 - 1050 x 1 mbar, £10.

Item 56. Prismatic binoculars, 7 x 50, £40.

Item 57. Typewriters, various makes, £5.

Item 58. Desk type calculators, four function, some with memory, £3.

Items 55-58 will only be sold against an invoice.

Item 59. Suction gauge, 0-30 x 1inch Hg circular scale, £3.

Item 60. Vacuum/compressor pump, Edwards ECB1, maximum pressure 1kgfcm$^{-2}$, vacuum 125 torr: riffled outlets for rubber tubing, £15.

Item 61. Pye potentiometer, 0-1.7V x 1μV: £5.

Item 62. Resistance box, 4 decade, 0-9999 x 1Ω, £2.

Item 63. Weatherproofed loudspeaker unit, 4W, 15Ω: 2½ inch dia. cone, 75p.

Item 64. Display unit, consisting of 5 Nixie tubes and bezel, arranged to count to £999.99, with 5 SN74141 drivers on printed circuit board, with multipin side connector lead, £5.

Item 65. Regulated power supplies, max. current unknown but thought to be in the region of 1A, outputs 2 x 50V, £6.

Item 66. As above, outputs 2 x 3.2V: 4 x 23.5V, £6.

Item 67. As above, outputs 2 x 4.8V; 2 x 30V, £6.

Item 68. As above, outputs 2 x 21V, £6.

Item 69. As above, outputs 4 x 21V: 2 x 3.5V, £6.

Item 70. As above, outputs 2 x 28V, £6.

Item 71. Stabilised power supply, type 1930 by Furzehill. Outputs 500V unstabilised, 500V stabilised, 100mA; 300V stabilised, 100mA; -150V stabilised, 50mA; low voltage a.c. outputs 4V,3A; 2.3V, 3A and 6.3V, 1A. With output voltmeter, £10.

Item 72. Signal generator, type TF144G/4 by Marconi. Frequency 85kHz to 25MHz in 8 ranges; output 1μV-100mV peak to peak in 6 ranges, with x1 - x10 fine control, external or internal modulation, 10-70%, internal mod 1kHz: weight 34kg, £10.

Item 73. Video oscillator, type TF885A/1 by Marconi. Frequency 50Hz-12MHz in 3 ranges. Output 1mV-31.6V in 10 ranges, with output voltmeter, £10.

Item 74. Single beam oscilloscope, type 1045K by Cossor, max. sensitivity 10mV/cm; attenuator x1, x10, and x100: time base ranges 10,50,100Hz, 1,10,100 and 500kHz: X input, TB output, and 1V calibration terminals, £20.

Item 75. Offset printer, type 324 by A B Dick. With instruction manual. Thought to be in working order, but has not been tested by us, £10.

Item 76. Plater, type Rapilith 254 by Agfa Gevaert. This prepares plates for use on the offset printer, item 75 above. Again, it has not been tested by us but it is thought to be in working order, £10.

Item 77. Single phase a.c. motor, 1/4hp, 1425rpm: V pulley output, £10.

Item 78. Worm gear box, 10-1 and 12-1 reduction ratios: V pulleys in and out, £1.

# Chemistry Notes

We have again heard reports of the age old problem caused by charcoal blocks smouldering long after the reduction of the copper or lead oxide was over and the laboratory closed up for the day. In one recent incident the blocks had been doused in water, but apparently must have dried out and continued burning. In another, some of these blocks were placed on a heat resistant (asbestos) mat but managed to damage the bench surface through this mat.

Repeated cooling of charcoal blocks in cold water with subsequent reheating will certainly shorten their life and one suggestion given to us by a teacher is to make disposable charcoal blocks by roasting pieces of wood in a tin with a loosely fitting lid (a fume cupboard is necessary!) After completing the reduction these can be extinguished by leaving them in water for some lengthy time before disposing of them.

Another idea is to make use of the elementary facts concerning combustion which we teach to young pupils. Simply placing the blocks in a tin, allowing about half a minute for the air inside to warm up before pressing the lid down tightly to exclude the air, results in the blocks being extinguished in a short time. We found that a block which had been in the tin for two minutes could not be made to glow again. An empty 2lb syrup tin will hold only four blocks (96mm x 30mm x 30mm) but there is no reason for not using several tins or one larger one. In addition the tin can be placed in a few centimetres of water in a sink or trough.

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Some time ago we received word of two laboratory accidents, one of which could have had very serious consequences. One day after school the cleaner's wooden rubbish container went up in flames. The fire was put out without serious damage, and investigation suggested that the cause of the fire was as follows. In one lab. a

teacher had dropped a small bottle of potassium manganate(VII) (potassium permanganate) and put the sweepings into the bucket. In another lab. broken glass from a conical flask which had contained propane-1,2,3-triol (glycerol) was put into the bucket. The cleaner tipped the contents of both buckets, together with used paper towels, into her own container, which caused the fire. Had the container not gone on fire until the school was completely emptied, a serious fire would have happened.

The second accident resulted from the experiment to spark air in a flask, as in the article in Bulletin 118. A technician had been told to dry the flask, and had given it a final rinsing with propanone (acetone). Igniting the spark caused the flask to explode, because of the remaining vapour, and our experience in the same experiment shows that the same can happen if methylated spirit is used to rinse the flask.

# Trade News

A recently published Department of Health notice advises all area Health Authorities of the danger of the use of the Rodwell Revotherm magnetic stirrer/heater which could result in operators suffering electric shocks. The notice advises that all such units should be disconnected from the electrical supply and taken out of service. The units should then be returned to Rodwell Scientific Intruments who will modify them in line with the DHSS requirements.

An error is present in Griffin and George's catalogue 80/82 on page 519. The incorrect catalogue number is quoted with thermochromic liquid (an accessory for the domestic and central heating models XHC-341-S/XHC-401-P). The catalogue number should read 203-035-010G and the pack size 1 litre.

We made a mistake in stating in Bulletin 120 that the Unilab digital display unit, cat. no. 092.681, was not compatible with t.t.l. In fact, two lamps in each of the 7 segments of the display are driven through a transistor from a SN7448 chip. Their reverse crystal readout, which will fit the gate of the THD slide projector, and which was exhibited at the Hull meeting of the ASE, together with modules for measuring pH, temperature and voltage should be available in early autumn. Expected prices are about £40 for the display, and £70 for the modules.

Available from Cherwell Laboratories are gas tight borosilicate glass syringes at very competitive prices. We have examined the 100cm$^3$ (smallest calibration 4cm$^3$ with easy estimation to 2cm$^3$ or less) and the 150cm$^3$ capacity (smallest calibrate 10cm$^3$ with easy estimation to less than 5cm$^3$) and found them to be very smooth running and gas tight. The graduation markings are fused onto the glass and they come in sizes of 1,2,5,10,20,30,50,100,150,200 and 250cm$^3$ capacity; prices here are given for some three sizes only.

| | Type A | Type B | Type C |
|---|---|---|---|
| 10cm$^3$ | £1.15 | £0.95 | £0.87 |
| 100cm$^3$ | 5.50 | 5.00 | 4.40 |
| 250cm$^3$ | 8.25 | 7.75 | 7.25 |

Type C has a glass tip luer fitting. Type B has a metal tip luer fitting. Type A has a metal luer lock. The minimum order is £10 and whilst there is no handling charge, postage and packing is charged.

Philip Harris have recently published a catalogue of "Resources for Environmental Science". This includes a wide range of equipment and materials useful in fieldwork. Especially interesting is the inclusion of certain test strips and test kits previously only obtainable from sources not well known to teachers. For example the Merckoquant test strips for a range of chemical species of environmental inportance are described together with the Esselte Studium water test kits. The catalogue is very comprehensive, offering equipment for fieldwork in a number of subject areas from Astronomy through Ecology and Meteorology to Soil Studies and Surveying.

Over the last few years great technical improvements have been made to open reel home-movie projectors. Many of these now have excellent automatic threading mechanisms, are dual gauge accepting standard or super 8, have a slow projection and still facility and can be run in reverse. Projection problems, jamming and tearing of films etc, can be much less frequent with open reel than with cassettes. For some time we have been advising science departments who have had loop projector problems and were looking around for replacements to buy a suitable open reel projector and 'decassette' their films. Others must have had the same idea because Philip Harris is now offering many of its 8mm films in open reel form. The range of 8mm films for biology, chemistry, physics and earth science is described in pages 699-716 of the 1980 Harris catalogue. Harris visual aids software is actually handled by Philip Harris Biological and should be ordered from the address on page 12 of this bulletin.

Spirit filled thermometers are available from S Brannan and Sons. We have tested two samples of three types of the 305mm size and found them to be somewhat inaccurate at higher temperatures. $-10^{o}$ to $+110^{o}C$ (Cat. No. 44/406/0, price £1.30) read too high by $4^{o}C$ at the boiling point of water. The $0^{o}C$ to $150^{o}C$ (Cat. No. 44/403/0, price £1.41) read too high by up to $2^{o}C$ at the same temperature and the $10^{o}$ to $+50^{o}C$ (Cat. No. 44/401/0, price £1.41) read too high by $0.6^{o}C$ at $40^{o}C$. They have a reasonably rapid response. Whilst they do not provide a cheap alternative to mercury thermometers they may be an alternative to those concerned with mercury spillages. They all have a squared plastic cap which also acts as a lid for the case.

In Bulletin 79 we described how sodium street lamps, which can sometimes be obtained from local authority Lighting Departments, can be made to function as a sodium light source. Since then we have sold a fair number of these through our surplus sales. At the time of publishing the article, both Griffin and George and Philip Harris supplied the special 'auto-leak' transformer which would operate a lamp. Since then a number of teachers have found that the present catalogue version of the transformer will not work with the street lamp, and the obvious answer is to purchase the control gear which lighting departments use with the lamps. This is obtainable from G.E.C., but they will only sell to electrical wholesalers, so that the school must find one in their own area. The equipment needed is for Sox lamp control gear, 35W, and consists of a choke, Z1616, at £15.61, and a capacitor Z1757N, at £2.30. Wiring instructions are printed on the choke, and it should be remembered that the lamp, which fits the normal bayonet socket, should be fitted vertically with the socket at the top.

# Display Laboratory

The following items have been added since the previous entry in Bulletin 119. Most are in the display laboratory and others will be demonstrated on demand.

| Item | Manufacturer or Agent |
|---|---|
| Sodium street lamp | SSSERC |
| Infra red radiation experiment | SSSERC |
| Random access memory | SSSERC |
| Once-a-week timer | SSSERC |
| Rotation of centre of mass experiment | SSSERC |
| Damped oscillation with the pH data memory | SSSERC |
| Formicaria | SSSERC |
| Mirror mazes | SSSERC |
| Thermostatic observation chamber for a microscope | SSSERC |
| Reduction using meta blocks | SSSERC |
| Petrol/oxygen explosion | SSSERC |
| Dial dynamometer | Griffin and George |
| pH meter PHJ-251W | Griffin and George |
| Pet Computer | SCET |
| Hot beaker holder | Mackay and Lynn |
| Alcohol thermometers | Brannan |
| Gas syringes | Cherwell Labs |
| Spill control pillows | Bennett |
| Microscope ER1300K | Irwin Desman |
| Microscope ER1300C/B | Irwin Desman |
| Signal generator 062.101 | Unilab |

The following items have been returned to their respective manufacturers since the bulletin 119 entry.

| | |
|---|---|
| Mettler PC4400 balance | Griffin and George |
| Gravitron E balance | European Instruments |
| Blue chips | Unilab |
| Magnetic flux density unit | Unilab |

S.S.S.E.R.C., 103 Broughton Street, Edinburgh EH1 3RZ
Tel. No. 031 556 2184.

Bennett and Co., Brimpton Common, Near Reading, Berks.

S. Brannan and Sons, Cleator Moor, Cumbria, CA25 5QS.

Cherwell Laboratories Ltd., P.O. Box 3, 1 Murdock Road, Bicester, OX6 7XB.

European Instruments, 80-82 Desborough Road, High Wycombe, Bucks.

G.E.C., 77 Grovepark Street, Glasgow.

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

Philip Harris Ltd., 34-36 Strathmore House, Town Centre, East Kilbride.

Philip Harris Biological, Oldmixon, Weston-Super-Mare, Avon, BS24 9AX.

Irwin Desman Ltd., 294 Purley Way, Croydon, CR9 4QL.

Mackay and Lynn Ltd., 2 West Bryson Road, Edinburgh.

Rodwell Scientific Instruments Ltd., 8 King's Road, Brentwood, Essex, CM14 4DG.

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

SCET, (Scottish Council for Educational Technology), Dowanhill, 74 Victoria Crescent Road, Glasgow G12 9JN.

Unilab Ltd., Clarendon Road, Blackburn, Lancs, BB1 9TA.