

# SCOTTISH SCHOOLS SCIENCE

## EQUIPMENT RESEARCH

### CENTRE

Bulletin No.125.

January, 1981.

# Contents

Introduction	- infra-red spectrograms	Page 1.
	- technicians' guide - microscope care and maintenance	1.
	- microbiology in Bulletin 126	1.
	- bulletin bulk distribution	2.
	- separate the science in the bulletin?	2.
	- cost index	2.
Physics Notes	- surplus equipment	3.
Chemistry Notes	- hazards of 1,2-dibromoethane	5.
	- modified meta blocks	5.
	- infra-red spectrograms	5.
Display Laboratory		7.
Trade News		7.
Address List		10.

# Introduction

When work was commenced in 1978 on updating the CSYS Chemistry equipment list it was realised that with the demise of Morris Laboratory Instruments and the Vuespec, there was no infra-red spectrometer suitable for schools. Older teachers may remember that we offered a set of spectrograms, prepared by Strathclyde University, to fill this need, in Bulletin 34. Faced with the same need, we contacted Heriot-Watt University, and with the kind permission and assistance of Dr Graysham of the pharmacy department a list of spectra prepared by ourselves and members of our Development Committee was made. Unfortunately a modern spectrometer produces big spectrograms (520 x 215mm) which would need to be reduced for school distribution, thus adding to the cost.

The list had been sent to the Chemistry Sub-committee of the Central Committee on Science for comment and approval, and through them we learned that Dr Meek of Jordanhill College of Education would be willing to run the spectra and that his spectrometer, being older, would fit an A4 size of paper without reduction. Details of the spectrograms are given in the chemistry notes section of this bulletin.

Dr Meek's spectrograms are available as Memorandum 44, from the Scottish Curriculum Development Service, at £1.60 per copy, which includes postage. Orders under £3 must be accompanied by a cheque or postal order, and orders over £3 by an official order. Teachers have permission to make photocopies or o.h.p. transparencies for use in their own school.

\* \* \* \* \*

Over the past year we have held a number of technician workshops on the care and maintenance of microscopes. The technician brings a microscope from the school, and is given guidance on the job of dismantling and cleaning it, and putting it together again. We supplemented these sessions with a cyclostyled pamphlet on the servicing of microscopes, so that even after the technician had returned to his/her school, there would be some help available, and some recall and reinforcement of the learning process.

At about the same time a similar idea was taken up by the A.S.E., and we are proud and pleased that John Richardson was commissioned to prepare the first of a series of A.S.E. commissioned pamphlets for school technicians. The series will include such titles as Microbiology, Glassware, Electrical Equipment, Electronic Equipment, Professional Apparatus from simple materials, Photography, Solutions, Aquaria etc. John's pamphlet on microscope maintenance is an expanded version of our cyclostyled sheets, and the printing and graphic facilities available to the A.S.E. make it a professional job. The pamphlet, Microscope Care and Maintenance, Technicians' Guide 1, can be obtained from SSSERC at a cost of £1 per copy, which includes postage.

\* \* \* \* \*

Our next Bulletin, No. 126, will be a bumper issue, in that it will be longer than usual, and it will be unusual in that it will

contain only advice on aspects of microbiology. As we said in Bulletin 124 there have been changes to the 'safe' list of micro-organisms since we published it in Bulletin 98, and as well as incorporating these, we thought it would be a good idea to collect in one issue other advice we have given on aspects of micro-biology, such as using pressure cookers for sterilisation (Bulletin 112) and performance testing of autoclaves (Bulletin 110).

\* \* \* \* \*

One change in our bulletin distribution which our Governing Body decided upon at its last meeting was to send the bulletin in bulk to the regional headquarters, whence it would be distributed through the regions' regular mail service. We believe that on average this will add a week to the time between emission and receipt. In one or two smaller regions without a regular mailing service we will continue to send the bulletin direct. We will continue to address envelopes as before, but these will now be parcelled before sending to the region. In Strathclyde, the distribution will be to the divisional education officers. It will mean that the ballots for surplus equipment will now be held a week later than previously, and of course adding another link to the chain increases the possibility that the bulletin may not get there at all. We regret that this has been forced on us by a very tight financial situation.

\* \* \* \* \*

One of the more frequent criticisms of the bulletin among the answers to our questionnaire, printed in bulletin 122, was a plea for separate sections for biology, physics and chemistry. Presumably the idea is to tear out those leaves applying to their own subject and file them, throwing away the others. This we are very reluctant to do. Within the seven leaves of a bulletin, we use items like 'Trade News' or the surplus equipment items as space fillers, putting in just so many as will fill up the available space at the end of other articles. To do this three times in a bulletin for the separate sciences would leave us with problems of where to put Trade News, or Display Laboratory, or even, dare we say it, Integrated Science. After ten years in which Integrated Science has been the established religion, this plea for separation rings in our ears like the image we have of the Catholic church in Poland, something which thrives in adversity.

Our reply to the critics is that one way, admittedly a compromise, is to ask for three copies of each bulletin to be sent to the school. It has always been possible to have this done, and over 200 schools at present get three copies, addressed to the principal teachers of biology, chemistry and physics respectively. They may then tear out whatever part or parts which are of no use to them, and keep the rest. They will nearly always have bits of other articles attached to their ends but this should not make the pile too bulky. In view of what we have already said regarding our financial situation we are obviously reluctant to increase the number of copies we have to send out, so that only those who feel a real need to have their own copy should ask to have this done.

\* \* \* \* \*

Our cost index of consumable items of equipment which is sampled twice yearly in May and November, and for which the base line is 100

in May 1974, was 265 in November last. This is an increase of 12.8% since November 1979 and 3.2% over the past six months.

## Physics Notes

The following items of surplus equipment are offered for sale, and are subject to the conditions laid out in Bulletin 116. Items between 1 and 78 were first advertised in bulletins 116 or 122, and are not subject to the ballot. Item numbers 79 and above will be balloted. Clients should realise that once an item has passed through the ballot it is available on our shelves to callers, and that although the inventory is correct at the time of writing, some items may have sold out in the interval, usually 5-6 weeks, before the bulletin appears.

- Item 1. Photographic film, 35mm, 25p.
- Item 3. " " , Tri-X-pan, 15p.
- Item 6. Polaroid film, type 57, 25p.
- Item 20. Silicon grease, £1.
- Item 21. Silica gel, 50p.
- Item 37. Rheostats, £2.
- Item 39. Helipots, £1.
- Item 44. Head and breast sets, £1.50.
- Item 45. Electrolytic capacitor, 30p.
- Item 59. Suction gauge, £3.
- Item 63. Loudspeaker unit, 75p.
- Items 65-70 inclusive, power supplies £6.
- Item 71. Stabilised power supply, 500V, £10.
- Item 79. Photographic paper, Kodak bromide WSG 3S, 5 x 7in, 100 sheets, £3.
- Item 80. As above, but 8 x 10in, 100 sheets, £4.
- Item 81. As above, but WSG 4S, 6½ x 8½in, 100 sheets, £3.50.
- Item 82. As above, Kodak Veribrom F2, resin coated, 6½ x 8½in, 100 sheets, £4.
- Item 83. As above, Ilford Ilfospeed, 3.1M glossy, resin coated, 8 x 10in, 100 sheets, £5.
- Item 84. Photographic fixer, Ilfofix, solid, in packets, to make 2.25l solution, 30p.
- Item 85. Colour developer, Kodak process Ektachrome E2/E3, first developer, to make 13.5l solution, 50p.
- Item 86. Farmer's reducer, bleaching agent, to make 250ml solution, 10p.
- Item 87. Dry battery, 6V bell type, spring terminals, 20p.
- Item 88. " " , 3V cycle type Ever ready 800, 15p.

- Item 89. Dry cells, 1.5V; we have a huge purchase of these (over 15,000) and those we have examined are within their shelf life. We would prefer to sell by the gross (N.B. a gross box weighs 13.5kg). Per 2, 15p; per 24, £1.50; per gross, £8.
- Item 90. Dry battery, 4.5V Admiralty pattern; these have different sizes of socket on a piece of paxolin. The larger fits a 4mm plug; the smaller can be drilled out and a 4mm socket fitted. We use these with t.t.l. integrated circuits, 15p.
- Item 91. Dry battery, Duracell PX21, 4.5V, 10p.
- Item 92. Prismatic binoculars by Barr and Stroud, 7 x 50; £30.
- Item 93. Desk calculators, four function, some with memory, various makes; £3.
- Items 92 and 93 will be sold only against an invoice on the school.
- Item 94. Signal generator, Advance J1; 15Hz-50kHz in three ranges, 0-25V; outputs at 5 $\Omega$  and 600 $\Omega$ ; £20.
- Item 95. Battery charger power supply, 13.5-15V at 2A; £3.
- Item 96. EHT power supply, 9kV and 18kV, 300 $\mu$ A. Contains two output meters (85mm dia. circular scale) for voltage and current which can be used with the e.h.t. off to measure external circuitry. When e.h.t. is on the unit gives an audible warning which increases in frequency as the e.h.t. is increased; £10.
- Item 97. Universal bridge, type TF868B by Marconi. 270 $^{\circ}$  20cm dia. calibration scale, reading 0-10, and 7 ranges on R, C, and L giving 0-10M $\Omega$ , 0-100 $\mu$ F, and 0-100H. There is also a x10 button on resistance, increasing the range to 100M $\Omega$ ; £15.
- Item 98. Stopwatch, 3 x 0.01s, £5.
- Item 99. Stopwatch, 60 x 0.2s, £3.
- Item 100. D.C. panel meter, 60mm dia. scale, 5 x 0.5mA, £2.
- Item 101. As above, 80mm dia. scale 5-0-5 x 0.5 $\mu$ A, centre zero, £3.
- Item 102. As above, 80mm dia. scale 2.5-0-2.5 x 0.1mA centre zero, £3.
- Item 103. As above, 60mm dia. scale 500-0-500 $\mu$ A centre zero; scale reads 250-0-250 x 10 divisions; £2.
- Item 104. As above, 60mm dia. scale 1mA f.s.d.; scale reads 0-250 x 10 divisions; £2.
- Item 105. Printed circuit board; contains 32 x 2N1303 transistors (germanium pnp, 30V, 300mA max.) and one OC23 (ger. pnp, 45V, 5A max) as well as resistors, capacitors; 50p.
- Item 106. As above, but with 10 x 2N1303 (see above), 10 x 2N1302 (ger. npn, 25V, 300mA max) 10 x ACY20 (ger. pnp, 20V, 500mA max) and 10 x ASY27 (ger. pnp, 15V, 300mA max); 50p.
- Item 107. As above, but with 10 x 2N1302, 10 x 2N1303 (see above) and 10 x OC29 (ger. pnp, 35V, 8A max); 50p. All the transistors on items 105-107 have short leads; the OC29 base and emitter leads are 10-15mm long.
- Item 108. Perspex offcuts; 48 x 18in in various thicknesses, clear and coloured, £2.40 per sheet; patterned sheet, £1.50.

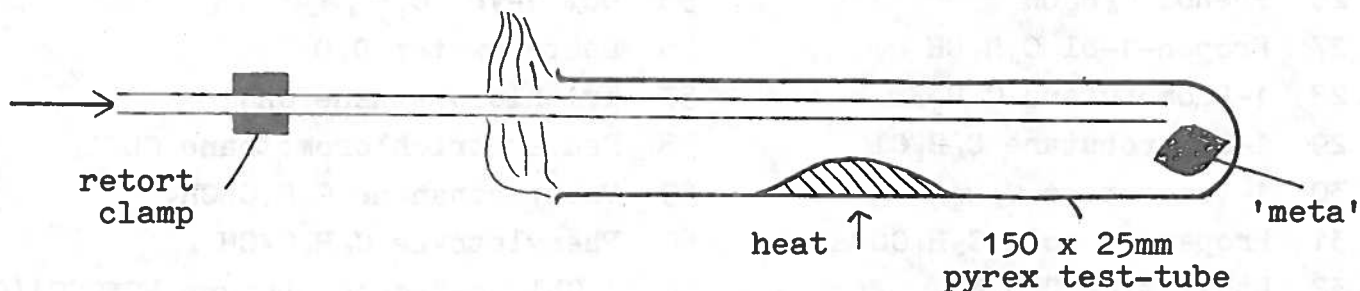
## Chemistry Notes

When preparing our list of chemicals for 'O' and 'H' grade (February 1979) we had doubts about the inclusion of 1,2-dibromoethane (ethylene dibromide) but it was included at the request of several teachers as an optional extra, under Section 2(i) of the list. We now have information, in the guidance note EH15/79, Threshold Limit Values for 1979, from the H.S.E. that this substance is recognised to have carcinogenic potential. For such substances "no exposure or contact by any route - respiratory, skin or oral, as detected by the most sensitive methods - shall be permitted. The worker should be properly equipped to ensure virtually no contact with the carcinogen".

In EH15/79, 1,2-dibromoethane is included in a list along with acrylonitrile, naphthalen-2-amine, benzidine, chloromethyl methyl ether, 4-aminobiphenyl, and 4-nitrobiphenyl, some of which are prohibited in this country. In these circumstances we think it would be most unwise that a school should stock this substance, and we have withdrawn it from our chemicals list.

\* \* \* \* \*

A useful modification of the method described in Bulletin 115 for the reduction of metal oxides with meta blocks comes from Linlathen High School. He suggests using a straight delivery tube which simultaneously supports the combustion tube and keeps itself clear of the copper(II) oxide. A slight upward tilt of the delivery tube removes any tendency for the test-tube to slide off.



\* \* \* \* \*

It was felt that our list of infra-red spectrograms should contain a large number of 'unknown' compounds, designated by a letter only. Accordingly, of the 71 spectrograms in the list, only the first fourteen (part A) are named, and they include the main classes of organic compound, and water. Part B numbered 15-71 are randomly arranged so that some can be used as unknowns and others may be used as further examples of the main classes.

A number of isomeric compounds are included, as are deuterated compounds so that the effects of mass can be seen. A correlation chart is given in simple form to aid identification of groupings and a plan of the mechanics and light path of the Perkin Elmer 137 spectrometer used to make the spectra is shown.

Infra-red spectra, Part A

- |                                   |                                      |
|-----------------------------------|--------------------------------------|
| 1 Hexane $C_6 H_{14}$             | 8 Butanone $CH_3 CH_2 COCH_3$        |
| 2 Hex-1-ene $C_6 H_{12}$          | 9 Ethanoic acid $CH_3 COOH$          |
| 3 Hex-1-yne $C_6 H_{10}$          | 10 Ethyl ethanoate $CH_3 COOC_2 H_5$ |
| 4 Pentane $C_5 H_{12}$            | 11 Phenylamine $C_6 H_5 NH_2$        |
| 5 Butan-1-ol $C_4 H_9 OH$         | 12 Benzene $C_6 H_6$                 |
| 6 Ethoxyethane $C_2 H_5 OC_2 H_5$ | 13 Methylbenzene $C_6 H_5 CH_3$      |
| 7 Butanal $C_3 H_7 CHO$           | 14 Water $H_2 O$                     |

Part B

- |   |  |
|---|--|
| 15 Methanol $CH_3 OH$                         | 44 Methanoic acid $HCOOH$                                    |
| 16 Butanoic acid $C_3 H_7 COOH$               | 45 Sulphur dioxide $SO_2$                                    |
| 17 Ethanol $C_2 H_5 OH$                       | 46 Ammonia $NH_3$  |
| 18 Hexachlorobutadiene $C_4 Cl_6$             | 47 2-Methylpropan-2-ol $(CH_3)_3 COH$                        |
| 19 Nujol Mixed alkanes                        | 48 Carbon dioxide $CO_2$                                     |
| 20 Olive oil                                  | 49 Benzoic acid $C_6 H_5 COOH$                               |
| 21 Methyl benzoate $C_6 H_5 COOCH_3$          | 50 Hexanal $C_5 H_{11} CHO$                                  |
| 22 Dimethylbenzenes $C_6 H_4 (CH_3)_2$        | 51 Tetrachloromethane $CCl_4$                                |
| 23 Cyclohexane $C_6 H_{12}$                   | 52 Hydrogen chloride $HCl$                                   |
| 24 Hexan-1-ol $C_6 H_{13} OH$                 | 53 Butan-2-ol $CH_3 CH_2 CHOHCH_3$                           |
| 25 Butyl ethanoate $CH_3 COOC_4 H_9$          | 54 Ethanal $CH_3 CHO$  |
| 26 Phenol $C_6 H_5 OH$                        | 55 Oct-1-yne $C_8 H_{14}$                                    |
| 27 Propan-1-ol $C_3 H_7 OH$                   | 56 Deuterowater $D_2 O$                                      |
| 28 1-Bromobutane $C_4 H_9 Br$                 | 57 Trichloromethane $CHCl_3$                                 |
| 29 1-Chlorobutane $C_4 H_9 Cl$                | 58 Deuterotrchloromethane $CDCl_3$                           |
| 30 1-Iodobutane $C_4 H_9 I$                   | 59 Phenylethanone $C_6 H_5 COCH_3$                           |
| 31 Propanoic acid $C_2 H_5 COOH$              | 60 Phenylethyne $C_6 H_5 C \equiv CH$                        |
| 32 Ethylamine $C_2 H_5 NH_2$                  | 61 3-Chloro-3-methylbutyne $HC \equiv CCl(CH_3)_2$           |
| 33 Propanone $CH_3 COCH_3$                    | 62 Polystyrene - $(C_6 H_5 CHCH_2)_x$                        |
| 34 Ethanamide $CH_3 CONH_2$                   | 63 Heptane $C_7 H_{16}$                                      |
| 35 Decanedioyl dichloride $(CH_2)_8 (COCl)_2$ | 64 2-Hydroxybenzoic acid $C_6 H_4 (OH)(COOH)$                |
| 36 Phenol $C_6 H_5 OH$                        | 65 Potassium carbonate $K_2 CO_3$                            |
| 37 Benzaldehyde $C_6 H_5 CHO$                 | 66 Trisodium phosphate $Na_3 PO_4$                           |
| 38 Methyl ethanoate $CH_3 COOCH_3$            | 67 Ammonium sulphate $(NH_4)_2 SO_4$                         |
| 39 Carbon disulphide $CS_2$                   | 68 Lead nitrate $Pb(NO_3)_2$                                 |
| 40 Ethane-1,2-diamine $C_2 H_4 (NH_2)_2$      | 69 Potassium cyanide $KCN$                                   |
| 41 Chloromethylbenzene $C_6 H_5 CH_2 Cl$      | 70 Copper sulphate $CuSO_4 \cdot 5H_2 O$                     |
| 42 Ethanoyl chloride $CH_3 COCl$              | 71 Hexaaminenickel tetrafluoroborate $[Ni(NH_3)_6] [BF_4]_2$ |
| 43 2-Methylpropan-1-ol $CH_3 CH(CH_3)CH_2 OH$ |  |



## Display Laboratory

The following items have been added since the previous entry in Bulletin 122. Most are in our display laboratory and others can be shown on demand.

Item	Manufacturer or agent
Chloroplast model	SSSERC
Polarisation colours	"
Binary multiplier	"
Microprocessor tutor	Welwyn
Elmac 4810 oscilloscope	Kramer
OSC 3C oscilloscope	"
Conductivity meter PJK-301	Griffin and George
Time/speed computer	Philip Harris
pH meter 502	Carwyn
pH meter 503	"

## Trade News

The time and speed computer, P16850/1 from Philip Harris, can measure and store up to 8 readings of the parameter on two channels which are independent of each other. Hence elastic collisions on an air track where two times or speeds may require to be measured simultaneously are possible. Times are measured to 1ms, and displayed on a 4 digit 7 segment display. When measuring speed, the results can be adjusted for 5, 10 or 20cm length of track. The computer can measure acceleration by using a U-shaped card, with the light beam interrupting both limbs. From the average speed over each limb, one can calculate acceleration from  $a = (v^2 - u^2)/2s$ . Although intended for use with the Harris light gates, we found that the computer input was compatible with t.t.l. The time and speed computer costs £145.52.

An educational computer, called a micro-processor tutor, which was designed by Newcastle Science and Technology Education Centre, is available from Welwyn Electric at a cost of £97. All data and instructions are entered via 8 switches with 8 associated l.e.d.s. Three of the switches deal with instructions, and the instructions which can be processed include load, store, add, subtract, logical and, complement, branch, branch if accumulator = zero. Accordingly the computer can deal with flow charts which include loops. Along with the computer comes a small d.c. motor and a set of l.e.d. traffic lights, either of which the computer can control. Three booklets are provided; the experiment manual, specimen programs, and a pamphlet showing how the computer works.

We have received two oscilloscopes made in Israel through their agents, Kramer and Co. The smaller one, OSC3C, is also available from Walden Precision Apparatus and costs just under £100. Sensitivity is 100mV per division to 50V per division in nine ranges, time base 1µS/div to 10ms/div in five ranges, plus an additional 'external' time/base position. Triggering is continuous via a potentiometer, from - to + level. The screen is round, 3in diameter. The larger oscilloscope, the Elmac 4810, has a 8 x 6cm screen, and the same specification as the OSC3C and sells from Kramer at £125.

It seems we were in error in stating in Bulletin 124 that cathode ray tubes for the Serviscope Minor can no longer be obtained. The technician in Golspie High School rang us to say that he had got one, part No. 154-0524-00 from Tektronix for £26.70. Although the type number on the tube itself is different from the original, the tube is a direct replacement as he can verify, having tried it out. It might be worth while for a school, or certainly for a science centre, to buy one or two of these as standby replacements.

We have received the following apparatus reports from CLEAPSE, which can be borrowed by writing to the Director of SSSERC.

- L4b Electronic balances supplement
- L31 Oscilloscopes for schools
- L156 Equipment list 2: for work with light
- L163 Bathroom and kitchen scales
- L164a Heating in primary science

The Janetzki T5 centrifuge, very useful for Scottish biology syllabus right up to CSYS level is no longer available through Copleys. The new agents are Clandon Scientific. Prices are still very competitive and a new version with an electric brake for increased safety is now made. The basic machine (INT-T-5) costs £54.90 and the model with electronic brake (INT-T-5B) £70. Rotors are extra with the 4 x 15ml swing-out (INT-205) and the 4 x 15ml angled (INT-206) rotors costing £13.75 each. The 6 x 15ml angled rotor (INT-207) costs £17.15 and the 8 x 15ml (INT-204) angled rotor £24.00. The rotor extractor (INT-514) is £6.85. All prices are ex-works. At the time of writing Clandon still have to obtain stocks of this version.

Self adhesive warning labels for chemicals are available in the form of rolls from Philip Harris. Each roll contains approx. 530 labels of the same type, perforated for easy removal of individual labels. Seven types are available i.e. corrosive, explosive, oxidising, harmful, highly flammable, toxic and irritant, and each conforms to schedule 2 of the Packaging and Labelling of Dangerous Substances Regulations 1978. An individual label measures 62 x 25mm and a roll of any type costs £2.42.

A disinfectant cloth, Wipex, is available from Griffin and George. The disinfectant is bonded into the cloth, so that only the correct amount is used, and as a warning the disinfectant is active as long as the blue stripes in the cloth remain. Wipex Cloths are ZZC-180-U in the catalogue, £5.95 for a pack of 20.

Jencons (Scientific) have changed their address to that given on page 10.

A new way of mopping a spillage is to place on top a "Spill Control Pillow" and simply allow it to soak up the liquid. The absorbent is amorphous silicate contained in a porous polyolefin bag. We found that the material of this bag could withstand concentrated sulphuric, hydrochloric and nitric acids as well as 2M and wet pellets of potassium hydroxide. The sample bag supplied to us was for "1 litre spills" and was placed successively in four portions of 250g of water in a basin for 15 seconds each time. Overall, 96% of the 1000g was absorbed, but on lifting the bag out of the last portion it was dripping profusely and a disposal bag or bucket of suitable material would be needed at hand. The appropriate neutralising agent can simply be added slowly to the pillow in the bucket. Information on neutralising agents can be obtained from books on safety e.g. our own SSSERC manual.

Clearly it is much simpler and less messy than stirring the spillage with the appropriate absorber. They do not however contain any chemicals to make the spilled liquids less toxic or hazardous and are simply designed to absorb. Care still has to be taken with the subsequent disposal and if necessary treatment of the bag prior to disposal. They may seem expensive at just under £1 per 250cm<sup>3</sup> bag and £3 for a litre bag, but this must be compared against the price of say calcium carbonate at £1.71 per kg. Spill control pillows are available from Bennett and Co. 20 pillows, 250cm<sup>3</sup> size, cat. no. 17-351 cost £19.50; 12 pillows, 1 litre size, cat. no. 17-370 cost £36.

Griffin and George are now sole agents for Eldon blood grouping cards. They are obtainable from Gerrard Biological Centre at the address given on page 10 of the bulletin.

Alpha Laboratories, mentioned previously in our bulletins as suppliers of Sealon film and transfer pipettes, have changed their address to that given on page 10.

Available from Mackay and Lynn are Tex pens at £1.30. They are suitable for writing on any surface up to 1000°C.

Poaching on the goodies which will make their debut at the A.S.E meeting - for it is still 1980 at the time of writing - Unilab are offering a biological amplifier which will display the electric waves associated with muscle activity in human and other animal subjects. When showing electrocardiographs, the amplifier shows the pulse rate by means of an audible 'bleeper'. We set out, then abandoned an attempt to do this ourselves because of the danger of causing electric currents to flow in any of the body organs, when connected to mains powered apparatus like an oscilloscope. Unilab overcame this problem by a method we had not thought of i.e. using an opto-isolator. This ensures that electrodes stuck to the skin, and all the electrical apparatus associated with them, is at low voltage. The amplifier will cost about £50. We are not so favourable to the suggestion that the signals should be recorded on a cassette recorder for later playback, because much of the impact of the biological amplifier must be in the immediacy of the response, for example to exercise, and after Watergate pupils will believe that tapes can be made to concoct anything.

From the same firm we have news of some additions to their Blue chip range. These are a 16 x 4 bit memory at £20.79; a shift register at £9.90 and a decoder and 7 segment display at £9.02.

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

Alpha Laboratories, 40 Parkham Drive, Eastleigh, Hampshire.

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

Carwyn Instruments, Pentraeth Road, Menai Bridge, Gwynedd,  
LL59 5LY.

Clandon Scientific, Lysons Avenue, Ash Vale, Aldershot, Hants,  
GU12 5PR.

CLEAPSE, Brunel University, Kingston Lane, Uxbridge, Middlesex.

Gerrard Biological Centre, Worthing Road, East Preston, West  
Sussex BN16 1AS.

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

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

Jencons Scientific Ltd., Cherrycourt Way, Industrial Estate,  
Leighton Buzzard, Beds LU7 8UA.

Kramer and Co., 9 October Place, Holders Hill Road, London  
NW4 1EJ.

Mackay and Lynn Ltd., 2 West Bryson Road, Edinburgh EH11 1EH.

Scottish Curriculum Development Service, Dundee Centre, Broughty  
Ferry, Dundee DD5 1NY.

Tektronix Ltd., Beaverton House, Station Approach, Harpenden,  
Herts.

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

Walden Precision Apparatus, Shire Hill, Saffron Walden, Essex.

Welwyn Electric Ltd., Bedlington, Northumberland NE22 7AA.