SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No. 121. June, 1980.

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Introduction

It is with deep regret that we record the death of Devon Reid, H.M.I. Devon, whom I have known since he taught in Madras College, was the S.E.D. representative in our Governing Body and the Development Committee, and was a tireless worker in the cause of science education. He will be much missed.

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Concurrent with the posting of this bulletin we have issued to schools an equipment and chemicals list for Sixth Year Studies Chemistry. We do not have a separate address list for SYS, but we have sent a copy, usually addressed to the principal teacher of chemistry, to all those schools which we think might teach the subject. If any such school has been omitted we will send a copy free of charge upon request.

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We include in this Bulletin a review of microscopes suitable for lower-school work. It is several years since we published a comparative survey of microscopes for work up to '0' grade. Since then prices have risen dramatically and several of the models we reviewed have been withdrawn. We have therefore up-dated our summary and the revised version appears in the 'Biology Notes'.

It is ironic that this period of educational 'cut-backs' should also be a good time to buy some types of optical equipment. With the pound hardening against the yen when some suppliers were holding large stocks, prices have held firm for some time. We have actually seen 'special offers' with some models coming down in price quite sharply.

However a less welcome trend was started before this move in prices occurred. With science departments desperately short of money the sales of very cheap instruments increased dramatically. The desire of teachers to purchase instruments in sufficient numbers to keep sharing to a minimum is very understandable. However we believe that there is a certain level of optical and mechanical quality below which the purchase of instruments ceases to be cost effective. Very inexpensive instruments usually do not produce images that allow pupils to see what we want them to see and they will not give long trouble-free service. Put more bluntly, there is no such thing as a free lunch!

We frequently encounter the attitude that instruments for younger pupils do not need to perform as well optically as those for pupils further up the school. We have made it clear before in these pages that we think this a mistaken view. However in present circumstances perhaps our position should be restated. In our view it is in the early stages of microscope work, when pupils are so inexperienced and lack practice in interpreting images, that well resolved and relatively aberration-free images are needed. This requirement for a minimum standard of optical quality at an acceptable price may mean compromising on maximum magnification and sophisticated stands and controls. However we are adamant that good optical quality is the major consideration.

Some of the keenest purchasers of very cheap microscopes have been the primary schools. Primary science seems to be going through a minor resurgence in some parts of Scotland. In some areas money for equipment is forthcoming from PTA's and schools funds. We are not convinced, for a number of reasons, of the value of ordinary monocular compound microscopes in primary schools. A decent stereo-microscope especially of the 'long-arm' type could be a major asset for upper primary environmental science courses. However, cheap 'toy' microscopes will be useful for little except to serve as status symbols. We exclude from this criticism some of the very useful magnifiers on a stand which look vaguely like microscopes but are of limited magnification.

We have no means of communicating directly with primary or middle school teachers. However we have been approached for advice by many primary heads who have heard of us through the grapevine. We would like to make it more widely known that we can offer this advisory service, not for just microscopes but for any primary science equipment or experimental work. We would be grateful therefore if those of our readers with contacts in primary schools would make this offer known to them.

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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 is now 257. This is an increase of 17.7% over the past year and 9.4% over the past six months.

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The Centre will not be open on Saturday mornings during the summer holiday, i.e. between 5th July and 16th August, both dates inclusive. This apart, we are open for business as usual during the summer.

Chemistry Notes

Below is the third of our articles from the ASE Safety Committee, Materials and Processes Group, Advice on Safety in Chemical Experiments. The others were, possible carcinogenic hazards in school science (Bulletin 117), and blood sampling (Bulletin 115).

The advice presented here has been prepared after extenisve consultation with science advisors, practising teachers and other interested persons. The experiments listed are largely those that are known to the working party to be restricted by one or more local education authorities and in many cases it also feels that the experiments are not appropriate for use in schools at all levels. Again, it is hoped that the consensus view presented here will be regarded by responsible bodies as a source of informed opinion on the desirability or otherwise of the experiments, leading to common agreed practice and fewer cases of over-reaction to possible hazards. Nevertheless a teacher remains legally bound by any restrictions imposed by his employer (i.e. in maintained schools, the Education Authorities and in independent schools, the governors).

One function that it is hoped the list will serve is to point out the dangers that are not widely known. Experiments such as the reaction of zinc and sulphur appear in many texts and many teachers have performed the experiment several times without mishap. Nonetheless cases of quite serious explosions have occurred with this mixture and although the reasons for this are not fully understood it does seem necessary to suggest that only teachers themselves should perform the experiment with full precautions as set out here.

It is difficult to allow for the widely varying circumstances in which the experiments mentioned here may be carried out and the list necessarily assumes usual school conditions. Cases are bound to occur where a teacher will exercise his professional judgement and not adhere to these recommendations. Thus an experiment listed here as suitable for teacher demonstration in a fume cupboard might be done by a responsible sixth form group in a school with adequate fume cupboard provision for classwork.

Similarly a teacher may know of an alternative, safer method to the standard method of performing an experiment. Where such cases are known to the working party these have been mentioned in the comments column.

Finally, the absence of any experiment from this list should not be taken to imply anything. The working party would be pleased to hear from members about any experiments that they think should be included in future lists or of any safer alternative methods of carrying out experiments listed here. In the case of any difficulty, SSSERC should be consulted.

The categories of restriction for each experiment are shown by letters as outlined below.

N Unsuitable. The experiment is considered unsafe for use in schools.

T For teacher demonstration only. Teachers should be thoroughly familiar with the technique to be used. It is assumed that these experiments will have been rehearsed before being done in front of a class for the first time.

S Considered suitable for supervised senior pupils. Some of these could perhaps be entrusted to responsible pupils in the final year of an O-grade, CSE or similar course.

O Considered safe as a class experiment in the last two years of O-grade or CSE and similar courses. It is essential here for the teacher to exercise his or her discretion as to the responsibility of a particular class. Any experiment listed here may present dangers to irresponsible pupils.

F The use of a fume cupboard is recommended. Again teachers may have to use their discretion and allow experiments classified in this way to be carried out in a very well ventilated room with small quantities of materials.

Restriction	
N	Ammonia, oxidation using oxygen in an enclosed apparatus. Use air (T). Oxygen may be used in an open vessel (T).
T,F	Ammonium dichromate(VI), heat ("Volcano experiment"). A fume cupboard is needed to avoid possible inhalation of chromate(VI) dust.

N	Ammonium dichromate(VI), heat with aluminium or magnesium powder.
T	Ammonium nitrate, heat. Heating a mixture of ammonium chloride and sodium nitrate is considered safer. Use safety screens.
T	Ammonium nitrite, prepare and heat. In solution only, concentration less than molar.
S,F	Aryl and acyl halides, reactions.
N	Cadmium iodide, electrolysis of molten. Lead bromide preferable (see below).
T,F	Carbon monoxide, reductions with. Use safety screens.
N	Carbonyl chloride, preparation.
N	Chlorine, reaction with ammonia.
N	Chlorine, reaction of a mixture with hydrogen. This refers to the gas syringe and similar experiments. It is possible to demonstrate the reaction in, for instance, a plastic bag. Burning hydrogen at a jet in chlorine is safe for teacher demonstration.
N	Chlorine, reaction with ethyne. The reaction where the gases are generated simultaneously by adding dilute hydrochloric acid to a mixture of bleaching powder and calcium dicarbide is acceptable as a teacher demonstration (T,F Use safety screens).
S,F	Chlorine, preparation. See 'potassium manganate(VII), reaction with concentrated hydrochloric acid'.
S,F	Chlorine, reaction with metals.
N	Chlorine oxides, preparation.
O,F	Crude oil, distillation.
N	Cyanogen, preparation.
N	Ethene or ethyne, explosion of a mixture with oxygen.
T	Ethene or ethyne, igniting in a gas jar or test-tube.
N	Explosives (e.g. mixtures of chlorates, manganates(VII) or nitrates with combustible substances).
T	Hydrogen, large scale generation and collection.
O	Hydrogen, generation and testing for on a test-tube scale.
T	Hydrogen, burning in air.
T	Hydrogen, burning in chlorine. } Use safety screens.
T	Hydrogen, explosion with air.
T	Hydrogen, explosion with oxygen.
T	Hydrogen, reductions using. Use safety screens for the normal scale experiment. Reduction of metal oxides may be performed on a test-tube scale using, for example, a mixture of zinc powder and calcium hydroxide in the same tube as the oxide to generate the gas. Such experiments may be classified O.
N	Hydrogen cyanide, preparation.
T,F	Hydrogen sulphide, preparation.
S,F	Hydrogen sulphide, use of gas.
O	Hydrogen sulphide, use of aqueous solution.
T or S,F	Iodine, heating in air.
T or O,F	Lead bromide, electrolysis, in which case the fume cupboard is essential.
O	Lead(II) carbonate, heating.
O,F	Lead(II) nitrate, heating.
O	Lead oxides, heating.
T	Lithium, heating. Use safety screens.
T,F	Mercury, heating. The fume cupboard is essential and must be left on for the duration of the experiment (i.e. while the mercury is above room temperature).

T,F	Mercury(II) oxide, heating. The fume cupboard is essential.
T	Natural gas, enrichment for reductions. If ethanal tetramer (metaldehyde or 'meta fuel') is used as the enriching agent, in a test-tube scale experiment, it may be classified O. The large scale experiment has proven dangerous, probably because of the extra dead volume introduced into the apparatus.
S,F	Nitrations, organic. In some cases when only a mild nitrating agent, such as dilute nitric acid, is necessary, a fume cupboard is not needed e.g. nitration of phenols.
N	N-nitrosamines, preparation from amines. See previous article on carcinogens (Bulletin 117).
T	Oxygen mixture, use of. See 'Potassium chlorate(V) and manganese(IV) oxide heating mixture'.
T,F	Phosphine, preparation.
S,F	Phosphorus halides, reaction with water.
O,F	Phosphorus, red, burning.
T,F	Phosphorus, white, burning.
O,F)	Plastics: heating polyurethanes and polystyrene.
T,F)	Plastics: heating PVC.
S,F)	Plastics: polymerization and depolymerization of acrylics.
S,F)	Plastics: polymerization of phenylethene (styrene).
)	The fume cupboard is essential.
O	Plastics: preparation of nylon 'rope'. Note that if a solution of dioyl chloride in tetrachloromethane is used this must be classified T,F. 1,1,1-trichloroethane may be used as solvent if the solution is freshly prepared.
T	Potassium, reaction with water. Use safety screens.
T	Potassium chlorate(V) and manganese(IV) oxide heating mixture. Many safer alternatives for oxygen prep. Use demonstration as illustration of catalysis only. Use safety screens.
O	Potassium manganate(VII), heating. Eye protection essential. Heat in small test-tubes filled with a loose ceramic wool plug to prevent spitting.
S,F	Potassium manganate(VII), reaction with concentrated hydrochloric acid for chlorine preparation. Cover the manganate(VII) with water first. This experiment is highly dangerous if sulphuric acid is used by mistake instead of hydrochloric. It is safer to use bleaching powder or sodium chlorate(I) and dilute hydrochloric or sulphuric acid.
N	Rocket fuels, preparation.
S	Silicon(IV) oxide, reduction with magnesium or aluminium. The reactants must be dry. Use safety screens.
S	Sodium, reaction with water. Use safety screens.
T,F	Sodium hydroxide (molten), electrolysis.
T	Sodium peroxide, preparation of oxygen from. Use safety screens.
T	Sulphur and zinc, reaction. Do not confine the mixture in any way, i.e. heat the mixture on a ceramic centred gauze or mineral fibre paper. Use safety screens.
O	Sulphuric acid, concentrated, reactions. With close supervision, otherwise S. Use a fume cupboard if corrosive or toxic gases are likely to be evolved.

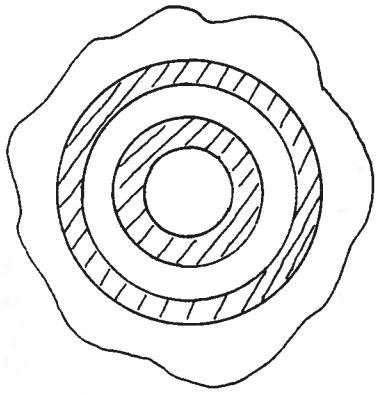
T Thermit reaction. Use safety screens (or perform outdoors). Fe_2O_3, Mn_3O_4, Cr_2O_3 are safe oxides to use. Do not use CuO, MnO_2, or CrO_3.

O,F Zinc burning.

Physics Notes

It is well known, but less easily demonstrated that the centre of mass of a body undergoing projectile motion is not affected by any rotational motion which the body may have. PSSC Physics has a multiflash photograph of a spinning Mole wrench, but this is not an easy experiment to do, and other textbooks have copied the idea, using various non-regular bodies. This is why we thought the idea below, published in a recent issue of the Physics Teacher, which is the U.S. equivalent of Physics Education, is such a good one. The observer needs only to look at the rotating body from a distance of a few metres.

The object is a sheet of hardboard, about 40cm diameter, and with an irregular outline, as in the figure.



Both sides are painted in alternate black and white rings, as in a bullseye target, the rings being 20mm wide. The difference between the two sides is that whereas one side has the centres co-incident with the centre of mass, those on the other side are about 20mm off centre. The centre of mass can be found by finding the place where the disc will balance horizontally about a needle point.

The sheet is held in the hand, with the plane vertical, by an edge, and flipped so that it is thrown up and can be caught. The flip should cause the disc to spin, and to those observers on the target the rings will not appear to rotate, while those on the opposite side where the rings are off centre will see the rotation. If the ring system is not brought out as far as the edge of the disc the difference between the two sides will not be obvious to the casual observer.

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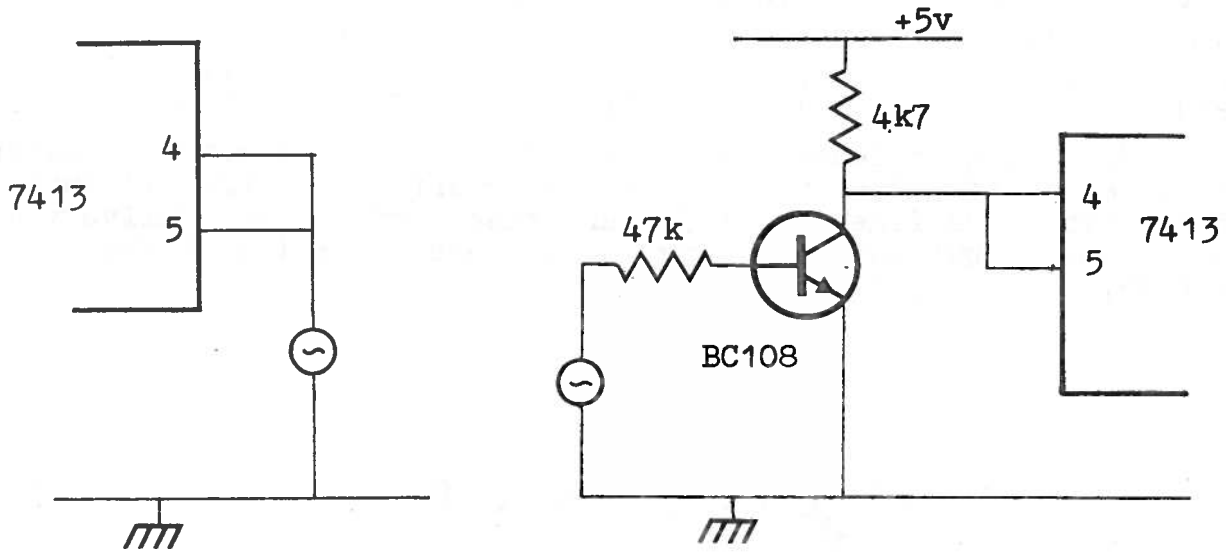
In Bulletin 115 we detailed a circuit which would convert the usual school scaler/timer to a frequency meter. The principle of the device is to apply the frequency to be measured, e.g. from a signal generator, to some of the inputs of a SN7413 Schmitt trigger, and a 1s pulse from a timer to the rest. The trigger transmits the input frequency only while the 1s pulse is present, and these are counted by the scaler.

Experience in using the circuit with different signal inputs has shown that some of them drain too much current into the 7413 so that it fails. We therefore inserted an input transistor between the Schmitt trigger and the signal input. It also means that the minimum input can be reduced to below 1V. The former input circuit is on the left, and the modification on the right.



Trade News

We have an offer of 55 back numbers of School Science Review between Nos. 147 and 210 (i.e. a few numbers are missing) for £5, available at the Centre. From the same source we have between 60 and 100 review copies of physics and chemistry textbooks offered at around half price. The list of titles and prices is available at SSSERC.

The optical products division of Bausch and Lomb have moved to the address given on page 12.

The following CLEAPSE reports have been received and can be loaned by writing to the Director of SSSERC.

L158	Laboratory Timing Devices.
L159	Pipette fillers.
L144a	Clearing up of mercury spills - further advice.
APP/28a	A simple electronic seconds timer.
BAR80	Restoring the vacuum in a Fortin barometer.

Plastic Pasteur pipettes 3cm^3 and 1cm^3 (graduated in 0.25cm^3) and micro-pipettes similar to those mentioned in Bulletin 111 are available from Cambrian Chemicals at £15.90 per 1000.

Sealon film is available from Alpha Laboratories in rolls 40m x 10cm for £9.90. It is very useful for excluding dust and moisture from open vessels like beakers and test-tubes. The suppliers claim it is resistant to most chemicals, including organic solvents (exceptions are ethoxyethane (diethyl ether) and chlorinated hydrocarbons). We found that a 4cm square of the film would seal the top of a 250cm^3 squat form beaker. The seal is relatively gas tight, and can be used to demonstrate thermal expansion of gases, air thermometers etc.

Oertling are selling at special prices some of their well tried mechanical top-pan balances. This offer is open until the end of July and is subject to being unsold. All the prices below will qualify for a 10% educational discount:

TP20	£591	TP45	£651	TP35	£605
TP31	511	TP46	631	TP41	720
PP30	546	21TD	734	31TD	665

The firm will also lease their HC22/00 dual range electronic balance for a rental of £26.67 monthly, £78.31 quarterly or £264.47 annually. These prices are fixed for a 5 year lease, and include delivery and installation, but not servicing. The purchase price of the HC22/00 is £895.

Biology Notes

On the following pages we give a comparative survey of microscopes for work up to 'O' grade. Prices are as up-to-date as we can possibly make them, but this is a volatile market much governed by exchange rates. It is imperative that prices be checked before ordering. Teachers seem to like the assessment into categories A, B and C. A is considered most suitable for school use: B satisfactory for school use; and C unsatisfactory. We would like to point out that sometimes separation into A,B or C is based on price considerations. An instrument's mechanical and optical performance may well merit an 'A' assessment but an uncompetitive price would place it in the 'B' category. Instruments that do not pass our optical and/or mechanical tests are classified 'C', regardless of price considerations.

The models listed have been tested at the Centre. Full test reports on individual models can be borrowed by Scottish teachers for up to one month. Requests to borrow reports should be made in writing to the Director.

Those unfamiliar with some of the terms used here are referred to the Biology Notes in Bulletins 65 and 66 where they will find them explained. Abbreviations used in this summary are as follows: (H) = Huyghenian eyepiece; (Wf) = widefield eyepiece; (P) = Pointer in eyepiece; (S) = Spring loaded or retractable objective; (M) = accepts Musselburgh smoke cell: (R) = objectives with RMS threads.

Model	Supplier and Price	Stand	Optics	Mechanics	Light Source	General Comments	Assess-ment
Swift Tecnar	Pyser Ltd £49.80 also sold by Harris and others.	Upright head; solid base	Eyepiece x10 (H or Wf). Objectives x4, x10, x20 (S)	Stage focussing Fixed upper and lower stops. Eyepiece held.	Mirror.	Satisfactory optically for Integrated Science. Mechanically very robust and well pupil-proofed.	A
Swift M240	Pyser Ltd £99.60 also sold by Harris and others.	Angled head; solid base	Eyepiece x10 (Wf) (P). Objectives x4, x10, x20 (R)	Stage focussing Adjustable lower stop fixed upper. Eyepiece held.	Mirror. Built-in mains or 12V available.	Very satisfactory optically and mechanically. Easy to use. Huyghenian eyepiece available. Not so competitively priced as formerly.	B
'Junior' microscope	Philip Harris £84.10	Upright head; open base	Eypiece x10 (Wf) (P). Objectives x4, x10 (R), (M)	Body focussing Adjustable lower stop fixed upper.	Mirror. Built-in mains or 12V available.	Very satisfactory optically and mechanically. This version does not meet our specification but would if fitted with the x20 objective available as an optional extra. Based on the Swift 950 series. Not so competitively priced as formerly.	B
'student' microscope	Philip Harris £39.85	Upright head; solid base swivels to upright or inclined positions.	Eyepiece x10 (Wf) (P). Objectives x4, x10, x20 (S)	Stage focussing Fixed top and bottom stops. Eyepiece held.	Mirror.	Satisfactory optically for Integrated Science. Apparently robust and pupil-proof. Competitively priced.	B

Model	Supplier and Price	Stand	Optics	Mechanics	Light Source	General Comments	Assess-ment
Olympus MIC	Griffin and George £46.00	Angled head; solid base.	Single objective with Galilean telescope system gives x40, x75, x150, x300 (M).	Stage focussing. Adjustable safety stop. Eyepiece screws into body tube.	Built-in mains or mirror.	Very easy to use but somewhat limited optically.	C
Griffin-Beck Student	Griffin and George £75.00	Upright head; solid base swivels to upright or inclined positions.	Eyepiece x10 (Wf) Objectives x3.35, x8, x20 (M)	Stage focussing Fixed safety stop eye-piece screws into body tube.	Built-in 12V (ex-ternal supply) or mirror.	Satisfactory opti-cally for Integrated Science. Mechanically robust. Glass conden-ser cover prone to cracking. Less com-petitively priced than formerly.	B
'Minor' microscope	Griffin and George £29.50	Upright head; open base	Eyepiece x10 (H) Objectives x4, x10 (M), x20	Body focussing. Fixed upper adjustable lower stops. Eyepiece held.	Mirror.	Very limited optically. Samples tested had mechanical faults.	C
STZ 'Zoom'	Bausch and Lomb £63.25	Upright head; open base	Zoom magnifi-cation change, 50 - 200X	Stage focussing Fixed safety stops. Eyepiece integral with body.	Mirror or add-on mains illumin-ator.	Zoom system very con-venient to use but optically very limited. Some mechanical faults on stand tested. SSM stereo heads fit the same stand.	C

Model	Supplier and Price	Stand	Optics	Mechanics	Light Source	General Comments	Assessment
'student' microscope 443	Prior £108.50 also sold by Griffin	Upright head; open base	Eyepiece x10 (H) Objectives x4, x10 (M), x20 (R), (S)	Body focussing Fixed lower stop. Eyepiece not held.	Mirror sub-stage mains or 12V available.	Satisfactory optically and very robust mechanically.	B
NES 200X(T)	Opax £59.50	Upright head; open base	Eyepiece x10 (Wf) (P). Objectives x4, x10, x20, (R)	Body focussing. Adjustable lower stop fixed upper stop. Eyepiece held.	Built-in mains or 12V or mirror.	Satisfactory optically up to '0' grade. Convenient to use. Adjustable lower stop can be 'locked'. Several other pupil-proofing features.	A
STN	Opax £39.50	Upright head; open base: small.	Eyepiece x10 (H) Objectives x5, x10, x20	Body focussing. Adjustable lower stop fixed upper stop. Eyepiece held.	Built-in mains or 12V or mirror.	Easy to use but optically very limited.	C
CA	Parisian Opera £59.00	Upright head; open base	x10 (H) Objectives x4, x10, x20 (R)	Body focussing. Lower stop fixed but adjustable with tools, fixed upper stop. Eyepiece held.	Built-in mains or mirror.	Satisfactory optically up to '0' grade. Several pupil-proofing features.	A

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

Alpha Laboratories Ltd., 40 Parham Drive, Eastleigh, Hampshire.

Bausch and Lomb Ltd., Highview House, Tottenham Crescent,
Epsom Downs, Surrey KT18 5BR.

Cambrian Chemicals Ltd., Beddington Farm Road, Croydon CR0 4XB.

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

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

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

Oertling Ltd., Cray Valley Works, St Mary Cray, Orpington,
Kent.

Opax Ltd., 142 Silverdale Road, Tunbridge Wells, Kent TN4 9HU.

Parisian Opera and Field Glass Co. Ltd., 24/5 Princes Street,
Hanover Square, London W1R 7RG.

Prior Scientific Instruments Ltd., London Road, Bishop's
Stortford, Herts CM23 5NB.

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