

SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

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SCOTTISH SCHOOL LEARNERS

DEPARTMENT OF EDUCATION  
SCOTLAND

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# Introduction

Most of the teachers reading this will already know something of the development and aims of SSSERC. For those who don't, what follows is a brief summary.

SSSERC developed from the work of the Advisory Committee on Physics, set up in 1962 to advise the Secretary of State for Scotland on all matters affecting the teaching of Physics in schools. This committee, with Dr S C Curran, Principal of Strathclyde University as Chairman, had been formed as a result of concern felt in official circles over the bad state of physics teaching and the shortage of physics teachers throughout Scotland.

The advent of the alternative physics syllabus gave rise to a Technical Sub-Committee within the Advisory Committee, composed mainly of teacher members, whose work was to examine and report on physics apparatus with a view to assessing its suitability for the new syllabus. In course of time it became evident that this arrangement was unsatisfactory for two reasons: (1) the volume of work was growing to such an extent that it was impossible to cope with it on a part-time basis, and (2) the machinery for conveying the results to the teachers themselves was cumbersome and had no proper financial basis.

The idea of a National Science Centre developed naturally from this. With full encouragement from the Scottish Education Department, a Consortium of Local Education Authorities was formed to run the Centre and to finance it by means of a levy on each authority in proportion to their secondary school population. Nearly all the authorities in Scotland agreed to support the Centre. Premises were offered by Edinburgh Corporation, and although not new, they have the advantage that they are central. Conversion has been going on throughout the summer months and will probably be completed by the time you read this.

The staff complement consists of the Director and his Assistant, both qualified teachers, a senior technician in charge of the workshop, an intermediate grade technician in charge of the display laboratory, a trainee technician and a secretary/typist. Besides workshop, office and stores, the accommodation consists of one display laboratory, 44 ft by 25 ft, and three smaller test and development laboratories.

In the smaller labs. the work of assessing manufacturers' apparatus, and of developing our own and other teachers' ideas for new apparatus will be carried out; these will not normally be open to the public. The display laboratory is being fitted out so that we can put on display to visiting teachers apparatus which we have tested, new experiments which we may have devised (or seen in the School Science Review, or in other schools, for we are certain we have no monopoly of new ideas), and new apparatus produced by manufacturers such as, for example, the equipment for the Nuffield Foundation projects in Physics, Chemistry, and Biology. This laboratory will be open to visiting teachers from 9 am to 5 pm on weekdays, and 9 am to 1 pm on Saturdays. It will be open for most of the Christmas, Easter and Summer vacations as it is intended that it should be available for teachers whenever possible. Teachers from a distance visiting the Centre are advised to do so in car- rather than bus-loads, as the display lab. does not have the circulation space to cope with large parties. Also, we believe that much benefit can accrue both to us and the teacher through informal discussion over the apparatus; this becomes impossible if the gathering is large.

We would emphasise that most of the equipment on display will be in working order, set out for a particular experiment, and it is hoped that teachers will spend enough time with us to do the experiment themselves. Teachers making a special visit and wishing to see a particular piece of apparatus should write the Director in advance, when every effort will be made to see that it is available.

When we have tested a particular piece of equipment, our procedure will be to put on file three or four copies of the report on it; teachers writing to the Centre will then be able to obtain these on loan for a specified period. A summary of the results of these reports in respect of a particular type of apparatus, say oscilloscopes, will then be given in future bulletins. It is intended to publish seven bulletins during the school year, at approximately six weekly intervals. The format of the bulletin was given careful thought; the style of the S.E.D. newsletter was rejected in favour of fewer pages of the larger foolscap size for easier filing. We suggest to all recipients that they start a file for this and subsequent issues.

At the moment, the bulletin is being addressed to Principal Teachers of Science, a post which we know has become obsolete in many schools. To send three copies to every school would, we feel, involve the Centre in a good deal of unnecessary expense. Where there are cases where the sharing of a copy between the various branches of science is unsatisfactory we invite teachers to write in to the Centre asking for a separate copy to be addressed to the Principal Teacher of Physics, Chemistry, or Biology as the case may be, and this will be done. Where we have extended ourselves is in sending a separate copy to the Principal Teacher of Technical Subjects in those schools which follow, or are about to follow the new Higher Engineering syllabus of the S.C.E. Much of the equipment needed for this is similar to that used in the alternative Physics syllabus, and we feel that these teachers may benefit from whatever advice we can give.

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At the time of writing, I am arranging with the Directors of Education to meet the Principal Teachers of Science in each local authority with two specific objects in mind: (1) to hear from the teachers themselves how the Centre can best help them, and (2) to provide what advice and information I can on the ordering of apparatus.

This means that the visit must precede the authority's annual apparatus requisition, and it is intended that all visits arranged will be over this term. Some authorities have written to say that they are sufficiently near Edinburgh for teachers to visit the Centre, and that they would prefer them to do this. Some have not yet replied, and in some cases the visit will already have taken place. To give an indication of the position at present, teachers with the following L.E.As. should expect a visit this term if it has not yet occurred: Aberdeen City; Aberdeen County; Angus; Argyll; Ayr; Banff; Bute; Caithness; Clackmannan; Dundee; Dumfries; Kincardine; Kirkcudbright; Lanark; Moray & Nairn; Orkney; Peebles; Perth & Kinross; Renfrew; Sutherland; West Lothian; Zetland.

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The position of the direct grant and independent schools has not been ignored. Some of them were in the forefront of the movement which launched the Centre into being, and it would be a retrograde step to drop the pilot now. Accordingly, this and future bulletins will go to these schools, and we hope that their /

their teachers will visit the Centre and share in its activities to the same extent as their L.E.A. colleagues.

## Opinion

It is stating the obvious to say that if the post of laboratory assistant / technician is to attract the calibre of worker which the job needs and deserves, then it must be made sufficiently interesting and rewarding to carry the candidate through the difficulties of the early stages. Yet we hear of a disturbing number of cases where laboratory assistants have complained of boredom for lack of anything to do, who have left the job for the same reason, or because they preferred a position with more money and less holiday - what is the advantage of having 12 weeks' holiday in a year, and nothing to spend on it? - or because they resented a salary scale which, by some machinery they could not understand, was related not to the conditions of employment, but to the salary of the junior clerkesses in the Education Office.

Many of these conditions are outwith the control of the individual teacher. Nevertheless, if the post of school laboratory technician is to become, as we believe it must, an integral part of our educational system with a proper career structure, teachers should be constantly campaigning for more technicians and improved conditions. To teachers who complain that they cannot get laboratory assistants we would say: let us create the right public image of the school lab. tech. as a worthwhile career with a proper status, and there will be no dearth of applicants. Is it too much to expect that the senior technician in any large secondary school may not one day enjoy the status now accorded to his opposite number in a University Department, where every student knows - even if the staff may sometimes be ignorant of it - that the Chief Technician ranks next in importance to the Professor himself? In an industrial society, the laboratory technician is one of the few careers which can offer the craftsman's pride of achievement. Nor, if the salary and working conditions are right, will we lose these technicians to the universities. There will always be men and women who prefer the variety of working in school science to the narrow specialisation of the university department. We should see to it that this advantage is not lost by too great a specialisation of the technician's course.

Teachers with proposed new schools under construction have a special responsibility. The lip-service paid to teacher consultation - "let me have the plans back by 4 o'clock" when 3B are champing at the bit on a Friday afternoon, is no way to ensure a harmonious relation between the teacher and the department he is eventually going to occupy - this must become a thing of the past. Perhaps in more than one case this attitude has been adopted after a teacher on being consulted has had nothing positive or progressive to suggest or, more alarmingly, has incorporated into the structure some of his pet fads which have remained an embarrassment to the L.E.A. and a source of annoyance to his successors long after the offender has passed into retirement.

Teachers have a responsibility to see that they are well informed and have taken the best possible advice on school laboratory planning, before making sure that their views are being made known to the architects at the earliest possible stage, and throughout the entire planning. The provision of adequate workshop facilities and storage space should be an essential item in any new Science Department. Advice on these and similar matters can be obtained by consulting the S.E.D. /

S.E.D.'s 'Education Building Notes No. 5, Science Rooms', available from H.M.S.O., price 3/-, or 'The Planning and Equipment of School Science Blocks', Sir Graham Savage, John Murray, 7/6d. The Science Master's Book, Fourth Series, Part I, contains a useful appendix on the equipping of a workshop, by John Emery of Glenalmond.

When all this has been said, however, the charge of boredom of the lab. assistant lies fairly and squarely on the teacher's conscience. Elsewhere in this bulletin we have a section suggesting various ways in which a lab. assistant can be used. Meanwhile, we teachers might do some soul-searching anent our own attitude to laboratory assistance. Are there not some among us who approach a demonstration as an actor does his monologue - 'this is my bit of fun; you sit and watch, and admire how good I am at it' ? To suggest to such an individual that a lab. assistant should set up the apparatus is an invasion of his sacred rights, to be rationalised with such phrases as "It's too delicate for you to manage"; "If it got broken we could never replace it", or "I gave it to him once to set up and he made an awful mess of it". If our lab. assistants are to grow into lab. technicians we must give them advice, help and, most of all, responsible work which is within their compass, even at the expense of a few broken bits of glassware, or ruined meters. In the early days the debit side of teacher time and patience will be large, but the balance will redress itself as time goes on.

Having stressed how much help the teacher must give to his lab. assistant towards making him a more responsible worker, equally we believe that it is no part of a teacher's function to ensure that the assistant acquires the knowledge of physics, chemistry or biology necessary to pass his Ordinary National Certificate, or other course exams. A Further Education teacher who sends his day release students back to their schools with instructions 'To find which of the following give precipitates when added to washing soda solution' or similar, needs to be advised of the respective roles of teacher and employer. In a properly run school there will be no time for the assistant to do this sort of thing, and in a properly organised course at the Technical College the need to farm this work out will be eliminated. To make the lab. assistant 'sit in' with the Fifth Year Science class, however necessary the instruction may be, is an admission on the part of the teacher that he cannot otherwise employ the assistant, and a blow in the face to the lad himself who thought he had finished with day school.

## Trade News

Note: Addresses of firms mentioned here and elsewhere in the Bulletin are given in an Appendix on the end page.

Polaroid have discontinued production of their Model 160 camera, and no further supplies are available. The more expensive Model 120 is scheduled to be replaced by a newer version which will take a film pack in place of the roll film now being used. Roll film for 160 and the current 120 cameras will continue to be manufactured. The current cost to schools of the 120 camera is £48; this includes exemption from Import Duty which must be applied for on form DFA3 and is obtainable from the Board of Trade, Tarriff Division, Duty Remission Branch, Sanctuary Buildings, 20 Great Smith Street, London SW.1, or from Polaroid themselves. A kit comprising 120 camera, case, winklight, meter, 4/S filter and two type 47 films can be obtained for £58. The firms are also marketing a new range of models 100, 101, 103 and 104 cameras, some of /

of which retail cheaper than the 120 above. These, however, have purely automatic shutters and the firm advise us that they cannot be used for stroboscopic photography.

Advance Electronics Ltd. have provided one or two of their current production instruments for stand-by use in schools. It is their intention that, should an Advance instrument break down in service, the school concerned should borrow the stand-by replacement until the original instrument has been repaired and returned. For this purpose we in SSSERC have one J1, one H1 signal generator, a V1 vibrator and a VM77B valve voltmeter. Similar provision has been made to serve the West of Scotland by leaving these models with the Physics Department, Allan Glen's High School. The firm make only one stipulation: that an intending borrower should notify their Scottish representative of the school and the instrument borrowed, either by telephone or postcard to: Mr J R Wilson, 15 Murchland Way, Irvine, Ayrshire, Tel. Irvine 2222. Since this is a regional service, neither SSSERC nor Allan Glen's can undertake to despatch these instruments to the school; they must be collected personally. Is anyone in Aberdeen - or other centres - willing to provide similar storage facilities?

Quickfit & Quartz ask teachers who use their assemblages or kits of apparatus, eg 23, 27, or 29BU to write to us suggesting any additions, substitutions or omissions in the components in these kits which their experience has shown to be desirable. Alteration to the design of the components themselves is another matter, but one which we will be very pleased to take up with the firm should you write to us.

James Scott (Electronic Agencies) of Glasgow are agents for - amongst other firms - Newmarket transistors and Venner Electronics. We have several copies of their advertising literature for teachers visiting SSSERC; please ask when you come. For others, their catalogue 1T1 gives full details of Newmarket transistors together with a cross-index of equivalents. The OC71 equivalent, for example, is offered at 2/6d; and the OC72 at 3/2d

The Scottish agent for all Mullard components is Harper Robertson Electronics of Glasgow. Components which may be difficult to obtain elsewhere (e.g. the photo-emissive cell 90AV used in the estimation of Planck's constant, School Science Review, No. 159, p.378)\* may be obtained there. As an example the OCP71 photo-transistor can be bought on a school order form for 19/6d. Although this is offered in the pages of Wireless World by Bentley Acoustic Corporation at 17/6d the price charged by the firm is in fact 27/6d. Z & I Aero Services also offer the OCP71 at 24/-.

\* The cost of the 90AV cell is £2.8/-. Unilab sell a complete apparatus, Photoelectric Unit PE2, except for the light source for £15.

Esso Petroleum Company, in addition to making the well-known physics teaching films, offer a loan service to Senior Secondary schools only, of some of the more expensive items of physics equipment (complete list below). Loan of any of the items listed, for a period of whole or half-term can be obtained free. The scheme is proving so popular with English Grammar and Public schools that bookings are being taken for some items for the early terms of 1967. Information regarding the booking position of any particular item can only be obtained by applying to the firm. The equipment available consists of:

<u>Quantity</u>	<u>Item</u>
10	Phywe Electrical Demonstration Apparatus
4	Cossor Double Beam Oscillograph
9	Cossor /

<u>Quantity</u>	<u>Item</u>
9	Cossor Single Beam Oscilloscope
4	Nicolson Expansion Cloud Chamber
10	Unilab Demonstration CR Tube
15	Unilab 3 cm Wave Apparatus
5	Cambridge Inst. Co. Surface and Interfacial Tension Apparatus
4	Unilab EHT Unit and Philip Harris Spark Counter
4	Phywe Electrical Oscillation Apparatus
3	Gallenkamp Thermostatic Water Bath and Viscometers
4	Leybold Fine Beam Tube
4	Phywe Franck-Hertz Helium Tube and Power Unit
5	Baker Polarising Microscope
1	Paulin Aneroid Barometer
4	Philip Harris Pocket Dosemeter and Ionisation Chamber
1	Hall 'Dumpy' Level
8	Cambridge Inst. Co. Disappearing Filament Pyrometer
6	Advance Signal Generator
2	Advance RF Signal Generator
3	Panax Ratemeter RM202
4	Panax Ratemeter 5054
6	Edwards High Vacuum Pump
9	Griffin and George Ripple Tank
5	Philip Harris Projection Electroscope
7	Pye Portable pH Meter
4	Philip Harris Polarimeter
3	Philip Harris Spectrometer
11	Panax Scaler
3	Philip Harris Vernier Microscope
4	Teltron Diode, Triode, Maltese Cross Tube, Perrin Tube, Deflection e/m Tube, Helmholtz Coils and Universal Stand
3	Pye Thermal Conductivity of Copper Apparatus
3	Pye Potentiometer Model 'S'
6	Leybold van de Graaff Generator
6	Philip Harris van de Graaff Generator
12	Nicolson Millikan Oil Drop Apparatus
4	Leybold Wulf Electroscope
3	Philip Harris Induction Coil
6	Philip Harris MKS Units Apparatus

A quarterly journal, Educational Electronic Equipment, which is sent free to all schools and educational establishments, will be of interest to all science teachers. Contents include reviews of new instruments and of apparatus exhibitions, and articles of educational interest. A tear-off, reply-paid folder enables requests for further information to be speedily sent off.

The Philip Harris supplement to their Physics Apparatus Catalogue (12th edition) lists such items as Newton spring balances, Millikan's apparatus, Americium alpha source (cheaper than the Plutonium source previously offered), solid block calorimeters and heaters, Joulemeter for 12V operation, complete apparatus for stroboscopic photography of magnetic ring pucks (excluding the camera), Venner stop-clock and liquid flow-meters. All prices are marked in the supplement. Also available shortly will be a price list of all apparatus, mostly made up in class kit form, developed in conjunction with the Nuffield Foundation physics project.

A series of leaflets from Griffin and George describing recent or new apparatus include Polyzote spheres from  $\frac{1}{2}$ " to 2" sizes for atomic models, the Johnstone Electrical Conductivity Apparatus, an educational Gas Chromatograph, diffusion cloud chamber, a Junior van de Graaff generator, Hall effect apparatus (see S.C.E. Alternative Physics Higher II 1965 paper, question 7(a), and Mullard Educational Electronic experiments, No. 10), a two-speed electric ticker timer giving 1/50th and 1/100th second markings, 'g' by free fall apparatus using the electric stop-clock.

A Brownian movement cell with built-in light source for individual pupil use, called the Whitley Bay Smoke Cell, is being produced by Morris Laboratory Instruments for £4. Their ripple tank is made of moulded transparent plastic and being detachable from the frame can be used for the oil film experiment. An energy conversion set supplied by the same firm includes a steam engine, a water turbine/pump and an electric motor/dynamo.

The 50 microampere meter, measuring  $2 \times 2\frac{3}{4}$  in. which has been a bargain for many months at 25/- in the pages of Wireless World has now gone out of stock. Through advertising inertia it may continue to feature for some time under Radio and T.V. Components but the firm advise us that stocks are exhausted.

Derritron (formerly Doran) Instruments have a three decade standard resistance box S991, 10 to 9,990 ohms on sale at £5.15/-, £5 for orders of 12 or more. The accuracy is 5% of the lowest ohmic value in the decade, and rating is  $\frac{1}{2}$  watt. Also on sale by the same firm are two new versions of the Weston standard cell; the first is a miniature cell, usable in any position, 4 in. long and less than 1 in. square section, with a terminal (not, by the way, 4mm) at each end. Catalogue No. E 4114, it costs £4.1/-. The other is a cartridge type which would clip and connect into a standard  $1\frac{1}{4}$  in. fuseholder. Catalogue No. E 4116, cost £1.19/-.

## Second-hand Equipment

It appears to us that a fruitful source of scientific apparatus consists of the rejects of industrial research laboratories and university departments. Many of these dispose of apparatus which although in good working order may have become obsolete. Schools working to broader tolerances may well find such equipment acceptable, and in fact our own laboratories owe much to the generosity of Ferranti of Edinburgh, and the Engineering Research Laboratories at East Kilbride. We believe that this could be developed through SSSERC so that it becomes commonplace for firms and universities to dispose of their material in this way, rather than to a scrap merchant.

Already this has begun in a small way, with three double beam oscilloscopes from Edinburgh University finding their way into schools. We are contacting university departments and industrial firms with a view to expanding this side of our activities, and we invite teachers to write in to SSSERC stating their requirements, and how much they would be prepared to pay for them. Equipment received by us is checked and if necessary put into good working order before being sent out to a school. For this service we make a small charge; even so the cost of any items offered will be little more than the scrap value.

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The procedure in dealing with requests will be first come, first served.

Accounting for such items is done through official channels, i.e. not petty cash, so that an intending purchaser should get clearance from his Director of Education before confirming an offer of apparatus.

## In The Workshop

For some teachers, a laboratory assistant is an embarrassment they wished they did not have to worry about. In this and future issues of the bulletin, this section will attempt to suggest ways in which the assistant's time could be usefully employed. The creation of this new post has come at a difficult time when, in many schools, the science department has divided into Chemistry, Physics, and sometimes Biology, each with a separate Head. To place one assistant at the service of these three individuals without any guidance as to how he is to set about his duties, is creating a situation wide open for exploitation by the assistant and certain to cause resentment amongst the less favoured departments.

If, as is customary, individual teachers have responsibility for individual laboratories, then it is very necessary that every such teacher should feel that he has a 'stake' in the assistant's time at some stage. A time-table therefore becomes essential, and we would suggest that for routine laboratory maintenance he should be allocated to each lab. for a double period each week, preferably when the lab. is empty and the responsible teacher free. During this time the teacher concerned has first claim on the assistant. If not required by him, the assistant can always be directed to the Head of Department for employment on other work.

Another routine which should be firmly established is that of cleaning and tidying up each day after school. Each lab. requires this service every afternoon, and working conditions should be arranged so that it can be done speedily and efficiently. Equipment for storage should be kept in trays or boxes; each with its numbered complement of items for easy checking. Pupils replace the apparatus in the box; the assistant stores the box in its proper place. This is so much easier than removing meters from a cupboard one by one (and occasionally dropping one through trying to carry too many at once).

Cleaning up can also be done at intermediate times throughout the day, e.g. morning break and lunch hour. Do not make the mistake of giving the assistant his morning break at the same time as the school; this should be his busiest period of work, when the labs. are empty. Instructions regarding jobs of a non-recurrent nature - set up Boyle's Law apparatus in Lab. 2 for start of second period tomorrow - should be written and 'spiked' in the workshop so that he can attend to them in rotation; this is the fairest way.

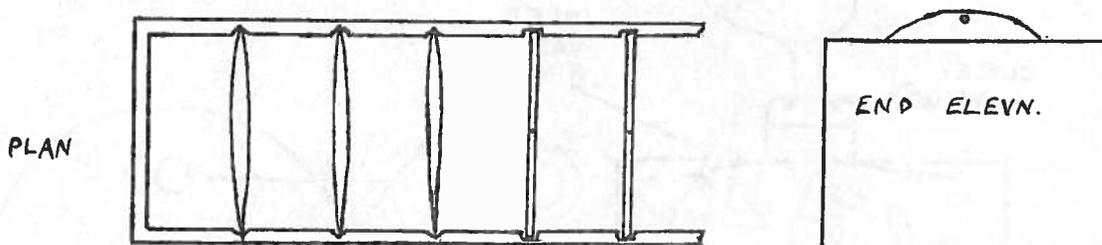
The rest of the assistant's time should be divided by agreement between the various branches, and used on work for the branch as a whole, such as acid dilution, preparation of connecting wires etc., or on development work. Each of biology, chemistry, physics should keep a laboratory manual, alphabetically indexed /

indexed, in which instructions regarding recurrent jobs are written up so that after he has been shown the job once, the assistant has only to refer to his notes on subsequent occasions. Jobs falling into this category are acid dilutions, battery charging, and the setting up of experiments. For success, the instructions must be clear and explicit, and written in language which the non-technical person can understand. Avoid the growing habit of name-dropping - there should be no Savart's wheel or Watson air-track.

Buy a few small tins of enamel paint and a fine brush and set the assistant to colour code the equipment where necessary. A spot of paint near the edge of your lenses and mirrors - different colours for different focal lengths - is much better than separate packets which invariably get lost or misplaced. Details of colour coding can be entered in the manual, but there is no reason why instructions for setting up, say, a model telescope should not read:

"Set up in separate clamps a yellow spot and a green spot lens two feet apart in line facing the window and looking on to the beach, green spot nearer the window. Adjust the distance between lenses until you can see the figures clearly, looking through the yellow at the green spot".

Where the same items develop an individual character, e.g. the basic meter such as the All-test or Crompton Universal Indicator, these can be numbered sequentially. Shunts and bobbins should also be colour-coded for use by the unskilled. A small depression drilled in the bakelite of these makes a more permanent receptacle for the paint spot than spotting the polished surface (and for this job it is better to bring the work on to the tool than vice-versa). Different coloured numbering can be used for single scale meters, e.g. red for moving-coil ammeters, yellow for D.C. voltmeters, green for moving-iron meters, etc. It then becomes easy to specify any individual meter in the lab. manual by colour and number reference.



Rather than have lenses stored in lidded boxes, and inside separate paper packets, all of which consume time when a teacher is seeking a given lens, teachers should find an open rack where type and number of lenses can be seen at a glance, a big time-saver. This is something which the lab. assistant should be able to design as well as construct, once the job has been explained to him - but check his design dimensions before he starts out with the saw.

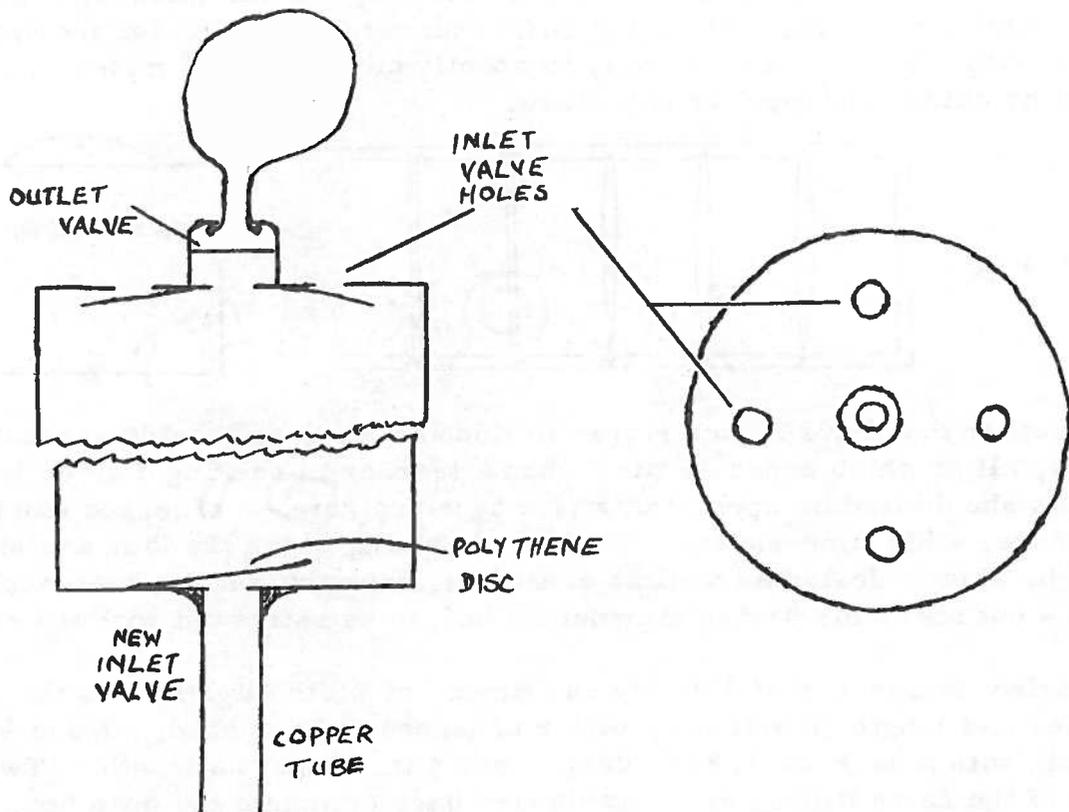
Select two pieces of  $\frac{1}{2}$  or  $\frac{3}{8}$  in. timber of width slightly less than the lens diameter and length to suit the number of lenses to be racked. Make V-shaped saw-cuts with a hacksaw  $\frac{1}{8}$  in. deep every  $\frac{1}{2}$  in. along the length. Two end-pieces of the same timber and a hardboard base complete the open box. The end piece width decides the box width and should be sufficient to slot the lenses into the cuts. Mounted in the rack with their coloured spot at the top, the lenses can be identified at a glance. Wider, normal cuts will be needed for concave lenses. Spots for these can be put on the lens perimeter itself.

Although the drawing shows both types of lens in the same rack, there is no reason why separate boxes should not be prepared. Having the lens slightly taller than the box makes for ease of removal, and also makes the coding spot more visible. Similar racks can be made up for spherical mirrors.

The variety of weird and wonderful gadgets, involving aspirators, football bladders, sometimes even the kitchen sink, devised by teachers so that they may inflate a balloon with coal gas or hydrogen is a tribute to their ingenuity but a sad commentary on the inability of manufacturers to meet the teacher's needs in this respect.

Sold in F.W. Woolworth's stores around Christmas, if not at other times of the year, is a simple party balloon pump consisting of two cardboard cylinders sliding one inside the other which can readily be fitted for controlled intake, so making coal gas inflation possible.

As sold, the air inlet consists of four holes on the top of the pump, covered on the inside by a plastic disc acting as an inlet valve. The outlet valve is in the centre of the top, and requires no alteration.



The existing inlet should be sealed off by cutting to size a polythene disc to cover the holes, using Bostik No. 3 or any other impact adhesive to attach it to the pump top. Next, drill centrally a 1/8 in. dia. hole in the metal base and /

and remove any burrs which may adhere to the inside of the base cap. This inside surface must be smooth round the hole edges to ensure good valve action. An inch length of copper tube  $3/16$  in. dia. or wider (if not obtainable locally, from K.R. Whiston at  $1/2d$  per foot) is soldered on the base over the hole. Use a long fine brush to put a dab of adhesive on the inside base near the hole, drop in a disc of polythene and manœuvre into position so that it covers the hole. When the adhesive has set, the pump is ready. Attach rubber tubing to the copper tube for gas intake. When inflating, pump a few times with the inlet gas on and no balloon attached, in order to fill the pump chamber initially.

A commercial version of this pump is now being produced by E.J. Arnold selling at  $3/6d$ .

- S.S.S.E.R.C., 103 Broughton Street, Edinburgh 1. Tel. WAV 2184
- Advance Electronics Ltd., Roebuck Road, Hainault, Ilford, Essex
- E J Arnold & Son Ltd., Butterley Street, Leeds 10
- Bentley Acoustic Corporation Ltd., 38 Chalcot Road, Chalk Farm, London N W 1
- Derritron Instruments Ltd., 24 Upper Brook Street, Mayfair, London W 1
- Education Section (T/11/41), Esso Petroleum Co Ltd., Victoria Street, London SW
- Educational Electronic Equipment, Milton Publishing Co Ltd., 31 Percy Street,  
London W 1
- H.M.S.O., 13A Castle Street, Edinburgh 2
- Philip Harris Ltd., Ludgate Hill, Birmingham 3
- Griffin & George Ltd., Braeview Place, Nerston, East Kilbride, Glasgow
- Morris Laboratory Instruments Ltd., 96-8 High Street, Putney, London SW 15
- Mullard Educational Service, Mullard House, Torrington Place, London WC 1
- Newmarket Transistors Ltd., Exning Road, Newmarket, Suffolk  
Queensway House,  
Polaroid (U.K.) Ltd., Queensway, Hatfield, Herts
- Quickfit & Quartz Ltd., Stone, Staffordshire
- Radio & T.V. Components Ltd., 21A High Street, Acton, London W 3
- Harper Robertson Electronics Ltd., 372 Argyle Street, Glasgow C 2
- Unilab, Rainbow Radio (Blackburn) Ltd., Blackburn, Lancs.
- Venner Electronics Ltd., Kingston By-pass, New Malden, Surrey
- K R Whiston, New Mills, Stockport, Lancs
- Z. & I. Aero Services Ltd., 44A Westbburne Grove, London W 2.