SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

Bulletin No. 59 December, 1972.

Contents

Introduction

There is a small but continual demand for back issues of our bulletins, almost equally divided between foreign and native subscribers, with the result that over the years a number of issues have gone out of print so that now some 10-12 issues are unobtainable. At a recent meeting of our Governing Body it was agreed in principle that we should reprint not more than 300 copies of Bulletins 23-58. We reprinted 300 copies of Bulletins 1-22 several years ago, and these issues are still available. It will take several months for this printing to be completed, and meanwhile we ask the indulgence of those who may be disappointed to find that the particular issue they require is out of print. In such cases we can usually arrange to photo-copy the article which may be that person's particular interest. Back numbers in print are sold at 5p each plus postage.

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Many teachers now in posts of responsibility may not have been teaching in 1965 when SSSERC was first established, and therefore may not be aware of the full details of the advisory service which we give in respect of manufacturers' equipment. One of the specific remits of SSSERC when it was set up was to test and report on apparatus offered for school use by manufacturers. It was obvious that we were placing ourselves at some risk in so doing; an aggrieved manufacturer might take legal action against us and we sought advice which resulted in SSSERC taking out an insurance policy against this possibility. While there are a number of conditions laid down by this policy the two which have most effect for teachers are that our reports must be treated as confidential documents, and that no manufacturer should have access to any information on models other than his own. These conditions mean that a report contains no references to or comparisons with other models, and that reports are not circulated outside Scotland. A bulletin supplement, which contains information on several models and which could be said to be comparative also has a restricted circulation.

These restrictions on reports and supplements mean that our reports are infrequently used by teachers when they take decisions on which model they will purchase. We have no means of knowing to what extent the bulletin supplements are used as a basis for decision but we have some evidence which suggests that teachers would prefer to have collated in one document the results of our tests on all the models we have tested of a given piece of apparatus. The Development Committee at a recent meeting considered these facts and decided that SSSERC should produce such summaries of the test reports. It was further decided that summaries should be updated every two years, which means that discontinued models would be deleted and new models brought into the summary at each updating. This may also imply the re-testing of models which have

not changed their catalogue number, but on which the manufacturer may have made improvements sufficient to warrant our re-examining the model. This means that it will be several months before we are in a position to compile a summary, but we propose to make a start with low voltage power supplies, centrifuges, and microscopes for 'O' grade work.

Readers will find in the 'Notes' sections of this bulletin lists of the models of these items which we will include in our summaries. We would welcome a reminder from any teacher or manufacturer who believes that we have omitted from the list any model worthy of consideration, because it is obviously desirable that the summaries should be as comprehensive as possible.

Physics Notes

In Bulletin 57, the surplus equipment carried mention of a differential pressure gauge under the title of air speed indicator. At that time we did not know how sensitive the gauge was, nor to what uses it could be put in schools. We have now carried out some tests which show that it could be extremely valuable as a pressure gauge, and a flowmeter. At the rear of the instrument are two tubes which fit standard rubber tubing; the gauge measures the pressure difference between the two orifices. Hence positive pressure at one orifice, or suction at the other will cause the pointer to move in the same direction, and the pointer will register the pressure difference from atmospheric, if the unconnected orifice is open to the air. The sensitivity is such that a pressure difference of $6 \times 10^{3} Nm^{-2}$ (45mm mercury) will give a pointer movement of about 270^{o}. The pointer has no stops so that it can be pressurised to move through a few complete revolutions. We have not tested its performance beyond the two revolutions for which it is scaled, the scale being an arbitrary and useless one of knots.

The whole instrument is sealed to preserve the pressure difference but if some care is taken the glass face can be removed so that the existing scale can be replaced by a paper scale indicating pressure. The alternatives are to paste a paper scale on the front face of the glass without opening up the instrument, or, what we have done, to draw a calibration graph for the existing scale. Calibration was done by attaching both the indicator and a water manometer via T-piece tubing to a bicycle pump, pumping up the pressure to maximum and then releasing the pressure in steps to get the readings. It is advisable to tap the glass of the indicator before taking a reading to guard against a sticky pointer. The calibration is best graphed on semi-logarithmic paper since the scale extends from a few hundred to 12,000 newtons per square metre.

One use for the device is as a voltmeter analogue in a water circuit. In this respect it is superior to a manometer; since it measures pressure difference it connects across the ends of the resistive element in the same way as a voltmeter. Moreover if one has a flowmeter, such as the MeTeRaTe direct reading

tubes, it becomes possible to illustrate Ohm's law. To give some idea of the order of magnitude involved, we used a 25mm length of tubing from a broken thermometer, the gauge of which we measured to be 24 SWG, as a resistive element. The resistance was further increased by inserting an equal length of 26 SWG wire. An aquarium aerator was used to pump air through this, the P.D. meter was connected via T-pieces and rubber tubing across its ends, and a flowmeter tube was put at the far end of the P.D. meter. With a flow rate of 150ml per minute, the pressure difference registered was 6600 newtons per square meter. If different lengths and bores of tubing are used as the resistive element, they behave in the way one would expect so that it is possible to illustrate the factors affecting resistance. If water is used instead of air as the medium, then lengths of standard glass tubing replace the capillary tubing.

The second application of the air speed indicator is as a flowmeter itself. Since there is a direct proportion relation between pressure difference and flow rate for a given resistive element, we can reverse the usual electrical practice and use a P.D. meter as a current meter. The constant of proportionality, for those who do not have a commercial flow meter, may be determined by coupling the P.D. meter with an appropriate resistive element to a 100ml glass syringe. If the syringe is clamped in the vertical position, a suitable weight on the piston will cause it to sink down at a constant rate which can be timed against the ml calibration on the barrel. It would be necessary to determine a separate constant of proportionality for each resistive element, but when this had been done it is likely that the meter could be used in a large range of flow rates. Applications of the meter include gas chromatography, analysis of atmospheric pollution.

The P.D. meter is sensitive enough to be used to verify the pressure law. Physics teachers have commented that the Bourdon gauge which is a Nuffield physics item and which can be bought either independently or as part of the Nuffield Boyle's Law apparatus, is too insensitive to give a reasonable estimate of the absolute temperature unless one uses dry ice as one determining point. The P.D. meter, connected to a 1 litre air-filled flask by as short tubing as possible, will give enough readings to allow a straight line graph to be drawn with the flask wholly immersed in a water bath. Greater accuracy is possible the larger the flask, since this reduces the fraction of 'dead' air in the tubing and the gauge itself. Finally at an elementary level the gauge can illustrate an air thermometer by connecting it to any glass flask and warming the flask with the hands.

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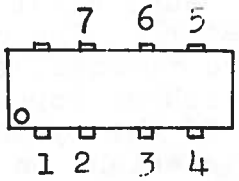
In Bulletin 55 we gave details of the construction of a meter amplifier which has proved popular with schools and for which we ourselves are finding an increasing variety of uses. Unfortunately the diagram and list of materials each contained an error. Firstly when we specified two PP9 batteries we overlooked the fact that those used in our own amplifier were size PP6, which are perfectly adequate, and that the PP9 size will not fit into the case which we gave in the list of materials. Secondly the outline drawing which we gave for the type 741 integrated circuit amplifier could be misinterpreted as being viewed from the bottom or pin side, because of the caption to that effect which was given alongside and which refers to the TBA221 only. The drawing as given shows the connections as seen from the top of the component, and there is a further identifying mark, not shown on our diagram, consisting of a recessed dot alongside pin 1. The diagram below shows what the device looks like, viewed from on top.



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As indicated in the introduction to this bulletin we propose to summarise the test results on low voltage power supplies, and will include the following models in the summary: Griffin and George GN59 (now L96-134); Griffin Lockavolt L96-102; Griffin L96-135; Philip Harris P7997/02, P7997/03, P7997/04, P7997/05 and P7997/06; Irwin and Partners EJ32 and J1; Linstead Electronics S4A; Radford Laboratory Instruments Lab 59R and N59R; Unilab Science Teaching Equipment 022.314, 022.316 and 022.319; Weir Electrical Instruments LV169; Zenith Electric Co, low voltage power unit.

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Of the more recent items advertised in surplus equipment, those detailed below are still available. The number in brackets indicates the bulletin in which details of each item can be found.

Item 291 (55). Developer 3 gall, 50p; 5 gall, 75p; 20 gall, £2.50.

Item 292 (55). Photo-flash bulbs, 2p.

Item 293 (55). Fluorescent lamps, 10p.

Item 294 (55). Low voltage SBC bulbs, 1p and 2p.

Item 295 (55). Low voltage MES bulbs, 1p.

Item 296 (55). Miscellaneous bulbs, 2p.

Item 308 (56). Amplifier, £5.

Item 310 (56). Air speed indicators, 25p.

Item 323 (56). Audio amplifier, £3.

Item 15 (57). Relays, 5p.

Item 16 (57). Switches, 5p.

Item 333 (57). Exposure meters, £5.

Item 334 (57). Component boards, 5p.

The following items are offered for sale for the first time:

Item 335. 5" scissors. Type (a) rounded blade ends, 50mm blades, chrome plated steel, 35p. Type (b) one pointed end, 60mm blades, steel, 20p. Please specify which type when ordering.

Item 336. Feeding tubes. 120cm flexible rubber tubing, 6mm internal and 12mm external diameter. One end carries a rubber funnel, top diameter 50cm. Apart from a 40mm length at the other end which is more flexible, the material can be used as vacuum tubing. Price 2p.

Biology Notes

As indicated in the introduction to this bulletin we propose to summarise the test results on microscopes suitable for 'O' grade, and will include the following models in the summary: Bausch and Lomb STZ 200; Didactic MD-2; Griffin-Beck Student; Meopta AZ-2; Olympus MIC; Olympus ST(N); Opax NES 200X; Open University McArthur Microscope; Parisian Opera Model C; Prior 443; Russian SHM1; Russian MBU4; Swift M240.

Trade News

Elesco-Fraser are sole agents in Scotland for Photain Controls which has recently introduced a light-dependent resistor with a difference. If a narrow strip of light ½ mm wide falls on the device, its resistance depends upon the position of the light beam on the resistor. The manufacturers claim that resistance varies linearly with position as the beam is moved from one end of the device to the other. This has obvious applications where it is desirable to convert a small displacement into an electrical signal, and may appeal to teachers seeking a SYS project. For example we hope to make it the basis of a top pan balance adaption for use with blind pupils. By being optically operated the sensor has the advantage that it does not interfere with the normal operation of the balance. The device is type MPC1051, price £2.00.

Spectra Chemicals have produced an aerosol cleaner called "Spray-Clene". This is a cleaning solvent which they claim is non-toxic and suitable for cleaning electrical parts, domestic appliances, textiles, the removal of tar etc. A special extension tube is fitted to enable spraying directly on to otherwise inaccessible parts. Price is 20p for 72g size and 42p for 283g. Available from Halfords.

G.W. Smith and Co. (Radio) Ltd. can supply the Russian pen recorder referred to in Bulletin 57. This is the model type H.320-1 costing £55.00.

Both Philip Harris and Griffin and George have produced a catalogue of Nuffield Secondary Science apparatus and materials. Nuffield Secondary Science is aimed at the same consumer as was originally intended for our own integrated Science, viz. the non-certificate pupil, and much of the apparatus is common to both courses. Neither firm provides an alphabetical index, which is regrettable. The item numbers in both catalogues are the reference numbers in the Nuffield Secondary Science Apparatus Guide, which are loosely alphabetically arranged. That is to say, they proceed in orderly fashion from 1 to 716, whereafter the section from 800 to 841 jumps in unpredictable fashion from yeast to John Innes Compost, from grain weevils to mouse food. The Harris catalogue adheres to number order as in Section B of the Apparatus Guide, so that it is no better and no worse alphabetically indexed than the Guide itself. The Griffin catalogue is based on the Field of Study listing of Section A, which means that without the Nuffield Apparatus Guide it would be very difficult to find a given item unless one knew precisely where in the Secondary Science course the apparatus was used. The Harris catalogue includes prices; Griffin's does not. Both have catalogue number references to their main catalogue, but in the Harris catalogue there are a number of items (they estimate about 25% of the total) which are new to the Harris range and not listed in the main catalogue. Neither firm is making a mailing shot of the catalogue to Scottish schools, but will send one if requested.

Carwyn Instruments have replaced their model 501A pH meter, reported on in Bulletin 51 supplement by model 501B of improved design. The cost is still £26, which includes the electrode. A new user's handbook is now available, cost 50p. It is very comprehensive, including instructions for use, servicing, fault finding, repair techniques, circuit diagram, use and care of glass electrodes and suggested experiments. If asked to do so, the firm will fit output terminals for connection to a chart recorder at an additional cost of 75p. These terminals give an output of 200mV per pH at very low impedance, up to a maximum current of 10mA, so that the output can be made to operate any chart recorder. We have run tests on the 501B and find it at least as good as the 501A.

Chemistry Notes

Electroplating Very often efforts at electroplating are unsatisfactory due to use of solutions of the wrong composition. From Craigroyston Secondary School, Edinburgh, we have obtained the following recipes for electroplating solutions. The original source of these recipes was an electroplating firm.

Nickel Plating

Nickel (II) sulphate - 6 - water 250g
Nickel (II) chloride - 6 - water 40g
Boric (III) acid 25g
Dissolve in 1 litre of water; filter and use at 40°C.

Copper Plating

Copper (II) sulphate - 5 - water 200g
Concentrated sulphuric acid . . . . . $27cm^3$
Dissolve in 1 litre of water; filter and use at room temperature. Better results are obtained by nickel plating first for about half a minute, then copper plating.

Zinc Plating

Zinc (II) sulphate - 7 - water 288g
Sodium chloride 175g
Aluminium (III) sulphate - 18 - water 28g
Dissolve in 1 litre of water; filter and use at 40°C.

Tin Plating

Sodium or potassium stannate (IV) 100g
Sodium hydroxide 10g
Hydrogen peroxide (100 volume) . . . . . $1cm^3$
Dissolve in 1 litre of water; filter and use at 60°C.

Silver plating using solutions of silver cyanide and potassium cyanide is not recommended because of the hazardous properties of these chemicals. Chromium plating with chromic acid is also not recommended because of the dangers of skin contact.

Plating currents with the solutions we have quoted should not be greater than about 80mA per cm^2 of object being plated.

Another extremely important factor in electroplating is that the object to be plated should be thoroughly cleaned, pickling in acid being normally used.

In pupil experiments three inch iron wire nails can be used. For cleaning, nichrome wire is attached to the nail, a length of about 20cm being ample. The nail is heated in a bunsen flame until red hot. A film of black oxide forms on the surface. In a fume cupboard, the nail, while still hot, is immersed in 20% hydrochloric acid in a boiling tube until copious evolution of hydrogen indicates that the oxide film has been removed. Safety precautions should be taken when carrying out the above cleaning process since acid spray may be produced. The nail is now rinsed thoroughly and electroplating carried out, the nichrome wire being used to suspend the nail in the plating solution and also for connection to the electricity supply. When the above process for cleaning is not suitable, the object should be cleaned as thoroughly as possible using degreasing solvent followed by treatment with acid of suitable type and concentration.

After plating and washing a plated article should be dried at just above room temperature. Finally the article can be polished using Jewellers' rouge which is available from Griffin and George under that name. Alternatively the rouge, which is iron (III) oxide, may be prepared by heating iron (II) sulphate.

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In the Chemistry Notes section of Bulletin 57 on the article describing a mechanical analogue for modes of vibration of molecules, an incomplete formula for the frequency of vibration was given. The formula should be:

$$\text{Frequency} = \frac{1}{2\pi c}\sqrt{\frac{K}{\frac{M_x \cdot M_y}{M_x + M_y}}}$$

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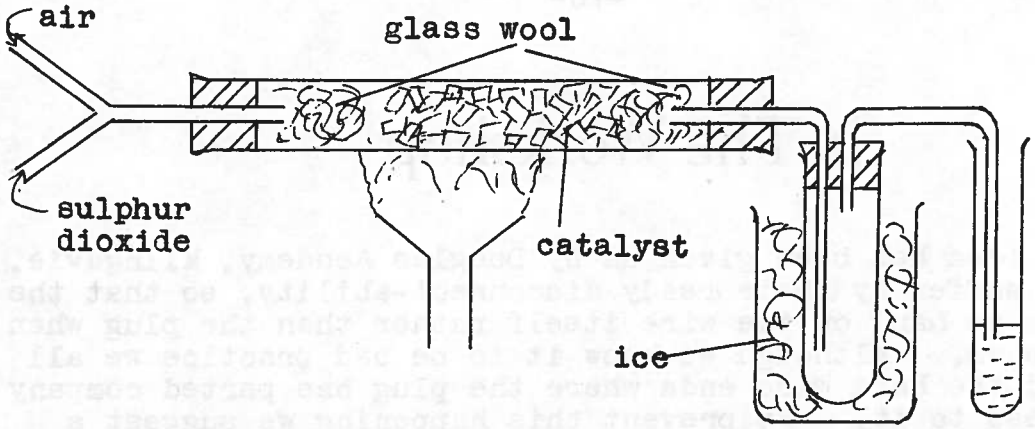
I.S.C. Chemicals Ltd. recently gave a large quantity of vanadium (V) oxide (vanadium pentoxide) catalyst for distribution to Scottish schools. This was given to Jordanhill College of Education, who have passed it on to us because of our publicity and distributution facilities. On receipt of 5p in stamps to cover postage and packing a school will be sent 20g of the firm's standard 598 catalyst, which contains 6.5% vanadium (V) oxide. The quantity will be limited to 20g per school, but since only 10g is required for the experiment, and the firm give a 5 year guarantee for continuous commercial use, this would not be a serious limitation.

We give below an account of the oxidation of sulphur dioxide as we have carried out in the Centre. The technique differs from that given in the instructional leaflet which we will send with the sample, because we tried to avoid the hazards associated with the use of conc. sulphuric acid as a drying agent.



10g of the substance, which comes in the form of pellets, is put in a combustion tube with a plug of glass wool at each end. We have done the experiment using air supplied by an aerator pump with a screw clip on the delivery tube to control the flow, and sulphur dioxide from a cylinder, and without drying either of the gases. Before turning on the sulphur dioxide, and with the air passing through, the combustion tube was heated by a moderate bunsen flame for 10 minutes to dry the tube and catalyst. Initially we tried using silica gel as drying agent for both gases, but found that there was considerable absorption of sulphur dioxide in the desiccant so that this method is not recommended.

A reasonable yield of sulphur trioxide, covering the bottom of a 25mm boiling tube was obtained in 10 minutes. As much of the sulphur trioxide fails to condense the experiment should be carried out in an efficient fume cupboard. If the experiment is done as we suggest there is no indication of gas flow through the apparatus, so that we arrange to pass the excess gases through a small quantity of water, just sufficient to cover the end of the delivery tube, in an open test tube. By doing this there will be no risk of suck back into the receiver if for any reason the flow of gases is stopped. If this happens a possible reason is blockage of the exit delivery tube by sulphur trioxide crystals, and the sulphur dioxide supply should then be stopped, but the aquarium pump left running to maintain a positive pressure in the apparatus.

If water at about $5^{o}C$ is used in place of ice in the condenser, liquid sulphur trioxide will be formed, which will crystallise if placed in a refrigerator. There is evidence that the catalyst may be damaged by prolonged contact with sulphur trioxide so that after the experiment it must be thoroughly flushed clear of the gas. To do this we found it necessary to maintain an air flow of about $50cm^{3}$/min for 30 - 60 minutes, heating the catalyst during this time. The end point is shown when the gas issuing from the exit delivery tube ceases to fume. Even if oxygen in place of air is used in the preparation we recommend that the flushing be done using atmospheric air on the grounds of expense. It is recommended that the catalyst be stored in the combustion tube itself, replacing the one-hole by solid rubber stoppers.

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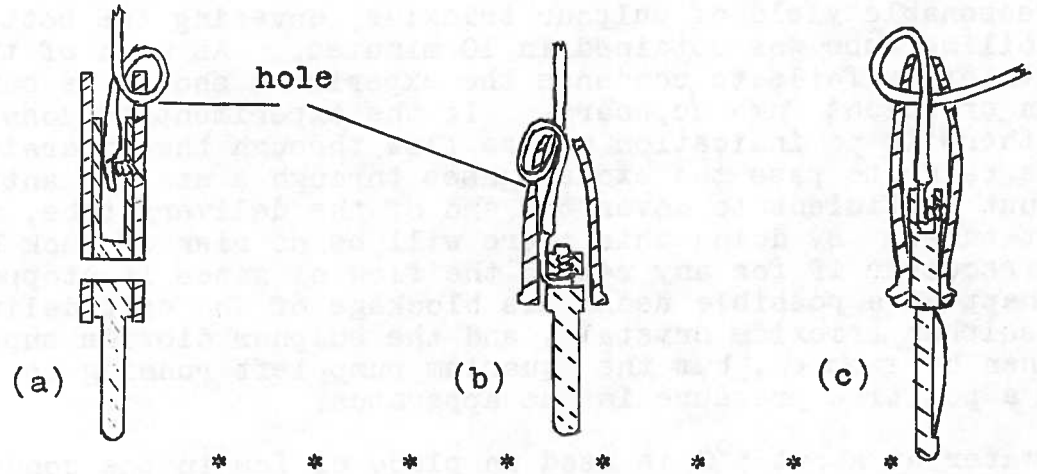
As indicated in the introduction to this bulletin we propose to summarise the test results on centrifuges, and will include the following models in the summary:
F. Copley Janetzki T5; Gallenkamp CF200; Griffin and George Piccolo; Griffin W10-800; Philip Harris C643/05; Arnold R. Horwell ARH angle head; M.S.E. Minette; Med-Lab MC96.

In The Workshop

This idea has been given us by Douglas Academy, Milngavie. 4mm leads suffer by their ready disconnect-ability, so that the user tends to haul on the wire itself rather than the plug when removing them. Although we know it to be bad practice we all do it, and the bare wire ends where the plug has parted company bear witness to it. To prevent this happening we suggest a method whereby the strain is taken on the plug insulation, instead of on the join between wire and grub screw. A hole is drilled in the side of the plastic insulation and the wire is looped through this before fixing it to the plug. With the hard plastic stackable or banana plugs from Radiospares, types (a) and (b) in the diagrams, a hole is drilled through one side of the plastic. With the flexible, moulded PVC cover of the Hirschmam plug, type (c), obtainable from Electroustic, the hole has to be drilled right through both sides of the insulator because the end opening of the insulator is so much narrower. This has the minor disadvantage that the wire leaves the plug at right angles.



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To identify stainless from other steels, including plated steels, scratch a small part of the surface to remove possible plating and dip into copper sulphate solution. All except stainless steel will show copper colouration due to deposition of the metal.

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To distinguish between pyrex and soda glass, dip it into trichloroethene (trichlorethylene). Soda glass will remain visible, but pyrex will disappear. This hint was given in the teachers' guide to Chemistry Takes Shape, Book 2, but may not be known to all technicians.

Bulletin Supplement

Summary of microscope tests The instruments listed below were tested on the 'H' grade procedure published in Bulletin 46. 'Phase contrast' refers to the relevant specifications in that Bulletin. Individual reports can be borrowed for one month by writing to the Director. The classifications used are:- A - most suitable; B - satisfactory for school use; C - unsatisfactory.

Model	Diamax	462	452
Manufacturer	Ealing Beck	Prior	Prior
Supplier	Ealing Beck	Philip Harris	Prior
Price	£84,60	£57,50	£43.25
Eyepiece	10x Huygenian	10x Widefield	10x Widefield
Objectives	5x/0.12; 10x/0.25; 45x/0.65	4x/0.12; 10x/0.18; 40x/0.65	4x/0.12; 10x/0.18; 40x/0.65
Optical Head	Inclines	Upright	Upright
Condenser	Abbe, N,A, 1.2	Abbe, N.A. 1.2	Simple, N.A. 0.65
Condenser Focussing	Spiral	Rack-and-pinion	None; fixed in stage
Condenser diameter	38.75mm	39.45mm	-
Phase contrast	Available £122.90	Available (Model 464) £81.00	Available (Model 454) £58.25
Illumination	Mains lamp available	Mains lamp available	Mains lamp available
Assessment	B	C*	C*

*Mechanically and optically unsatisfactory.

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

Bausch and Lomb Optical Co. Ltd., Aldwych House, Aldwych, London, W.C.2.

Carwyn Instruments Ltd., Carwyn, Pentraeth Road, Menai Bridge, Anglesey.

F. Copley and Co. Ltd., Private Road Seven, Colwick Industrial Estate, Nottingham, NG4 2ER.

Ealing Beck Ltd., Greycaine Road, Watford, WD2 4PW.

Electroustic Ltd., 73b North Street, Guildford, Surrey.

Elesco Fraser Ltd., 36 St. Vincent Crescent, Glasgow, C.3.

A. Gallenkamp and Co. Ltd., Technico House, Christopher Street, London, E.C.2.

Griffin and George Ltd., Braeview Place, Nerston, East Kilbride.

Philip Harris Ltd., 63 Ludgate Hill, Birmingham B3 1DJ.

Arnold R. Horwell Ltd., 2 Grangeway, Kilburn High Road, London, N.W.6.

Irwin and Partners Ltd., 294 Purley Way, Croydon CR9 4QL.

Measuring and Scientific Equipment Ltd., 25-28 Buckingham Gate, London, S.W.1.

Med-Lab Ltd., 2-6 Agard Street, Derby, DE1 1EA.

(MeTeRaTe) Glass Precision Engineering Ltd., Mark Road, Hemel Hempstead, Herts.

Opax Ltd., 6 Frant Road, Tunbridge Wells, Kent.

Open University, Walton Hall, Walton, Bletchley, Bucks.

Parisian Opera and Field Glass Co. Ltd., 24-25 Princes Street, Hanover Square, London, W1R 7RG.

Photain Controls Ltd., Randalls Road, Leatherhead, Surrey.

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

Radford Laboratory Instruments Ltd., Bristol, BS3 2HZ.

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

G. W. Smith and Co. Ltd., 3-34 Lesle Street, London, W.C.2.

Spectra Chemicals Ltd., Haywards Heath, Sussex.

Unilab Science Teaching Equipment, Clarendon Road, Blackburn, BB1 9TA.

Weir Electrical Instrument Co. Ltd., Bradford-on-Avon, Wilts.

Zenith Electric Co. Ltd., Cranfield Road, Wavendon, Bletchley, Bucks.