SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

Bulletin No. 52 December 1971.

Contents

Introduction

The Association for Science Education Annual Meeting is being held this year in the University of Stirling from the 28th December to 31st December, 1971. We are giving an exhibition of equipment at the meeting and we take this opportunity of thanking the A.S.E. for making it possible to let our visitors to Scotland see some products from S.S.S.E.R.C. On each day of the meeting three members of our staff will be present and one member of the administrative staff will be staying overnight. Our Centre in Edinburgh will open on each day of the meeting from 9 a.m. until 5 p.m. as usual.

The only days on which the Centre will be closed during the Christmas and New Year's Holidays will be Christmas Day, New Year's Day and Monday, 3rd January.

In the Chemistry Notes we give a test procedure which we are applying for the assessment of colorimeters. We shall be pleased to have information from teachers on colorimeters they have used. For example, how an instrument stands up to class use would be a useful addition to our test results.

In the Biology Notes we print lists of recommended slides and transparencies for the new biology and integrated science syllabuses. We asked all the known suppliers of these materials to tell us which of the listed titles they can supply, and whether they would be prepared to supply them in the sets specified. We also requested samples for assessment so that we could check that the titles to be supplied were suitable for the syllabus work. As a result of these approaches, several of the suppliers are adding new material to their range and trying out new staining techniques, while some are also intending to list the sets separately. A final request made was that, where the sets are separately listed, some details of the stains used, and resultant colours of tissues, should be given for each title. In recent years a much wider range of stains has been used for school slides, and many of them are unfamiliar to teachers. We therefore felt that such details would be appreciated, and some firms have already agreed to supply this information.

In assessing the material we have been very much aware that slides from the same supplier vary more in quality than any other equipment used by science teachers. We have, therefore, simply categorised the slides as suitable or unsuitable, and in doing so have placed most emphasis on staining technique and relevance. Only in cases where the great majority of slides have been poorly sectioned or stained have these latter criteria weighed heavily in our assessment. Most of the material is on extended display in the Centre and teachers are therefore invited to come in and compare for themselves, or to write or telephone for more detailed advice.

Those firms mentioned in the Supplement have supplied all of their available material for assessment. In the case of other suppliers, we have not yet seen the complete range of available titles; when we have done so, details will also be published.

Opinion

Frequently, in conversation with teachers and technicians, we find that too many either rarely see the Bulletin or never see it at all. There may be a good reason for this in some cases. In your school, is the Bulletin made available to all the science staff, including technicians, or is it considered so valuable that it is locked away with confidential documents, or is it thrown to the side and forgotten? We are pleased to know that in many schools the Bulletins are carefully filed and made freely available to teachers and technicians. At our exhibitions many of the items on show have been described in a Bulletin and in our Exhibition Catalogue we therefore give the Bulletin reference. Need we state that it is rather surprising to be asked, "What is this Bulletin you refer to?"

Biology Notes

Slides and transparencies for the new syllabus. In consultation with our Development Committee we have drawn up the following lists of recommended slides and transparencies for the new biology syllabus. The two lists are intended to be complementary since it is expected that both slides and transparencies will frequently be used in the same lesson. The committee felt most strongly that photomicrograph transparencies are often the best way of demonstrating material to groups of pupils. Their main disadvantage is that one cannot search for different structures as when projecting a demonstration slide; on the other hand, they are usually photographed from outstanding slides, are of consistent quality, and are easier to project.

Both slides and transparencies are listed in sets, designated by letters as follows:

IS denotes that the set is required for Integrated Science, First Cycle.

OG denotes that the set is required for 'O' Grade.

HG denotes that the set is required for 'H' Grade.

P denotes that the slides should be available in pupil quantity, usually one per two pupils.

D denotes that the slides should be available in demonstration quantity, of one per laboratory or department.

T denotes transparencies, which should be available on a scale, of one per laboratory or department.

Set ISP. T.S. dicotyledon root, e.g. Vicia; T.S. herbaceous dicotyledon stem, e.g. Helianthus; T.S. mesophytic dicotyledon leaf, e.g. Prunus.
Approximate cost of 12 of each of the 3 titles, 36 slides in all - £8.00.

Set OGP. Set ISP, and in addition: T.S. compact bone; T.S. spinal cord; teased nerve fibres; T.S. nerve, general structure; V.S. lung, general structure; T.S. woody stem, annual rings, e.g. Tilia; R.L.S. woody stem, e.g. Tilia.
Approximate cost of 12 each of 10 titles, 120 slides in all - £26.00

Set HGP. Set OGP, and in addition: L.S. striated muscle; L.S. cardiac muscle, stained for Purkinje fibres and intercalated discs; V.S. kidney, general structure; L.S. root tip, mitosis, e.g. Vicia.
Approximate cost of 12 of each of 14 titles, 168 slides in all - £40.00.

Set ISD. T.S. root nodule for Rhizobium; Rhizobium smear; various bacteria including cocci and bacilli; T.S. Cucurbita stem; L.S. Cucurbita stem for sieve tubes and vessels.
Approximate cost of 5 slides - £1.50.

Set OGD. Set ISD, and in addition: T.S. aorta, artery and vein, stained for elastic, muscular and connective tissue; human blood smear; V.S. lung, stained for elastic fibres; T.S. woody stem, first year, e.g. Tilia.
Approximate cost of 9 slides - £3.00.

Set HGD. Set OGD, and in addition: human chromosomes, male or female; locust testis squash; Drosophila salivary gland squash; set of about 5 slides showing development of e.g. Echinus to gastrulation; L.S. dicotyledon stem apex, for meristem; L.S. dicotyledon root apex, for meristem.
Approximate cost of 19 slides - £8.00.

Set IST. Human blood smear; L.S. tooth; T.S. small intestine, injected; V.S. kidney, injected, L.P.; V.S. kidney, injected, H.P.; V.S. kidney, L.P.; V.S. lung, injected, H.P.; V.S. lung, injected, L.P.; mammalian egg; mammalian sperm; V.S. eye; L.S. angiosperm root, showing elongation; T.S. herbaceous dicotyledon stem, e.g. Helianthus, L.P.; T.S. herbaceous dicotyledon stem (vascular bundle), e.g. Helianthus, H.P.; T.S. herbaceous monocotyledon stem, e.g. Zea, L.P.; T.S. Cucurbita stem, L.P.; L.S. Cucurbita stem, xylem and phloem; T.S. mesophytic dicotyledon leaf, e.g. Prunus; set of about 6 showing pollination and fertilisation; worker honey bee, leg with pollen basket; bacteria - cocci, bacilli and spirilli; T.S. root nodule, with Rhizobium; Rhizobium smear, typical form.
Approximate cost of about 28 transparencies - £6.00.

Set OGT. Set IST, and in addition: T.S. cartilage; T.S. spinal cord; motor nerve ending; T.S. aorta, artery and vein, for elastic muscular and connective tissue; T.S. ovary, with mature follicle; T.S. testis; T.S. woody stem, first year; T.S. woody stem, with annual rings; T.S. xerophytic leaf, e.g. Ammophila; T.S. hydrophytic leaf, e.g. Nymphaea; T.S. mesophytic monocotyledon leaf, e.g. Zea; young embryo in embryo sac of, e.g. Capsella; Amoeba, structure; set of about 4 showing Amoeba feeding; Paramecium, structure; set of about 4 showing Paramecium, contractile vacuole cycle; Spirogyra, conjugation; Mucor or Rhizopus, sporangia; Mucor /

Mucor or Rhizopus, zygospores; Penicillium, sporangia; yeast, budding; V.S. Fucus conceptacle for antheridia; V.S. Fucus conceptacle for oogonia; V.S. fern prothallus, antheridia; V.S. fern prothallus, archegonia.
Approximate cost of about 60 transparencies - £15.00.

Set HGT. Set OGT, and in addition: L.S. cardiac muscle, Purkinje fibre; V.L.S. pituitary gland; V.S. skin; set of about 10 showing meiosis in locust or grasshopper; set of about 6 showing meiosis in, e.g. Lilium; set of about 10 showing mitosis in, e.g. Crocus; L.S. coleoptile showing tropic curvature; visible spectrum; chlorophyll absorption spectrum; photosynthesis action spectrum; deoxyhaemoglobin absorption spectrum; oxyhaemoglobin absorption spectrum; carboxyhaemoglobin absorption spectrum; set of electron micrographs showing the following - cell wall; cell membrane; endoplasmic reticulum; nuclear membrance; chloroplast; mitochondria; golgi body; ribosomes; microvilli; pinocytosis; striated muscle; whole plant and animal cells. (A set of electron micrograph prints would suffice in place of the transparency set).
Approximate cost of about 110 transparencies - £30.00.

The criteria used in assessing the suitability of material submitted by the suppliers are listed below. It is stressed that sectioning and mounting quality can be quite variable, even between samples from the same supplier; we have borne this point very much in mind in making our assessments.

1. Relevance. The material should contain those structures required by the syllabus.

2. Sectioning and mounting quality. The section should be of an appropriate thickness and free from dirt. It should be free from tearing and there should be minimal distortion in mounting; the mount should be free from air bubbles.

3. Staining quality. Staining should be even, and should not be so heavy as to obscure important structures. Most important of all, however, appropriate stains should be used, so that the required structures are clearly differentiated. The standard histological stains are haematoxylin and eosin, but these usually give only a limited differentiation of tissues. Stains such as Masson, Azon and Van Gieson/iron haematoxylin are now being used by some suppliers, and these often differentiate much more clearly.

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Injecting Xenopus laevis. This is described on page 40 of "Biology by Inquiry" Teacher's Guide 1. It can be tricky; we are prepared to demonstrate the technique at future SSSERC Exhibitions, if requested beforehand.

Chemistry Notes

Test Procedure for Colorimeters. Colorimeters to be tested are those using some form of photo detector as distinct from those which use standard solutions for visual comparison with solutions of unknown concentration in order to estimate their concentration.

There is a considerable price and quality range of colorimeters but we are interested in those which have specifications and price suitable for school use. Efficiency of colorimeters is dependent on a number of factors such as light source, wave-length selection, sensitivity control, detector characteristics, meter sensitivity and accuracy.

The test procedure covers these factors and can include absorptiometers and spectrometers. The former are really colorimeters designed for work with very dilute solutions and using cuvettes of path lengths from 2.5 to 25mm and even up to 100mm. Spectrometers use a spectrum for waveband selection instead of filters and in these if waveband selection is high, say 30nm or above, then it might be called a spectrocolorimeter.

The colorimeters will be examined and reported on according to how their construction, specification, etc. measure up to the data given in the following list.

Colorimeter.	Model No.	Supplier.
Price.		Included in price.
Not included but required.		Additional accessories available.

1. Construction. Material used, dimensions, controls, sockets for power built in or external meter, etc., cuvette holder.

   If meter included, its sensitivity, accuracy, scale size.

2. Operation. Use of controls, effectiveness of controls, speed of operation, reproducibility.

3. Optical Design. Description of this, noting whether the following are used: Condenser lens, heat filter, light filter, iris or slit light control, lens before cuvette, parallel rays through cuvette or focussing at its centre without light falling on its sides, lens between cuvette and photo-detector.

   All non transmitting surfaces inside the colorimeter should be black and stray light should not enter the optical compartment.

4. Light Source. Description of lamp, its power, cost and replacement. Is battery fitted inside or power sockets provided? Is I.R. filter used? What type of battery is recommended and is it suitable for providing steady illumination?

5./

5. Wavelength Selection. Whether by (a) Filters, their waveband and material used. Their bandwidth should be less than the absorption bandwidth of solution. (b) Interference filter which provides a quick selection of wavelengths. (c) Diffraction Grating. (d) Prism. (b), (c) and (d) would be classed as spectrometers.

6. Cuvettes. Type, size, path length, capacity and minimum volume of solution required. Cuvette holder, shift mechanism and cuvette compartment arrangement. If test tubes are used as cuvettes they should fit snugly in holder and ideally, they should be matched for similar optical properties.

7. Detectors. Photo detector may be a photocell or photo-resistor. (1) Type of detector and whether photo-voltaic or photo conductive. (2) Whether battery or amplifier used in detector circuit. (3) Focussing of light on the photo detector. (4) Is there any provision to prevent damage to meter when filter is withdrawn? (5) What is wavelength range of the detector? Is it suitable for the visible light range? (6) Meter should read zero when no light falling on detector; if not, what is dark current value?

8. Sensitivity Control. (a) Is this by light slit control? If so, what is mechanical arrangement? (b) Is control by varying intensity of bulb? (c) If detector has powered or amplifier circuit. is sensitivity also controlled by variable resistor or switched pre-set resistors to give a range of sensitivities?

9. Performance of Instrument. This is tested by obtaining optical density concentration curves for potassium permanganate. In addition spectrometers can be checked for bandwidth definition, e.g. by means of didymium glass ON16. This shows strong yellow absorption band at 585nm. A very good spectrometer can split this 585 band into peaks at 573 and 590nm. Any value above 2% transmission at 585nm is due to stray light and bandwidth effect.

The use of the instrument for specific experiments in chemistry and biology will also be considered.

Comments. The accuracy, reproducibility, ease of operation, design, construction and any other advantages or disadvantages of the instrument are noted. Price is another factor to be considered. The instrument is then classified: A. Most suitable for school use. B. Satisfactory for school use. C. Unsatisfactory.

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In Bulletin 39 we described an apparatus for gas chromatography. The column dimensions and material made it suitable for use with town or natural gas at normal supply pressures as carrier gas. To increase the scope of the instrument it is necessary to use finer column material, e.g. Celite 40 - 60 mesh and possibly $\frac{1}{4}$in. bore instead of 3/8in. bore column, but if this is done, the carrier gas must be supplied at a higher pressure to obtain a suitable flow rate. A cheap method of pressurising the carrier gas is described in the "In the Workshop" section. A fairly steady flow of the gas is obtained if the silica gel drying column is placed between the pump and chromatograph in the gas circuit.

Physics Notes

Demonstration of Relative Weightlessness. Remove completely the top from a metal can, the larger the better. Drill a small hole in the bottom of the can. Pass an elastic band through this hole and secure the outside end, e.g. with a paper clip. On the other end, inside the can, attach a plumb bob, e.g. 200 grams. Hold the inverted can so that the extended rubber band allows the weight to be seen below the rim of the can. Allow the can to fall (onto something that is soft and noise absorbing!) and note that during fall the bob disappears inside the can! Since both are under free fall, the bob is weightless relative to the can, there is no tension on the rubber band, and it contracts to its normal length. Seen in the Australian Science Teachers' Journal, November 1965. See also Bulletin 17 for another method.

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Current Capacity of Small Nife Cells. Some teachers have expressed interest in the amount of current which can be drawn from the small 80mm x 55mm, 1.3 volt, Nickel cells obtainable from SSSERC at 15p. each. Tests carried out at the Centre indicate that the cells have an internal resistance of the order $2 \times 10^{-3}\Omega$, and that they are quite capable of delivering currents in excess of 50 Amp for short periods.

On a test rig consisting of an ammeter (50A) and 50cm of 20 gauge copper wire, a single cell delivered a steady 36 Amp for 10 minutes, (but after that time the P.D. fell rather rapidly). Thus it would seem that banks of these cells are suitable for demonstrations involving large currents; in most cases the resistance of the connecting leads will be the main limiting factor.

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Does sound travel through a vacuum? The standard demonstration that sound waves cannot travel through a vacuum is to hang a bell inside a bell jar and show that the bell becomes less audible as the air is pumped out. Does this really show that sound waves cannot traverse a low pressure space? In an article in the September volume of "Physics Education" R.G. Chambers draws attention to the fact that, under reduced pressure, the vibrational energy of the bell cannot be efficiently transferred to the air, so that the drop in audibility is due solely to failure of the vibrations to transfer from the bell into air. However any energy that does enter the air is transmitted to the walls of the bell jar as long as the sound wavelength is large compared to the mean free path of the remaining air molecules, thus the "vacuum" would let the sound energy travel through it if only it could accept such energy from the bell. Reference: Physics Education, Volume No. 5, September 1971, page 272.

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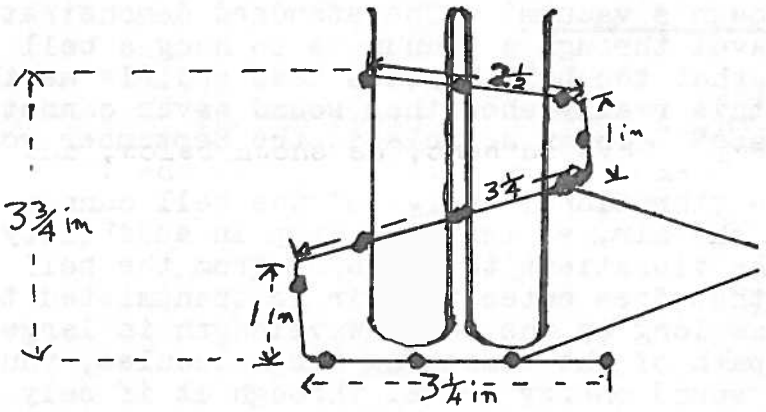
Pin Hole Camera in Reverse. The following interesting optics item was sighted in the Australian Science Teachers' Journal (August 1963). When a filament lamp (clear glass) is placed about 25cm above a sheet of clear glass, and a small opaque object, e.g. seed or shot, is placed on the glass, an image of the filament will be seen on a sheet of white paper placed about 50cm below the glass sheet, but the image will be a shadow in the shape of the filament.

If the sheet of glass is replaced by a shallow layer of water on a flat bottomed trough, similar effects can be seen by (a) stirring to form bubbles, (b) allowing drops to fall onto the water surface, (c) or floating a speck of cork on the surface. It would be a good exercise to explain why a half submerged lead shot gives a bright image; or why the image formed by the floating cork changes if the cork is wet by rubbing between wet fingers.

In The Workshop

Test-tube Racks. In Bulletin 48 we described how to make 19mm test-tube racks from 1 inch x ½ inch wire mesh. Our reason for using this size was because we were already using it for animal cages. Since then, however, we have made similar racks from 1 inch x 1 inch mesh, which is not only little more than half the price of the 1 inch x ½ inch material, but requires no cutting out of wire to form the 1 inch x 1 inch spaces.

A strip of the wire mesh 11 inches long is bent, as shown below, so that the cross spars on the base fall between those on the two higher levels. Test-tubes placed in the rack rest on the base cross spars. The width of the strip of mesh used depends on the number of tubes to be accommodated. The cost of a rack to hold ten 19mm test-tubes is under 2p. 'Weldmesh' from B.R.C. Engineering Company is an alternative material to the 'Twilweld' mentioned in Bulletin 48. It is stronger and slightly cheaper in bulk.



Cross spars.

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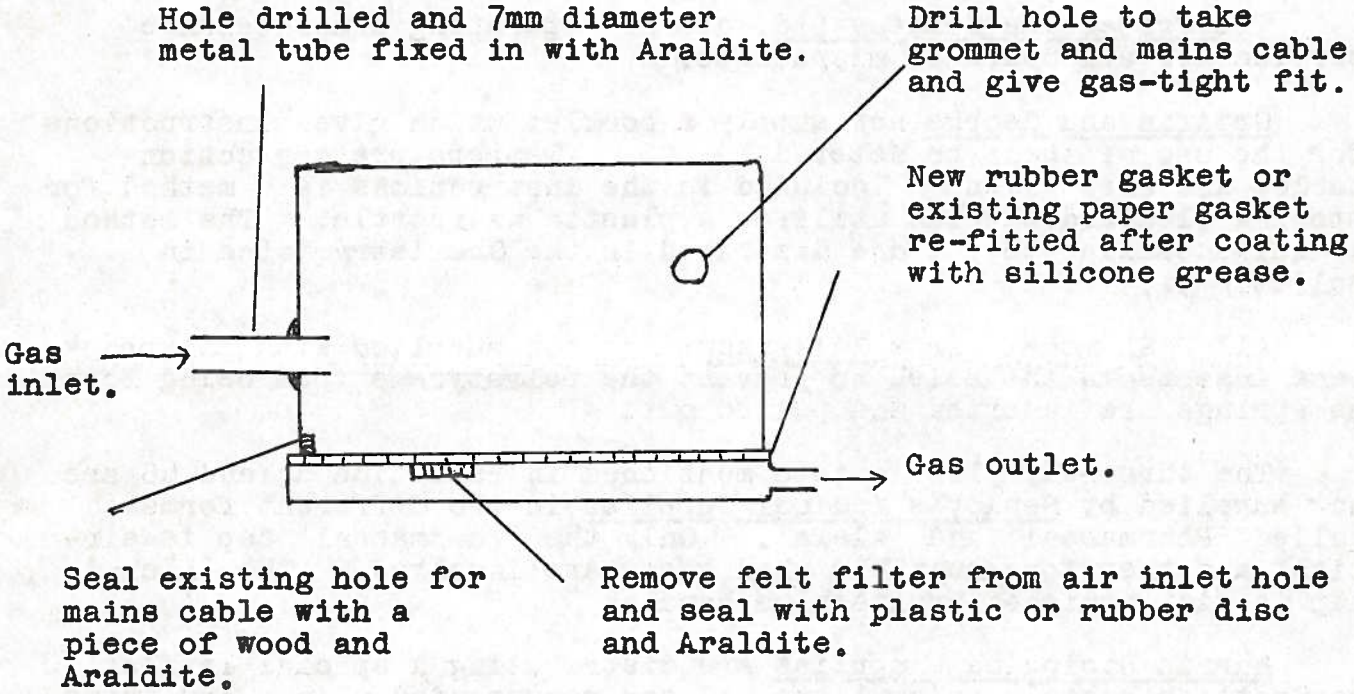
An aquarium aerator pump of the diaphragm type in moulded plastic case can be converted quite easily for compression of gases as well as air. The following idea is from Dunfermline High School. The aerator used here is available from pet shops and suppliers of biological materials. This model from Philip Harris costs £1.75.

The alterations consist of adding an inlet tube for the gas and making the whole of the rest of the pump gas tight, the existing outlet tube being retained. The diagram below shows the work involved in converting the pump.

Tests on the converted pump gave the following results. Pressure of town gas was increased from 6in. to 48in. of water. Maximum flow rates in gas chromatography columns were: 120cm^3 per minute for 3/8in. bore, 140cm length containing 40 - 60 mesh celite; 65cm^3 per minute for $\frac{1}{4}$in. bore, 155cm length containing 40 - 60 mesh.



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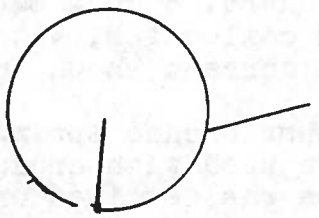
An Eyepiece Pointer for a Huygenian eyepiece can be made from thin wire, e.g. 5A fuse wire. This is bent, as shown below, and dropped on to the eyepiece field stop.



Diameter a little more than eyepiece so that the wire is held quite firmly in position.

Trade News

The Parisian Opera and Field Glass Company Model C microscope has now been modified as follows: 1) The eyepiece is now fixed by a grub screw, 2) A larger, 40mm diameter mirror has been fitted. 3) A fixed stop held by an Allen screw has replaced the adjustable one. Cost including import duty is £17.50. Also available from the same firm is the Tohyoh range of binoculars. Cost of the 8 x 30 model including case, carrying strap and neck lanyard, is £7.00.

The 'Stereomaster' microscope from W. R. Prior and Sons, mentioned in the supplement to Bulletin 47, is now £56.00 with 10x and 20x magnifications.

Oxoid Ltd. have stopped producing their 'Agaroid' agar sausage.

The Projectina Company Ltd. are now operating a maintenance service for all makes of microscope.

Griffin and George now supply a booklet which gives instructions for the use of their pH Meter S.34.200. Temperature correction tables are also given. Included in the instructions is a method for storing electrodes which utilises a plastic washbottle. The method is quite similar to the one described in the Chemistry Notes in Bulletin 51.

All PEEL models from Gallenkamp are now supplied with polypropylene inserts in the holes to prevent the polystyrene from being torn as springs are inserted and pulled out.

The three-way plastic taps mentioned in Bulletins 44 and 48 are now supplied by Henley's Medical Supplies in two different forms, called 'Pharmaseal' and 'Alexa'. Only the 'Pharmaseal' tap is air-tight and therefore suitable when gases are involved. The 'Alexa' tap is distinguished by its blue handle.

Harris Biological Supplies are distributing a special leaflet to Scottish schools which lists all the recommended slides and transparencies for the new Biology syllabus (see Biology Notes) together with details of the stains used and the resultant colours of tissues.

A meter amplifier, designed to give 10mA output for input currents of 50μA, 500μA, 1mA or 5mA, is available from The Weir Electrical Instrument Company. The amplifier is designed to increase the sensitivity of such existing meters as the Weir 9 inch Demonstration Meter which has a robust 10mA movement. The amplifier operates from two 9 volt batteries, and is priced at £18.22.

Available free from Weir is a wall chart, 89cm x 64cm, showing the co-axial magnet assembly of a moving coil meter, with typical values of flux, spring torgue, turns and current shown in SI units.

Project Technology can supply phosphor bronze spring connectors at £1.40 per 100. The connectors can be used with ordinary peg-board for making up circuit boards. Their use was detailed on page 16 of "School Technology", March 1971.

Bulletin Supplement

We list below a summary of microslide and transparency sets submitted to the Centre for assessment. The abbreviations used to denote the sets are explained in the lists under Biology Notes. The classifications used in the overall assessment of each set are:

Supplier	SSSERC Set	Missing Titles	Overall Assessment	Catalogue Numbers	Price £	**
Gerrard and Haig	ISP	Complete	S	-	6.60	
	OGP	"	S	-	17.00	
	HGP	"	S	-	28.40	
	ISD	1	S	-	1.45	*
	OGD	2	S	-	2.20	*
	HGD	3	S	-	6.00	*
	IST	3	S	-	6.10	*
	OGT	7	S	-	13.35	*
	HGT	16	S	-	17.25	*
Harris Biological Supplies	ISP	Complete	S	SS.IP	8.00	
	OGP	"	S	SS.OP	26.50	
	HGP	"	S	SS.HP	40.00	
	ISD	"	S	SS.ID	1.50	
	OGD	"	S	SS.OD	2.70	
	HGD	"	S	SS.HD	7.20	
	IST	"	S	ST.I	6.30	
	OGT	"	S	ST.O	14.15	
	HGT	"	S	ST.H	27.00	
Northern Biological Supplies	ISP	Complete	S	-	3.00	
	OGP	4	U	-	6.00	*
	HGP	7	U	-	7.00	*
	ISD	4	U	-	0.09	*
	OGD	7	U	-	0.18	*
	HGD	12	U	-	1.68	*
G.B.I. (Labs)	ISP	Complete	S	-	6.16	
	OGP	"	S	-	24.62	
	HGP	"	S	-	33.63	
	ISD	"	S	-	1.51	
	OGD	"	S	-	2.45	
	HGD	"	S	-	6.33	

** Prices for pupil sets are for 12 of each title.
* Prices of incomplete sets.

S.S.S.E.R.C., 103 Broughton Street, Edinburgh, EH1 3RZ.
Tel. 031-556 2184.
B.R.C. Engineering Ltd., Lichfield Road, Stafford.

Gallenkamp Ltd., Portrack Lane, Stockton-on-Tees.

G.B.I. (Labs.) Ltd., Heaton Street, Denton, Manchester, M34 3RG.

Gerrard and Haig Ltd., Gerrard House, Worthing Road, East Preston, Sussex.
Griffin and George Ltd., Braeview Place. Nerston, East Kilbride.

Harris Biological Supplies Ltd., Oldmixon, Weston-super-Mare.

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

Henley's Medical Supplies Ltd., Alexander Works, Clarendon Road, Hornsey, London, N.8.
Northern Biological Supplies, Cheltenham Avenue, Ipswich.

Oxoid Ltd., Southwark Bridge Road, London, S.E.1.

Parisian Opera and Field Glass Company, 24-25 Princes Street, Hanover Square, London, W.1.
W.R.Prior and Sons, London Road, Bishop's Stortford, Herts.

The Projectina Company Ltd., 8 Montgomerie Terrace, Skelmorlie, Ayrshire.
Project Technology, College of Education, Loughborough, Leicestershire.
The Weir Electrical Instrument Co. Ltd., Bradford-on-Avon, Wiltshire.