SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

Bulletin No. 85. December, 1975.

Contents

Introduction

In the September bulletin we gave a list of surplus equipment, some of which we expected to be over-subscribed for, and this proved to be the case. We have had complaints from schools in the Strathclyde region that they had their Monday holiday during that weekend and consequently did not see the bulletin until Tuesday. This would have happened in some part of the country whichever September weekend we chose, and our reason for posting when we did was to take advantage of the last of the 5½p letter rate.

Here we are again listing items such as typewriters, calculating and adding machines, for which we expect a big demand, and we intend trying a new system of reservations which should be at least as fair as the old. The bulletin will again be posted on a Friday and we hope that it should be in all schools by the following Tuesday. Accordingly we will not accept orders for any of the items listed until we open at 9 a.m. on the Wednesday morning, and then only by telephone. Letters, or requests by personal callers, will be dealt with 24 hours later, on Thursday. All other arrangements for collection, payment etc. are as before, and we do earnestly ask anyone buying surplus equipment to read the details of these, given on page 1 of Bulletin 83.

Some of our items, such as the adding machines, or the mechanical calculators, may have greater application in the primary than the secondary school, and we are prepared to sell these to any primary school under a Scottish regional education authority. Our difficulty is to make this fact known to primary school teachers and we therefore ask science advisers and others to mention this to their primary colleagues.

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Our cost index of consumable items of apparatus (= 100 in May, 1974) now (5/11/75) stands at 138.7. This is an increase of 18% since January of this year. Any reader wishing the information will be sent the list of items on which the index is based.

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The Centre will be closed Wednesday through Saturday, 24th - 27th December, and Thursday and Friday, 1st and 2nd January, 1976.

Biology Notes

In our specifications for microscopes, resolution is stressed as an important parameter. However for many biological applications contrast can be even more important. In much biological work, cells in solution are examined. These cells often have a refractive index little different from the solution surrounding them. Consequently little scattering of light occurs at cell boundaries, and an image of the cell and its components is difficult to produce. In addition, the effect of any light which is diffracted is swamped by light passing straight through the specimen. Obviously in these situations the contrast is poor, and interesting objects in the specimen may be barely visible. Thus increasing the resolution can be unproductive, if the 'improved' image is indistinguishable from its background.

Selective staining techniques can be used to render components of the image visible. Unfortunately most staining techniques kill the cells and it is never certain that all of any particular component has taken up the dye. For many purposes it is necessary to employ techniques for rendering cells and their contents visible, which do not have the disadvantages inherent in staining. One of these is a special type of interference microscopy, which is being increasingly used in schools - phase contrast. A substantial number of schools now have phase contrast microscopes, usually as single teacher/demonstration instruments. We suspect that many more would like to have some sort of facility for observing living cells, but economic constraints mean that purchase of phase contrast instruments is necessarily given a low priority. To these schools and others which would like to equip a number of microscopes for viewing living material we offer the following suggestion for an inexpensive modification giving polarising facilities as a substitute for a phase contrast system.

Many objects of biological interest have areas of asymmetry or are made up of oriented structures. In ordinary light these may appear transparent and practically invisible. However, plane-polarised light will produce intensity differences between those cellular components which are oriented and those which are randomly arranged. In a polarising microscope, light is first passed through a polariser, so that vibrations are confined to one plane. It then passes through the specimen, where bi-refringent materials may split it into several components, leading to phase differences and hence differences in intensity from one part of the image to another. In addition optically active cell components may rotate the plane of polarisation. The light then passes through a second polaroid, the analyser, crossed with the polariser, and located between the objective and the eye of the observer. If no change has occurred either by optical rotation or bi-refringence, then the field will appear quite dark. However, oriented regions in a specimen will be bright with the intensity of any particular part depending on a number of factors.

Many teachers may know of the use of a piece of polaroid, taped to an aperture of a sub-stage disc diaphragm, as a way of distinguishing in chemistry between isotropic and anisotropic crystals. We suggest taking things one stage further and adding a piece of polaroid at the eyepiece. This is sometimes done as a cheap way of converting a standard microscope for geological work. This does not give a true polarising or petrological microscope, but in practice it proves a useful aid for the observation of living cells. On an 'O' grade type microscope the polariser will probably be fitted to the aperture of a disc diaphragm. The facility is most likely to be required on the high power (x20) objective. Therefore a piece of polaroid should be sellotaped or glued over the hole which comes nearest to illuminating 2/3 of the back lens of this objective. On more sophisticated instruments the most likely location for the polariser is in the filter ring of the condenser. The polaroid can either be cut to fit the ring or more simply a piece of approximate size can be taped to it.

If the eyepiece has a stop for a graticule, the polaroid analyser can be cut so that it fits on the stop and is held by the inside wall of the eyepiece, (Fig. 1).

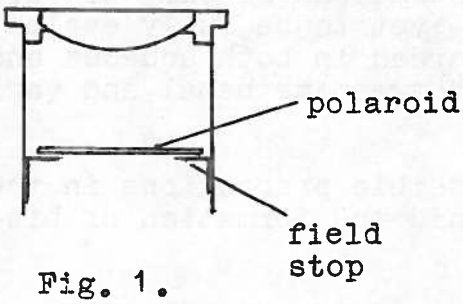

Fig. 1.

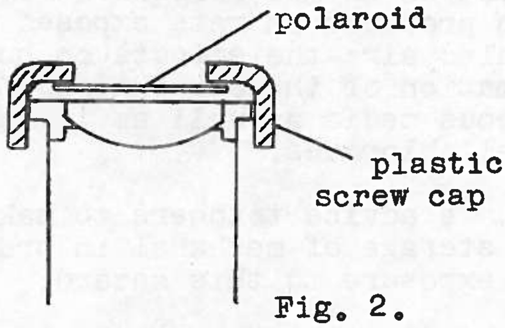

Fig. 2.

If the eyepiece has no suitable stop then a plastic screw cap from a Winchester or other reagent bottle can be drilled out and a piece of polaroid stuck to the underside of the hole. This will then fit over the eyepiece, (Fig. 2). The polariser and analyser will normally be used in the 'crossed' position which should give the best contrast. However if the eyepiece or plastic cap fitting are free to rotate it will be possible to adjust the contrast to some extent. It should be borne in mind that this is not what happens in a proper polarising microscope, where polariser and analyser are normally fixed in the crossed position, and the specimen is rotated on a rotating stage. In that case adjustments of contrast are effected by sliding a quartz wedge in or out of the optical path.

It is not likely that there will be a requirement for petrological microscopy in the proposed 'O' grade geology syllabus. For those who wish to demonstrate some of the bi-refringent properties of minerals as an extra, the modification described above is an inexpensive substitute for specialist petrological instruments. Some geology supply houses provide matched pairs of polaroids which can be used for the conversion. Suitable squares which can be cut with scissors are available from Philip Harris and Griffin and George. For those with Vickers (e.g. M10A), T.O.E. (Zenith Biolam), or Pyser (Swift) equipment, and who prefer the ready-made to the home grown solution, cap polarisers, analyser eyepieces and other conversion accessories are available from these firms for some of their instruments.

Chemistry Notes

In Bulletin 80, in an article on disinfectants we said that methanal (formaldehyde) vapour could combine with hydrochloric acid vapour to form a carcinogen. This information was based on a very short note in 'Biohazard', the Imperial College handbook. Recently a fuller notice was published in the Institute of Biology journal, 'Biologist' (Vol 22 No. 3, August 1975) to the effect that bis-chloromethylether (bis-CME) can form spontaneously when methanal and hydrochloric acid vapours mix in air, at ordinary room temperatures and humidities. The higher the humidity, the faster the rate of bis-CME formation. A steady state level of bis-CME has been reported to occur within one minute at 20°C and 40% relative humidity. Usually parts per million of methanal and hydrochloric acid yield parts per thousand million of bis-CME. Bis-CME is known to be a potent carcinogen and minute exposures may be sufficient to produce its effects. Tumours have been produced in rats exposed to concentrations of only 0.1 p.p.m. in inhaled air; the effects on humans have yet to be fully evaluated. Formation of the compound has been recorded in both aqueous and non-aqueous media as well as in reactions between methanal and various metal chlorides.

We advise teachers to take all possible precautions in the use and storage of methanal in order to avoid the formation of bis-CME and exposure to this hazard.

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We have a note of two laboratory accidents. In the first, a bottle of calcium carbide, originally containing 250g, had been in store for over 10 years; each year 2 - 5g was taken from it. The bottle was a clear glass, wide-necked reagent type with a heavy ground glass stopper. When the bottle was lifted from the shelf, it shattered at the shoulder, showering pieces of glass around.

The second accident concerns the use of a vacuum cleaner as a compressed air source to drive a bench blowpipe. The cleaner was a cylinder type. On the blowpipe, which was burning, the air valve had been left open and the vacuum cleaner was switched off. After a time when the cleaner was switched on there was a mild explosion. blowing off the end of the cleaner body. Town gas was being used, and it had flowed along the air tube into the cylinder and was ignited by a spark produced when the cleaner was switched on. The switch contacts were inside the cylinder. If such an arrangement is being used the air valve on the blowpipe should be shut at all times when the cleaner is switched off.

Physics Notes

A number of physicists in F.E. Colleges have indicated their willingness to give help, sometimes to lend apparatus, even to allow attendance at college to use equipment, to students doing CSYS projects. A teacher who wishes to use this service and considers himself sufficiently near any of the institutions named below, should get in touch with the physics department to explain the nature of the problem, and he will then be directed to the appropriate individual.

University of Glasgow, Dept. of Natural Philosophy;
University of Strathclyde, Dept. of Applied Physics;
University of Strathclyde, Bio-engineering Unit;
Glasgow College of Technology, Dept. of Mathematics and Physics;
Bell College of Technology, Hamilton, Dept. of Physics;
Scottish College of Textiles, Galashiels;
Notre Dame College of Education, Physics Dept.;
Paisley College of Technology, Physics Dept.

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The following items of surplus equipment are still available, and from item 591 onwards we give details of items not previously listed. Customers should note the new arrangements for reserving items, given on page 1 of this bulletin. We are limiting the sale of items 566, 611 - 617, and 627, 628 to one per school. For items previously notified the number in brackets gives the bulletin in which details will be found.

Item 375.	(67)	Wire recorder, £5.
Item 414.	(69)	Nickel cadmium battery, £1.
Item 436.	(72)	Developer, 10p.
Item 438.	(72)	Linagraph paper, 50p.
Item 444.	(72)	Adding machine, £2.
Item 445.	(72)	Tape writing machine, £1.
Item 485.	(74)	Steel calipers, 10p.
Item 494.	(74)	Transistor, 1p.
Item 497.	(74)	Rat cage top, 30p.
Item 502.	(77)	Multi-way connector, 10p.
Item 503.	(77)	Multi-core cable, 5p.
Item 504.	(77)	Silicon diode, 1p.
Item 505.	(77)	Mixed value potentiometers, 30p.
Item 506.	(77)	Mixed value resistors, 10p.
Item 507.	(77)	Mixed value resistors, 10p.
Item 508.	(77)	Twin-ganged potentiometer, new values: 10 + 10 kΩ: 50 + 50 kΩ; 2 + 2 kΩ; 100 + 5 kΩ, 10p.
Item 510.	(77)	Wire-wound potentiometer, new value 50 Ω, 10p.
Item 517.	(77)	115 V motor, 50p.
Item 518.	(77)	Transformer, £1.
Item 538.	(77)	Developer, 50p.
Item 541.	(77)	Developer, 20p.
Item 542.	(77)	Colour film chemical, 50p.
Item 544.	(77)	Colour film chemical, 50p.
Item 545.	(77)	Colour film chemical, 50p.
Item 552.	(77)	Polaroid film, 50p.
Item 553.	(77)	Eyeshield, 1p.
Item 554.	(77)	Polythene bottle, 1p.
Item 555.	(77)	Polythene drum, 25p.
Item 556.	(77)	Planar diode, £7.
Item 559.	(77)	Gas-filled triode, £10.
Item 564.	(83)	Planar triode, £8.
Item 566.	(83)	Typewriter, £1.
Item 572.	(83)	Nickel cadmium cell, £1.
Item 573.	(83)	Uniselector switch, 20p.

Item 574. (83) Keyswitches, 30p.

Item 575. (83) Transformer, 20p.

Item 577. (83) Developer, 20p.

Item 585. (83) Control unit, 30p.

Item 590. (83) Rotary switch, 2-pole 3-way: new value, 1-pole 7-way, 5p.

Item 591. VR9E zener diode on heat sink, 5p.

Item 592. Printed circuit pre-set potentiometers, 50 Ω; 5 kΩ: 12 kΩ; 25 kΩ: 50 kΩ, 1p.

Item 593. Large track wire-wound potentiometer, continuous rotation, 10p.

Item 594. Heavy duty potentiometer, 4 Ω: wound with metal band, not wire, 10p.

Item 595. Wheatstone bridge: two ratio arms giving x or ÷ 1, 10, 100, or 1,000: 4 decade variable arm 0 - 10 kΩ: terminals for battery and galvanometer, £3.

Item 596. Wheatstone bridge: ratio arms giving x or ÷ 10, 100, 1,000 or 10,000; 5 decade variable arm 0 - 100 kΩ. Dimensions 28 x 56 x 20 cm high, £5.

Item 597. Vernier potentiometer type P10 by Cropico. Range 1.8 V x 1 μV; terminals for driver cell, standard cell and 4 test inputs. Potentiometer current adjustable by 5 decade rheostat giving 22 Ω x 2 mΩ steps. Standard cell e.m.f. selection on 21 position switch giving 1.018 - 1.019 x 50 μV steps. Five position switch for galvo series resistance giving 0, 1, 10 or 100 kΩ, or 1 MΩ. Dimensions 72 x 40 x 18 cm high; weight 23 kgf, £5.

Item 598. Volt ratio box by Cropico. Inputs 15, 30, 75, 150, 300 and 600 V: output 1.5 V. Impedance 100 Ω/V, £2.

Item 599. Switched potentiometer, 10 position, giving ratios of 200, 100, 80, 40, 20, 10, 8, 4, 2, and 1 to 1: maximum resistance 20 kΩ: maximum 440 V, 50p.

Item 600. Grassot fluxmeter, calibrated 60 - 0 - 60 with 1 division = 15,000 maxwell turns. The fluxmeter has a rear window and mirror for use with a light pointer, £2.

Item 601. Dual range d.c. millivoltmeter, 50 and 100 mV f.s.d.: 270 mm mirror-backed scale 0 - 100 x 1 divisions. In wooden case, £3.

Item 602. D.C. microammeter, 0 - 500 x 5 μA; 160 mm mirror-backed scale. In wooden case, £2.

Item 603. Triple range d.c. voltmeter, as item 602, but 3, 15, and 150 V f.s.d.: scaled 0 - 150 x 1, £2.

Item 604. Dual range d.c. voltmeter, as item 602, but 3 and 50 V f.s.d. scaled 0 - 50 x 0.5, £2.

Item 605. Triple range d.c. milliammeter, 3, 10, and 50 mA. 320 mm mirror-backed scale 0 - 10 x 0.1 divisions with diagonal vernier to 0.02. In heavy metal frame (weight 12 kgf) with levelling feet and spirit level; dimensions 36 x 40 x 12 cm high, £2.

Item 606. As above, but scaled 100, 500, and 1,000 mA, £2.

Item 607. Moving iron voltmeter, 125 V, scaled 20 - 125 x 1 with vernier to 0.2; style etc. as item 605, £2.

Item 608. Moving iron ammeter, 2.5 and 5 A f.s.d., scale 0.5 - 5 x 0.05, vernier to 0.001, style as item 605, £2.

Item 609. D.C. voltmeter, 5, 20, 100 and 500 V f.s.d., 350 mm mirror-backed scale 0 - 100 x 1 divisions. Weight 15 kgf, £2.

Note: Meters 601 - 609 are intended for horizontal use only, and although they have large scales, they could not be used as demonstration meters.

Item 610. A.C. ammeter, 5, 10, 20 and 50 A f.s.d.; 120 mm mirror-backed scale marked 1 - 10 x 0.1 divisions, £3.

Item 611. Odhner mechanical calculator, 13 digit main register, auxiliary registers 8 and 10 digit, £1.

Item 612. £sd adder, capacity £1M, 50p.

Item 613. Electronic calculator, Canola 161; 4 functions and memory. 16 digit display, digits 15 mm high. Dimensions 39 x 52 x 27 cm high, £5.

Item 614. Electro-mechanical calculator with print-out; 12 digit capacity, £3.

Item 615. Electro-mechanical calculator, Contex 55, 11 digit display, £2.

Item 616. Mechanical calculator, Facit; two 16 and one 9 digit registers, £1.

Item 617. Electro-mechanical calculator, Marchant Figurematic: one 16 and two 8 digit registers, £3.

Item 618. Three phase transformer, 440 V input; 4450 V, 245 mA output. Weight 25 kgf, £1.

Item 619. E.H.T. transformer; primary tapped for 75, 100, 150, 200, 220 and 240 V; by means of a shorting link the secondary output can be 8, 10, 12 or 15 kV at 17 mA. Weight 21 kgf. £4.

Item 620. Megger insulation tester by <u>Evershed and Vignoles</u>. Ranges 0.05 - 100 MΩ x1, x2, ÷2 and ÷5, £3.

Item 621. Electro-static voltmeter, scaled 1 - 4 x 0.1 kV; ranges x0.5, x1 or x2 selected by placing small riders on the moving vane. In wooden case 36 x 22 x 52 cm high, £3.

Item 622. Film winder; this will take 35 mm or wider, and provides a 30 cm dia. turntable with continuously variable speed in the range 45 - 800 rev/min, £2.

Item 623. Micro-film viewer for 16 mm film, but will accommodate microscope slides; x25 magnification; 53 x 53 x 100 cm high; screen area approx. 30 x 30 cm. Not suitable for demonstration as the screen is almost horizontal, £5.

Item 624. Micro-film viewer, 16 mm film as above but with nearly vertical back-projection screen. Dimensions 34 x 26 x 50 cm high; screen area 21 x 27 cm, £5.

Item 625. Addressograph machine; a single lever action presses an inked roller through a prepared stencil card to the envelope or other single sheet material. A wax stencil cut-out could be used on the card, and sample cards will be supplied with the machine, 50p.

Item 626. Addressograph machine; similar to above but larger, and designed to print one copy from a series of cards, e.g. for printing a set of envelopes for an address list, £1.

Item 627. Electric typewriter, I.B.M. golf ball type, £5.

Item 628. Electric typewriters, various makes, £3.

For manual machines, see item 566.

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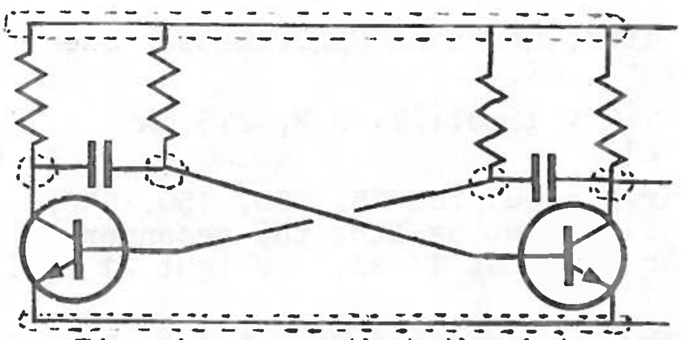
There may be schools which integrate their electronics course with chemistry, to the extent of etching their own printed circuits from copper laminated board. If so, we wonder how many use the principle, apparently universal in publications dealing with the subject, of etching off all the copper save a number of thin strips which connect the various components? It may be that in this form the finished circuit bears some resemblance to the wires with which the preceding generation of circuits were connected; to us it has seemed unnecessary and wasteful. In a complex circuit with many connections, no doubt it is the only way, but in the pupil situation where one or at most two transistors are being used, is it not simpler to etch out boundary walls between different areas of copper? Consider, for example, the multivibrator circuit below:

Fig. 1.



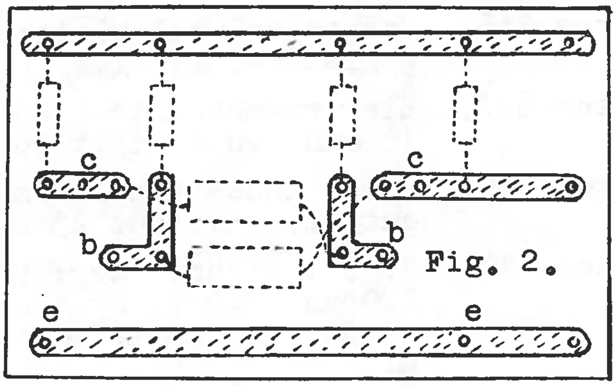


Fig. 2.

From Fig. 1 we see that the interconnection of components requires six areas insulated from each other. In the 'strip' form of p.c.b. this would be etched to appear as in Fig. 2. Dotted lines show how the components would be wired, and all except the shaded areas would be etched off. But Fig. 1 shows that all that is required electrically is for each set of holes to be connected, and to be insulated from all other sets. This in practice means one blob of varnish or resist covering all the holes in a set, and no blobs running into each other. The shape or outline of the blob is immaterial.

When the layout of components on the p.c.b. has been decided, the holes required are marked and drilled out, as in Fig. 3, which has the same hole positions as Fig. 2. The board is then divided up as shown into six areas; this can be done with lead pencil. The pupil then paints over all the holes within the same area with resist, taking care only to avoid the pencilled lines. It seems to us that if we arrive at broad areas of resist, separated by equally broad areas of bare copper, so that only about 50% of the original copper is etched off, we will run less risk of broken or shorted connections than if the ratio is 10:90 in either direction.

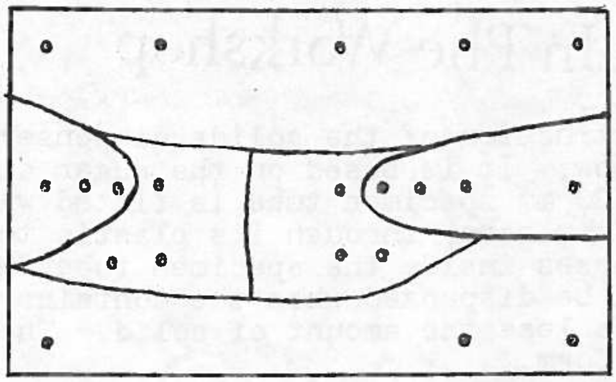


Fig. 3.

Trade News

A leaflet on safety dropped through our letter box the other day. From Griffin and George, at the foot of page 19 it asks,

HAVE YOU READ?

'Recommended practice for schools relating to the use of living organisms and material of living origin', a Schools Council Publication. Yes, we have, and under section 7.4.1., page 15 we read that 'Disinfectants containing cresols or phenols are unsuitable for school use, since they have a corrosive effect on the skin and are dangerous to the eyes'. Which makes us think that Griffin's haven't read it, because on the same page as the question we found an advertisement for Lysol, 227-080/010, as a general purpose disinfectant.

The last batch of Olympus HSC phase microscopes, L07-324, imported by Griffin and George had an incorrect type of phase condenser, and some of these have been sent to schools by mistake. The incorrect condensers can be identified in that the adjustment of annuli is by means of two levers, and not the usual knurled knob arrangement. Also the bottom of the condenser is open and there is no filter ring. Schools which have recently taken delivery of an HSC which may have the wrong type of condenser should contact Griffin and George at their Birmingham address.

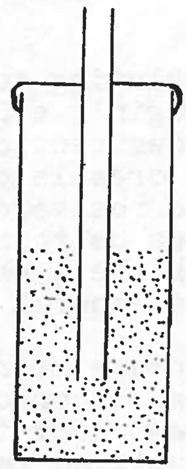
Tiga Marketing have recently launched the 'Gakken' Microscope Viewer Model 200. Apparently based on microfilm reader technology the viewer gives a x200 image from microscope slides on a screen 8 cm square. Thus it allows individuals or even two or three people to inspect 'head up' displays of images of microscopic specimens. The whole device measures only 210 x 104 x 245 mm and costs £32.75. Schools are entitled to a 25% educational discount which brings the price down to £24.56.

Unilab have introduced a mini-demonstration meter, Cat. No. 381.111 at £25.25. It has a 125 mm scale, and is scaled 0 - 10 with clear markings at 0.5 and printing of even digits. The basic movement is 100 µA, 1 kΩ and it can be used with the same shunts etc. as their student meter, 081.117.

In The Workshop

The action and construction of the solids dispenser will be obvious from the sketch below. It is based on the sugar dispenser used by cafes etc. A 75 x 20 mm specimen tube is fitted with a length of glass tubing, 5 - 7 mm bore, through its plastic top. The depth to which the tubing passes inside the specimen tube determines the amount of solid which will be dispensed when the container is inverted; the deeper the tube, the less the amount of solid. The solid must be in powder or granular form.

The dispenser has the advantages that approximately equal amounts will be dispensed with successive 'shots', until the level of solid falls below the end of the glass tube, and that the teacher has greater control over the amount of chemical used than if spatulas or other methods of extraction are used. Also it is our belief that spillages are reduced by using the dispenser. Depending on the amount of chemical required for the experiment, other sizes of container and glass tube can be used equally well.



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The following two models of diode and transistor were sent us by a teacher in Ardrossan Academy. We built both models in the slide boxes which Kodak supply for holding 35 mm mounted transparencies and which measure 110 x 60 x 20 mm. The box is in yellow plastic with a transparent plastic lid. In the narrow ends of the box - what will be top and bottom of the completed model, two 15 mm dia. holes are cut. The hole is the bottom can be further opened out with a file to an oblong shape, or even filed out square.

The 'diode' is constructed by attaching a 60 x 10 mm strip of aluminium sheet with a flexible hinge to a point 30 mm from the top of the box. A 12 mm dia. polystyrene ball, representing an electric charge, dropped in at the top will deflect the strip downwards and drop through to the bottom and out. If the same is tried with the model inverted, the gate closes, being held against the transparent lid of the box. The critical point in the construction is the hinge used to secure the aluminium strip to the box. It must be sufficiently flexible to allow the weight of one of two balls to operate it, but have enough spring to allow the strip to recover. We used fairly thick polythene strip, cemented with Evostik, but the constructor could experiment with other materials such as insulating tape.

In the transistor model, (see Fig. 2), the same holes at top and bottom are required, but in addition a slot is cut in the top of the box to allow the top part of the hinged gate to protrude. In the lid of the slide box a 15 mm dia. hole is cut for the base of the transistor, and a block of perspex measuring 10 x 3 mm, and the full width of the box is cemented on. Two holes are cut in the sides of the lid to take a round peg, cut from a plastic knitting needle. The holes are large enough to allow free movement fo the peg, which will be the fulcrum of the gate. With the peg in position, the L-shaped piece of aluminium strip is cemented to it with Araldite, and when this has set, the second piece of aluminium is fixed to the first with a length of insulating tape. A stop cut from the same knitting needle is cemented into the base of the slide box. The model is assembled by fitting the end of the gate through the top slot and then fitting the lid onto the box.

The action of the model is as follows. Two or three polystyrene balls are put in the top, and do not pass through because the gap between the gate and the far wall is too small. Pushing a similar ball into the hole representing the base tilts the gate into the position shown by the dotted lines, and allows all the balls to drop through the model.

It should be stressed that the operation of either model is not in any way related to what actually happens in a diode or transistor, and for this reason some may prefer to have everything hidden from view in an opaque box. In the transistor model, all that is attempted is to show that current through the transistor is not achieved until a charge is presented to the base, and that then a small current into the base produces a larger current through the transistor.

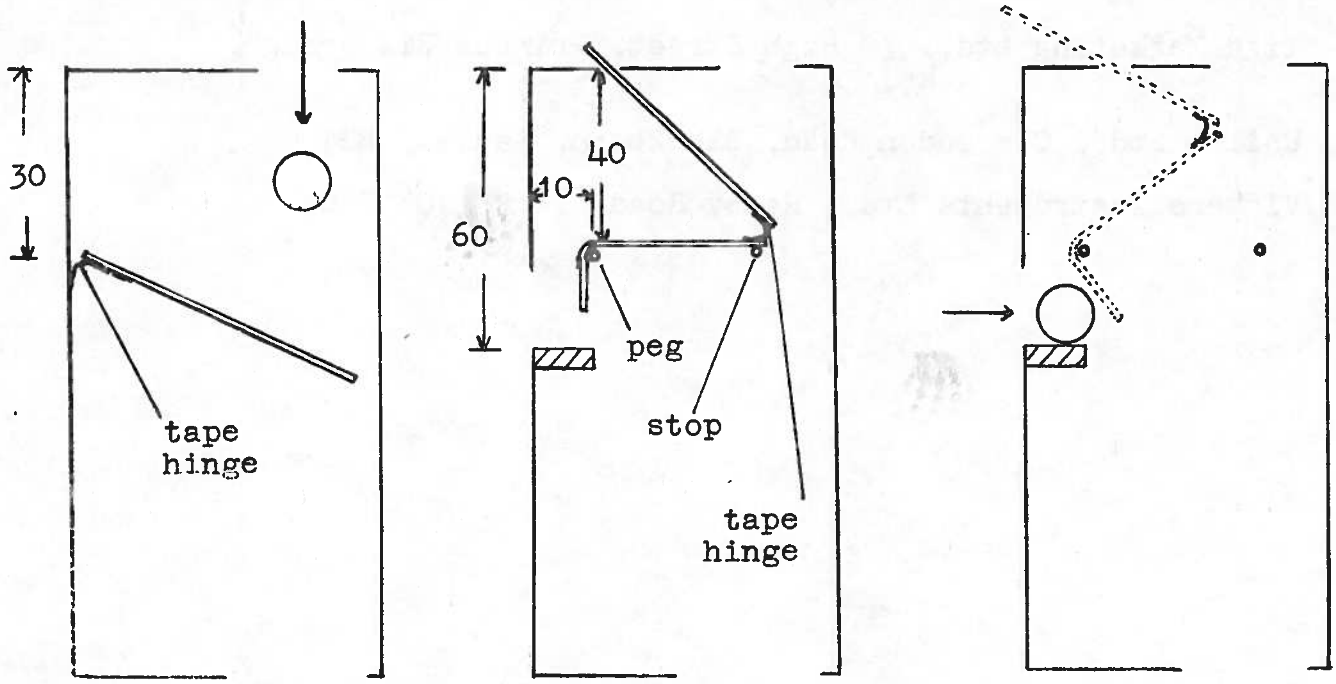

Fig. 1. Diode. Fig. 2. Transistor.

All dimensions in mm. Not to scale.

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

Croydon Precision Instrument Co. Ltd., Hampton Road, Croydon,
CR9 2RU.

Evershed and Vignoles Ltd., Acton Lane Works, Chiswick,
London, W4.

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

Griffin and George Ltd., Frederick Street, Birmingham, B1 3HT.

Philip Harris Ltd., 30 Carron Place, Kelvin Industrial Eastate,
East Kilbride, Glasgow, G75 OTL.

International Business Machines Ltd., 389 Chiswick High Road,
London.

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

Technical and Optical Equipment Ltd., Zenith House, Thane Villas,
London, N7 7PB.

Tiga Marketing Ltd., 78 High Street, Princes Risborough,
Bucks.

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

Vickers Instruments Ltd., Haxby Road, York, YO3 7SD.