SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

Bulletin No. 111. March, 1979.

Contents

Introduction

We have recently sent out an up-dated list of equipment for Integrated Science, based on the new Heinemann worksheets which are the product of the National Working Party on mixed ability teaching of the material. Most of our readers will know that the working party adopted a 'core plus extensions' technique, where all pupils will study the core material, but the extensions have been graded into more, average and less able. This makes it difficult for us to postulate the scale on which the equipment should be provided, as not all pupils will require to use the extension material. What we have therefore done is to indicate demonstration, stations and extensions materials D, S and E, leaving the principal teacher to decide how many he may require of each type.

We have sent the list to all Scottish schools on our normal bulletin address list, and to all those others to whom we believed that the Integrated Science list would be of value. We excluded certain categories of addressees, such as Principal Teachers of Technical, foreign subscribers etc. If anyone who normally receives our bulletins and has not received a copy of the list would wish one, it will be sent free of charge if they notify us. Others not on our distribution list who wish to have a copy are asked to enclose 25p with their request. Copies additional to those already sent will also be charged at 25p each, or 15p to callers at the Centre.

In order to calculate an inclusive figure of what it would cost to equip a laboratory to teach the syllabus, we assumed that ten of each of the core items, two of extension items, and one of D and S items would be needed. If we then take the lower of the two prices for each item on the list, the total comes to £3320. To that must be added another £90 for the quantities of chemicals listed in Appendix I. Approximately £1100 of the total is for demonstration items of which one per department should be sufficient - things like the van de Graaf generator, compressed gas cylinders etc. Unfortunately these totals, which we calculated on prices applicable six months ago, are already out of date. Many firms introduced new price lists for the recent A.S.E. annual meeting, and others have indicated price increases taking place in January or February. The only way to take account of this inflationary situation is to use our cost index which is calculated annually in November and May. The prices we have quoted in our I. Sc. List could be assumed still valid in November, 1978.

Our method of calculating the cost index may not be infallible. In the past two Novembers we calculated that the rise in prices over the previous twelve months was close to 11%. At the A.S.E. meeting an English science adviser addressing a symposium on the subject stated that 'across the board' prices were rising on average by 15-18% annually. There may be a valid reason for this discrepancy - we may be talking about different things. Our cost index is calculated on a weighted average of consumable items which require annual replacement and does not take durables into account. It is certainly possible to find examples of durables which have increased in price by much more than 18% over the last year - almost any imported item will show this effect due to the falling value of the £. The problem with assessing such costs is that durables are bought so infrequently, and it is next to impossible to be certain that one is comparing like with like. Developmental technology means that new models improve and old models become obsolete more rapidly. In the next few years we predict that schools will face a major financial burden as their old Serviscope Minor or OS12 oscilloscopes become not worth repairing, and they have to buy what may be a much improved 'scope at 5-6 times the price. To them it will seem that the annual price increase, averaged over the lifetime of their old oscilloscope, is nearer 50 than 15%.

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Sooner or later it happens with surplus equipment. It happened with air-speed indicators, with anti-gas shields, with rubber balls, ideal for making ball and spoke atomic models and of poor thievable quality because they would not bounce. There is little interest when they are first mentioned in the bulletin, they lie unwanted in boxes in the bargain basement for months or even years. Then suddenly something clicks, there is a run on them and some people are disappointed.

Now it has happened with hour-meters. We first advertised them nearly three years ago, in June, 1976. We mentioned then that they might be used to check the life of o.h.p. lamps. We re-advertised them in September of that year and again in June, 1977. They got another mention in June, 1978, and then they were dropped: we thought them unsaleable. Now because we gave an account of how one teacher used them in an obvious but scientific way to verify a hypothesis which many were putting forward, we have had a rush for hour-meters, and people have been disappointed.

There is a moral in all this; read your Bulletin carefully. Do not be put off at the time if you have spent all your annual requisition. We will keep material allocated in the ballot for months if necessary, until the teacher has the money to pay for it. When an item has been through the ballot and not sold out, anyone can buy it at any time.

Some people are understandably concerned about the quality of the material. All we can say is that items which are not in working order are so named, others can be assumed to work when we sell them. Obviously second hand material must have worn parts and we cannot guarantee how long they will last. If an item breaks down within 2-3 weeks of the school's receiving it we will take it back and try to repair it, failing which the school will get its money back. Those who are near enough to do so can come to the Centre and examine items offered in the ballot. If they wish, they can select the particular model they want from a batch being offered, and if they are successful that is the one they will get. In fact over the years we have had very few complaints about the surplus material. Perhaps this is not so much because the material is good, but that out knock-down prices are little more than scrap value anyway.

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The annual meeting of the Scottish Branch A.S.E. will be held in Moray House College of Education, Holyrood Road, Edinburgh from 10th - 12th April. During the meeting we will have the usual exhibition of items of apparatus that have appeared in the bulletin over the past year, and also of some that are still to appear. The Centre will be closed for the Easter week-end immediately following the meeting, from Friday 13th - Monday 16th April, both dates inclusive.

Chemistry Notes

About the middle of the autumn term we sent out a questionnaire on the storage of flammables to what we hope was a random selection of 50 schools. The questionnaire asked the principal teacher of chemistry the quantity of flammables in stock at that time, and the quantity which was ordered annually. Separate returns were asked for the three branches of science, and for the departments of Art, Technical, Home Economics, Secretarial (duplicating spirit) and Janitorial (fuel for lawnmowers). The fact that we got 50 replies, which must be a record for any questionnaire, must reflect the concern which principal teachers feel about the storage of flammables. We would like to thank all who sent in returns; to get the facts we wanted cost a good deal of time and trouble, some of which could have been avoided if we had had the sense to spell out what the H. and S.E. mean by a highly flammable liquid, and give a borderline example. It is one with a flash point of 32°C or lower e.g. crude oil (32°), pentan-1-ol (33°), phenylethene (31°).

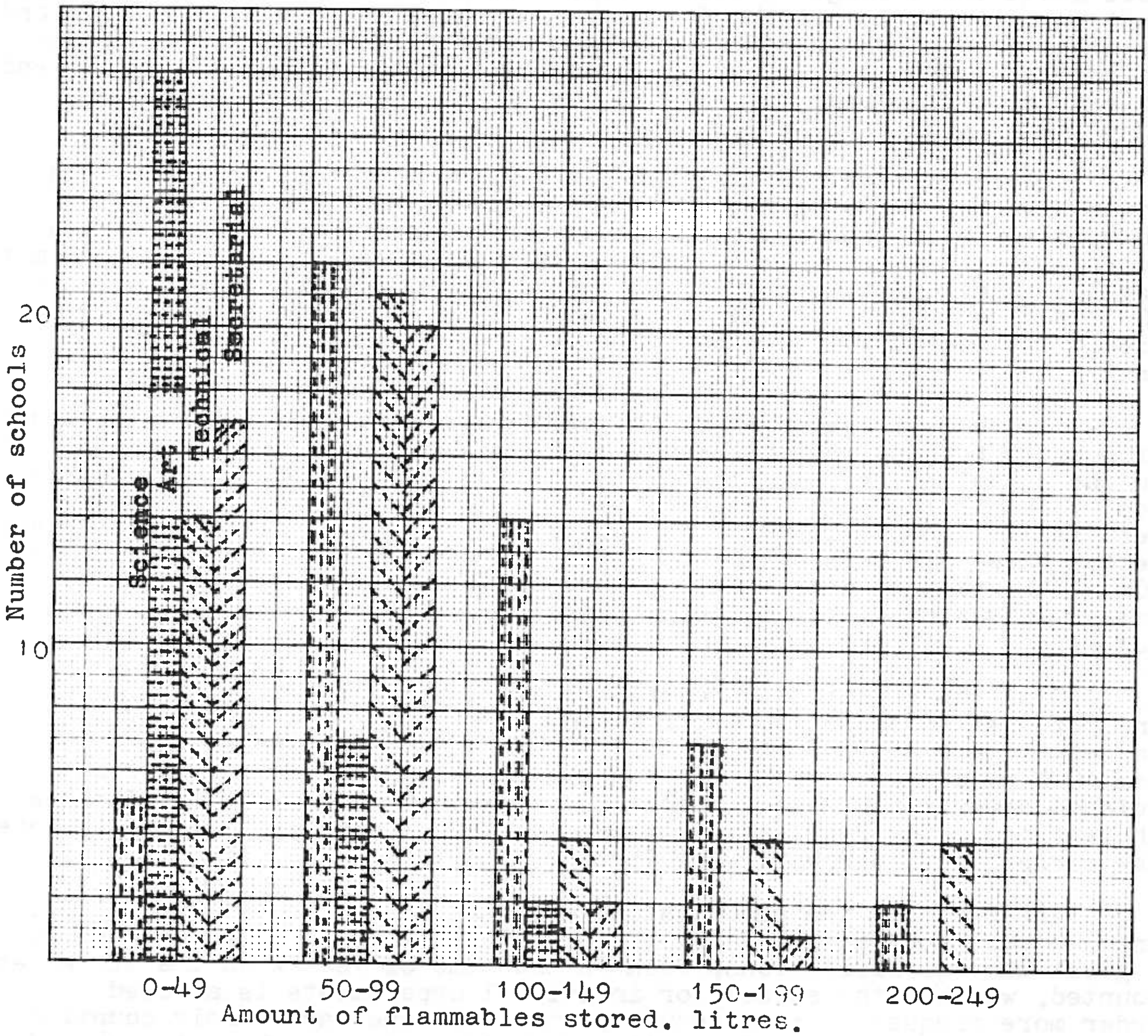
Our reason for the questionnaire was that one HSE Inspector had given a verbal decision that a school would be treated as a 'single workplace' in interpreting the Highly Flammable Liquids and Liquified Petroleum Gases Regulations, 1972. This would have the effect of limiting the total quantity held by all departments in a school building to 50 litres, and then only if an approved type of storage cabinet were used. We wanted to show that this limitation was completely unrealistic.

The results are shown on the bar graph below, which gives the number of schools holding various amounts, broken down into the four main areas in the school. We found that the others - home economics and groundsmen - contributed very little to the total. On the basis of these results, if the HSE inspector's ruling were applied, half the art departments, three quarters of the technical and secretarial departments, and 90% of the science departments are by themselves contravening the regulation, never mind what is being stored in other departments in the same school.

Some other facts derived from the questionnaire may be of interest, and not just to those who contributed. The stock must relate if only vaguely to the size of the school. The mean of the amounts in stock per 1000 pupils was 312 litres for all departments, and 104 for the science departments alone. The largest amount was 800 litres for the whole school, the smallest 91 litres. For the science department alone the corresponding amounts were 250 and 22 litres.

The ratio of the amount stocked to the amount ordered annually is another quantity which may have significance. It is hedged around with a great many qualifications, such as the time of year when the stock was counted, whether the school, or individual departments is allowed to order more frequently than annually etc. If one were merely counting bottles and ignoring the diversity of their contents, the ratio should be 1+ immediately after the order has been delivered, and diminish gradually to near zero at the end of the yearly period. At the other extreme a ratio several times the 1+ implies over-stocking and consequently an increased and unnecessary hazard. If asked to put a figure on it, we would say that around 3-2 depending on the time of year was reasonable. A figure much greater than this suggests (for the science department) that a major part of the stock consists of bottles whose contents diminish by 10% or less annually, and that the department would be safer with smaller bottles, replaced annually.

The results showed that over all departments the mean value for the ratio of stock to order was 2.1 - greatest value 6.9, least 0.33. For the science department alone, the mean ratio was 3.6 - greatest 8.2, least 0.75. Because a science department has a wider variety of flammables, we would expect the ratio to be greater there. Also, in many cases the minimum available quantity of a chemical can sometimes amount to a 10 years' supply for the school. We still think that an average of 3.6 indicates hoarding, and maybe science teachers should ask themselves if an easier way of storing flammables would be to have less of them.



For convenience, one technical department with 300-349 litres, and one art department with 400-449 litres have been omitted from the chart.

Biology Notes

As far back as Bulletin 20 we described an elementary piece of apparatus for demonstrating human pulse beat using a milk straw pointer on a drawing pin. The originator of this simple but elegant idea, Dennis Belford, one time Assistant Director at the Centre and now at Liberton High School, Edinburgh, has recently shown us a new version of this apparatus. The milk straw has been replaced by an optical pointer, using a 10 x 5mm piece of plane mirror.

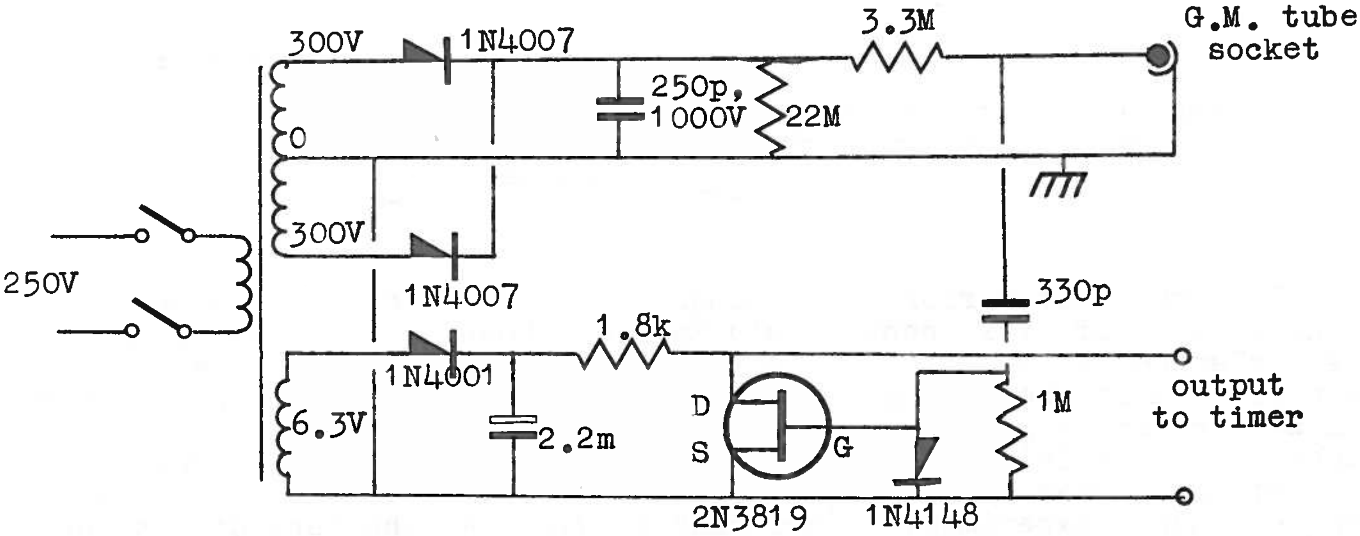
The 'chip' of mirror is attached at an angle to the drawing pin using a piece of plasticene or blu-tack as shown. The drawing pin is then balanced on the site of the radial artery at the wrist, which is held relaxed in the supinate position on the bench. The light source can be a slide projector, lecture torch or, if conditions allow, sunlight. A parallel beam is best because it produces less divergence of the reflected beam and a brighter patch of light on the wall. The teacher should experiment before-hand to discover the best conditions for his/her laboratory. With a good subject, the patch of light will dance on the wall for a distance of up to one metre, and it is obvious that the pulse beat is a double one. Boys make better subjects than girls because they usually have less subcutaneous fat around the radial pulse.

Physics Notes

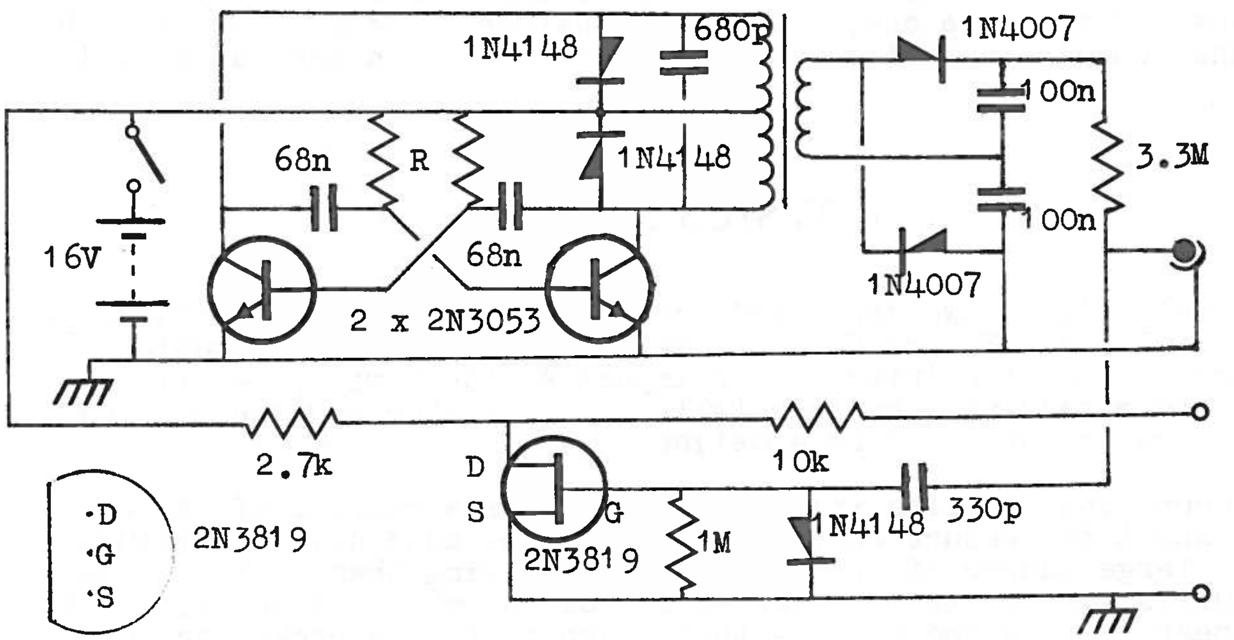
In Bulletin 101 we described how the uses of the timer/frequency meter of Bulletins 86 and 87 could be extended to cover mechanical switching of the time interval for impact switch timing, reaction timing, and measuring g by free fall. Now we show how the unit can become a scaler, driven from a Geiger tube.

Because the sampling time of the timer is a maximum of 1s, which is far too short to measure any random count, one must devise a method of taking a large number of 1s samples and averaging them. We suggest three pupils; one of these observes and calls out the timer readings as they appear, the second punches these numbers into a pocket calculator together with the + sign, and the third keeps a tally of the number of times the + sign is punched, stopping the process when 100, 200 etc. readings have been obtained. Because the processes are random there is no need to ensure that the 100 readings are consecutive so that no one should panic if a reading is lost. If measuring background count rate, the process is simpler. One marks out four squares on paper corresponding to counts of 0, 1, 2 and 3, and puts a tally mark in the appropriate box as the counts appear, stopping when the most commonly used box is full, or when one reckons to have at least 200 readings.

The output of a G.M. tube consists of short duration negative pulses. Because the load resistor for the tube is of the order of megohms, a device with very high input impedance is needed to match the pulses to the low impedance input to t.t.l. A field effect transistor performs this function. The other problem is how to generate the high voltage required for the anode of the G.M. tube (+ 425 V in the case of MX168). Since practically no current is required to be supplied by the h.t., it is not difficult to design a d.c. converter circuit which will develop the necessary volts. An alternative, if one has an old h.t. transformer from a radio set - the kind that used valves instead of transistors! - is to rectify directly from that. Accordingly, two circuits for the conversion are shown.



a). Conversion circuit using a mains transformer.



b). D.C. converter circuit.

The value of R, which determines the frequency of the multi-vibrator, should be found by trial and error with a 0 - 1000V voltmeter across the power supply output. Varying R tunes the circuit until the transformer (R.S. Components 196-280) is in resonance, and for this reason R should be set to get maximum output. In our own case R was 1.8 kΩ and the resonant frequency 6.8 kHz. The 16V power supply may be provided by a battery or a smoothed low voltage power unit. Varying the supply voltage will alter the h.t. to the G.M. tube e.g.

Supply volts	14.0	15.0	16.0	17.0
Output volts	395	420	445	470

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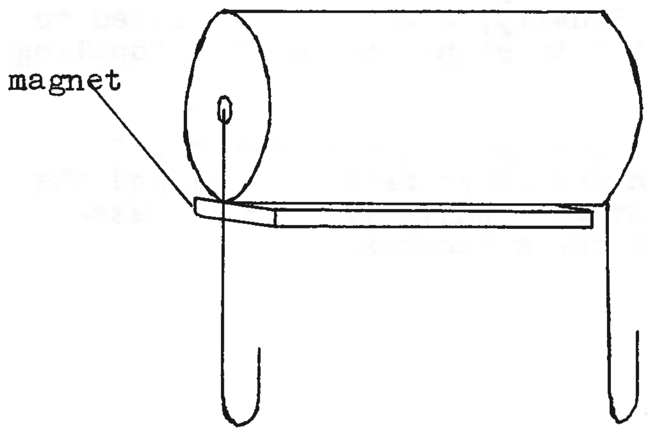
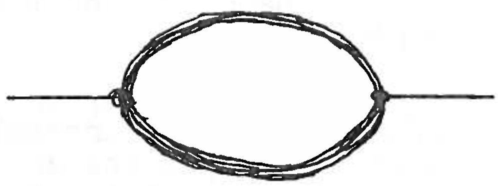
The design below for a commutator-less d.c. motor has been taken from a booklet, 'Simple Physics Apparatus' by R. F. Simpson of the Department of Education, University of Hong Kong, although it was first brought to our notice by an American visitor to the Centre. Two paper clips are opened out at one end and soldered to the poles of an HP2 or SP2 cell. Elastic bands or sticky tape may also be used as a means of making electrical contact, but if this is being given as a more able option to Section 15 of the integrated science course, it might be better to eliminate this source of failure. A coil is wound from 26 s.w.g. enamelled copper wire, of 12-20 turns round two fingers, with each end brought out as shown in the figure. Wrapping each end two or three times round the torus will keep the turns of the coil in place and will make it easier to adjust so that the coil is balanced about the axis formed by the ends of the wire.

The enamel is cleaned off with a knife, or emery paper, at each end, for a distance of halfway round the wire. The cell is supported as shown, and a ceramic magnadur magnet from the Westminster kit slipped into position beneath it where it will hold itself by its attraction for the steel casing of the cell. The coil is then placed on the paper clip supports and will usually be made to rotate by giving it a starting push or moving it longitudinally to make better contact with the clips. The obvious explanation is that as only half the wire is cleared of enamel - and we leave it for the teacher to decide which half, in relation to the plane of the coil, should be bared - current can flow only during a half turn, and the momentum of the coil carries it round to complete the turn.

The use to be made of this as a more able option must be for the teacher to decide. The pupil could be presented with the complete thing and asked to discover how it works, or he could be asked to wind his own coil and to find how much of the wire ends should be bared and where. In any event, having arrived at the explanation of the preceding paragraph, the bright pupil should be able to predict that if the wire is bared all round its circumference the motor will not work. The trial of this, and the explanation of the surprising result we leave as a most able option for the teacher him/herself.





In The Workshop

This model was made several years ago at the suggestion of a Dundee teacher, to show how the stability of a double-decker bus could vary depending on whether the passengers were all on the top or the lower deck. The shape of the bus is cut from hardboard to the dimension given in Fig. 1. Holes marked ⊗ are drilled to take 10mm long 6BA bolts which are counter-sunk into the rear of the hardboard and bolted tightly. These projections, except for the lowest on the left of the figure take the weights which represent the bus itself (lower two), the lower deck passengers (middle two) and the upper deck passengers (upper two). The weights themselves are discs 8 x 35mm diameter cast in lead, each with a central hole so that it fits over the projecting nut and bolt. Each disc weighs about 100g.

The bus shape must be capable of being tilted freely so that it does not slide or fall over until it becomes unstable. A hardboard frame, 40 x 45cm, is fixed to a wooden baseboard. Bolted at one end is a wooden arm AB (Fig. 2) to support the bus. The arm tilts about A, and to prevent the bus sliding down towards A, the lowest of the 6BA bolts fits into a notch C. Behind this notch the arm is cut away sufficiently to allow the bus model to move freely. At end B a counter-sunk 4BA bolt on the arm passes through a slot cut in the hardboard frame and carries a wingnut so that the arm can be fixed at any inclination. A scale marked every 5° of inclination is put alongside the slot. A small block of wood is glued to the bottom right corner of the bus model at the front, to prevent it from falling between the lever arm and the frame as it is being tilted. A length of sheet aluminium is fixed to the end of the arm to form a lifting handle.

To prevent the model from falling forward as it is being tilted, a piece of thin perspex secured by 5mm thick spacers of wood or perspex at each side, is bolted to the top of the frame. The exact shape of the lower edge of this piece is best left to be determined when the model is being tested. It must be high enough to clear the lead disc at the upper right, and low enough so that the top right corner of the bus model is always behind the perspex. As the model rotates about A as long as it is stable and about C when it starts to topple, the lower edge is not simply the arc of a circle. Finally, a 4BA bolt is fixed to the left hand edge of the frame at D to stop the bus from toppling completely.

With our model, the empty bus can be tilted to about 42° before it becomes unstable. When the lower deck is full and the upper deck empty the angle is about 40°, while if all the passengers are put on the top deck the angle becomes 32°.

Diagrams not to scale.
Dimensions in mm.

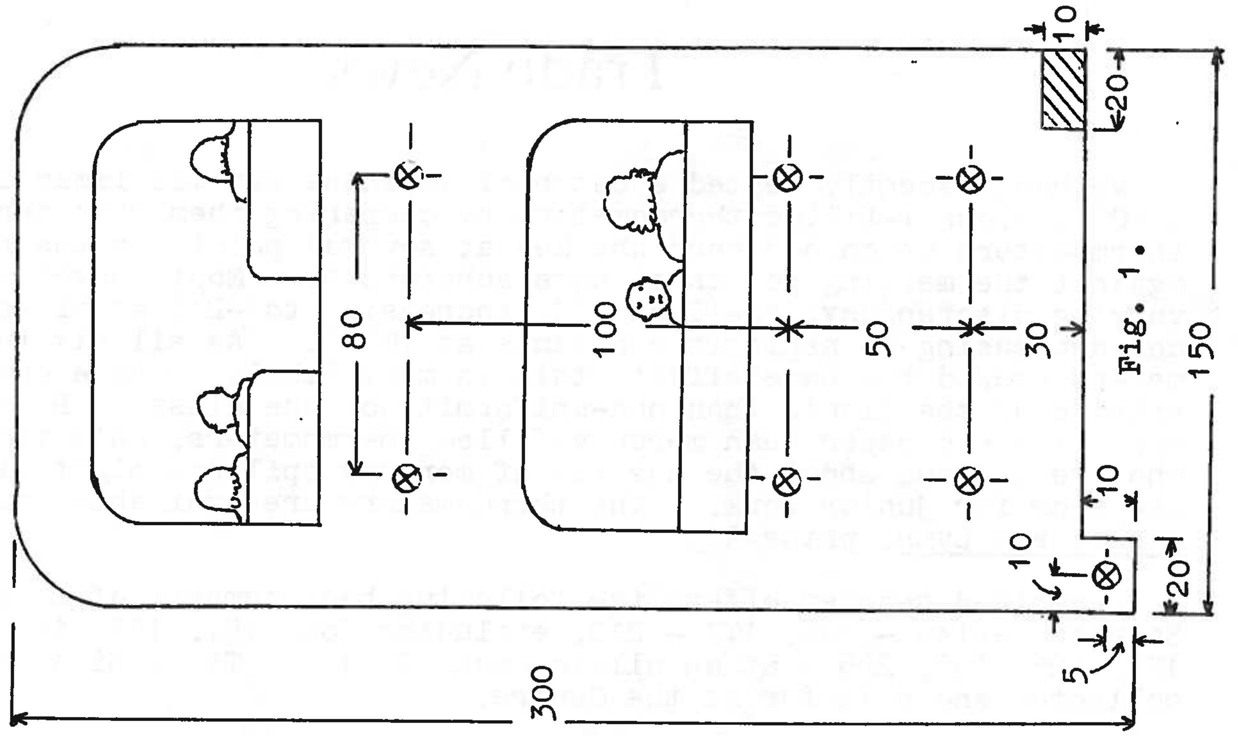


Fig. 1.

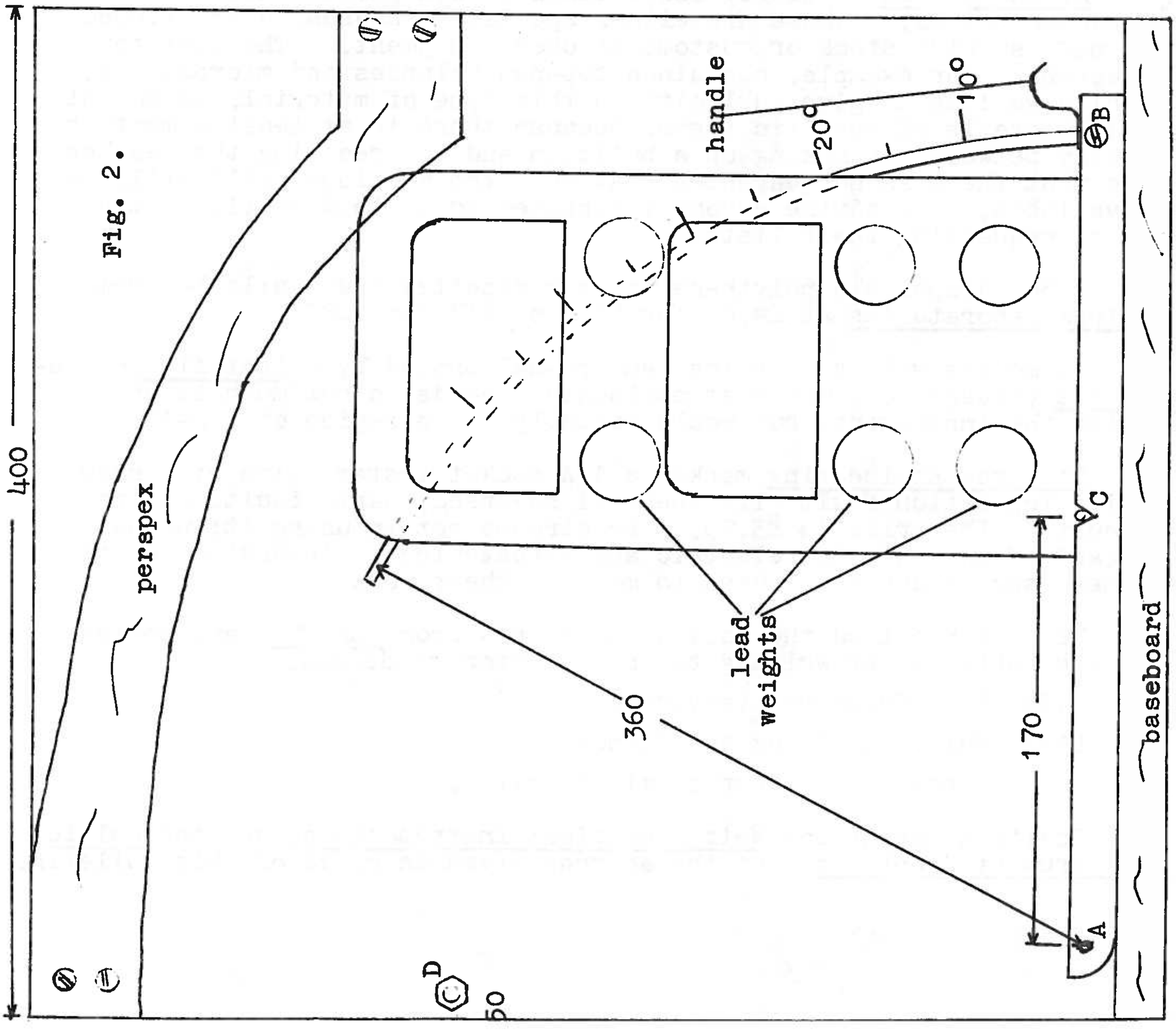


Fig. 2.

Trade News

We have recently tested a batch of Japanese partial immersion 0-100°C alcohol-filled thermometers by comparing them with mercury thermometers which had been checked at several points in the range against the melting points of pure substances. Most showed a varying discrepancy, small at 0°C, increasing to -2°C at mid-range and decreasing to negligible amounts at 100°C. As all six thermometers showed the same effect, this is more likely to be a characteristic of the liquid than non-uniformity of the glass. Being very little cheaper than mercury-filled thermometers, only those who are anxious about the hazards of mercury spillage might wish to use them for junior work. The thermometers are available from Mackay and Lynn, price 96p.

A retired teacher offers the following back numbers of School Science Review - Nos. 147 - 210, excluding Nos. 154, 157, 163, 164, 172, 186, 190, 206 - at an all-in cost of £15. The copies can be collected and paid for at the Centre.

A. Christison regularly issue lists of equipment available at reduced prices. These are either special purchases, discontinued lines, surplus stock or customers' used equipment. The list for December, for example, contained top-pan balances and microscopes. While we like to give publicity to this type of material, we cannot give details of specific items, because there is at least a month's delay between our making up a bulletin and its reaching the teacher so that there is no guarantee that any item mentioned will still be available. We advise anyone interested to write directly to the firm requesting their lists.

3.5ml disposable polythene Pasteur pipettes are available from Alpha Laboratories at £9.60 for 500, or £17 per 1000.

Avometers will be serviced and re-calibrated by Scientific Instruments (Glasgow). The cost obviously depends on how much is wrong with the instrument, but would probably be in region of £12-16.

Galatrek Engineering market a 13A socket tester which will show live insulation fault, live-neutral reversed, earth fault, neutral fault. The price is £3.95. Be circumspect in using it: we have heard of installation electricians threatening to 'black' a school where such a device is used to monitor their work.

We have received the following reports from CLEAPSE, and copies may be obtained by writing to the Director of SSSERC.

L136 Fume Cupboards (revised)

L147 Soldering Irons and Stands

L149 Mercury and other chemical spills.

Scottish agents for Weir Electrical Instrument Co. are the Celtic Instrument Supply Co., at the address given on p. 12 of this bulletin.

We mentioned in Bulletin 103 that borosilicate glassware of Czech origin, marketed by Hestair Hope, should be used carefully and that perhaps it was not such a good buy as the price suggested, being prone to break. We have now had it extensively tested in three schools, one of which equipped one laboratory with Czech, and another with Pyrex glassware as a control. In all three schools there was no detectable difference in breakage rates between the two samples so that, particularly for beakers and test-tubes, the Czech material would seem to be good value for money.

For example:	Czech	Pyrex
Squat form 250ml beaker	22p	52p
Conical flask 250ml	32p	68p
Test-tubes, 17 x 160mm per 100	£3.89	-
16 x 150mm per 144	-	£10.40

Autoclavable latex gloves, cat. no. 222/0605 which give better grip and more sensitive touch than many makes, are available, size 5-9½ in boxes of 100 at £7.50 from A Christison. There is also a discount for larger quantities.

A similar material, Microtouch gloves can be obtained from A Young and Sons at £4.10 per 100.

The Scientific and Optical Products Division of Bausch and Lomb UK Ltd. has moved from its Hampshire offices and is temporarily accommodated in the head office address given on page 12. All correspondence should be sent to this address until further notice.

The annual meeting of the A.S.E. in Reading was the occasion for the introduction of a greater quota than usual of new items of apparatus, too many for us to have the space to describe them here. Some however, are in the different category of being a new idea, and not merely a new example of an old one. Most novel perhaps was the Philip Harris data memory, C49700/1, selling at £157. This box, which has six input ranges from 30mV - 10V f.s.d. takes 512 readings of the input in a time which can be switched from one per ms to one every twenty minutes, and stores them. The result can be read out on a 0-1V scale at any of the input rates either on a voltmeter or a chart recorder, or they can be put on an oscilloscope at a repetition rate of 100Hz. If desired, two input channels can be used to record two different parameters, the box then samples and records them alternately, and will play each back separately. If the two channel record is put on the oscilloscope, the data memory has its own beam splitter circuit to separate the channels on the display.

Unilab were showing a prototype digital display which could be projected with a slide projector. If the idea finds favour with teachers, and it is one which we have felt to be much needed in schools with a lecture theatre, then they will produce modules to provide digital display of various parameters like voltage, current, temperature, pH etc.

Ideas for Education had a digital version of the Venner stopclock, but with a difference. This one will record two successive passages of a blanking card through a light beam, displaying the first automatically and storing the second until it is brought up by pressing a switch. Forward and reverse velocities of an air track vehicle in a collision can then be both recorded and extracted at leisure. The catalogue number is LF 534, price about £65. Incidentally the firm also has the last remaning stock of the original Venner clock, LF 535 at £36.

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

Alpha Laboratories Ltd., 169 Old Field Lane, Greenford,
Middlesex, UB6 8PW.

Bausch and Lomb UK Ltd., 11 Queen Anne Street, London, W1M 9FD.

Celtic Instrument Supply Co., Drymen, Glasgow, G63 0AG.

A. Christison Ltd., Albany Road, Gateshead Industrial Estate,
Gateshead, NE8 3AT.

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

Galatrek Engineering, Scotland Street, Llanrwst, Gwynnedd, N. Wales.

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

(Hestair Hope) Thomas Hope Ltd., St Philip's Drive, Royston,
Oldham, OL2 6AG.

Ideas for Education Ltd., 87a Trowbridge Road, Bradford-on-Avon,
Wilts, BA15 1EE.

Mackay and Lynn Ltd., 2 West Bryson Road, Edinburgh, EH11 1EH.

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

Scientific Instruments (Glasgow) Ltd., 9/11 Radnor Street,
Glasgow, G3 7UA.

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

Weir Electrical Instrument Co. Ltd., Bradford-on-Avon, Wilts,
BA15 1BU.

A. Young and Sons Ltd., 37/39 Constitution Street, Edinburgh.