SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No 138 November 1983

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Philip Harris, Lyne Lane, Shenstone, Staffs. WS14 0EE. Tel. (0543) 480077.

Philip Harris Biological, Oldmixon, Weston-super-Mare, Avon BS24 9AX. Tel. (0934) 413606.

MEDC (Microelectronics Educational Development Centre), Paisley College of Technology, High Street, Paisley PA1 2BE. Tel. (041) 887 0962.

Medical Wire and Equipment Co. (Bath) Ltd., Potley, Corsham, Wiltshire SN13 9RT. Tel. (0225) 810367.

Tait Components Limited, 973 Sauchiehall Street, Glasgow. G3 7TQ. Tel. (041) 339 9959 or (041) 339 6343.

Unilab Limited, Clarendon Road, Blackburn, Lancs. BB1 9TA. Tel. (0254) 57643/4.

Z.I. Aero Services Limited, 44a Westbourne Grove, London W2 5SF. Tel. (01) 727 5641.

SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Microelectronic Applications Projects in Schools
Two Year Fellowship 1984-1986

A temporary fellowship is available at SSSERC for the purposes of researching and writing a series of technical monographs for schools, on general techniques in microelectronics and in interfacing devices to microcomputers and microprocessors.

The aims of the project are:

— to further encourage, and support technically, open-ended project work and problem solving in microelectronics in schools.

— to promote microelectronics as an ideal medium for teaching design and engineering principles within the context of the real world of making and doing.

— to widen opportunities for school students and teachers to experience the more technical aspects of this new area. This in order to deepen the understanding of all, as much as to encourage the few who may discover in themselves a flair for this new technology.

The project is industry/education grant-aided by the Scottish Economic Planning Department as agents for the Department of Trade and Industry and by British Petroleum PLC. In-kind support has been committed by a number of commercial and industrial concerns.

Qualifications for Fellowship

Evidence of knowledge and practical experience of electronics, micro-electronics and of effective technical writing are essential.

School teaching and/or wide industrial experience are desirable.

How to apply

In order to allow time for circulation of this notice to schools, the **opening** date for the reception of enquiries has been set as the 1st of December, 1983. After that date further details of the project itself and of terms of appointment will be available from Lothian Region Education Department who provide management assistance, as host authority, to SSSERC.

For this further detail please apply to:

Division 2, Personnel,
Lothian Regional Council,
Education Department,
40 Torphichen Street,
Edinburgh EH3 8JJ.

Quoting "SSSERC Fellowship".

Introduction

Technical Officer

Following the early retirement of Eric Edington (see Bulletin 137) a vacancy for a Technical Officer was duly advertised. This post has now been filled. We are pleased to welcome Mr J. G. Buchanan to the staff of SSSERC. 'Ian' Buchanan is an experienced technician/ engineer with a varied laboratory, workshop and commercial background.

For the first time in four years the Centre is once again fielding a full side. Hopefully (fingers crossed) our 'customers' can look forward to a yet more effective service.

Planning Committee

Also announced in the last issue was the resignation of Ian Young as Science Adviser member and chairman of this committee. The nominee of the science advisers group for their new Planning Committee representative is Mr John Wilson, Science Adviser for Dunbarton Division, Strathclyde.

Evaluation samples offer

A ballot is advertised in this issue. Many of the items described are ex-evaluation samples and have been generously donated by several manufacturers and suppliers. We would wish to record here our gratitude to the firms involved (see p. 15).

Christmas and New Year closure

We hereby give early warning that the Centre will be closed for the whole of the week 26th—30th December 1983 and on Monday, 2nd January, 1984.

—pick another number

Please note that SSSERC now has a second telephone line. For technical reasons this has a different area code and is:

031-557 1037

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Opinion

'Caveat emptor'

"Things are oft not what they seem
Skimmed milk masquerades as cream"

W.S. Gilbert
"HMS Pinafore"

In the developmentally explosive world of micro-electronics and microcomputing, teachers are faced with a plethora of opinions, articles, letters and reviews of this piece of hardware, that service and the other piece of software. Those few well qualified to write these pieces are often in the van of development. Sometimes, not unnaturally, commercial interests seek their help as knowledgeable specialists. Sometimes, such folk seek to exploit commercially their own ideas or devices. All very right and proper, laudable even, especially in the current politico-economic climate. There is nothing fundamentally wrong in having a vested interest. However when such knowledgeable folk write their reviews they should, like the minister preaching on adultery, always remember where they left their bike.

If such interests were always openly declared, this would avoid vituperative correspondence of the kind we have witnessed recently in the columns of certain educational computing magazines.

For our part, we seek to practice what we preach. It is SSSERC policy that neither this Centre nor any individual member of its staff have any direct financial ties or any paid consultancy arrangements with any equipment supplier. SSSERC is a wholly independent body funded in the main from local Government sources and is responsible, through its Governors, to the Education Committee of the Convention of Scottish Local Authorities. We have no commercial interest in any of the items of equipment we review or report on.

The content of the "Trade News" section of the "Bulletin" is under the direct control of SSSERC's Director as editor. 'Trade News' items are selected for interest and in an attempt to achieve some long term balance between each of the large firms and between them and smaller concerns. No payment is ever sought, nor accepted, for publishing these items. The only 'adverts' for which we accept a small payment is for non equipment items such as courses or meetings, these announcements appearing on the inside back cover.

We make all this clear so that readers are aware that though our fare may betimes be plain, stodgy and badly cooked,—with it you need take no salt.

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CLEAPSE Guides

We have recently received the following new or revised publications from our sister organisation—**"CLEAPSE School Science Service"**. Copies of these publications may be borrowed for up to one month by application to the Director of SSSERC.

L.153 "Interfacing Laboratory Equipment to Computers". Part A: Principles, with Terms Explained for the Beginner.

L.114 "Small Rechargeable Cells".
Covers the properties of those cells which have the same dimensions as familiar disposable cells and batteries; gives advice on where to buy them and on charging; lists sizes and codes, prices and suppliers. Completely revised.

L.164b "Portable Laboratory Gas Burners".
For schools without mains gas, permanently and, in particular, temporarily. Addresses and prices quoted.

SSSERC Guides

With the bringing up to strength of the SSSERC staff we have begun to overhaul some of our outstanding tasks. By the time this issue reaches the schools we should have completed and printed the first of our own stand alone guides to appear for sometime. This publication **"Microtutors—A Review"** will be available on request in November. Each Regional and Island Authority will receive complimentary copies via. its Science Adviser or nominated correspondent. Further copies will be available from SSSERC at 40p a copy including post and packing.

We would like to acknowledge here the technical and other assistance we have received from **MEDC** in the preparation of the above publication.

In the pipeline are technical guides to the purchase and use of environmental equipment, and the purchase, use, repair of pH meters and electrodes. A little further away is a comprehensive guide to electrical safety in science. This last publication will attempt to gather between one set of covers the widely scattered advice and information presently available on this topic.

* * * * * *

Safety Notes

Accident reports

The first two items under this heading are reprinted, with permission from the ILEA publication "Science News".

"Hydrogen explosion again!"

This time within ILEA, the following occurred when hydrogen was being generated in a glass flask, using zinc and acid. In order to speed up the reaction, the teacher removed the bung and poured in additional acid, allowing air to enter the flask. The hydrogen was ignited at the outlet (to demonstrate the formation of water) and the apparatus exploded.

Chlorine

In this incident, the class was using "Insight" card no. 21, which asks the pupils to describe the colour and smell of chlorine. The teacher invited pupils to sniff directly at a gas jar of chlorine, with distressing results.

These accidents were entirely avoidable, and illustrate the need for care and common sense in the handling of dangerous chemicals."

Exploding Batteries

A member recently reported to ASE an explosion resulting from a pupil's attempt to re-charge a silver oxide button battery. Unless specifically designed to be re-chargeable (and such cells are clearly marked), **it is very dangerous to attempt to re-charge any battery.** Attempts to re-charge ordinary batteries can lead to the production of large volumes of gas in a confined space, consequent build-up of pressure, and a resulting explosion. Alternatively, toxic and/or corrosive materials may leak out of the case. Heating the batteries can have similar effects, as can inserting one of a set of cells the wrong way round.

Conc. sulphuric—again

We have had a report from a school of an accident which occurred during the refilling of bottles with sulphuric acid. One particular bottle,contained only about 2cm depth of a liquid which was noticed to be somewhat less viscous than normal. Upon pouring fresh concentrated sulphuric acid into this bottle much heat was evolved and the base cracked with some acid being splashed on the technician's legs.

It is presumed that the residue may have been an old sample of acid greatly diluted by water absorbed from the air. This can happen if stoppers have been left off the bottle for any period of time. The school involved now recommends that any such small residues of concentrated sulphuric acid are discarded and the bottle refilled rather than just topped up.

Electrical safety

During our 'Spring' clean, and consequent routine checking and testing of our own portable electrical equipment stocks, our technician recently rejected three Russian fast response chart recorders (sold by **Z & I**). These were withdrawn from use because of an earthing fault. The same fault was identified independently by technician staff in the science section of

Woodlands Teachers' Centre Glasgow. Woodlands staff have kindly supplied us with details of a suitable modification for the earlier H320-1 model. We have worked out a similar modification for the more up to date H3020-1 model. Notes and drawings describing these alterations are available from SSSERC on request. The fault is a potentially serious one and we would recommend that schools holding these recorders withdraw them from use pending modification.

This is just the latest in a long line of problems connected with items of older equipment which do not meet safety standards currently applied. This doesn't always mean that the older standards were inherently less safe. In a few cases all we can honestly say is that they were different.

In most instances the 'faults' we have observed in older equipment, particularly power supplies, have been to do with inadequate earthing, specifically of transformer mountings and metal switch dollies etc. Other common faults are poor earthing of sectional cases; apparently double insulated cases breached by metal parts; ventilation grilles with over large apertures; external mains fuses and poor cable entry and clamping arrangements.

We are building up a dossier of examples for one section of our electrical safety document. (See p. 2). We would be pleased to hear from any school which has experienced electrical safety problems with old items of equipment—particularly if they can also supply some answers! Currently we have one or two sets of notes and drawings on power supplies (old Unilab models) which are available on request from the Centre.

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Foundation Science Notes

Energy in the home

The "Energy in the Home" subtopic of the "Energy" core includes an investigation of heat losses in model houses and of some ways of reducing those losses. Details of the construction and use of these model homes have been given in both the Exemplars (produced by Dunbarton and by Lothian). In the same way as we have suggested modifications to and sometimes alternatives for other pieces of equipment (eg. wave power and wind power) in recent Bulletins, some of our experience of "houses" is offered here.

Our thanks are due to Thomas Muir High School who not only allowed us to see their models, but also permitted some irreversible modifications to be tried out. We also understand that some of the basic designs for such models were produced by Grange High School and would also acknowledge that source.

Four types of experiment using two types of house are listed in the Dunbarton exemplar. The names below are ours given solely to aid description:

(i) Workcard 3.2.5A the "gable" for investigating loft insulation.

(ii) Workcard 3.2.5B the "long house" for investigating single leaf versus cavity wall.

(iii) Workcard 3.2.5C the "long house" for investigating open cavity versus filled.

(iv) Workcard 3.2.5D the "gable" again, for investigating the effect of draughts.

Given here are a few tips on the working of the models all of which, in our opinion, give sufficiently striking results—see (a). In addition several other modifications of these models are given in section (b) and also some other d-i-y versions in (c).

(a) **Some comments on models described in the exemplars**

(i) in the experiments in 3.2.5B and C strange results can be obtained if the inner dividing walls do not make a close fit with the ceiling (which in the case of the long house is also the roof), as convection currents can carry hot air over the top of a partition wall into a cooler "end" room. Thus care is needed with this part during construction. In addition after some usage the roof (ceiling) warps a little due to the heat. What was initially a good fit becomes a leaky one. One easy solution here is to lay sufficiently thick 'fingers' of cotton wool along the top of these partition walls and to press the roof down so as to compress the wool and make a seal.

(ii) the inner walls should be of thin cardboard, or aluminium sheet painted matt black, rather than of plywood. A single layer of 6mm ply is quite a good insulator. The combination of a layer of air trapped between two such sheets does not produce a sufficiently big difference in the rate of heat loss if easily noticed differences are required (see Table 1).

(iii) the use of a 150 watt bulb will give more striking differences in the rates of heat transmission (Newton's Law of Cooling again!). Be warned, however, that the middle room can become very hot. Despite trying hard we have, to date, failed to start a fire or even produce a smell of cooking wood or cardboard. However in the interests of safety it is not advisable to leave the bulb switched on either unattended or for long periods.

Some of the components of the structure eg. insulating sheets of expanded polystyrene or sheets of cardboard may be stored inside the house and it is prudent to check before switching on that these have not been left lying close to or against the bulb.

(iv) the mains lead should be clamped, eg. with a P-clip, to the floor of the house and a grommet used to pass the cable through the wall near the floor.

(v) spirit thermometers are preferred. Not only are they more easily read, but there is no dangerous contamination in the event of a breakage. A 'house' contaminated with mercury would not be worth decontaminating and so have to be discarded. Spirit filled thermometers are readily available eg. **Harris** C79330/1-10° to +50 °C price £1.20.

(b) **Structural modifications to the above houses**

If desired, a modification of the houses can be made to allow all of the required experiments to be performed using a single house. This will greatly ease any problems of storage. If, on the other hand, a school wished to have each factor examined by pupils in a

END ROOM SEPARATED FROM CENTRAL ROOM (HEATED) BY	TEMP. RISE IN °C AFTER (i) 10 mins.	(ii) longer period	TEMP. IN °C RISE AFTER (i) 10 mins.	(ii) longer period
6mm ply walls				
insulated cavity	+0.5	+3.0 (22 mins.)	-	-
uninsulated cavity	+1.9	+7.9 (22 mins.)	-	-
(using cotton wool seal with both versions)				
cardboard walls				
insulated cavity	+3.0	+6.6 (22 mins.)	+5.3	+9.4 (18 mins.)
uninsulated cavity	+5.8	+12.2 (22 mins.)	+10.9	17.7 (18 mins.)
aluminium sheet walls				
Insulated cavity	+0.6	+2.3 ((22 mins.)	-	-
uninsulated cavity	+2.3	+5.4 (22 mins.)	-	-
matt blackened aluminium sheet				
insulated cavity	+2.4	+8.1 (22 mins.)	+3.4	+6.1
uninsulated cavity	+4.7	+13.3 (22 mins.)	+8.1	+14.1
ROOF INSULATION only single cardboard wall between each end room and central room				
room with polystyrene on roof	-	-	+16.0	+20.5 (14 mins.)
room with plain roof	-	-	+14.5	+17.5 (14 mins.)

Table 1.

series of three or four separate station experiments, then there would be no advantage in carrying out the modification described below.

In addition to the modification described, a wooden 'gable' house was altered so as to have a removeable pitched roof giving easier access to the interior for changing the partition walls. For the sake of simplicity the details of that modification have been omitted here, but can be made available if required.

The "long" house can be modified to perform all the prescribed functions:

(i) windows and doors can be cut out of one of the end rooms from opposite walls, and single thin partition walls are used to maximise the rate of heat flow to the end rooms. The temperature of the two end rooms can be compared in order to see the effects of draughts.

(ii) the effect of adding loft insulation can be investigated very simply by placing on the roof, above one of the end rooms, a slab of expanded polystyrene. Again an indication of the different rates of heat loss can be obtained by observing that the temperature of the room with the insulated roof increases faster than that of the room at the opposite end without an insulated roof. This method contrasts with that in workcard 3.2.5A where the heat escaping is detected by the rise in temperature of the roof space.

The "long" house has, of course, no roof space. Whilst many real houses do have flat roofs, teachers may prefer to have a pitched model. The "long" house does have the virtue of being simpler to construct than a 'gable' house and the modifications are also simple to carry out. Specimen results obtained with this house are shown in Table 1.

(c) Other d-i-y versions

Quite good results can be obtained from:

(i) two very simple models requiring a minimum of materials or construction time. The first is essentially a plain cardboard box with a bulb fitted onto the floor and partition walls. The second idea, that of using a large coffee tin, was sent to us by Mr C. Armstrong of Earlston High School. Both houses will demonstrate the required principles, however some may prefer a model house of more conventional design;

(ii) a more traditional looking house built of a cardboard box but having a pitched roof.

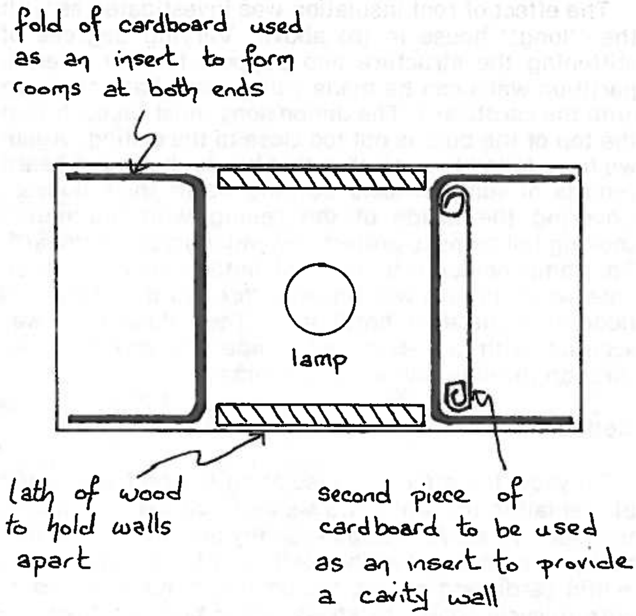

Fig. 1.

Some schools reported to us that they cannot even afford to buy plywood these days!

Probably the most important factor is the balance between the wattage of the bulb and the dimensions of the box. Figures given below show typical temperature changes to be expected. Using a box of similar size it will be a simple matter to find by trial and error the most suitable rating of bulb. The roof was simply the closed flap lids of the box and any gap was covered by placing a piece of cardboard between the last two flaps. When a 150 watt bulb was used the effect of insulating one cavity showed up well.

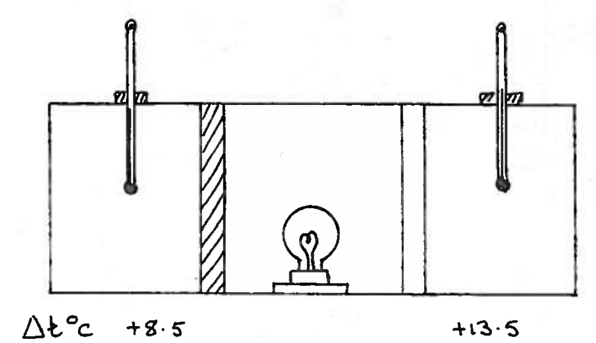

Fig. 2. bulb ~ 100 watt
box ~ 400(l)×260(w)×260 mm (h)
end room ~ 90 mm

The effect of roof insulation was investigated as with the "long" house in (b) above. Varying degrees of stiffening the structure and support for the internal partition walls can be made using small battens glued onto the cardboard. The dimensions must be such that the top of the bulb is not too close to the ceiling. Again we have failed to even char this house, but have heard reports of some schools burning down their houses! Covering the inside of the ceiling with aluminium cooking foil helps to protect any endangered cardboard. The lamp holder was screwed onto a small plywood base which in turn was screwed through the cardboard floor to a piece of hardboard. The mains lead was secured with a P-clip just inside the box and led through the side wall with a grommet.

Coffee tin

To show the effects of insulating the roof space and of insulating the walls two separate coffee tins should be used. These are usually readily available from that resource centre called the staff room! The first tin has a thin cardboard ceiling set on two crossed pieces of wire (bicycle spoke thickness) about halfway down the tin (Fig. 3). The heating supply was a low voltage bulb secured to the bottom of the tin.

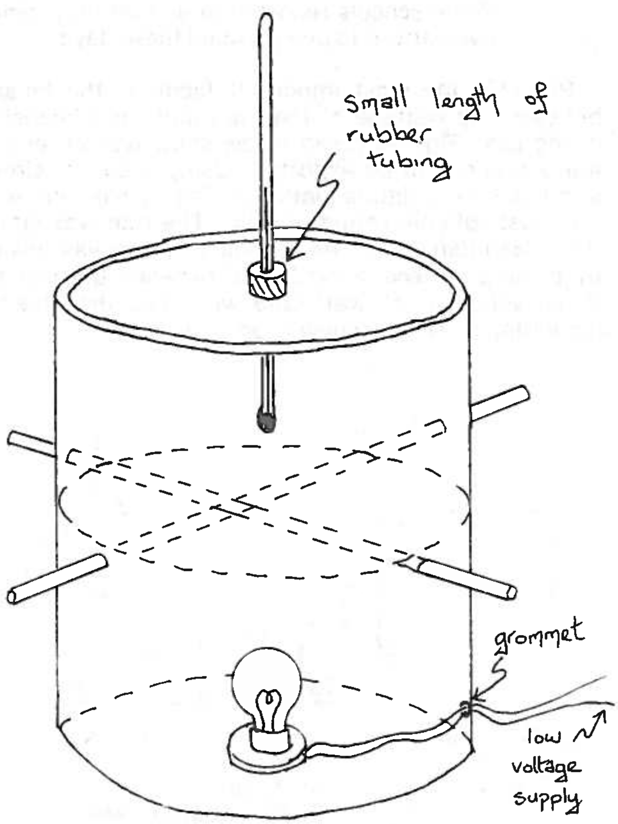

Fig. 3.

The temperature of the air in the roof space above the tin can be measured with the thin ceiling alone and with insulation above the ceiling. The results for two runs, using a 12V 24W bulb (as fitted to ray boxes) both starting close to room temperature ie. 22°C and 24°C are shown below.

TIME (mins.)	0	2	4	6	8
TEMP. RISE OF ROOF SPACE (initially 24°C).	0	+4.5° (4)	+12.0° (12)	+19.0° (18)	+24.5° (23)
TEMP: RISE OF INSULATED ROOF SPACE (initially 21.5°C)	0	+3.5°	+9.0°	+14.5°	+19.0°

Table 2.

Using a 6V 18W bulb similar results were obtained but with smaller differences eg. at 8 mins. the rises were 18.8° and 13.5° respectively.

If the disc of card is not a perfect fit or warps after a while, hot air leaking through the gap will distort the results somewhat, giving an apparently greater improvement with the extra insulation. Any such gap

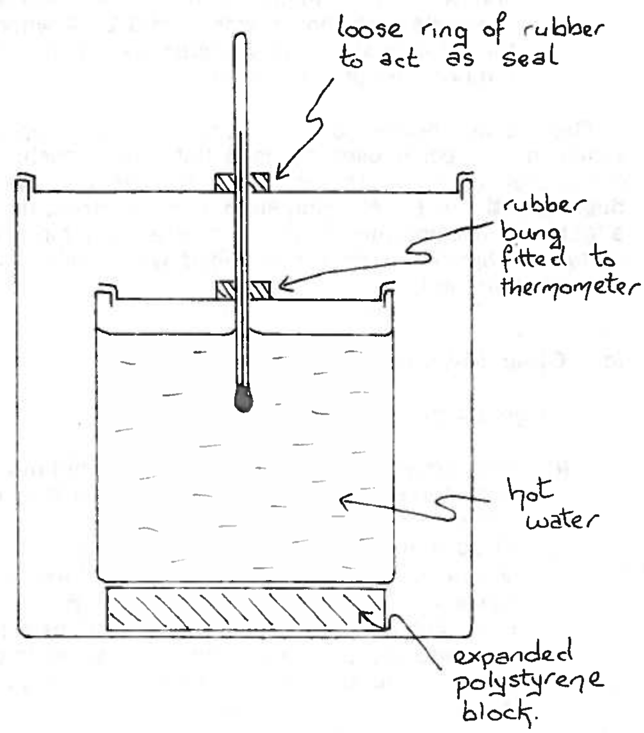

Fig. 4.

can be stopped with curved 'fingers' of cotton wool (results in brackets in Table 2).

A second tin can be used to demonstrate the effect of insulating the walls. A second smaller tin (we used a 2lb syrup tin) filled with hot water is placed inside the larger one and the rate of cooling of the water monitored with and without insulation. An advantage of tins over the wooden houses (to say nothing of the cardboard houses) is that, because of greater overall heat loss rates, the benefit of insulation under the more extreme conditions of very low temperatures can be demonstrated. Placing the large tin in iced water simulates this effect. (Table 3).

OUTSIDE TEMP.	TEMP. FALL OF WATER FROM 60° IN 30 MINS.	
	air cavity	insulated cavity
ambient 20°C	6°C	4.5°C
iced water	10°C	5.0°C

Table 3.

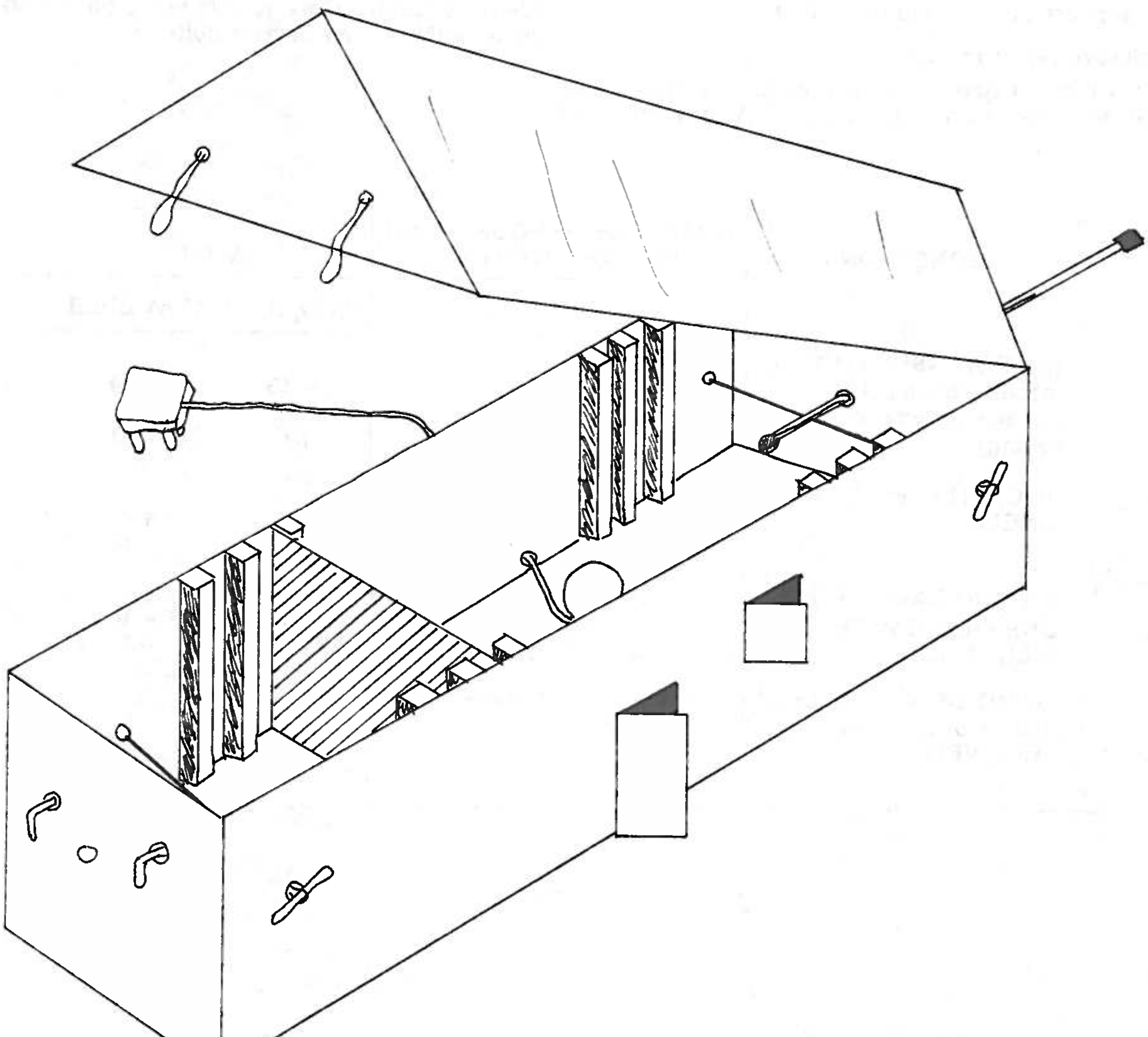

Fig. 5.

Rubberised carpet underlay was used as insulation material in the above demonstration. This is easily rolled and fitted into the large tin and is much more convenient to use than granules of polystyrene or other loose fill. The space below and above the inner heat 'source' was also insulated using the more pliable foam rubber.

An interesting observation made was that on the first run using cotton wool the apparently insulated hot water tin lost heat faster than did the uninsulated one! Afterwards we found the cotton wool to be quite damp from condensed water vapour and presumably it had then become a good heat conductor. It is important to minimise the extent of escape of the vapour from the inner tin. A bung fitted onto the thermometer will make a seal over the hole in the lid of the inner tin and will also support it at the required height.

Cardboard House (Fig. 5)

This was constructed from a cardboard butter box obtainable from most supermarkets. A little glue and a few strips of wood provided the rest of the materials needed for construction as outlined in the Workshop section.

Extra stiffening struts of cardboard or wooden blocks can be glued on where necessary. The roof can be hinged at one gable end and pulled downwards at the other end by the action of the elastic bands looped over cuphooks on the walls.

Results for both 150Watt and 100Watt bulbs are shown. (Table 4).

Despite being unable to set this house on fire with a 150Watt bulb we do consider the 100 Watt bulb to give adequate results. Once your house is built it should be tested with different sizes of bulb.

CONDITIONS	TEMP. RISE OF ROOF SPACE IN 10 MINUTES (°C)	WITH 100W BULB	WITH 150W BULB
(i) **ROOF INSULATION** (sheet of 5mm polystyrene placed above ceiling)	(a) without insulation	+16	+29
	(b) with insulation	+13	+24
(ii) CAVITY WALL and SINGLE	Rooms separated by (a) single wall	+14	+24
	(b) double (ie. cavity)	+9	+13
(iii) TWO CAVITY WALLS ONE FILLED WITH INSULATION	Rooms separated by (a) cavity (insulated)	+8.5	+10
	(b) cavity (not insulated)	+9	+12
(iv) INTERNAL WALLS AND INSULATION REMOVED	'Open' plan with doors and windows (a) open	+17	+24
	(b) closed	+15	+45

Table 4.

* * * * * *

Instrumentation

VELA—a review

The name VELA stands for versatile laboratory aid. It has been developed with government backing through the MEP, JMB and ASE to enable pupils to work with a microprocessor-based measuring instrument. The firm who manufacture and market VELA is **Educational Electronics.** The Department of Trade and Industry, through their promotion of micro-electronics in schools, have provided funds so that secondary schools can purchase one VELA at half-price. The full price is £180. Schools wishing to buy VELA under the DTI scheme should order through their Education Authority and not direct from Educational Electronics. Independent schools should order through the Centre for Educational Technology.

Fig. 1.

In arriving at your decision on whether or not to purchase VELA you will no doubt wish to eschew greed, which the DTI market distortion offer promotes. The facts on which to base your decision are laid out below. These 'facts' are also interlarded with our professional opinions on certain features. It is left to the intelligent reader to make the necessary distinctions. Of course the nice thing about opinion is that, like advice, it can always be ignored!

VELA both delights and disappoints. It delights because its versatility opens up a fascinating period of inventiveness in experimentation. It disappoints because everything that it does may be done better by other devices. It's not an easy device to review in part because of its complexity and in part because where it disappoints the disappointment can be qualified. This review consists of ontheonehands and ontheotherhands. Whilst occasionally we may be critical of specific features of VELA the general concept of a micro-processor based, versatile, laboratory instrument is not under attack. We attempt to take a detached view of what a multi-purpose, versatile, laboratory instrument should be capable and to indicate where VELA currently matches up and where its short-comings lie.

Specifications

The design specifications are listed in Table 1. Although VELA is a programmable device, in normal

Feature	Notes
4 analogue input channels	bipolar inputs, range ± 2.5V each input has switched amplifier giving 3 gains, x0.1, x1, x10, onset of data capture achieved by either manual or automatic triggering, 4mm sockets.
1 pulse input	senses inputs in the range +1V to +25V, pulse input can be amplified with one of the analogue amplifiers, Uses—event timing, pulse counting and frequency measurement, synchronization pulses, 4mm sockets.
16 digital input/output lines plus 4 control lines	provides direct access to all 20 output lines from one of VELA's 3 PIA chips (peripheral interface adapter, an input/output chip), uses—digital control work, parallel communication line with a microcomputer, 26-way 'D' type connector
1 analogue output port	output range + 2.5V in steps of 20mV, uses—output data from RAM to oscilloscope or chart recorder, waveform generator, eg. ramp staircase generator for control work, 4mm sockets
1 sync output	uses—trigger oscilloscope trigger data logging 4mm sockets

Table 1. Hardware specifications.

operation the user would not be expected to write his own programs. It has sockets for three EPROMS, memory chips which contain programs. Vela is supplied at present with just one EPROM. The other two EPROM sockets are empty and are provided for either further software from the developers of VELA or for the user's own EPROMs.

VELA's first EPROM contains sixteen programs. Running one of these programs, program 7, say, is as simple as keying 07 followed by a parameter (a fancy name for number) which specifies the rate of data capture when used for data gathering. By way of contrast VELA is simpler to operate, than a micro-computer and the teacher who wants to avoid the hassle of QWERTY keyboards, disk drives, cassettes, VDUs and computer operating systems may prefer VELA.

Talking of microcomputers we should explain that our disappointment with VELA comes from being able to achieve higher standards of performance with a microcomputer system than with VELA. This is perhaps an elitist attitude because it would be wrong of us to give the impression that if only you buy a microcomputer all your problems of data capture are solved. In many ways they would have just begun (see for example the complexity behind the measurement of time in Bulletin 136). VELA is a simpler to use versatile laboratory instrument than a microcomputer system. It is also very much cheaper. These points must be weighed against its more limited performance.

A view expressed by the developers is that a well run laboratory, given adequate funding, should have as resources both microcomputers and intelligent data gathering devices, such as VELA. The routine measurement tasks of a more common place nature would be performed by the easy-to-use versatile instrument leaving the microcomputer free for other purposes.

The reviewer is aware, and the reader's attention is drawn to this, that many of the current shortcomings of VELA are due to there being only sixteen programs ready at present. We are also aware that many further programs are under development and will be available shortly. We have therefore to bridle our criticism because of this.

What does it do?

1. **Digital voltmeter** VELA can be used to take single readings of voltage, but it becomes interesting in its ability to sample and store in memory. It comes programmed to sample one or four channels. The intersample time unit for slow data logging can be chosen from 1 to 999 seconds. For fast logging the time unit is awkward, (30 + nx50) microseconds, where n is chosen by the user between 0 and 999. There is space for 4096 readings, or 1024 readings per channel if working with 2 to 4 inputs. The user can either stop data logging whenever he wants or allow it to continue till memory fills up. Resolution is one part in 256, but because it is a bipolar device resolution for a monopolar input is one part in 128. Accuracy depends on the ADC (1%) and amplifier (2%) and is about ± 3%. Once data logging is complete the user can work through memory, the readings being shown one at a time on a 7-segment display. Two bad points about this are

   a) the decimal point does not reflect the range being used and the readings have to be interpreted accordingly, eg. with a gain of 10, a reading of 1.84 represents 18.4V.

   b) the user cannot apply mathematical functions to the data, eg. simple scaling with a multiplication factor, taking the inverse, squaring, etc.

   Since both defects can be remedied by software there is hope for the future.

   It is in our opinion that this function, that of being what the trade calls an intelligent digital voltmeter, could have many uses in science laboratories from first year classes upwards.

2. **Storage Oscilloscope**

   Data held in memory can be displayed in three modes in addition to the 7-segment display, these being oscilloscope, chart recorder and micro-computer. The oscilloscope display may be the one most commonly used with VELA. The minimum intersample time is 30 microseconds, therefore fairly fast transient events can be captured. One standard experiment which is markedly improved by VELA is the examination of sound signals. This is readily achieved by plugging a microphone directly into one of the analogue inputs, running the fast data capture program, and displaying the output on an oscilloscope, the trace being considerably clearer than that usually obtained.

   Some defects to bear in mind: The oscilloscope output is difficult to trigger and we suspect that the triggering pulse is just not quite right. The trace is also susceptible to noise and can be jittery. Indeed anyone who has been accustomed to using a microcomputer for data capture will be disappointed with this aspect.

3. **Timing** Time can be measured to a resolution of 1 millisecond and a variety of gate sequences have been incorporated in one of the programs and will prove useful (Fig. 2). It is also possible to time up to eight separate events, whether overlapping or not. Defects with the timing facilities include:

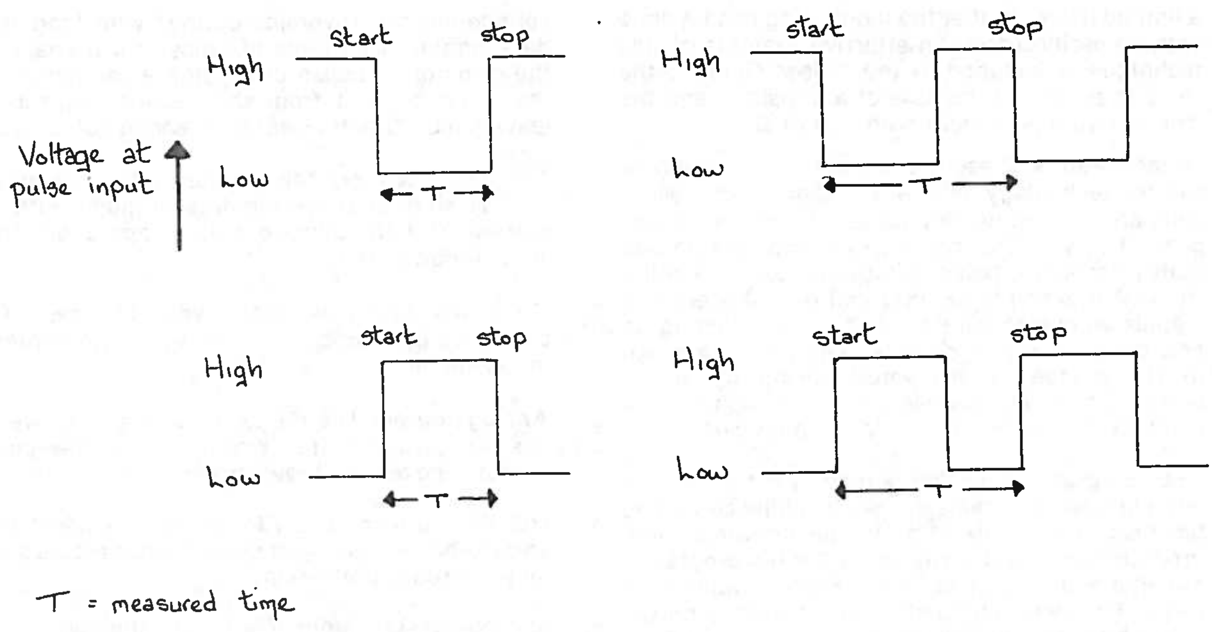

Fig. 2. Gate sequences.

a) inability to perform arithmetic operations on data, eg. compute speed from time,

b) awkwardness which more or less amounts to an inability to do anything else while measuring time, a hardware constraint due to the microprocessors chosen.

Both defects are removed by using a BBC microcomputer instead of VELA.

4. **Frequency** Operates through a range from 1Hz to 20kHz though, by lengthening the gating period, very low frequencies can be measured. An analogue channel amplifier may be used to boost the incoming signal.

5. **Pulse counting** Some interesting data analysis on the count rate from a radioactive source can be done with VELA. Its designers deserve credit for having looked beyond the capture of data to actually doing something with it. For work of this sort you would require a Geiger counter with loudspeaker output, the signal from this being taken to VELA. One simple effect which VELA shows is the randomness of countrate, the oscilloscope trace being covered with a band of dots, the y-ness of each dot being dependent on countrate. The trace is built up in real time, one dot per second, and is an effect worth experiencing. Another experience which should not be missed (sorry, we sound here like a TV company promoter) is the count rate distribution curve, again plotted in real time, this elegant exercise taking two or three hours to complete.

6. **Dual beam oscilloscope** This facility allows two signals input to VELA to be displayed as a dual trace. It is of little worth since the maximum frequency which can be handled is about 500Hz and both signals have to be in harmonic relationship for a stable trace.

7. **Waveform generator** At present the generation of waveforms requires a tedious input of data. This facility is of little use as it stands. Perhaps the second EPROM will contain the means of generating useful waveforms?

8. **Ramp generator** One of the standard techniques in control work is the facility to sweep through and output a range of voltages. VELA provides this facility. However it does not allow the user to do anything else with VELA at the same time, eg. to monitor the effect that is being changed. We see this as being a serious limitation and look to the second EPROM for redress.

Having made this declaration we find that we have to qualify it with yet another caveat. There is limitless scope for inventiveness in experimentation and if something cannot be achieved in a direct fashion then there may be an indirect means. There is, as the saying goes, more than one way of skinning a cat. With the case in point, the fact that VELA at the moment cannot directly monitor the effect that is being changed by the ramp is a limited defect in that the monitoring can be done with an oscilloscope. An effective example of this technique is included in the "User Guide"; the ramp is applied to the base of a transistor and the collector voltage is monitored on a CRO.

9. **Other features** These are largely in the realm of control technology and are disappointing when compared to what can be done with a microcomputer. VELA is more awkward to operate and belies its name, being not particularly versatile. By way of example the user can output a eries of signals on one of the 8-bit I/O lines switching on and off a variety of devices. The example given in the manual is everyones' favourite, traffic lights. There is, however, no provision in the software for sensing inputs. Very annoying!

10. **User programs** Provision is made for the user to write his own programs in 6800 machine code. The technical manual explains to the knowledgeable programmer how to write and enter his programs, but this will only cover a very small number of users. For those who don't know how to program in machine code we would not advise using VELA to find out. There are easier ways such as using a microcomputer with an assembler, screen editing facilities and the means for saving programs. The BBC micro is an excellent example. We also would not recommend buying VELA to learn about microprocessor systems. It is however an interesting microprocessor system in its own right and might be worth buying by the knowledgeable as a way of working with the 6800 family.

We will elaborate a little for those who aren't too knowledgeable. A machine language program such as might be run on VELA looks like this

79, 54, 189, 254, 17, 50, 76, 129, 255, 38, 248

The same program in assembly language is easier to work with

```
        CLRA
BACK    PSHA
        JSR $FE11
        PULA
        INCA
        CMPA #$FF
        BNE BACK
```

A VELA user would have to write his assembly language program on paper, code it into hexadecimal numbers then transfer to the decimal code seen above. A lengthy process.

Hardware review

1. **Power supply** Draws 0.8A from either a.c. or d.c. low voltage supply. Riverside outings with long term data logging are flights of fancy, not perhaps for the common criticism of lugging a car battery to the riverside, but from the security aspects of leaving a £180 instrument unattended outdoors.

The manufacturers tell us they intend replacing the TTL chips on board the present model with low current CMOS chips enabling operation from smaller power units.

2. **Keyboard** Touch sensitive with 16 keys. This precludes user programs from ever being entered in assembler.

3. **Analoge output** The digital to analogue converter has an output buffer which boosts the power output. The output impedance is 560R.

4. **I/O lines** Educational Electronics are developing an external box giving 4mm connector access and a high degree of protection.

5. **Microprocessor family** VELA uses the 6800 family which is popular in industry whereas the two families in popular school microcomputers are 6500 and Z80. If you are interested in microprocessor work we don't think it matters which family you use, nor that you use several. If you can master controlling one you will readily be able to transfer to another.

6. **Documentation** The user manual (81 pages) is well written and gives easy to follow instructions on operating the device. The absolute newcomer to electronic measurement may require some assistance (from a more knowledgeable colleague) in interpreting parts of the text. There are plenty of applications, largely drawn from standard physics syllabuses, which are thoroughly described.

The technical manual (54 pages) which is also supplied gives a detailed hardware/software description. As we said earlier it will only be relevant to a knowledgeable person.

We have also received a draft copy (again very lengthy) from Educational Electronics of a paper on commercial transducers available, and partly (the bulk of the document) on d-i-y transducers. It provides comprehensive coverage of the subject. We welcome this approach, since it encourages project work and doesn't treat teachers as lifeless noddies who have to buy absolutely everything they require.

7. **Microcomputer link-up** The technical manual provides details for the one-way transmission of data from VELA to three models of microcomputer,

BBC B, PET and RML 380Z. We envisage the availability in future of EPROMS for bidirectional communication. This should open up the free usage of VELA to many more, allowing control programs to be written in high level language in a microcomputer.

The one-way link up already provided (VELA → microcomputer) allows the user to regard VELA as a laboratory microcomputer interface, data logging and graph plotting being carried out by the microcomputer. We should point out, however, that VELA was primarily designed as a stand-alone device. The role mentioned in this paragraph is of secondary importance.

Points to think of

Bear in mind the following points

1. Ease of use. Operating VELA with the programs provided is simple. The instructions are good and most programs require just a few keystrokes to load and run.
2. Bench clutter. Considerable.
3. Time to set up. Longer than using a stand-alone instrument.
4. Black box syndrome. (It is black!) The manner in which the programs are coded up by numbers reinforces this impression. However microelectronics is all about coding and unravelling codes, and that is what the DTI is backing.
5. Future backing. Looks impressive.
6. Disappointment. As we said at the beginning each facility provided by VELA can be better achieved by other means though often at greater expense. The limitations of instrumentation is a teaching point and this could be turned into a virtue.

Small school problem

The decision on whether or not to buy VELA is particularly poignant for a small school such as a Scottish two year secondary. The decision centres on "what would I use it for?" If the answer is "not much", it is not worth it. Some suggestions for use at S1/S2 level are listed below.

storage oscilloscope—examining sound waves

intelligent digital voltmeter—monitoring experiments,
eg. rates of cooling,
diurnal temperature—light level patterns,

timing—reaction time,
speed of air rifle pellet

control—switching light emitting diodes

VELA does lend itself to project based work but the teacher would have to be keen on that approach. He would also have to be prepared to construct a variety of sensors, temperature, light, etc. with electronic components.

Even at the subsidised price of £90, a single VELA may represent a large slice of a small science department's requisition. In very small schools, it may be almost half, as one of our enquirers would confirm.

Longer term considerations

The other problem we forsee with the new generation of all-singing, all-dancing, hardware is that of committment. You buy VELA (or GiPSI) now. Are you then committed to invest in the EPROM's, add-on modules transducers and all the other current vapourware?

This is the razor blade or stencil syndrome. Market a razor or a duplicator with a unique head, at competitive prices, and make your money from the captive market for the blades or stencils. Or will history repeat itself and will we see third parties making compatible add-ons?

As we suggested earlier—there's a lot to think about.

Footnote

We understand from the developers that a number of changes will be made to the hardware and software from the middle of November. These changes in part reflect the criticisms from ourselves and others.

1. Space made for 4 EPROMs (3 at present).
2. Intersample time tidied up.
3. Decimal point will move with range.
4. Oscilloscope triggering to be improved.
5. Replacement of DAC to reduce noise on trace.
6. x-y cursor to be made clearer.
7. RAM changed to CMOS cutting operating current from 0.8A to 0.46A.
8. Battery back-up provision to enable field readings.
9. Extra memory provision.
10. 2 analogue input channels with extra range, -1.25V to +1.25V, thus making better use of the dynamic range of the ADC for popular sensors with outputs 0-1V.
11. 5V output for users.

Other items in the pipeline include a book on programming VELA (£8 approx.) and the second EPROM (£20-£25 approx.). This EPROM will include, amongst other things, a number of logic tutor programs enabling VELA to simulate a range of combinational and sequential logic circuits.

* * * * * *

Surplus Equipment offer

This offer is somewhat complicated—sorry! In general it is subject to our conditions of sale laid down in Bulletin 116. However the goods for sale fall into four categories with a major sub-division of non-ballot and ballot items.

Items up to and including number 239 are older stock and have been previously advertised. More detailed descriptions of these items can be found in the relevant bulletin issue (number given in list). None of these items are subject to ballot but are available on a first-come, first-served basis.

Items with numbers greater than 240 are **all** subject to ballot. Items 241 to 255 inclusive are newly acquired stock. Items 256 to 268 inclusive are SSSERC owned equipment now surplus to requirements. All of the items are offered at an economic price. However items 269 to 310 inclusive are all ex-evaluation samples supplied to us free of charge for testing and exhibition purposes.

The suppliers of these items have generously agreed that their apparatus should be distributed to schools, rather than be returned to the warehouse or factory. Most items of any value are offered subject only to a small handling charge of £1.00 per item, plus any revelant post and packing charges. For low value items the handling charge will be waived. This handling charge is intended **solely** as a contribution towards our administrative and other costs. This sort of offer is unlikely to be repeated. It follows a spring cleaning exercise and a resolve to keep evaluation stocks under tighter control with short turn-round times.

Which reminds us—to remind you! Items are only posted out or freighted if we receive a specific request to that effect, otherwise we assume that goods will be collected. We still have a few items awaiting collection from the last two ballots. Unless we hear from the schools involved very shortly, we shall offer these goods to others. No offence is intended but some of these items are in short supply and too useful to be left mouldering on our shelves.

Item 89	Bulletin 125	photographic fixer	30p per box
Item 165	Bulletin 129	bimetallic strip, 30cm	40p
Item 178	Bulletin 132	bromide paper WSG4	£5.00
Item 183	Bulletin 132	35mm b/w film 1000′ in can	£5.00
Item 206	Bulletin 132	Ilfospeed paper developer 51	£3.50
Item 209	Bulletin 132	milliameter, centre zero	£3.50
Item 212	Bulletin 132	large wirewound pot 25W 8R	80p
Item 215	Bulletin 133	12V motor double ended	£2.50
Item 216	Bulletin 133	'J24' 12V power supply	£3.50
Item 222	Bulletin 133	small speaker/microphone inserts	30p
Item 226	Bulletin 133	bromide paper, WSG2	£5.00
Item 235	Bulletin 133	6V lantern battery, spring terminals	70p
Item 236	Bulletin 135	bromide paper WSG3	£5.00
Item 239	Bulletin 135	colour slide film (tungsten light)	70p

Items 241 to 255 inclusive are newly acquired stocks and are subject to ballot.

Item 241	bromide paper WSG4 30.5x40.6cm (12x16″) 100 sheets.	£6.00
Item 242	Veribrom F1 paper 40.6x50.8cm (16x20″) 100 sheets.	£10.00
Item 243	Ilford 'safety' film SP352 10.2x12.7cm (4x5″) 25 sheets (—useful stuff this for photomicrography without a camera etc.)	£1.00
Item 244	Ilford wash crystals 10x32.5g sachets per box	20p
Item 245A	Ilford FP4 cine film, 35 mm so suitable for stills, in bulk 400′ in a can	£5.00
Item 245B	Kodak Ektachrome 200ASA 35 mm colour transparency film per cassette	60p
Item 246	Kodak Tri-x-pan 400ASA, 36 exp. per cassette	30p
Item 247	Paterson 35mm proof printer	£3.00
Item 248	Paterson print tongs, pkt. of 2	30p
Item 249	Ilford D and P film clips	5p each
Item 250	'Rowi' roller film squeegee 20cm, as new	£1.00

Items 251 to 255 are precision potentiometers donated by Beckman via a school in Fife. This explains the ridiculously low prices for these precision components. The small charge reflects only our costs in sorting and advertising. Please specify item numbers **and** values.

Item 251	As new Beckman helipots, 3 turn, 5R; 200R; 300R; 125K.	10p each
Item 252	As above, but small, 10 turn: 100R; 220R; 500R; 1K; 2K; 2.5K; 5K; 10K; 20K; 25K; 27K; 30K; 50K; 100K	15p each
Item 253	As above, but medium sized, 10 turn: 25R; 250R; 500R; 1.5K; 5K; 10K; 30K; 100K; 250K; 350K	20p each
Item 254	As above but double ended, or long, spindled ype: double—10R; 200R; 1K; long spindle—300K	30p each
Item 255	As above but large, single turn—5K; 10K; 200R; large ten turn 150R; 100K	50p each

Items 256 to 268 are SSSERC owned equipment surplus to our needs.

Item 256	small motor/dynamo mounted on stand	50p

Item 257 hand powered generator on wooden stand 50p
Item 258 model mass spectrometer (bagatelle type) 50p
Item 259 circle of reference apparatus 50p
Item 260 projection air table (o.h.p.) 50p
Item 261 set of Osmiroid 'Centicubes' 1cm cubes in plastic used to build up shapes, histograms etc. £1.00
Item 262 'Matchbox' 'Cascade' game or toy 50p
Item 263 20' soil heating cable (Roberts Electrical 75W, 240V £2.00
Item 264 rod type thermostat for use with above for d-i-y propagating bench 18"long, 240V, variable and scaled 30°-90°F £3.00
Item 265 "Ventmaster" hydraulic automatic vent opener for wooden framed greenhouse£2.00
Item 266 Labtech two pan balance, very basic primary level apparatus showing principle 30p
Item 267 'Millipore' aseptic filtration apparatus 50p
Item 268 'Armstron' electronics kit £1.50

Items 269 to 310 inclusive are all ex-evaluation/exhibition samples kindly donated by the firms named. Catalogue numbers are not quoted since in many cases these would refer to out-dated catalogues. Unless specifically indicated a standard handling charge of £1 per item applies, plus post and packing if despatch is requested.

Item 269 Chandos pH meter A47 (no electrode—too old)
Item 270 Chandos pH meter A471 (no electrode)
Item 271 Chandos conductivity meter A18
Item 272 Labgear laboratory light unit, lamp housing with condenser on adjustable stand
Item 273 Leybold-Heraeus pulse electroscope
Item 274 Leybold-Heraeus circular motion apparatus
Item 275 WPA C065 colorimeter
Item 276 WPA EN50 d.c. amplifier electrometer
Item 277 WPA CM25 conductivity meter
Item 278 WPA C10 pH/mV meter
Item 279 WPA C5 pH meter
Item 280 Philip Harris colour mixing set
Item 281 Philip Harris pH and redox meter
Item 282 Philip Harris conductivity meter
Item 283 Philip Harris variable l.v. power supply 0-12V
Item 284 Philip Harris dialammeter and diavoltmeter
Item 285 Philip Harris projection meter (o.h.p.)
Item 286 Philip Harris dissolved oxygen meter and electrode
Item 287 Philip Harris ticker timer apparatus (no handling charge)
Item 288 Philip Harris 'Worcester' circuit board
Item 289 Philip Harris colorimeter (has undergone some very slight modification for development work)
Item 290 Harris Biological Fossil replica sets 1, 2 and 3
Item 291 Philip Harris mechanical equivalent of heat apparatus
Item 292 Philip Harris field light probe, photocell on two piece fibre glass extension pole.
Item 293 Philip Harris environmental light comparator
Item 294 Philip Harris environmental pH meter
Item 295 Philip Harris 'Newton's rings' apparatus (no handling charge)
Item 296 Griffin and George air bearing and range of circular motion accessories (£2 handling charge)
Item 297 Griffin and George frictionless puck, air type.
Item 298 Griffin Torbal mechanical top pan balance —case a little worn now
Item 299 Griffin and George air track accessories
Item 300 Griffin and George Franck-Hertz apparatus
Item 301 Griffin Biological (Dutt?) ESP eye model
Item 302 as Above, heart models (2)
Item 303 as above, brain model
Item 304 as above, knee joint showing ligaments
Item 305 Carwyn, pH meter
Item 306 Carwyn, pH/mV meter
Item 307 A.M. Lock, range of electronics kit items (£2 handling charge)
Item 308 A.M. Lock, demonstration meter
Item 309 Nombrex frequency meter
Item 310 Chiltern pH meter pH 11A

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In the Workshop

Cardboard House

The walls and floor of the house were made out of a cardboard butter box (510mm(L) x 210mm (W) x 230mm(H)). Any box even approximating to these dimensions would be satisfactory. For safety reasons the height must be sufficient however to give a good clearance twixt bulb and ceiling. The top lid flaps were cut down to approx. 30mm in width; the longer sides had self-adhesive draught strip stuck on them in order to give a better seal with the roof. Nine strips of wood 10x10mm in section were glued on the side walls to act as guides for the internal walls. The cavity walls were made of four pieces of card 230x210mm. The ceiling, again of cardboard, of area equal to the floor area had two U-sections of cardboard glued on the underside so as to minimise any convection current 'leaks' over the wallheads.

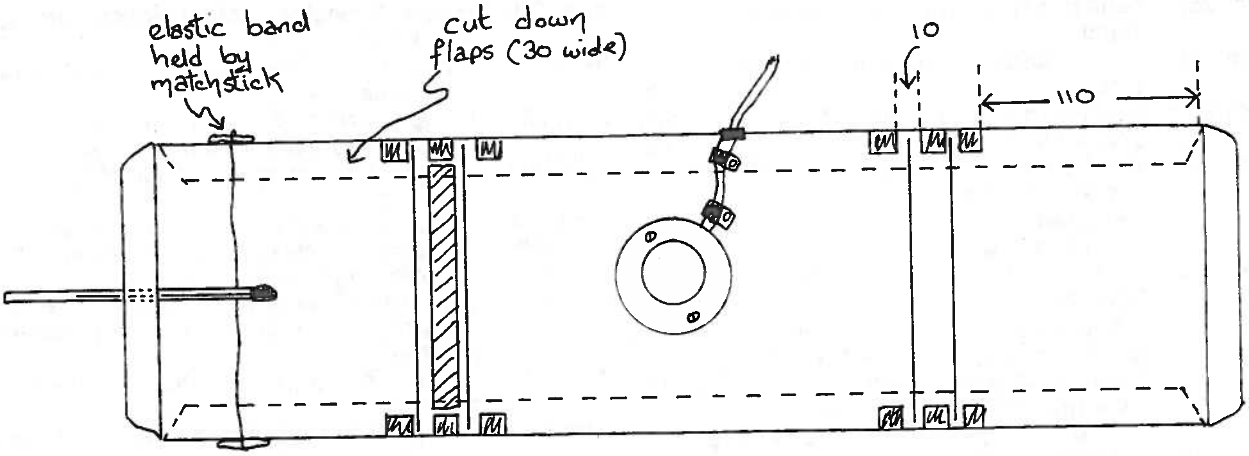
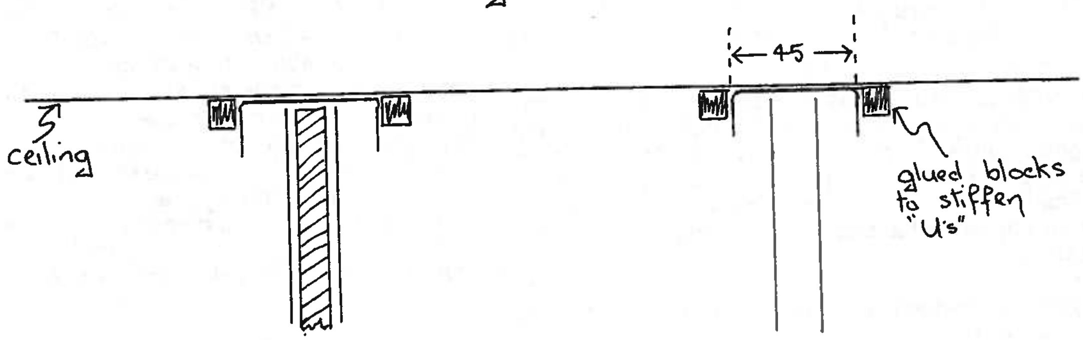


Fig. 1.



all dimensions in mm.
Fig. 2.

The ceiling rests on the top of the guides for the partition walls, the shortened flaps folded down over the top and the roof section placed in position on top in turn.

A small strip of cardboard was used as a hinge to attach the roof at one gable and two elastic bands from the roof to cuphooks on the other gable kept the roof pulled downwards so as to give a good seal.

Layers of polystyrene equal in area to that of the ceiling could be placed on top of the ceiling before lowering the roof. The roof section was simply constructed from two slopes glued onto gable sections of the appropriate angle and reinforced along the ridge. If necessary some cross struts of elastic bands could be added.

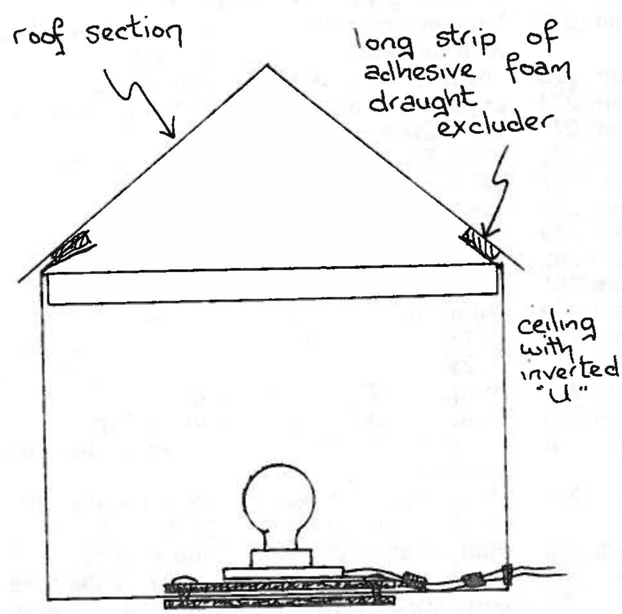


Fig. 3.

Thermometers in the end rooms enter in a hole in the end wall and the bulb is supported on an elastic band stretched between two opposite walls approximately halfway along the length of each end room.

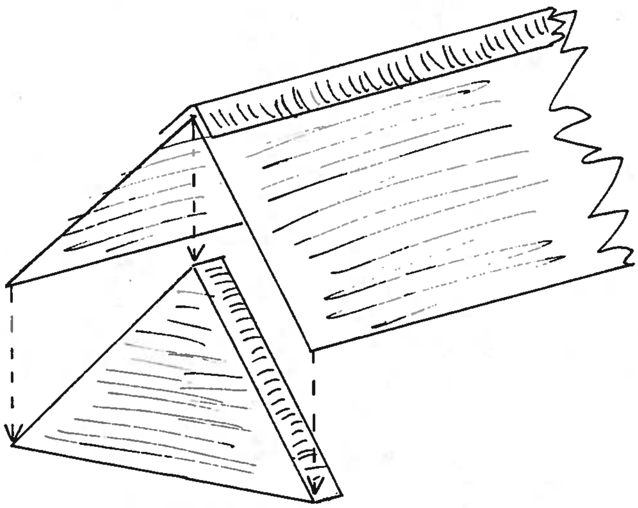


Fig. 4.

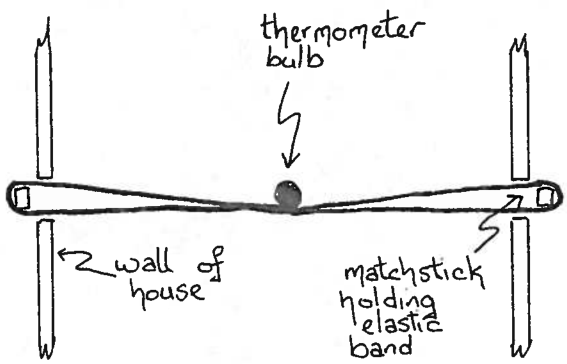


Fig. 5.

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Trade News

Tait Components Limited are a young Glasgow firm who are making a determined bid, not without success, either, for a share of schools' electrical, electronic component and small handtool market. Their success is due to their competitive pricing and we recommend that schools obtain a copy of their catalogue. Items of interest include:

1. LCD digital multitester, HD31, at £47.50, featuring autoranging and bipolarity.
2. Analogue multimeter, NH41, at £4.95, with 11 ranges, voltage, dc, 10/50/250/1000, ac, 10/50/250/1000

   current 100mA, resistance—2 ranges.
3. Resistance substitution box with 36 preferred values between 5Ω and 1MΩ, price £3.50.
4. Resistance chart which converts both ways between colour code and resistance, 15p.
5. Analogue panel meters, 3 ranges, 4 sizes at £2 to £4.95.
6. Electronic components, eg.
   ¼W resistors, 11p per pack of 10
   7805 voltage regulator, 1A at 75p
   led (red, green, yellow) 10p.

New catalogue

A short "Autumn 1983" product guide is available on request from the **C.P. Instrument Co. Ltd.** This contains some sophisticated equipment outwith the usual school price range. In part though it deals with lower priced, useful items such as plug-in mains time and thermostatic switches, low cost timers and digital thermometers etc.

New products from 'G & G'

We have recently received press releases from **Griffin and George** on a wide range of new products. Lack of space precludes detailed description here. Further details should be available from your local representative or the Griffin 'Product Enquiries' department. The new products announcements cover:

An Appliance Power Check Meter, EMH-300-101P; two new ranges of computer furniture—Gallid computer trolleys and Selmor Engineering's self assembly range; ZX81 and Spectrum speech synthesiser 'S-packs'; and add-on (self adhesive overlay) push button keyboard for the ZX81, CRA-704-600T; a mains equipment, high current continuity earth leakage tester, EHL-830-010L; digital tracers for transferring drawings to screen with Spectrum (CRA-782-W) and BBC B (CRA-896-G) and, finally, a range of rechargeable Ni-cad batteries (BMT-720) together with a corresponding battery charger (BMT-724-500B).

—and from Philip Harris

We have also received a pair of leaflets from Harris sources. From Philip Harris comes a leaflet describing computer hardware—BBC B; ORIC-1; LVL and Cumana disc drives as well as Seikosha graphics and Epson dot matrix printers. From Harris Biological is a description of their latest software and books. Copies of both these leaflets should be available from the addresses on the inside front cover of this issue.

'Lab-bags'

We rush to explain—lest we be accused of being MCP's that we refer merely to a new range of autoclavable disposal bags from **Medical Wire.** Designed for the disposal of biohazardous waste, these bags come in a range of three sizes—305x660mm; 406x630mm and 630x840mm at £11, £17 and £27.50 per 200 respectively. Medical Wire are also a useful source of small specimen and media contain s, wire mesh baskets, metal test tube racks and brushes etc.

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S.S.S.E.R.C.

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November 1983