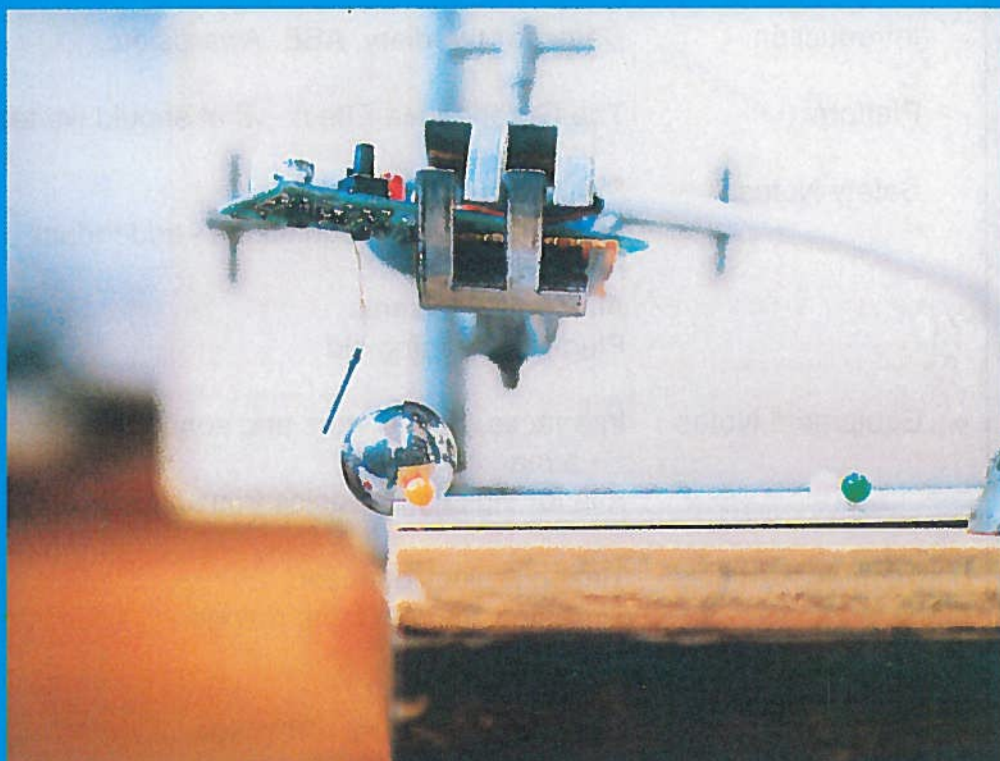
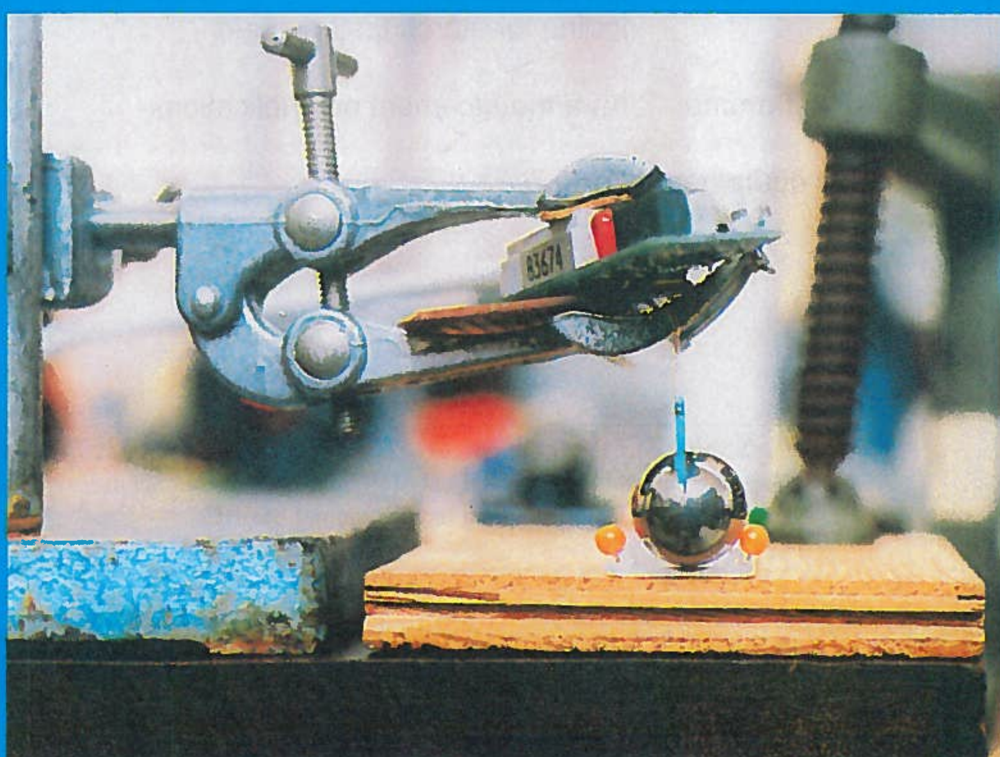
SCOTTISH SCHOOLS EQUIPMENT RESEARCH CENTRE

Science & Technology Bulletin

For: Teachers and Technicians in Technical Subjects and the Sciences





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INTRODUCTION

Dates for the diary

ASE (Scottish Region) Annual Meeting

The 1995 meeting will be held in Bannockburn High School, Stirling from the 11th to the 13th of April. The emphasis on practical and hands-on activities seen at the Culloden meeting last Spring looks set to continue. For example part of the planned programme will include :

Self-help Trouble-shooting Workshops

The idea behind this session is to include both those practical activities which for some teachers always go well (their *bankers*) as well as the problem practicals which never seem to work. Through sharing of experience, and possibly wisdom, in both categories of practical work it is hoped that the eventual whole will indeed be greater than the sum of the parts (even if some of them break).

If you are willing to take part in this session then drop a line to Elizabeth Sinclair. For information on the Annual Meeting or ASE activities generally then contact the Regional Secretary, Stuart Farmer. (Both addresses are listed on the inside rear cover of this issue).

Seventh International Science Festival

The festival proper will begin on the 31st of March and run through until the 17th of April 1995. Copies of the full programme will be available in January.

The Schools' Programme, as usual, will begin much earlier - the 1995 programme will start on 27th February and will span six weeks or so. Details of the full schools' programme were planned to be available by December '94 and by the time this Bulletin issue reaches you a copy of the programme may already have been sent directly to your school. If you don't get either a copy of the schools' programme or a postcard request form then you can if you wish write to the festival office address given on the inside rear cover of this issue.

Schools well away from the Central Belt should also be aware that Science Festival staff both offer an outreach service and are willing to give advice to those planning to stage their own local science or technology events. And, there's more . . .

Science and Technology Awareness Week

As if all that lot wasn't enough the National Awareness Week, that hardly anybody seems to have heard of[1], gets another shotty in 1995 (third week of March). At this rate we science and technologists are going to end up at one year-long party. Probably beats teaching, but then . .

Last year's intended extravaganza was patchy and thus wasn't. But we have to admit that we did much enjoy the rewards for our minor efforts as an exhibitor in an event for the general public staged in the Rothes Halls in Fife. So much so that we'll be going back - to Glenrothes - now there's devotion for you considering the navigational difficulties presented by any *New Town* centre! Just getting to the car park and into the back door of the Rothes Halls should qualify anyone for a British Association Medal and a Problem Solver of the Year Award.

And, speaking of Awards . . .

[1] This reminded me of Ian Morris' joke about Information Technology Year being such a well-kept secret.

Congratulations!

UK Science Teacher of the Year

The outcome of the judges' deliberations on the nominations for the 1994 Times Educational Supplement Award was announced whilst some of us were at the ASE UK Annual Meeting. This TES Award Scheme is run in conjunction with the Association for Science Education. The secondary award is sponsored by the Association of the British Pharmaceutical Industries (ABPI).

It gives us great pleasure to join many other individuals and organisations in offering our congratulations to the winner of this year's secondary award - Mrs Jess Cooke of Lenzie Academy. In addition to the national recognition of her work and that of her pupils, Jess also receives a cash prize as does the school.

It is coincidental but Jess also gets a mention elsewhere in this issue. Well before we heard of her award we had already accepted for publication drawings of a teaching aid designed by one of Mrs Cooke's pupils - a member of the thriving Lenzie Academy Science Club.

Ninety-four was obviously a good year for Scots science and technology educators. Not only did Jess manage to take this award but did so just before the end of a term of office for David Standley as national (UK) Chairman of the ASE. David was the first teacher working in Scotland ever to occupy the Association Chair.

And, just to round things off, Alistair Ritchie, Senior Supervisory Technician at Fraserburgh Academy received an MBE in the New Year Honours List.

Here's to 1995!

Guest author

Overleaf begins an article on the Greenhouse Effect. Unusually for the Bulletin it is not the work of anyone in the SSERC staff team but that of Dr Wilson Flood, an Area Adviser in Dumfries and Galloway. It was written in a personal, not an official, capacity and is based on a longer somewhat more technically detailed piece first published in the the School Science Review. We are most grateful to Dr Flood for this contribution to the Bulletin.

The Greenhouse Effect - what should we teach?

Wilson Flood

For many teachers in Scotland an important event in 1993 was the publication of official papers on *5-14 Environmental Studies* which in Scottish Education encompasses the science, social subjects and technology curriculum in primary and early secondary stages.

As in many curricular documents, the knowledge section is defined in skeletal terms. Thus, the expression "studies should focus on" is used, without giving any clues as to extent or depth of treatment. Since there is to be no terminal examination for certification purposes nor the equivalent of National Testing it may perhaps have been assumed that definition of depth did not matter greatly. But it surely does matter that any information under consideration does bear some resemblance to the truth of things. So, in the section *Understanding Earth and Space* we find that *studies should focus on :*

> - fossil fuels: occurrence, combustion and effects of the emission of greenhouse gases

And I would be surprised if what was told to pupils up and down Scotland were not something like the following:

> "A greenhouse effect is now definitely threatening the planet, that carbon dioxide is its cause, and that the resulting global warming taking place will raise the temperature of the planet to such an extent that the polar ice caps will melt. Great tracts of low lying land will be overwhelmed by rising sea levels. Large numbers of plant and animal species will die. (The greenhouse effect takes its name from the way in which heat is trapped in greenhouses, the analogy being drawn between that and the ability of certain atmospheric gases to retain heat)."

How much of the above has actually been established as being incontrovertibly true?

Well, effectively, none of it. It belongs to the *we're all going to die* school of environmental science that is good for selling newspapers which are on the whole less interested in the slow process of establishing a few facts. Therefore, in the service of British education (since greenhouse gases also crop up in the science syllabus of the National Curriculum) and at the risk of upsetting some of you in challenging a few of your own assumptions, may I present some 'facts' about greenhouse gases and the effect that is named after them.

The first is that, far from being some new threat to the planet, the greenhouse effect is perfectly natural and without it life as it presently exists on this planet would be quite impossible. The Earth absorbs heat energy from the sun and reradiates some of it back into space. However, measurements of the amount of reradiated energy indicate that the Earth behaves as if it had an average surface temperature of -18°C. Since the actual average surface temperature is closer to +15°C it is clear that something is trapping considerable amounts of heat. That something is the greenhouse effect and without it our planet would be to all intents and purposes lifeless and cold.

It is true that the effect is caused by the presence of certain gases in the atmosphere and these are called collectively for the purpose of this phenomenon the *greenhouse gases.* These gases are able to absorb heat energy and are characterised by being made of molecules containing different types of atoms. This means that most gases therefore qualify as greenhouse gases but that, significantly, the important atmospheric gases, oxygen and nitrogen, do not. The main greenhouse gases in the atmosphere, in increasing importance, are low level ozone (nothing to do with the hole in the ozone layer), nitrous oxide, methane, chlorofluorocarbons (CFCs), carbon dioxide and water vapour.

It may come as a shock to learn this, but it is a fact that, compared to the other greenhouse gases, water vapour is so plentiful that it is estimated that it is responsible for about 99% of the total greenhouse effect. Not only that, but carbon dioxide - for technical reasons we need not go into here - is, molecule for molecule, a rotten greenhouse gas. A molecule of methane produces 27 times the greenhouse effect of a molecule of carbon dioxide while the bruisers of the greenhouse world, CFCs, are more than 15,000 times as effective. So, why all the fuss about carbon dioxide? Probably because, after water vapour, it is the next most plentiful greenhouse gas and large additional amounts of it are being produced year on year. But, for all the large quantities of carbon dioxide produced, and leaving water vapour out of the calculation, it is estimated that it is only responsible for 50% of any additional greenhouse effect due to mankind's activities. The remainder is due to those other more effective greenhouse gases which are present in the atmosphere in much smaller but insidious concentrations.

Research has been carried out on planetary temperature variations exhibited over the past 160,000 years. By taking samples of ice from glaciers and examining the gas composition of bubbles of air trapped within glaciers the analyses have shown that when the temperature of the planet has risen in the past, then so has the concentration of carbon dioxide in the air and vice versa.

But, as those of you who have been using *Thinking Science* or *Techniques in Assessing Practical Skills (TAPS)* will know, this does not prove that the latter causes the former. It may well have been the case that the changes in these two variables were being brought about by changes in one or more other variables. It may be a circumstantial rather than a causal relationship. One thing we can be sure of : the large swings in atmospheric carbon dioxide concentration that apparently occurred tens of thousands of years ago were not caused by mankind's activities so there must have been other factors at work.

More recent studies on average global temperature and carbon dioxide concentration do show a slight increase in temperature of 0.5°C since 1860 accompanied by a 17% increase in the atmospheric carbon dioxide concentration. However, the correlation is not at all exact; most of the temperature increase took place before 1920 and the major part of the carbon dioxide increase has occurred since 1960. Such a temperature change is not outwith expected variation. But, it is a fact that the 1980's was the hottest decade since records began - something which may be significant (although if this latest summer has been anything to go by the trend has been reversed somewhat!). It is also worth pointing out that the *average global temperature* is neither particularly easy to define nor to measure, and that recent satellite data have shown no evidence of global warming.

At present rates of human activity, and ignoring any other factors, we could assume that the amount of carbon dioxide in the air will double in about 40 years. As the case always seems to be with science, it is not however that simple. Plants use up carbon dioxide during photosynthesis so the build up of carbon dioxide would be slowed down by increased rates of plant growth, particularly of oceanic algae. Carbon dioxide is also fairly soluble in water so slightly greater amounts would dissolve in oceans, lakes and rivers. Taking these factors into account the doubling of free atmospheric carbon dioxide might take slightly more than 100 years.

Once we include the addition to the atmosphere of other pollutants (which all happen to be greenhouse gases), then over the next 100 years we might expect a small percentage rise in the greenhouse effect. It is not easy to predict what the effect of this will be in terms of temperature increase because of other factors, such as cloud cover and pollutant haze.

Global warming would cause increased amounts of water vapour to be present in the atmosphere which would possibly result in an increase in cloudiness. Depending on the distribution, type and height of clouds formed, greater amounts of solar energy might be reflected back into space. That would help in partially cancelling out any global warming.

Even if we ignore the unpredictability of cloud cover, we can be pretty certain in the next century of an increase in high level pollutant haze. This will certainly have a cooling effect. Vapour trails from passenger jets are included here. For example in the Spring, it is quite often the case that a clear blue sky can completely cloud over in less than an hour following the passage of a single 'plane. It would surely be a terrible irony to rely on one environmental problem (pollution) to save us from the effects of another (global warming).

The question remains as to what is the best course of action to take? There would seem little point in pursuing this present vendetta against carbon dioxide if it doesn't prove to be the main villain of the global warming piece, (assuming that there is any global warming in the first place). The most pragmatic strategy at present lies in what is known as *tie-in*, that is to say taking action which, even if it has no effect on the problem, will yield benefits in other directions. So, whether or not there is an increasing greenhouse effect and whether or not carbon dioxide is the cause, it must still make good environmental sense to find ways of destroying fewer forests, burning less wood, using less fossil fuel, and producing less in the way of atmospheric pollutants.

Of course one way of doing this is to use more nuclear energy! And another way is to burn less coal and close down the resulting unnecessary coal mines! And, I must admit it, this article was prompted by powerful television and newspaper advertising issued by the DTI's Energy Efficiency Office informing us that carbon dioxide was the main greenhouse gas, and that, if we did not use less carbon dioxide producing fuels, the resultant heating of the planet would raise sea levels and kill all the animals including, curiously, whales. I suppose that if the planet heated up enough it would be true to say that the corresponding heating of the oceans would change marine ecosystems to such an extent that whale populations might be threatened. However, it is the case that ocean temperatures remain relatively invariant and it does rather ignore the fact that oceanic species face other and rather more immediate threats of extinction.

The situation concerning global warming is extremely complex. In a short article one can only attempt an overview. Although the popular image of the scientist is that of a rather detached, cold, other worldly figure, science is bound up in real life. We need to be aware of the political dimensions in all of this. Having once fixed in the public mind that carbon dioxide is an environmental threat, all sorts of actions can be justified, from fuel taxation to permanently altering the energy source profile of this country. Science teachers have a duty to identify and to discuss as many as possible of the key issues in complex matters such as global warming, to confront their pupils with them, and to help them to appreciate the crucial importance of objectivity and an open mind.

But any teacher who attempts to present the *truth* about global warming to his or her pupils faces a daunting task. This is due not least to the mass of speculative and even contradictory information circulating at present.

Is there global warming due to increasing levels of greenhouse gases or is there not? The truthful answer is that, right now, nobody really knows for sure.

Further reading

Managing Planet Earth (W H Freeman and Co, 1990)

Understanding Our Environment (Royal Society of Chemistry, 1992)

Generating Power in a Green World (Hobsons Publishing plc, 1991).

Dr. Flood is an educational adviser with Dumfries & Galloway Regional Council but writes here in a personal capacity.

Practical work with DNA

Health and safety implications of school practical work using DNA and of equipment and materials ancilliary to such usage are described and assessed. It is concluded that the practical work catered for in two recent kits is not only acceptably safe but also educationally valuable.

A number of educational agencies and suppliers are now marketing materials and kits which involve the use of DNA (deoxyribonucleic acid) in procedures that illustrate aspects of its biochemistry and use. Investigations with DNA were reviewed by the Association for Science Education (ASE) in 1988 in Topics in Safety [1]. Developments since have led the Association, through its Safeguards in Science Committee, to reconsider the health and safety aspects of such work in schools and FE colleges. Accordingly, in July 1994, ASE convened a conference to which were invited representatives of those with an interest in the field : professional microbiologists, educational project officers and suppliers, the Health and Safety Executive, the DfE and the Scottish Office Education Department, CLEAPSS and SSERC etc.

This article reports some of the outcomes of that conference. Several issues which might impede progress in the practical education of students in this area were also identified and strategies for the future agreed. It is understood that a similar report, based on the consensus achieved at the conference, will appear in a forthcoming issue of *Education in Science*, the official journal of the ASE.

The key conclusions of the conference were that most of the risks in practical work with DNA kits arise from chemical hazards of dyes and stains or from electrical power supplies. These hazards are well known in schools and FE and may be readily dealt with so that attendant risks are controlled.

Why DNA?

There are a number of reasons why some work on DNA is now a necessary component of the science education of every pupil or student. These include curricular, moral or ethical, and economic reasons :

- The basic science upon which DNA technologies are founded has a place in the National Curriculum for England, Wales and Northern Ireland. It is also an important topic in nearly every UK school examination syllabus in biology or science.
- Despite the prominence of DNA in syllabuses a recent survey of GCSE students' knowledge and attitudes [2] showed that a third of pupils asked did not know what biotechnology and genetic engineering were. Nearly half could not give examples of either.
- Because much of the basic science is well established many developments in genetics are now technology driven. In the absence of any practical illustrations in the classroom, the gulf will widen between the largely theoretical treatment of the topic in schools and practice outside.
- Genetic modification lies at the heart of many biotechnological developments : It is a core technique of a technology which, like all others, has potential for mis-application as well as for great and general good. DNA technologies do hold possibilities for national economic and social benefit.
- There is growing public awareness of DNA technologies, their possible applications and implications. It is vital that any public debate as to the merits and pitfalls of such developments be well informed;
- A number of countries, notably Denmark, the USA and more recently Germany and Japan, have introduced practical work on these topics into their school science courses.

Why practical work?

A survey in September 1992 by the National Centre for Biotechnology Education (NCBE) demonstrated clearly the gap between theory and practice in schools so far as DNA is concerned [3]. The NCBE data showed that although over 90% of the biology syllabuses in the schools surveyed included gene technologies only about 1% of those schools carried out any relevant practical work.

Teachers will want to close this gap, so improving the match between practical work and the demands of syllabuses. Until recently this wasn't feasible on grounds of cost or of health and safety. In Denmark, parts of the USA and in a few UK schools some practical work on DNA was introduced almost a decade ago. However such activities often used research type procedures modified only slightly, if at all. That meant they also used expensive apparatus and presented hazards unfamiliar to many teachers.

Another inhibiting factor may have been the advice, in a DfE booklet on microbiology [4], that "No attempt should be made in schools or colleges to practise the techniques of genetic engineering . . ." Although exactly what was meant by genetic engineering was not precisely defined, this may have been sound advice ten years ago when everyone was, understandably, cautious. Such advice has been overtaken by events. We understand that the DfE may be actively re-considering its policy.

Kits for UK schools

Within the last year or so, two inexpensive DNA kits have been specifically designed for schools; one at NCBE and the other by the Science and Plants for Schools (SAPS) project[1]. Both of these kits have been fully described or reviewed elsewhere including in this publication (see Further Reading). This present article concentrates on safety aspects, both of these particular kits and of likely developments which lie beyond them.

1 In the latter part of 1994 the two project teams began co-operating in the design, production and distribution of such kits.

Risk Assessments

A summary of the hazards and risks of a wide range of biotechnology activities in schools was provided in reference [1]. Table 1 uses a similar approach but in the narrower context of the use of DNA in school practical work. It focuses on the NCBE and SAPS kits and on any other risks attendant on possible DIY versions, extensions or modifications to them.

Type and Source of Hazard	Nature of the risk	Type of activity in which risks may arise	Means of limiting risk
Chemical hazards			
Reagents used in kits :			
buffer solutions	toxicity	making up solutions for extracting/dissolving DNA	choice of buffer type, use of solutions only needing dilution limited scale.
detergents	allergenic reactions	making up DIY solutions from concentrate or powders. Use to breakdown membranes when extracting DNA etc.	detergent type SDS (short for sodium dodecyl sulphate synonym sodium lauryl sulphate as used in domestic detergents, shampoos etc); dilution; scale
ethanol	toxicity and fire	- redissolving plant extract - methylene blue used in ethanolic solution	scale - small volume technique; keep off skin; gloves of suitable type
enzymes	allergenic reaction	restriction enzymes used to cut DNAs (eg *Eco*RI, *Bam*III *Hind*III)	scale and containment : only micro gram quantities used, adsorbed on sides of plastic microvials; solutions are a few microlitres only
dyes/stains	toxicity/allergenic reactions	- loading electrophoresis wells - staining DNA fragments on electrophoresis gels	kits use bromophenol and methylene blue or modified forms thereof; keep off skin; control spillage and avoid use of other stains such as ethidium bromide (listed mutagen); gloves of appropriate type may be needed.
electrophoresis gels	toxicity (if polyacryl-amide gels used) burns or scalds from molten gels	making up and using gels	make agarose gels only, follow good practice in making up (as for agar); adhere to kit instructions if using a microwave oven; at this level if you use polyacrylamide gels : do not make up or cast your own, buy them ready made.
DNAs	hypothetical genetic effects	making up and handling DNA solutions and digests	with the types of DNA used in the these kits the risks are insignificant

Table 1 Analysis of hazards, risks and preventive or protective measures to limit such risks in some educational activities using DNA.

Type and Source of Hazard	Nature of the risk	Type of activity in which risks may arise	Means of limiting risk
Microbial hazards			
DIY use of DNAs other than those provided in the NCBE or SAPS kit especially if unknown or incompletely character-ised.	infection (more likely - transfection) via skin with viral DNA contaminants	making up and handling DNA solutions and digests	The kits use plant DNAs, Lambda phage DNA and Calf Thymus DNAs only and the risks are insignificant.
Electrical hazards			
gel tanks and power supplies attached thereto	electrical shock burns and fire	connecting and discon-necting supplies and using gel tanks especially overnight running. Buffer is highly conductive and gels are directly handled within it. Gels may have to be run unattended overnight.	use low voltage (< 24 V) supplies from dry cells or a well designed mains to low voltage device. If higher voltages to shorten run times are used, professionally designed apparatus must be used (interlocked tank terminals, current limited, shrouded leads. Teacher use only unless pupils >16 & trained. See ref.[1] for notice on overnight running
Other physical hazards			
centrifuges	physical injuries	centrifuging extracts and DNA (eg in the extraction of nuclear and chloroplast DNAs [SAPS kit only])	proper use of a centrifuge of an appropriate design observing the usual precautions
ultraviolet radiation	carcinogenic effects on skin, damage to eyes	examining stained gels using short-wave UV radiation	avoid use of ethidium bromide as locating agent (mutagenic) and short wave UV then not required In any case the UV filter needed is relatively expensive.

Table 1 continued

Overall conclusions

In the versions available at the time of writing, neither the NCBE DNA gel electrophoresis kit (The Lambda Protocol) nor the SAPS DNA Technology Kit gave any cause for particular concern. Few if any of the hazards and risks associated with the use of these kits are likely to be new to experienced science teachers. All of them may be adequately controlled by following normal good laboratory practice. Adequate information as to these risks is available to teachers either within the instructions accompanying the kits or in third party sources such as *Hazcards* or *Topics in Safety*.

There may be more concern for health and safety where enthusiasts seek to construct DIY versions of such apparatus or, having obtained a basic kit, may extend its use to other enzymes, DNA sources, stains etc. Such teachers would need to seek competent advice before so proceding and adopt the basic control measures shown in Table 1.

Novel procedures

There are a number of other practical protocols which could be used to illuminate parts of science courses which currently receive only theoretical treatment. Some of these are already educational activities in other countries. Several of them could be better tailored for educational use by making them cheaper or intrinsically safer to carry out. For example :

- isolation of bacterial or viral DNAs;
- ligation of DNA;
- transfer of DNA between certain organisms;
- the polymerase chain reaction.

But parts of these protocols may be seen as elements of *genetic manipulation* and thus subject to UK requirements under the relevant regulations [5] for formal registration and the setting up of a local advisory group. These formalities are possible disincentives to necessary educational developments. The majority of professional bodies and other organisations represented at the ASE convened seminar were of the opinion that the current HSE review of this area is an opportunity also to re-examine educational practice in this field.

References

1. *Topics in Safety*, 2nd Edition, ASE, 1988.
2. *Biotechnology and genetic engineering : students' knowledge and attitudes*, Lock, R. and Miles, C., Journal of Biological Education (1993), 27 (4).
3. *Safety Implications of biotechnological investigations in UK schools*, Madden, D., European Initiative for Biotechnology, 1993.
4. *Microbiology in schools and further education : An HMI Guide*, HMSO for the DfE.
5. *Genetic Manipulation : Health and Safety Regulations and Guidance, 1978*, HMSO for the HSE, now updated in *The Genetically Modified Organisms (Contained Use) Regulations, 1992, SI 3217*, HMSO.

Further reading

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DNA technology kits - a review, SSERC, Feature Article, Bulletin 180, Spring 1994.

The influence of teaching on knowledge and attitudes in biotechnology and genetic engineering : implications for teaching controversial issues and the public understanding of science, Lock, R., Miles, C. and Hughes, S., School Science Review, ASE (in press).

Appendix

List of organisations represented at the conference :

ASE; Biochemical Society; CLEAPSS; DfE; HSE; IoB; MISAC; NCBE; RSC; SAPS; SOED; Society for General Microbiology; SSERC, the Wellcome Trust.

Work Equipment Regulations - addendum

Standards and the CE mark

We have received comment that our interpretation of requirements for CE marking (Bulletin 182) may have misled some of our readers. Apparently readers may have got the impression that the only way for a manufacturer, importer or supplier to obtain the CE mark on a product is to demonstrate full compliance with a relevant technical standard, in practice an EN (European Norme).

In fact CE marking covers only what are termed the essential health and safety requirements. The overall requirements of a technical standard may extend well beyond these essentials. Some therefore argue that buyers need to be wary when advised that CE marking requirements are strictly equivalent to those of a complete EN standard since full compliance with the latter may mean unnecessary expense.

This is why we chose our words carefully in the article in Bulletin 182. We did write that : *In the short to medium term the situation will remain complex. This is because many categories of work equipment are not yet covered by a Product Directive and because such directives are not retrospective*. And, we also said : *One way of demonstrating such compliance with essential health and safety requirements will be by designing and manufacturing to the new harmonised standards.*

It may well turn out that the minimum requirements for a CE mark fall short of those for certificating compliance to a full standard. In other words a CE mark may be nowhere near the equivalent of a Kitemark.

Recent clarification and comment on the requirements for the CE marking of personal protective equipment (PPE) has proved helpful in this respect. PPE is subject to a separate set of regulations which are also part of the six pack. Here the requirements for compliance and the certification thereof may well depend upon the complexity and the standard of protection which is to be afforded by the equipment.

For simple items self-certification by the manufacturer may suffice and he may affix the CE mark himself. With other items compliance may have to be demonstrated through third party tests and certification. Yet more complex items may also have to be independently monitored in manufacture by a *notified body* nominated by the Government in the country of manufacture.

For a number of reasons we remain of the view that EN Standards, are central to the issue. That is why those in the educational sector, customers and suppliers both, need a better say in the formulation of many of them.

Felt-tip pens

We have read a report of a thirteen year old boy who developed acute dermatitis after writing on his hand with a marker pen [1]. Later patch testing showed that he had become sensitised to low concentrations of some of the components of the ink, namely 2-hydroxy-5-tertiarybutyl benzyl alcohol, 2,6-bis(hydroxymethyl)-4-tertiarybutyl phenol and to 4-tertiarybutylphenol-formaldehyde resin. (Incidentally these PF resins can also be found in adhesives, plywood, glass and mineral fibres, brake linings, papers, in various inks and in integrated circuits.) Casarett and Doull [2] had previously reported a chemically similar compound, 4-tertiarybutylphenol, as being a significant contact sensitiser. This latter compound is also a photosensitiser, resulting in de-pigmentation of the skin.

Marking pens and felt-tip pens are widely used in everyday life and contact with the skin, either intentional or accidental, is very likely for many of us. Indeed many use the back of the hand as a notepad which cannot be left or lost until they wash their hands. Yet contact dermatitis from this source is not very common.

This example makes the point that not everyone exposed to known sensitisers will go on to develop full sensitisation, but also that there is no way of knowing in advance which individuals are easily sensitised. So the best advice must be for all and not just atopic persons (those with a history of childhood ezcema, asthma, etc) to take the precautionary approach of reducing exposure to a minimum when handling known sensitisers and allergens. Some authorities argue that there are perhaps no persons who will not eventually become sensitised if exposed to a sufficiently high dose exposure.

Once a person has become sensitised to a particular substance, the only remedy to protect them is avoidance of all exposure to it. It is preferable to prevent sensitisation occuring in the first place than to have to segregate those who have become sensitised.

Many of the more important of the known sensitisers are to be found in Appendix 10 of the 'Yellow Book' [3], which most schools will have or from the free leaflets such as 'Respiratory Sensitisers, a guide for employers' available from the HSE. A very useful Guidance Note on how to control respiratory sensitisers is available from HSE Books [4].

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1. Hagdrup,H., *Contact Dermatitis*, September 1994, 31(3), 154-156.
2. Casarett ,L.J. and Doull, J., *Toxicology, the basic science of poisons*, 1991, Pergamon Press
3. *Preparing COSHH Risk Assessments for Project Work*, SSERC.
4. *Preventing Asthma at work*, HSE, 1994, ISBN 0 71760661 9.

Alternative solvents

As you probably know, our old friend 1,1,1-trichloroethane will soon be no longer available, because of its damaging effects on the ozone layer. It was so good at replacing 'carbon tet' and chloroform in most applications.

We have been in consultation with suppliers as to substitutes since 1992. So far the results have hardly been satisfactory, and having little of great interest to report, we have reported nothing. Two of the main patent alternatives put forward have been the *Volasil* oils from Merck and the *Rhodiasolv* solvents from Rhone Poulenc.

Volasil 244 and Volasil 245 are cyclic silicones carrying methyl groups with 4 and 5 siloxane groups respectively. Volasil 344 is a blend of the other two. They differ very slightly in a variety of physical properties and their miscibility with a range of other solvents is similar. Volasil oils are immiscible only with the more polar solvents, namely water, methanol, methanoic acid, ethoxyethane, ethane-1,2-diol, acetonitrile and ethanoic acid. Volasil boiling points (172 to 175 °C) are a bit on the high side to be useful for solvent extraction, but their low flammability makes their general use attractive. They can certainly be used as a solvent for bromine in the preparation of dibromo derivatives, but aqueous bromine is fine for most unsaturation tests. Their toxicities are low, but if they do burn (flash points 55 °C , 56 °C and 72 °C) a cloud of fine silica is formed; this is likely to be very toxic. The Volasils will have a lot of interesting properties in their own right and this could be fun, but their use as solvents is limited. Typical prices are £21.00 for 2.5 litres. The MSDS recommends disposal by specialist contractor.

Rhodiasolv RPDE is a blend of high molecular weight esters with low flashpoint, produced mainly for the paint industry. ICI, when contacted again very recently were still recommending trichloroethene! Zero marks out of ten to ICI. Several other large suppliers have failed to develop any alternative and seem little concerned - disappointing.

At the moment there does not seem to be a universal replacement for 1,1,1-trichloroethane and it is a more a case of horses for courses. Some of these alternatives are already known and some have been recommended in the Standard Grade Chemistry Practical Guides, eg the use of cyclohexane as the non-aqueous solvent for the nylon rope trick. We are in the process of examining the several courses used in Standard and Higher Grades and at CSYS level and will be reporting on this, but are still hoping that something better will be designed by chemical manufacturers. In the meantime hang onto your existing stock of 1,1,1-trichloroethane, use it carefully and, where it is easy to do so, recycle it. By doing so you are releasing only minimal amounts to the atmosphere. Depending on the particular use and on the quantities it may be easy to wash out the contaminant with the appropriate aqueous solution, eg aqueous sodium carbonate for solutions of bromine followed by washing with water, drying and then redistilling it. Rhone Poulenc still have stocks for sale.

Plug-top teaching aid

Templates for the construction of a large scale demonstration model of the wiring of an electric plug are provided and their use described.

Some of the problems associated with pupils practising wiring up 13 A plugs were raised in a recent issue of the Bulletin [1]. Since then we have received a design for a large scale demonstration model for use as a teaching aid prior to pupils carrying out the wiring exercise. Please note that there is no suggestion that demonstrations with such models might be an adequate substitute for the actual practical exercise using real 13 A plug-tops.

The design is the work of Murray Hall, a pupil of Lenzie Academy and a stalwart of the Lenzie Academy Science Club (LASC).

Enlarging the templates

Templates are provided on facing pages 10 and 11 overleaf. Each is only $^1/_5$ of the proposed finished size of the LASC version which is A1 - big enough to explain the principles to a typical Clydebank home crowd. Should you feel that A1 is a bit OTT then we found that enlarging each of the drawings twice in the photocopier gave a model large enough to demonstrate to a class or sub-group thereof. That is, the whole A4 Bulletin page is enlarged up to A3 (141%) and then the resulting figures again are enlarged 141% so that each occupies its own sheet of A3.

Construction

As with many such models the instructions turn out to be simple to understand but only once you have made the first model and your own mistakes! Murray Hall sent us a comprehensive set of instructions and we will try to do justice to them in this short article.

Materials The LASC model was constructed out of corrugated cardboard, a material which the school and club find very useful for modelling and construction generally. They have ready access to supplies of this type of card. We built ours out of the card we use to cover some of our publications (160 gm^{-2}). Whilst this worked reasonably well as a personal or temporary model it would not be sufficiently robust for demonstration purposes. The use of cardboard or the corrugated card originally suggested would provide a more durable model.

Cutting out Our first bit of advice is to read all of the instructions (twice!) before making any cuts. Note that:

W denotes waste (cut out and discard)

G means keep to one side or leave on template for glueing later

Each of the four enlarged templates is first glued or taped to a piece of the chosen constructional material.

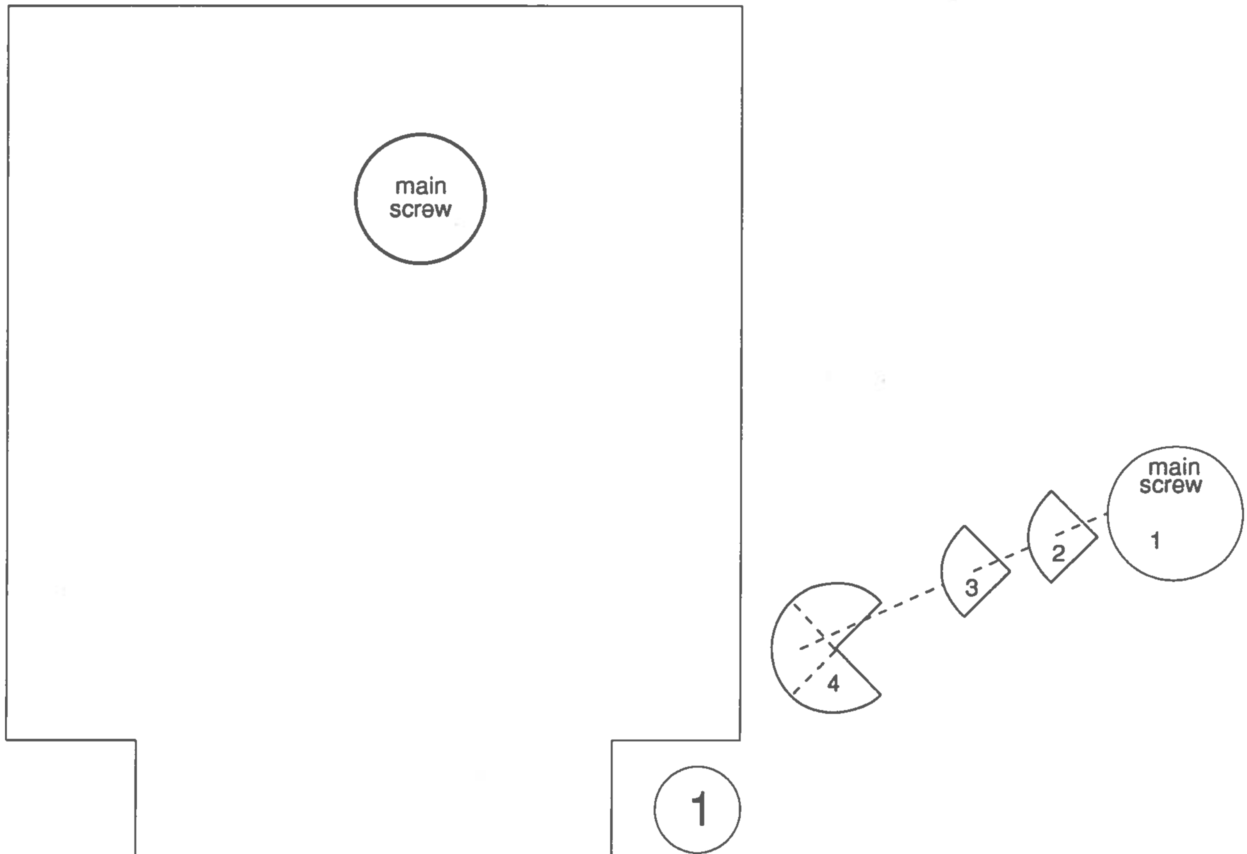
- Template 1- cut round the heavy black line, remove the part labelled *main screw* and keep it to one side.
- Template 2 - cut out all of the parts shown with a heavy black line i.e. *G, E, N, L, Fuse*, and *cable grip*. Keep to one side. Discard the areas marked *W. Cut out the plan of the plug top.*
- Template 3 - again cut out all of those parts denoted by a heavy black line that is all the areas denoted *G*, and the shaded wires denoted *neutral, earth* and *live*. Keep all of these to one side. The areas marked *G* in the lighter lined boxes are left on the template whilst those marked *W* are cut out and discarded. Again cut out the plan of the plug top.
- Template 4 - cut out the area marked *G* and keep it. Cut out and discard that marked *W*. You guessed it - cut out around the plan of the plug top!

Assembly First, place template 3 face down on a flat surface ensuring that all of the cut outs have been removed as described above. Using the glue points shown fix template 4 to template 3. Using those parts which hopefully you did not throw away - assemble and glue together all of the components of the main screw as shown in the inset on page 10. Then glue rectangles *E, L, N* to their respective *G*'s at the ends of each cable cut-out. Glue the *fuse* and the *cable grip* in place with a touch of glue on each of their glue points.

The cable cores can now be coloured and when dry slotted under the cable grip and placed in position. Then place the cards one on top of the other and hold them together with the main screw. You should now have a large serviceable model for demonstrating the proper wiring of a plug top.

Reference

1. *Concern over pupils wiring plugs*, Safety Notes, Bulletin 181, SSERC, 1994.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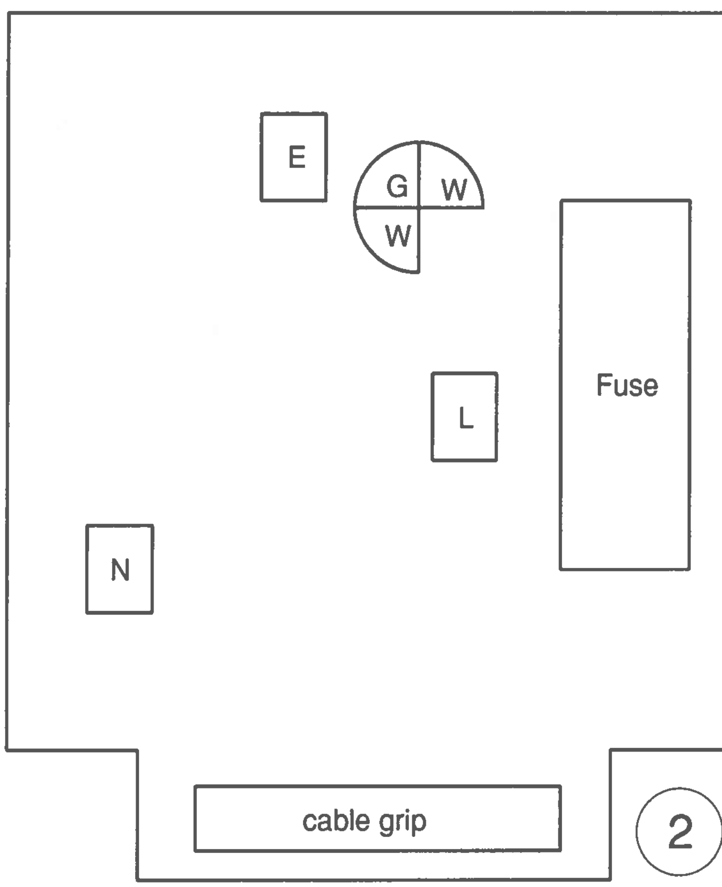
E
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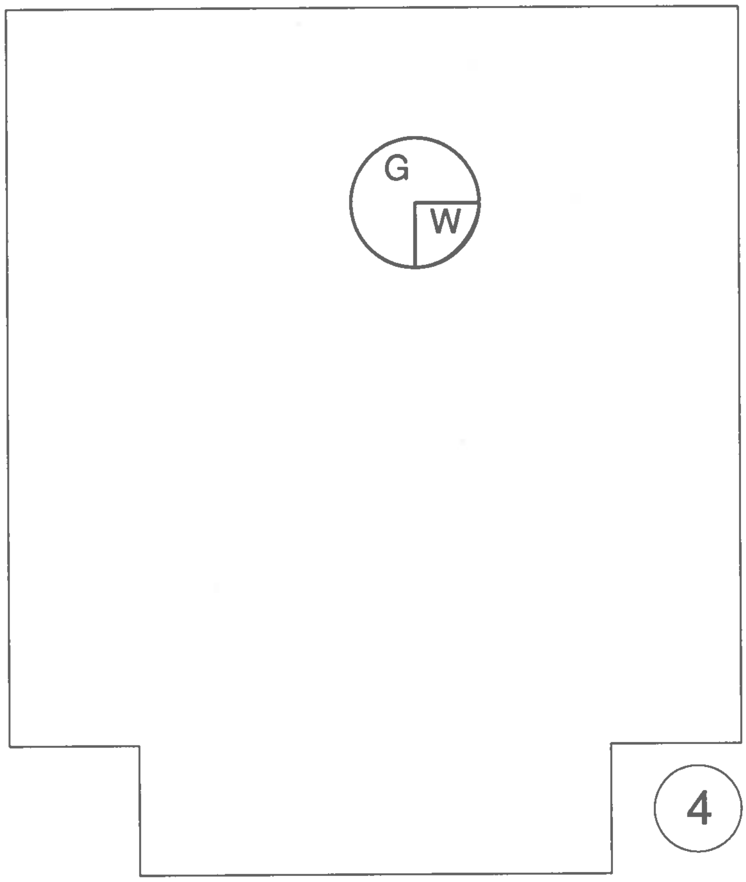
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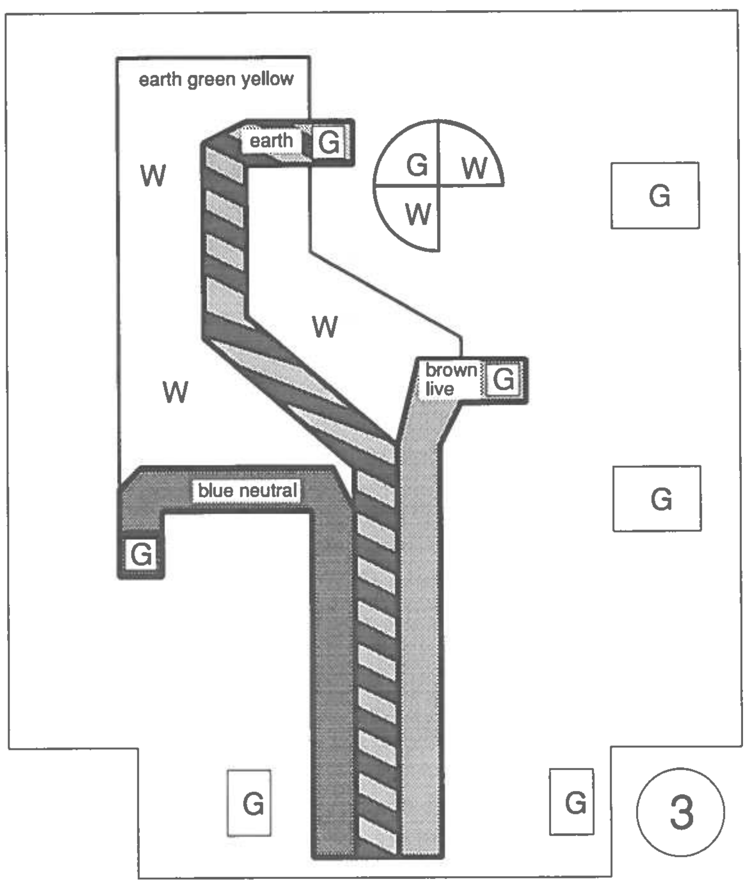
earth green yellow
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Interfaces, dataloggers and sensors - a market survey

An updated summary of SSERC's advice on computer choice is given and a number of tables are presented which give information as to what is currently available together with details of sources, prices and order codes or catalogue numbers.

It is now some years since we last carried in the Bulletin any overall surveys of this type of equipment [1,2]. The field is so subject to continual change that we have instead preferred to update the more general sections of our *Interfacing in . . .* series of staff development materials.

Direct enquiries on purchasing have however again been on the increase. Some kind of summary of what is currently available may thus prove useful. This we have tried to tabulate for each category of equipment. We have attempted to cover each major microcomputer platform used in education giving the range of available and relevant devices together with catalogue numbers and an indication of price. This summary was compiled in the period either side of the major trade shows at the ASE Annual Meeting and BETT (both early January 1995). We may have missed some new items but having attended the ASE meeting we are fairly confident that our compilation is fairly complete - but only at the time of writing!

Computer choice

We continue also to be asked for advice on which type of computer - Acorn, Apple or IBM (and compatibles) - is the best to use for science and technology education applications. This provides another reason for us to present an updated summary of interfacing devices and sensors. Established readers of the Bulletin will know of our stated preference in the past for the use of Acorn machines in science and technology education (although these views have been persistently misrepresented as extending to all departments and educational applications - which never was the case).

The major reason for that recommendation was the ease with which Acorn machines (first the so-called BBC series of models, then Archimedes and A-series models) could communicate with the outside world for the purposes of datalogging and control. At the same time, the various Acorn models could also adequately meet other requirements for IT application in science and technology. For a period also the Archimedes and A-series models were the only RISC (reduced instruction set computer) devices available at anywhere near affordable prices and their advanced operating system (RISCOS) offered very considerable advantages over most others.These issues were dealt with in more detail in SSERC Bulletins 163 and 169 [3, 4].

We no longer hold such firm views as to the overwhelming advantage of using Acorn machines. To a large extent many of their advantages have now been eroded. Choice of a particular type and model of microcomputer now increasingly depends on a specific mix of factors including the applications you have in mind, what you can afford and on a host of other, non-technical, considerations. These include matters such as compatibility with existing equipment and software or with other systems elsewhere in the school, college or education authority area.

This shift of emphasis has come for science and technology education because of the advent of intelligent interfaces and dataloggers, together with markedly increased reliability in communicating with computers via serial links. The BBC B and Master had their own on-board analogue to digital converters whilst the Archimedes and A-series models were easily upgraded to provide such a facility. Connecting these computers to the outside world was thus a fairly painless business. Other makes, in contrast, were both difficult and relatively expensive to use for gathering in data or sending out control signals. That gap has now closed.

With intelligent external hardware containing its own analogue to digital conversion circuits and its own significant amounts of memory, one interface or datalogger may be compatible both with a range of makes of computer and a wide range of sensors. The external hardware becomes independent of microcomputer type. What do have to be varied are the type of lead and connector used and the software to receive or transmit the signals and to interpret, process and display them.

That is not to say that we are now merely sentimentally attached to our various Acorn machines here in SSERC - whether old or new. They still have their many uses. In the case of our more up to date A-series hardware these systems are still technically far superior to any models the other manufacturers can offer at anything like the same price. For one thing we still use them to type-set this publication and to prepare all of the drawings both for it and our various graphics library products.

It is to say that no longer would we automatically confine our recommendations just to Acorn but would consider all of the circumstances of a user before giving any advice whatsoever (and we may not offer any at all if the planned application is outwith our areas of expertise).

cont./p.15

Interfaces to Analogue Port (BBC type)	Cat. Number	Price - £	Supplier
Connecting box - black	E60010/1	39.95	Philip Harris
Extra Sense A-D Port Ext. Module	506BBC	29.00	Deltronics
Sense IT (5 pin DIN inputs)	674	39.00	Deltronics
Sense IT Kit (Sense IT, light level, 2 x light gates, light switch, Toolkit software, 24 worksheets)	670/BBC, /ARC or /RML	115.00	Deltronics
Sense (uses Sense & Control sensors)	6700	49.00	Data Harvest
Primary Sensing Pack (Sense, 2 x temperature, 1 x light, 2 x pressure mats, digital connecting block, PriSM software, Curriculum Pack)	PS1/2/3	185.00	Data Harvest
ADC Interface	6280	49.00	Data Harvest
Beaver Sensing Kit (analogue card, remote input card, light, turn and temperature sensors)	532.234	99.75	Unilab
Simple Interface (4 analogue and 2 digital inputs)	532.010	48.03	Unilab
Interface to 1 MHz Bus (BBC type) port			
Microcomputer Interface (analog, digital I/O, relays)	532.001	262.80	Unilab
Dataloggers - Serial Port (of various computers)			
Simple Logger (4 channel datalogger, BBC only)	532.037	107.61	Unilab
PowerBase (datalogger & controller)	532.012	345.00	Unilab
Extra Sense (5 pin DIN inputs, serial port type)	680ARC/PC	93.00	Deltronics
Smart Box (Interface, manual, leads & software)	SB-01+	275.00	Economatics
Smart Box EV (enhanced version retains progs.)	SB-EV+	365.00	Economatics
Universal Interface (serial port type)	E11500/4	129.50	Philip Harris
DL plus 32 (LCD display, record up to 20 data files)	E40000/8	329.75	Philip Harris
DL plus 128 (LCD display, rec. up to 100 data files)	E40400/2	425.00	Philip Harris
System SM Physics Curriculum Pack (DL+ 32, distance, magnetic flux, sound, IR SensorMeters, Datadisc Pro, power adaptor, junction box, serial & SensorMeter leads, 15 curriculum worksheets	E31000/7	945.00	Philip Harris
System SM Chemistry Curriculum Pack (DL+ 32, temperature, conductivity, pH, UV SensorMeters, Datadisc Pro, power adaptor, junction box, serial & SensorMeter leads, 15 curriculum worksheets	E31100/0	995.00	Philip Harris
System SM Biology Curriculum Pack (DL+ 32, pressure, temperature, light, oxygen SensorMets, Datadisc Pro, power adaptor, junction box, serial & SensorMeter leads, 15 curriculum worksheets	E31100/0	899.00	Philip Harris
Sense & Control (including power supply unit)	6000	179.00	Data Harvest
S & C General Purpose Data Capture Package S & C, power supply, serial lead, 3 x temperature 1 x light, 1 pH (no probe), 2 x light gates	6021	370.00	Data Harvest
LogIT starter pack (LogIT, light & temperature sensors and plastic carrying case	CRD-100-Q	199.90	Griffin & George
LogIT CheckIT (add-on LCD display for LogIT)	CRD-150-560M	59.90	Griffin & George
LogIT All-in-One Pack (LogIT, CheckIT, light & temperature sensors, power pack, LinkPack starter software and serial cable + plastic case	CRD-107- XXXX Suffix is machine dependent	319.00	Griffin & George
LogIT Quad Pack (4 x LogIT, 2 x power packs, CheckIT and 2 x plastic cases with manuals	CRD-108-010L	875.00	Griffin & George
LIVE system (interface, serial lead + temperature & light sensors in storage case - March '95)	TBA	TBA	Griffin & George

Table 1 Descriptions, order codes or catalogue numbers, prices and suppliers for interfaces and dataloggers

Sensor type Cat. No. (Price - £)	First Sense Philip Harris	SensorMeters Philip Harris	Blue Box etc. Philip Harris	Unilab etc.	LogIT Griffin & George	Data Harvest (Educ. Elec.)	Deltronics	SMART Economatics
Breathing rate					CRD-130-580U (42.00)			
Conductivity		E30060/9 (120.00)	E60118/9 (64.00)	425.027 (50.86)	CRD-220-680 (158.00)	6165 (59.00)		
probe (if extra)	E30065/8 (73.82)	E60119/1 (88.25)	424.005 (35.98)	424.005 (35.98)		6166 (69.00)		
Current (high, to 10A)		E30090/7 (89.50)	E60110/5 (49.95)					
Current (low, up to 1A)		E30130/4 (89.50)	E60112/9 (54.75)		CRD-130-635V (24.90)			
Dissolved oxygen		E30320/9 (98.75)	E60140/3 (51.30)	421.008+ (58.53)	CRD-220-650B (158.00)	6170 (69.00)		
probe (if extra)		E30320/9 (69.41)	E30365/9 (69.41)	424.009 (104.51)	included above	6171 (69.00)		
Distance		E30160/2 (120.00)		414.043 (190.00)			9200 (69.00)	
ECG			H7088/4 (154.07)	743.001 (115.07)				
Electrometer			Q73010/7 (198.77)	003.816 (74.00)				
Extension leads	E11100/9 (6.00)	E30872/4 (5.12)	as above	as above	CRD-130-500V (9.90)			
(different lengths)	E11110/2 (19.95)				CRD-130-560D (11.90)			
Humidity (relative)	E11020/1 (54.95)	E30200/9 (120.00)	E60120/8 (102.50)	425.025 (57.97)	CRD-130-630Y (69.90)	6195 (69.00)		SS-425 (39.00)
Infra red irradiance		E30240/0 (145.00)	E60122/1 (121.15)			6220 (69.00)		
Joulemeter/Wattmeter			Q42850/6 (175.50)	082.605 (180.00)	XHM-843-010B (230.00)			
Light (linear)			E60127/0 (75.90)	425.020 (56.72)	CRD-130-625B (59.90)			
Light (logarithmic)	E11010/9 (39.95)	E30280/1 (95.25)	E60124/5 (39.80)	425.020 (56.72)	CRD-130-510S (19.90)	6120 (15.00)	617 (6.20)	SS-410 (18.00)
Light gates (pair)	Q37750/9 (99.00)			414.044 (120.00)	CRD-130-595H (49.90)	6140 (2 off-48)	616 (2 off-24)	
Light gate source					CRD-130-605H (17.90)			
Light switch					CRD-130-515Y (19.90)	6150 (11.00)	616 (5.20)	
Magnetic flux		E30320/9 (125.00)	E60130/0 (79.95)	612.003 (125.00)			623 (24.00)	624 (24.00)
Magnetic switch					CRD-130-535C (17.90)		231 (3.20)	
Manometer (electronic)			E60132/4 (56.75)					
Materials tester				871.620 (495.00)				
pH		E30390/8 (125.00)	E60150/6 (50.20)	425.022 (45.59)	CRD-130-550G (39.90)	6180 (39.50)	621 (49.00)	
probe (if extra)		Y37220/4 (39.80)	Y37200/9 (39.80)	425.060 (34.30)	PHP-100-150P (43.75)	2251/2 (42/97)	included	
Position	E11060/2 (59.60)	E30420/2 (89.00)	E60154/3 (61.25)	425.029 (TBA)	CRD-130-590R (44.90)	6131 (39.00)	620 (22.00)	SS-415 (30.00)
Potometer			H70350/8 (70.00)		YUH-180-X (31.65)			
Pressure (air)	E11030/4 (85.75)	E30030/0 (110.00)	E60115/4 (96.50)	425.025 (57.97)				
incl. gas pressure		E30540/1 (130.00)	E60155/5 (100.95)					
Pressure pad switch						6190 (24.00/2)	622 (5.40)	
Pulse rate			E60157/9 (55.94)		CRD-130-55T+ (143.50)	9000 (79.00)		
Push switch					CRD-130-530M (14.90)		202 (3.60)	
Radioactive count rate		E30500/0 (140.00)	E60159/2 (87.75)	532.006 (103.45)				
Geiger probe		E30502/4 (95.00)	Q88510/0+(219.55)	051.581 (136.20)				
Reflective light switch					CRD-130-520P (27.90)	6150 (11.00)		
Rotation	E11050/9 (39.95)			532.047 (14.13)	CRD-130-590R (44.90)	6135 (19.00)	620 (22.00)	
Sensor-computer leads	included	included	standard 4 mm	standard 4 mm	included	included		
Sound	E11040/7 (44.50)	E30620/9 (110.00)	E60160/9 (64.00)	425.026 (52.26)	CRD-130-585K (39.90)	6220 (39.00)	626 (15.00)	
Start/mark switch					CRD-130-525F (14.90)			
Strain gauge			E60162/2 (114.60)					
Temperature (high T)		E30700/8 (110.00)	E60180/4 (106.15)	424.014+ (89.43)	CRD-130-575N (59.90)			
Type K probe (if extra)		E30702/1 (30.00)	E60182/8 (29.60)	424.015 (31.16)	included			
Temperature (low T)	E11000/6 (39.95) CRD-130-570A (22.90)	E30660/0 (89.95)	E60170/1 (66.58)	425.023 (61.07)	CRD-130-505L (14.90)	6100 (19.00)	614 (9.40)	SS-400 (15.00)
Temperature difference		E30730/6 (110.00)						
Ultra violet		E30730/6 (145.00)						
Voltage		E30460/3 (89.50)	E60185/3 (49.95)		CRD-130-540J (24.90)			

Table 2 Descriptions, order codes or catalogue numbers, prices and suppliers for sensors etc.

A key reason why we may yet stick to using Acorn-series machines for much of our own work is what has been termed machine convergence. This has come about as designers and manufacturers other than Britain's very own Acorn have turned to getting more processing power through radical technical measures rather than by merely cramming more or bigger chips onto their computer boards. Thus we have seen both Apple and IBM move over to RISC type systems. At the same time true dual machines have been introduced in the shape of Acorn's Risc PC (Acorn/IBM) and Apple's PowerMac (Apple Mac/IBM).

The summary tables

Because often the same interface or datalogger with its full range of sensors may be compatible with all three major computer types we are able to summarise information on suppliers, catalogue numbers and prices for these by means of a table for each (Tables 1 and 2). A separate table is needed however to show information on the different types of serial lead and connector required for different computers (Table 3).

Note that where a lead is shown as being available then there will usually also be software to support that particular computer and interface or datalogger combination. It does not mean however that a full range of software options (several different packages, from more than one author or source) is necessarily available to support that combination. Note also that some suppliers combine the price of the lead with that of one type of connecting software.

We just do not have the necessary time or space to fully list all of the available software variants, each of which may be available in three or more versions to suit different makes of computer. That would need a table as big or bigger than those we have managed to draw up combined. We can however make a current recommendation as to one particularly "good buy" for general use. This has to be one of the variants of the *Insight* package. These are available to suit either serial or analogue outputs from a wide range of dataloggers and interfaces and to run on any of the major three computer types.

cont./over

Supplier Interface or datalogger Cat. No., price (£) etc.	**Data Harvest Sense, Sense & Control**	**Deltronics Extra Sense+**	**Economatics Smart Box (EV)**
BBC B/Master	6400 (17.00)	Included	SB-01-BBC
Acorn (serial port fitted)	6407 (17.00)	680ARC	SB-01-ARC
Acorn Pocket Book or Psion Series 3	6460 (17.00)	not available	not available
IBM/compatible 25 pin serial port	6406 (17.00)	680PC	SB-01-PC
IBM/compatible 9 pin serial port	6406 (17.00)	680PC specify 9 pin serial	SB-01-PC specify 9 pin connector
Nimbus PC186	6402 (17.00)	not available	SB-01-RM186
Apple Macintosh	6405 (17.00)	not available	SB-01-MAC all software/connect packs are £49.50 each
4 mm adaptor leads	6151	not available	

Supplier Interface or datalogger Cat. No., price (£) etc.	**Griffin & George LogIT etc.***	**Philip Harris Universal/DL+**	**Unilab Powerbase**
BBC B/Master	CRD-110-010G (29.90)	E11575/2 (15.00)	not available
Acorn (serial port fitted)	CRD-110-030A (29.90)	E11570/3 (15.00)	532.013 (96.00)
Acorn Pocket Book or Psion Series 3	CRD-140-065G (29.90)	not available	not available
IBM/compatible 25 pin serial port	CRD-110-051P (49.90)	E11560/0 (20.00)	532.015 (96.00)
IBM/compatible 9 pin serial port	CRD-110-051P (49.90)	E11550/8 (15.00)	532.015 (96.00)
Nimbus PC186	CRD-110-051P (49.90)	E11580/6 (20.00)	not applicable
Apple Macintosh	CRD-110-070L (49.90) *All prices inclusive of connecting software	E11565/9 (20.00)	532.014
4 mm adaptor leads	CRD-130-545W (21.90)	E60010/1 (5.75)	not applicable

Table 3 Order codes and prices etc. for connecting leads and ancilliaries for various makes and models of microcomputer and interfaces and dataloggers.

This choice is not however likely to suit the physicists nor, for some applications, the technologists. This is because the former have a need for fast data capture where even microseconds may count. Technology teachers may require fairly sophisticated control facilities. Equipment and software particularly suitable for such applications will be reviewed in a future issue.

These days the limits to the speed of data capture may reside with the external hardware rather than with the data capture software or the vagaries of a particular operating system. If a datalogger can be programmed to capture data at a high rate then so long as the software can program the logger to capture data quickly, it may *remote fetch* - as the jargonists have it - that data at a much more liesurely rate. More on that anon - but not in this issue.

References

1. *Interface reviews*, Interfacing Notes, Bulletin 154, SSERC, November 1986.
2. *Interfacing - The datalogger cometh*, Equipment Notes, Bulletin 169, SSERC, April 1991.
3. *After the Master - Which Computer?*, Equipment Notes, Bulletin 163, SSERC, September 1989.
4. *Computer choice - again*, Equipment Notes, Bulletin 169, SSERC, April 1991.

EQUIPMENT NOTES

Kits for digital electronics from JJM

JJM Electronics have designed two kits with which to support practical work in the Digital Electronics Optional Topic in CSYS Physics. Both kits are reviewed here. The kits are also of use in other courses.

Kit 1 : Circuit boards for CSYS Digital Electronics

JJM Electronics have devised an electronics kit comprising five boards which together provide exactly what is required for this Optional Topic in CSYS Physics - that is unless you prefer working with raw chips and breadboard. Some of us do! The kit is curriculum specific. That is to say, all the necessary practical work that should be undertaken to support the learning outcomes can be done, and satisfactorily. As far as we are aware, there is no other inexpensive logic kit which meets this need. Every other we have looked at has features which are not in the course, and lacks features which are in the course.

The facilities on the five boards are listed in Table 1. Not least are those to be found on the Logic Test Functions Board, which provides the inputs and outputs needed to test logic circuits. Indeed if you are short of cash and cannot afford the full kit, this one board would be worth buying to support work with logic devices on breadboard.

The boards are unenclosed. All interconnections are made with 2 mm sockets. Leads are not supplied with the kit, but can be supplied additionally. Our only concern is with the type of terminal used for the power leads, which may be vulnerable to damage. Responding to this criticism, JJM assure us that there is no fault history associated with this part. In any case, the supply can be taken to 2 mm sockets, which make the terminal redundant.

Product	Facilities	Price
Logic Test Functions Board	Clock, variable frequency, 2 single pulse generators from debounced switches, Binary counter with 4-bit output, 4 switches to set logic levels, 6 logic indicators (buffered LEDs), Logic probe	£27.50
AND/OR Gates Board	4 x 2-input AND gates, 2 x 2-input OR gates, 2 x 2-input exclusive OR gates, 3 x inverters	£11.90
NAND/NOR Gates Board	4 x 2-input NAND gates, 4 x 2-input NOR gates, 3 x inverters	£11.30
D-type Flip-Flop Board	4 independent D-type flip-flops with positive edge triggering and set and reset inputs (74HCT74)	£12.80
J-K Flip-Flop Board	4 independent J-K flip-flops with negative edge triggering and set and reset inputs (74HCT112)	£12.80
Set of all five boards		£73.00
Set of 2 mm leads	22 leads	£21.00

Table 1. Facilities on Circuit Boards for CSYS Digital Electronics made by JJM Electronics.

All parts on the boards have been found to work reliably, whether in isolation or with other parts in complex circuits. The boards are populated with a mix of LS, HC and HCT families. We did not find any operational problem presented by this assortment. It is good that the edge triggering on the two types of flip-flop, positive on D-type, negative on J-K, matches SCCC Support Series 6. It is also good that relatively complex circuits mixing flip-flops with combinational logic work reliably. Similar circuits built on breadboard with HC series logic can be bedevilled by logic races or spikes which require capacitors to be inserted in the oddest places. None of these problems were experienced with this kit.

The boards may also find use in Higher Grade Technological Studies.

Verdict

A - most suitable for use in Scottish schools and non-advanced FE.
(Code : A = most satisfactory, B = satisfactory, C = unsatisfactory)

Kit 2 : Prototype Board Projects for CSYS Physics Digital Electronics

This is a further electronics kit by JJM Electronics for use in the Digital Electronics Topic in CSYS Physics. It is based on prototype board (or breadboard, its synonym). The kit comprises 22 different integrated circuits, some discrete components and four prototype boards, each of which is populated with a utility circuit (Table 2).

The many integrated circuits supplied with the kit fall into two groups. There are those that directly relate to the syllabus and to the SCCC syllabus interpretation (LS08, 04, 32, 00, 02, 86, 74, 76, 47 and arguably LS293 and ZN426E). We'll refer to them as *Group A*. The remainder, *Group B*, (LS148, 138, 247, 280, 283, 393, 95, 164, 670, 21 and 27) are not required by the syllabus, but help to illustrate points in the course and to expand on them.

The CSYS course is structured bottom-up in the development of ideas. You start with a simple structure, add to it, explain what happens, and continue getting ever more complex. The structures in Group A except for LS47, LS293 and ZN426E are either simple gates or flip-flops from which adders, encoders, counters, shift registers and so on are built.

The structures included in Group B are certainly interesting and imaginative. They expose the teacher and pupil to a glimpse of the vast array of digital devices on the market. By opening the minds of young persons to this resource, Group B is worth having. They also point to the way in which engineers work - consulting the catalogue for the optimum fitment! No one would use two 93s when a single 393 would suffice. The 4-bit shift register 195 uses four flip-flops and dozens of gates. Surely no-one would ever make one up from first principles!

Therefore in our judgement Group B is a useful extra resource for this course.

The breadboard approach with Groups A and B is therefore seen by us to be worthwhile either as the sole resource, or as an additional resource to the JJM Circuit Boards because (1) it introduces pupils to prototype board work, and (2) it provides the riches of Group B.

Following these general remarks, we have some specific comments :

1 The kit should have been based on the HC series rather than LS because relatively very few circuits are built from LS as nearly everyone now uses CMOS.

2 The notes on prototype board projects are well written and very helpful. They are supplementary to SCCC Support Series 6. Almost the entire contents of the notes are either extra-curricular, or approach syllabus concepts from an extra-curricular route via Group B devices. They are adequate to support independent working by pupils.

3 Because LS series specify sinking currents into outputs as a general rule, the mixture of sinking and sourcing is wrong and confusing.

4 The pre-wired utilities on prototype board are useful, but how long will they remain untouched? Utilities should preferably be permanent circuits, either on stripboard or on printed circuit board.

5 The 180 Ω resistors in series with LEDs could more efficiently be replaced with 560 Ω or 680 Ω for red LEDs and 470 Ω for other colours.

In summary, we like the concept of this second JJM product, Prototype Board Projects for CSYS Physics Digital Electronics. Basically it is a useful resource, but we dislike some of the detail. The price of the kit is £40.

Verdict

B - satisfactory for use in Scottish schools and non-advanced FE.
(Code : A = most satisfactory, B = satisfactory, C = unsatisfactory)

Prototype board	Utility
Board A	4-bit switched input, single LED indicator, space for i.c.
Board B	8-bit switched input, space for i.c.
Board C	manual clock (debounced switch), automatic clock (pulse generator), space for i.c.
Board D	8-bit LED display

Table 2. Utilities provided on breadboard with Prototype Board Projects for CSYS Physics Digital Electronics.

TECHNICAL ARTICLE

Timing projectile motion

The time of flight of a projectile can be automatically measured by using two vibration detectors, as used in security applications, to trigger an electronic timer.

This is an adaptation of an experiment designed by Pat Cleary, PT Physics at St Ninian's High School, Kirkintilloch, and colleagues, for automatically measuring the time of flight of a projectile. The purpose is to show that the time of a horizontally projected ball bearing falling to the floor has always the same value irrespective of the speed of projection or range of trajectory. The apparatus (Fig. 1) comprises two impact and vibration detectors which start and stop a digital timer. The upper of the two detectors has been adapted by disconnecting its internal bi-morph vibration element and substituting a similar bi-morph which dangles over the lip of the bench. When the ball is projected, it brushes against this bi-morph, thus triggering the detector and starting the timer. The lower detector is mounted on a horizontal wooden board resting on the floor. The board is aligned to lie in the vertical plane of the trajectory and carefully levelled. When the ball strikes the board, the vibration created by the impact triggers the detector and thereby stops the timer. The lower detector should be positioned, at that end of the board which is directly under the lip of the bench, safe from a direct hit. A curved runway is mounted on the bench from which to launch the projectile with different speeds.

Sensor Technologies UK Limited (SenTecs) make the detector (part number SV1). It would seem to be widely available from security companies. We ordered one from Alarm Express Limited in Glasgow and it was delivered to us in Edinburgh the same day - all for £9. Subsequently we found that a company next door to us, Gardiner Security Limited, sells them over the counter.

The SV1 detector is smart. Its transducer is a piezoelectric device which appears to be similar to the Bi-morph (vibration) Element (285-784) sold by RS Components (Fig. 2), who charge £1.45 for a pack of five. The detector circuitry includes an analyser, sensitivity control, latch and relay. The relay contacts are normally

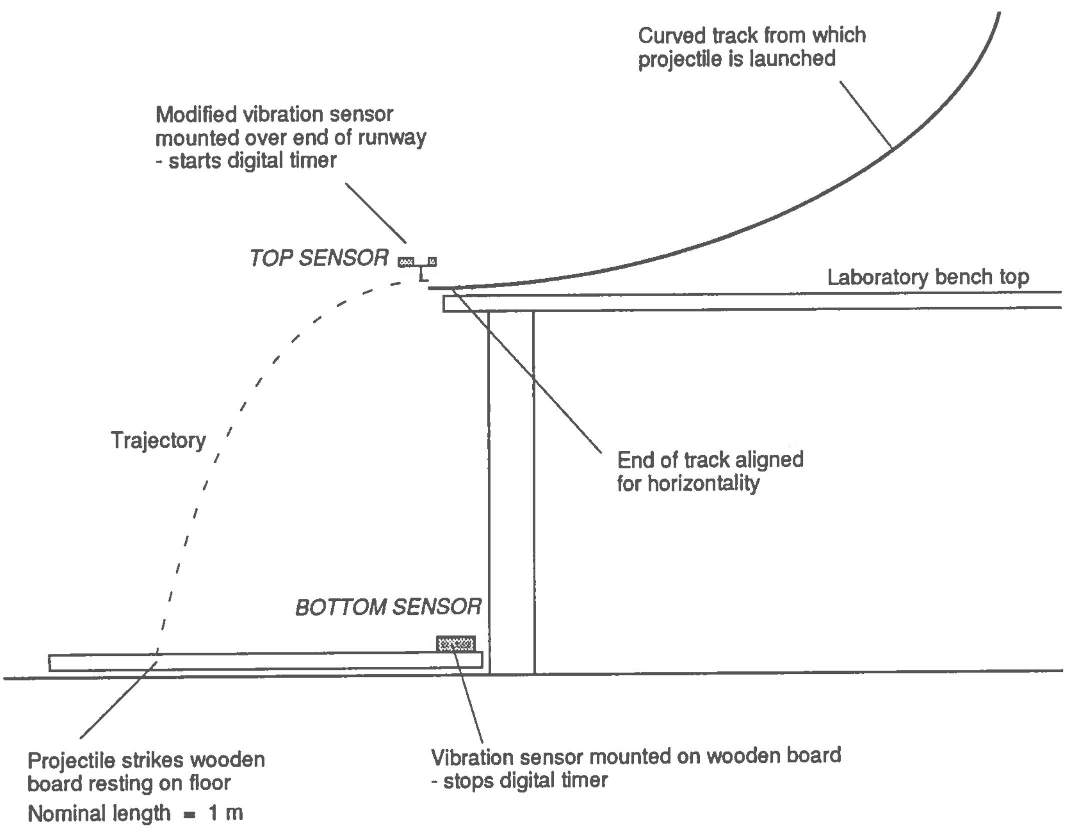

Figure 1. Apparatus layout showing the curved track from which the projectile is launched, the striking board and the positions of the two sensors.

closed and have a 10 Ω, ¼ W resistor in series. When an impact or vibration is sensed, the relay contacts open for a period of not less than 1 s.

To modify the SV1 detector that fits above the end of the runway, open the enclosure, carefully unsolder the bi-morph embedded on the detector and attach a replacement RS bi-morph by soldering to the relevant contacts (Fig. 3).

Of the seven terminals on the SV1 detector (Fig. 3) only four are used in this application. The two adjacent to the LED (1 and 2) connect to a 12 V d.c. supply. The next two (3 and 4) connect to the digital timer. The exact method of connection depends on the characteristics of the timer. Circuits for five different timers are given (Fig. 4-8). We suggest using non-screened, 6 core, 7/0.2 mm cable as this is readily available and quite cheap from security firms. Otherwise for the 4 core version try Tait Components (310-240, £7.35 for 100 m) or RS (362-831, £8.06 for 25 m). If the negative terminal of the 12 V d.c. supply is commoned to the negative terminal of the alarm circuit (lines 2 and 4 of the terminal block) then only 3 core cable is required for the connection to the timer.

A zener diode (BZX79 series, 5.1 V, RS 283-659) is required in some circuits (Fig. 4, 5, 7, 8) to set the logic level input at 5 V. These same circuits also need an external power supply. This should be 12 V d.c., either smoothed or voltage regulated.

Our projectile was a 19 mm diameter steel ball. For the curved track we used a lid from rectangular PVC trunking measuring 25 mm by 16 mm in cross section. We got this from the electrical section of a DIY store (Texas, part number CT302). RS part number 605-251 would seem to be similar, but RS sell trunking in packs of six. This trunking lid has an overall width of 25 mm and an inside

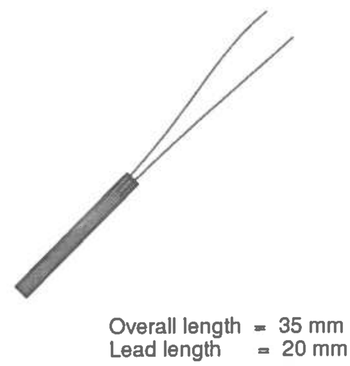

Figure 2. The sensor - a piezoelectric ceramic bi-morph element from RS Components (RS 285-784).

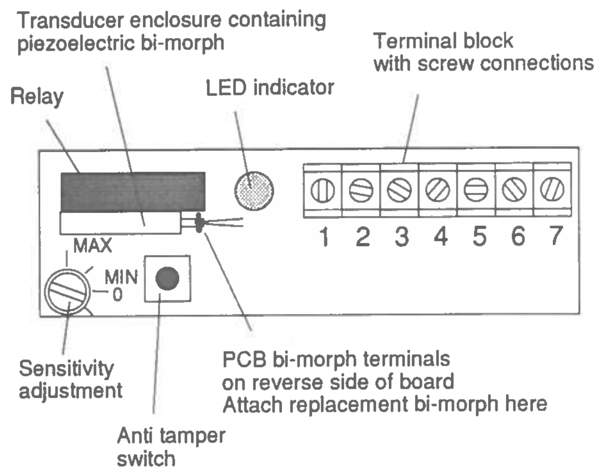

Figure 3. Layout of components on the top surface of the printed circuit board in the vibration detector, type SV1.

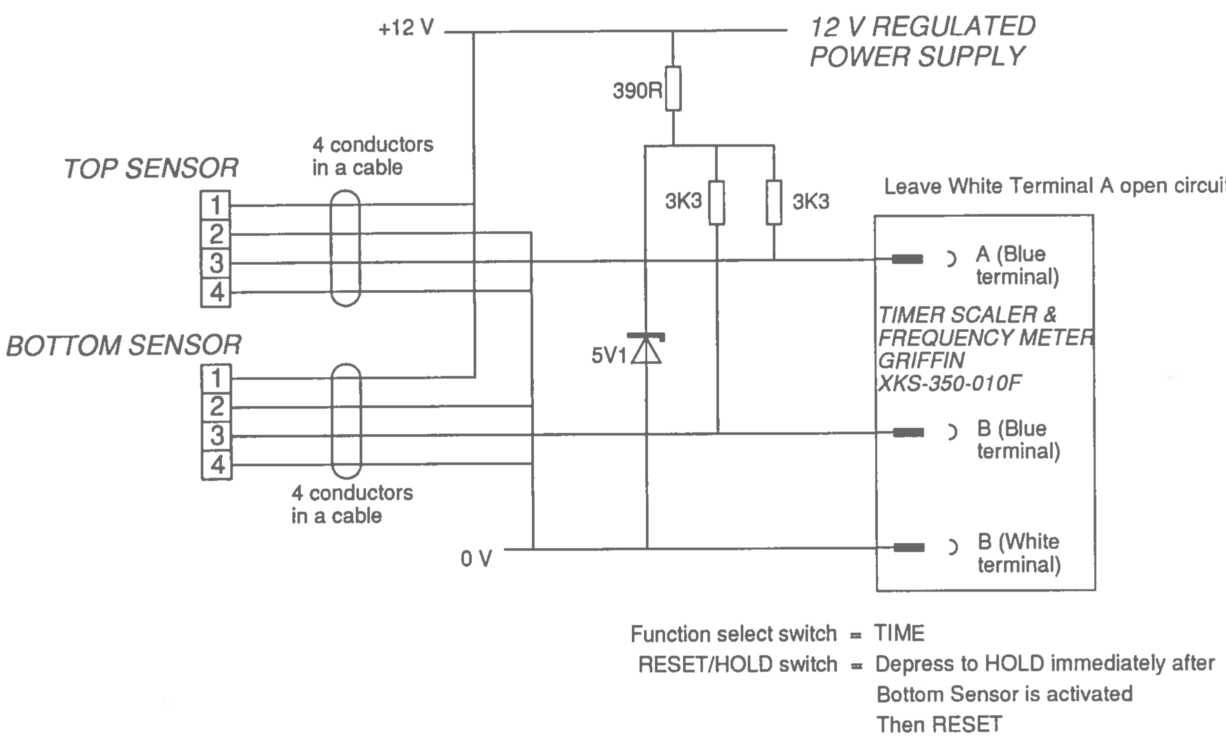

Figure 4. Circuit diagram connecting two vibration detectors, type SV1, to a Griffin Timer Scaler & Frequency Meter, XKS-350-010F.

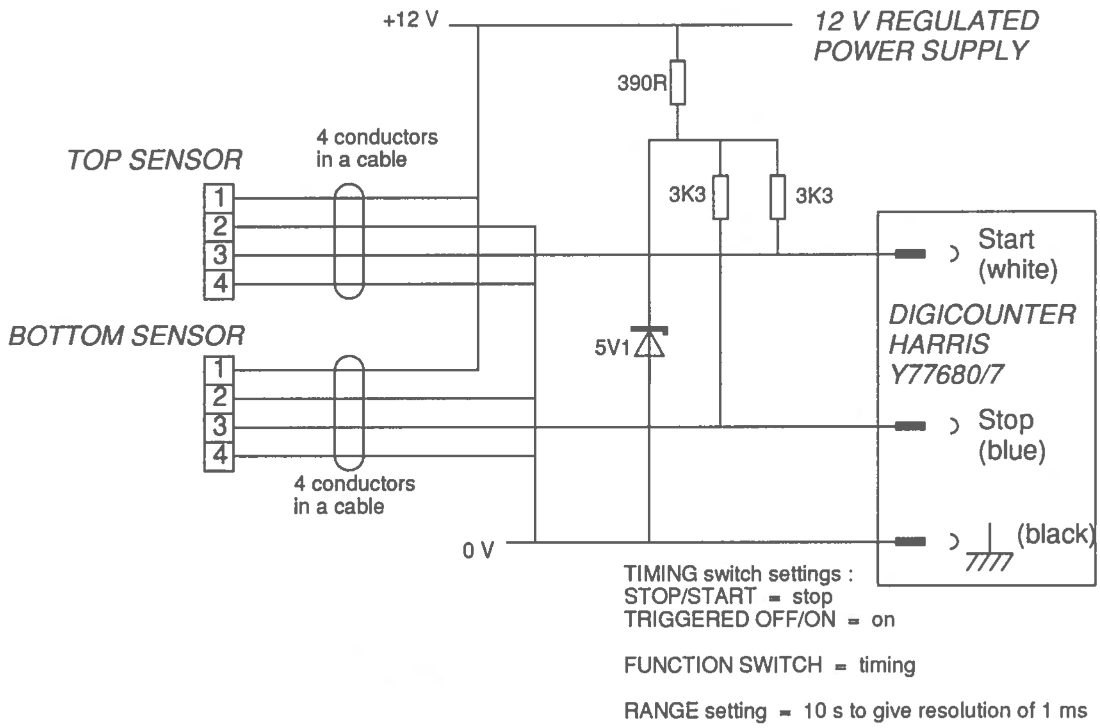

Figure 5. Circuit diagram connecting two vibration detectors, type SV1, to a Harris Digicounter, Y77680/7.

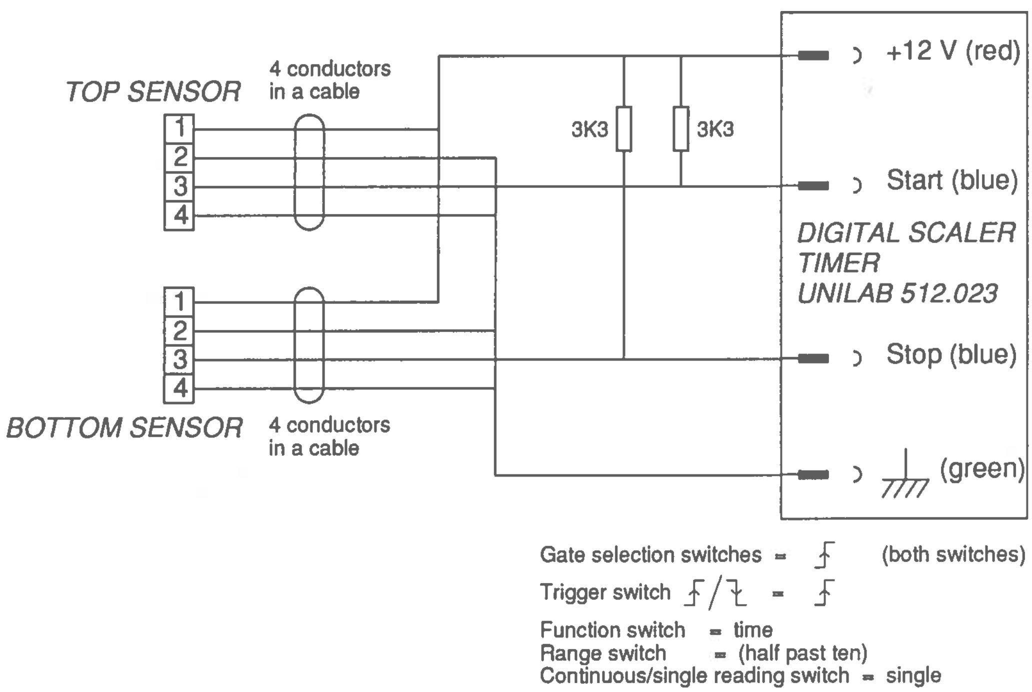

Figure 6. Circuit diagram connecting two vibration detectors, type SV1, to a Unilab Digital Scaler Timer, 512.023.

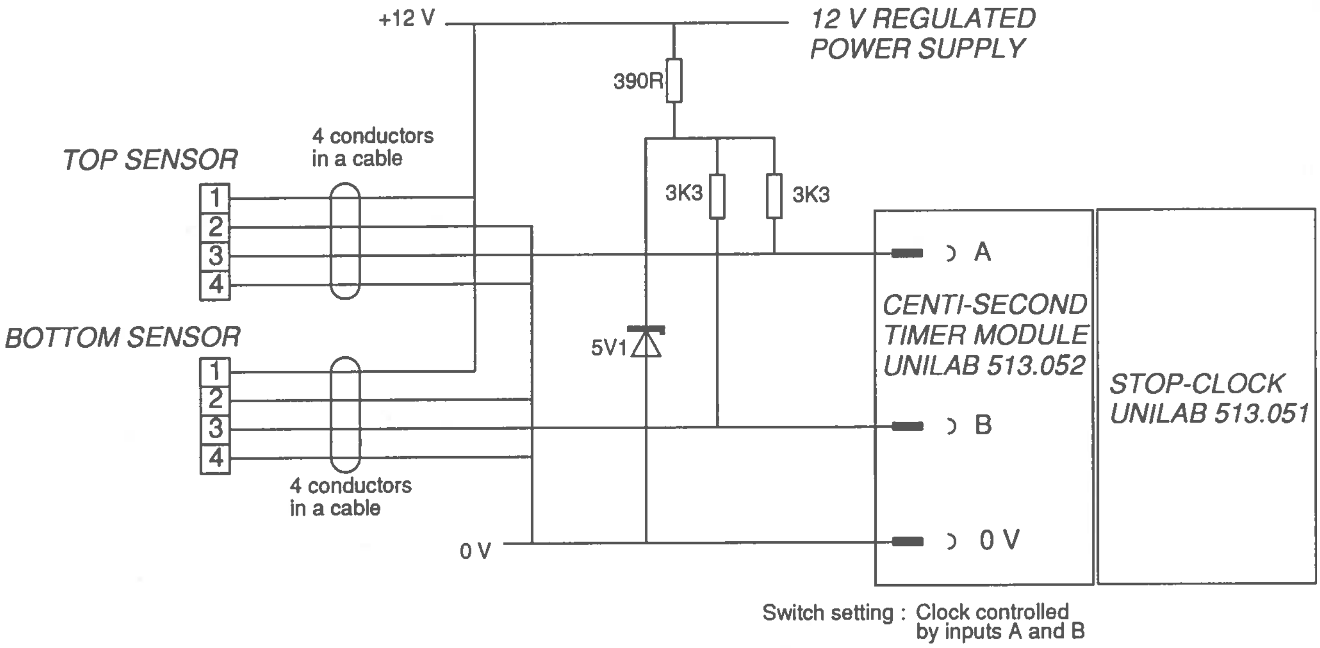

Figure 7. Circuit diagram connecting two vibration detectors, type SV1, to a Unilab Stop-Clock, 513.051.

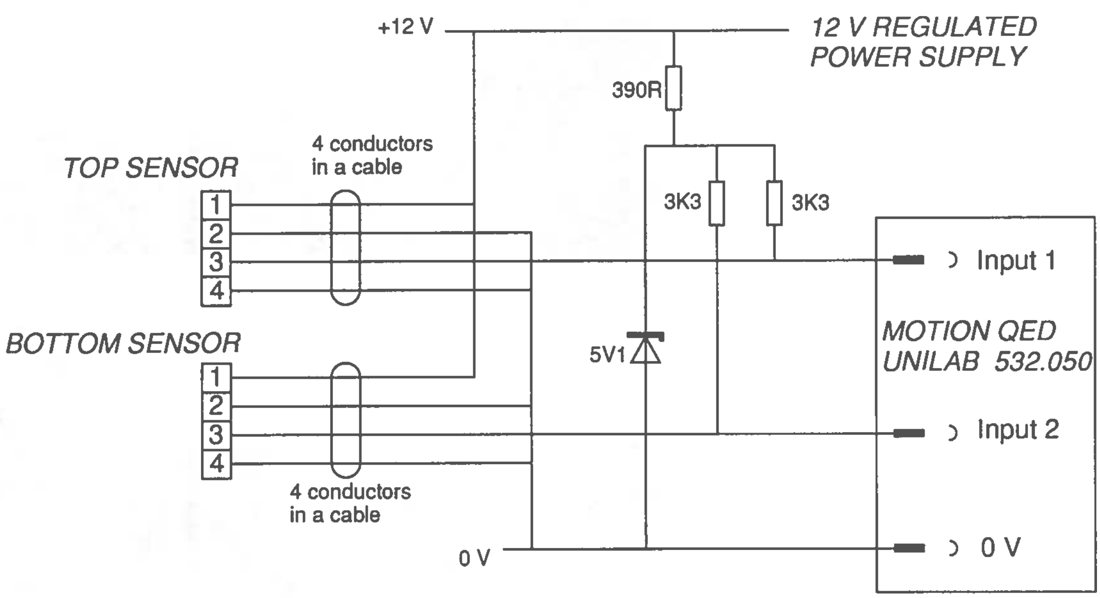

Figure 8. Circuit diagram connecting two vibration detectors, type SV1, to a Unilab Motion QED, 532.050.

width of 15 mm between the projecting ridges down either side. Although many plastic mouldings twist and warp when bent into a curve, this type of moulding does not distort when flexed into a curved shape. This track is sufficiently wide for a 19 mm diameter ball to have one point of contact. However in practice the ball tends to run alongside one lip such that it has two contact points (Fig. 9).

The trunking lid should be secured by map pins to wooden squares (10 cm) supported by clamp stands. Details of the apparatus at the point where the ball is projected off the runway are given in photographs (Fig. 10-11). The trunking lid can be seen pinned to a 10 cm wooden square that itself is secured by a G-clamp to the bench top. The end of the runway has been levelled by a spirit level and suitable spacers have been placed under the wooden square. The modified detector can be seen held in the jaws of a laboratory clamp. The bi-morph element is suspended from this by fine wires.

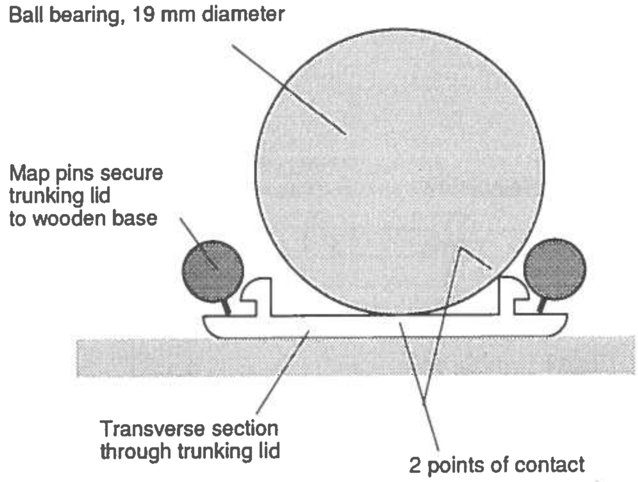

Figure 9. Transverse section through ball and runway showing the points of contact.

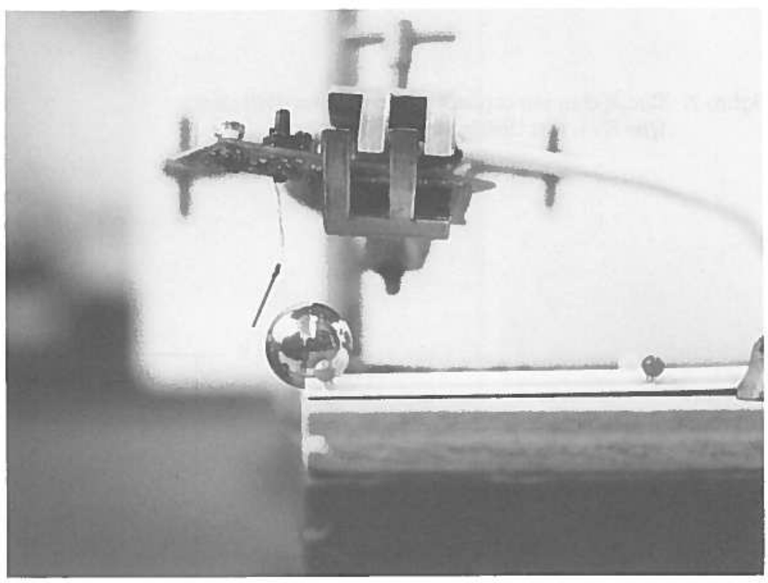

Figure 10. Ball bearing at end of runway - looking transversely across track.

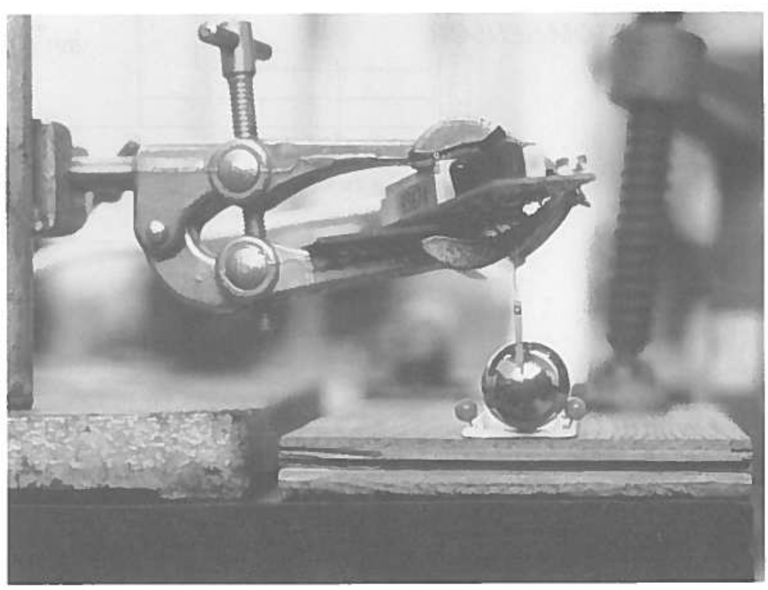

Figure 11. Ball bearing at end of runway - looking along the track.

Physical investigations

Probably the main application of this apparatus is showing that the time of flight for a horizontally projected body is constant and independent of the range. The apparatus seems to demonstrate this property of nature convincingly (Table 1).

Several other quantitative investigations can be carried out relating further measurements :

Gravitational acceleration : by calculation from time of flight.

Horizontal range : judge by eye where the ball strikes the board; a thin layer of sand on the board may indicate the strike position with greater accuracy.

Horizontal projection velocity : by calculation using your measurement of horizontal range.

Horizontal projection velocity : from two SV1 detectors with dangling bi-morphs set up 10 cm apart at the end of the runway (a further SV1 detector on the floor is still required) ; three event times need to be measured with a Motion QED or similar timer - the values of velocity from the two methods should then be compared.

Vertical velocity component at impact : by calculation from time of flight.

Resultant velocity at impact : by calculation.

Kinetic energy at impact : by calculation.

Potential energy prior to release : from the measurement of height fallen - comparisons of kinetic and potential energy may then be made.

There are some complicating factors to watch out for. The main application - showing that the time of flight for different paths is constant - is not significantly affected provided that you don't measure time in fractions of a millisecond. The complications themselves might form the substance of an interesting investigation. Here they are, in no order of significance (no doubt there are also further complicating factors) :

Because the shock wave through the wooden board takes a finite time to reach the sensor, there will be a delay dependent on the distance the wave has to travel. But since the speed of sound through wood is about 4 km s^{-1} any delay is usually trivial.

As the ball rolls down the runway, potential energy is transferred into translational ($^1/_2 m\,v^2$) and rotational ($^1/_5 m\,v^2$) kinetic energy, the second relationship holding for one point of contact only.

Height of release (mm)	1	2	5	10	20	50
Drop time values (ms)	422	423	420	422	423	427
	423	421	420	424	423	423
	424	421	425	422	423	425
	424	422	424	423	424	422
	426	428	423	421	423	422
	425	423	420	422	425	423
	421	423	423	425	424	423
	424	426	421	422	425	425
	422	423	422	421	423	426
	422	423	422	424	423	423
Mean values (ms)	423	423	422	423	424	424
Uncertainty in mean values (ms) (95% confidence limits)	± 2	± 2	± 2	± 2	± 2	± 2

Table 1. Values of drop time against release height on ramp. Time measurements made with a Unilab Motion QED.

The previous factor gives the ball top spin, which may reduce the range.

A further complication arises because the ball usually has two points of contact, not one, with the runway. The spin axis of the ball is therefore liable to skew with respect to the vertical plane of the runway. The ball may even cross over the runway from one side to the other. Thus when projected it will probably be hooked or sliced.

Frictional forces retard the ball on the runway and in flight.

However if there is not enough friction on the runway, the ball will slide and not acquire its quota of rotational energy.

Acknowledgement

This article is based on a detailed description sent to us by staff in the Physics Department at St Ninian's High School, Kirkintilloch, the staff being Mr P Cleary (PT), Mr A Alexander, Mr A Donnelly and Mr I Ireland.

The original description specified using either metallic foil or a microswitch with which to sense the release of the projectile from the runway. Whilst both these triggering methods are effective, we felt that there were advantages in using a second vibration sensor in modified form as described above. With a vibration sensor, the projectile is not disturbed, you have the convenience of automatic latching and avoid any need for manual resetting.

TECHNICAL ARTICLE

Tungsten filament lamp ratings

Measured values of power have been found to lie consistently below rated values. Why is this?

We had an enquiry on tungsten filament lamps asking why measured values of power lie consistently below rated values. Since the measurement of lamp power is a Standard Grade Physics experiment, the discrepancy has probably been noticed by many. Reasons for the difference reveal much on electrical measurement and on the lamps themselves. Having plausible reasons for discrepancies is a continual need for physics teachers. Tungsten lamp wattages are yet a further example of the apparent breakdown of physical law on the workbench. Whenever you try to measure something, why do you not get the answer you expect?

To outline the problem, a school reported running different low voltage lamps at their rated operating voltage V, which they measured. They also measured the current I and compared the product $V\,I$ with the power rating P of the lamp. Their problem was that the values of $V\,I$ were consistently lower than the rated lamp power. They reported that for an a.c. supply, the differences lay between 15% and 20%. For a smoothed d.c. supply, the differences lay between 10% and 14%. For an unsmoothed d.c. supply, the differences were even worse.

In researching the problem, we carried out some laboratory measurements and consulted British and international standards. Starting with the standards, the one which relates to domestic mains type tungsten filament lamps [1] (25 W to 200 W, 100 V to 250 V) specifies the following limits :

maximum limit : the maximum power dissipated by the lamp shall not exceed 104% of rated wattage plus 0.5 W.

minimum limit : the initial luminous flux from the lamp shall not be less than 93% of the rated luminous output of the lamp (as tabulated in the standard).

Now the lumen is the SI unit by which the visual effect of a flux of luminous energy is evaluated. Therefore the minimum limit is specified in terms of visual effect rather than power dissipated. Since it is scarcely practicable to work with lumens, trying to show conformance with the standard is not a feasible school investigation.

The above comments refer to domestic type, mains lamps. Low voltage automobile lamps are specified differently [2]. Some types of automobile lamp are specified like mains lamps; that is their maximum limit tolerance relates to power dissipated whereas their minimum limit relates to luminous flux. Other lamp types have both maximum and minimum typical values for wattage. The wattage tolerances range between ±6% to ±15% with the typical value being ±10%. There are many dozens of lamp types specified in the standard, each with a separate specification. As a rule of thumb, we could assume that the typical tolerance on new automobile lamps is ±10% of rated wattage. We are unlikely to be far astray provided that several different lamp types are to be tested.

Looking now at some bench test results, we measured the electrical power drawn by a randomly selected sample of mainly aged tungsten filament lamps. All of these had SBC fittings. Our measuring instruments were a pair of digital multimeters that had been calibrated against our laboratory standard instrument. The multimeters read V and I. Power was drawn from an a.c. supply with continuously variable output so that the output voltage could be set to the rated voltage of the lamp.

The test (Table 1) shows that, except for one lamp, the second listed, all the values of $V\,I$ lie within 4% of the rated lamp wattage. The second value, which is out by 16%, shows that the actual power ratings of some lamps can lie outwith typical specification.

Omitting the second lamp's results because the lamp is obviously anomalous, the mean value of the percentage of rated wattage is 99%. This indicates concordance between the lamp specification and the actual measured value. So what is the problem? There are in fact many reasons why there can be discrepancies between the measured value of $V\,I$ and the lamp's rated wattage. One of them was unexpected.

Lamp rating	V (V)	I (A)	$V\,I$ (W)	% of rated wattage
12 V 21 W	12.02	1.67	20.1	96
12 V 24 W	12.01	1.68	20.2	84
12 V 36 W	12.00	3.05	36.6	102
12 V 21 W	12.01	1.69	20.3	97
12 V 21 W	12.01	1.75	21.0	100
6 V 24 W	6.00	4.00	24.0	100
6 V 36 W	6.01	5.93	35.7	99
6 V 24 W	6.00	3.88	23.3	97
6 V 18 W	6.00	3.06	18.4	102
6 V 24 W	6.00	3.93	23.6	98

Table 1. Comparison of measured values of power against rated wattages for ten different types of low voltage tungsten filament lamp.

1. *Tolerance :* Obviously a small proportion of lamps can lie outwith the tolerance

2. *True r.m.s. reading meter :* The current and voltage waveforms from LV supplies are usually of three kinds - a.c. sinusoidal, d.c. rectified and d.c. smoothed. All three kinds, even the nominally a.c. sinusoidal waveform, are typically highly distorted. It is therefore technically difficult to measure the r.m.s. values of current and voltage. The sort of multimeter used by schools, which are inexpensive, bottom-of-the-market instruments, measure r.m.s. values only roughly. Typically this type of multimeter reads low by between 1% and 6%, or even more. Therefore if both V and I are read low by 6% each, the product VI is too low by 12%.

   True r.m.s. reading meters are expensive, costing upwards of £200. One simple way of dodging the problem is to work with a voltage regulated supply which is ripple-free. Inexpensive meters usually measure ripple-free values of current and voltage with great accuracy and within the meters' specification. One useful type of voltage regulated supply for this type of work is the lead acid battery with rheostat control.

3. *Phase difference between V and I waveforms :* We have looked to see if there might be a phase difference and failed to find one. This is unlikely to be a source of error.

4. *Resistance of ammeters and voltmeters :* When using digital multimeters, the ammeter shunt resistance is quite significant. Therefore the voltmeter must be connected directly across the lamp. In its other position it can read low by about 3%.

5. *Length of connecting leads :* We compared the effects of using a raybox lampholder which had a 2 m long connecting lead with another lampholder with the shortest leads that could reasonably be contrived. By comparison, the value of VI with the 2 m lead to the raybox read 3% too low.

6. *Accuracy of voltage setting :* Some means of precisely adjusting the voltage setting of the power supply is essential. We use a laboratory power supply with a continuously variable transformer such as the Irwin *EJ32*, Unilab *Ranger*, or Weir *LT Supply*. The voltage output has to be readjusted for each lamp because its level depends on the load's impedance.

7. *Settling time :* After a lamp is switched on it should be allowed to heat up for at least one minute before any readings are taken. The current diminishes by a few percent during this warm-up period.

8. *Ageing of lamps :* The resistance of tungsten filament lamps increases with age because the filament slowly burns away. Because in this application the lamp is operated at its specified voltage, the power drawn by the lamp V^2/R decreases with age since V is effectively a constant. From discussions with the National Physical Laboratory, the rate of reduction in power output per 100 hours will be less than 1%. The typical life of many domestic types of tungsten filament lamp is 1000 hours. Automobile lamps [3] have a minimum rated average life that is as low as 100 hours for some types, or as high as 1500 hours for other types. The median rated average life may be less than 300 hours. Trying to estimate a limiting value on the power reduction that comes from ageing is going to be imprecise. Because most automobile lamps have a lifespan which is less than 300 hours, the ageing effect can be presumed to be less than 3% for most lamps.

   As an aside, most laboratory workers operate tungsten filament lamps at constant current rather than constant voltage. By operating at constant current, the optical output remains reasonably steady, but the operating power *rises* with age!

Reasons for the discrepancies between measured and rated wattage can in all probability be found within the above list of causes. The differences had been found by the school to depend on the type of supply. This points to significant instrumentation errors when measuring a.c. and d.c. rectified waveforms. The smallest differences (10%-14%) had been found to occur with a smoothed d.c. supply. The instrumentation error with this type of waveform is likely to be quite small.

At this point in our investigation we felt that we had gone through all the possible causes. Therefore some further measurements were required to nose out any further factor that might be underlying the problem. We therefore bought a batch of ten raybox lamps rated 12 V, 24 W (Philip Harris, part number R47820/7), choosing these because we reckoned that they would be the sort of lamp that a school would probably use in this experiment. To our astonishment we found that the power dissipated by each of these lamps, new, lay at about 10% below their marked value (Table 2). The actual power dissipated ranged between 89% and 91% of the marked wattage. This then may be the largest contribution to the differences found by the school. Harris, incidentally, have been unable to provide us with either a performance specification or standard to which the lamps had been designed.

Referring back to Table 1, our one rogue measurement related to a raybox lamp. It does seem as though this is the worst sort of lamp to use in this work.

Running times (h)	0	100	200	300
	90	88	88	87
	89	88	87	87
	90	88	87	87
	91	88	88	87
	89	87	86	86

Table 2. Ageing process of five lamps : data shows actual wattage as percentage of rated wattage. Value falls by about 1% per 100 hours. Running life was just over 400 hours.

Having bought our batch of similar lamps, we ran them for an extended period to investigate the effect of ageing and to record lifespan. Five lamps were tested. The filaments of all five fused after running for 400 - 460 hours. The power dissipated fell by about 1% per 100 hours running time (Table 2).

Summary and recommendations

1. The typical tolerance on new automobile lamps is ±10% of rated wattage. It therefore pays to investigate several different types. Retain for future use a batch of lamps whose actual wattage is found to be close to the rated wattage.
2. Raybox lamps from Harris were found to have an actual wattage 10% below rated wattage.
3. Power output falls by about 1% per 100 hours running time.
4. Most multimeter types read low by between 2% - 6% when measuring anything but a ripple free waveform. In order of significance, from worst to best, is non-smoothed d.c., a.c., smoothed d.c. and ripple-free d.c. Therefore for preference use either a lead acid battery or smoothed d.c. supply, in both instances with a continuously variable voltage control.
5. The voltmeter must be connected directly across the lamp.
6. Minimise the lengths of connecting leads.
7. Allow a settling time of 1 minute before taking readings.
8. Excepting tolerance, all the effects bias towards a measured value that is lower than the rated value.

References

1. BS 161 : 1990 *Specification for tungsten filament lamps for domestic and similar lighting purposes. Performance requirements.*
2. BS 6737 : 1986 (1993) *Specification for dimensional, electrical and luminous requirements for lamps for road vehicles.*
3. BS 6797 : 1986 (1993) *Specification for performance requirements for lamps for road vehicles.*

TECHNICAL NOTES

Impending gloom?

Have the lights become dimmer all over Scotland?

It is apposite that the Short Twentieth Century - the period so dubbed by the historian Eric Hobsbawm beginning with the assassination of Archduke Ferdinand in Sarajevo and ending with the gloom of the nineties as the millennium is awaited with general foreboding - should be marked by a dimming of lights. It has, for the majority of the inhabitants of the Earth, been a ghastly period. Possibly we Scots have fared better than most.

By how much will lights dim because of voltage harmonization with our European partners? Before harmonization, the public supply voltage was kept within 6% of 240 V. Post harmonization, the upper limit will be 230 V plus 10%; the lower will be 230 V minus 6%. According to one of the two suppliers, Scottish Power, the effects will not be noticeable because the operating overlap of these tolerances is similar. In common with other suppliers, Scottish Power will continue to maintain voltage at its nominal 240 V value. Near the source of supply, the level will be around 250 V, whereas at sites remote from the source, the level will be nearer to 230 V. From the Electricity Association the average supply voltage is 245 V.

In fact harmonization is Orwellian doublespeak; it has nothing to do with harmony :

- There was a European agreement in 1988 that the voltage should be 230 V across Europe.
- Since that time mainland European countries have been steadily moving from 220 V to 230 V supplies.
- The UK Government and electricity suppliers originally declined to come into line and decided to remain at 240 V.
- But in 1993 the UK Government accepted the standard rated voltage of 230 V provided that wider tolerances were permitted, i.e.

  from 1995 supplies may vary from 216 V to 253 V;

  from 2003 this widens to 207 V to 253 V.
- Despite this apparent harmonization, the UK electricity suppliers will make no change to the supply voltage.
- So from January 1995 there will be no change to the supply into a building but it will be called "230 V" not "240 V".
- Manufacturers and consumers now have the worst of muddles to contend with.
- UK manufacturers must continue to make two versions : for the 240 V supply that the UK is sticking with and for the 230 V supply in Europe. Both sets of goods may well have identical 230 V markings.
- European suppliers will send goods to the UK designed to operate at 230 V. Voltage sensitive goods such as motors and lights will not operate properly and could become unsafe.

Effect on tungsten filament lamps

Lamps are highly sensitive to voltage. If a 230 V lamp is operated at 240 V its running time is reduced to 55% of normal. At 253 V, to 26%. Also the safety impact of such overheating on the fixed wiring and on the luminaire may be significant.

Does a voltage reduction in the nominal level by 4% to 230 V have any noticeable affect on lamp illuminance? Experience suggests that it does. It is not infrequent for persons to remark "How dim the lights are tonight" on a cold winter's night at teatime when demand is at its peak and voltage approaches its lower limit.

To investigate to what extent voltage reduction will have on lamp illumination, we ran a tungsten filament lamp rated 240 V, 100 W, off a variable voltage supply and recorded the illuminance with an ESMI meter[1]. Note how the rate of change of illuminance with voltage increases with voltage (Table 1, Fig. 1).

Lamp voltage (V)	Illuminance (lux)
100	< 10
120	10/20
140	30
160	50
180	80
200	110
210	140
220	160
230	190
240	220
250	260
260	290

Table 1. Variation in illuminance at an arbitrary distance (about 80 cm) from a 100 W 240 V lamp operated off different voltages.

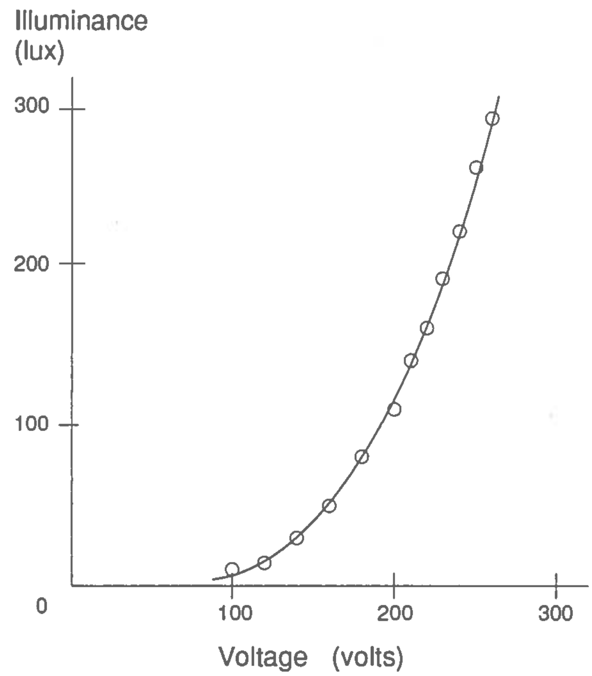

Fig. 1 Illuminance of a tungsten filament lamp versus voltage

If we take the illuminance at 240 V to be our standard, a voltage drop of 4% to 230 V produces an illuminance drop of 14%. At the new lower limit of 216 V, the illuminance is only 68% of its value at 240 V (Table 2). These effects are far from insignificant. Lamps may indeed become dimmer all over Scotland!

	Lamp voltage (V)	Illuminance (lux)	Percentage illuminance relative to 240 V running
240 V standard :			
Upper limit	254	270	113%
Standard	240	220	100%
Lower limit	226	180	82%
230 V standard :			
Upper limit	253	270	113%
Standard	230	190	86%
Lower limit	216	150	68%

Table 2. Illuminance and percentage illuminance relative to 240 V operation for 100 W tungsten filament lamp at tolerance limits of 240 V and 230 V supply voltages.

Three effects mitigate the gloom. Because the response of the eye to light intensity is logarithmic, a 14% drop in illuminance whilst being noticeable is hardly significant. Secondly, the brain will quickly become accustomed to gloom by the process of habituation. Thirdly, lamp manufacturers may eventually produce lamps designed to operate at 230 V.

Summary

If there is any educational point to this note, it is that the actual nominal supply voltage remains for the time being, and probably for many years to come, at 240 V, but it will be called "230 V"! The effects on products are too confusing to predict.

In our next issue we hope to consider Euroharmonising effects on candlelight.

[1] ESMI temperature and light meter made by British Gas.

Motor speed control - Higher Grade Technological Studies

In the SSERC published Case Study based on a Dry Feeder System one of the methods suggested for motor speed control is the use of a tachogenerator [1] . The tacho used at the time of writing the case study was a precision motor from Portescap. These, as many of you will know, are no longer stocked by us since the Escap motors we could now purchase cost around £18.00 each, which gets a bit expensive as part of a class set. However we do have a limited stock of precision motors (Item 786) at £15 which make ideal tachogenerators.

We have been long aware this problem and had before suggested the use of a cassette motor or one of our used tachogenerators (Item 773 tacho ex-equipment) from our surplus stock. Investigations with that tachogenerator worked well in SSERC, but some teachers have reported problems with some of these tachos giving a non-linear output. We had not experienced this having only taken samples for test. There thus may well be the odd duff one out there. But remember that we always would replace such items free of charge!

Our new stock of cassette motors (Item No 779 £1.25) has been tested and appear to be one other solution. The latest versions still have the same centrifugal speed governor but in addition have a built in smoothing circuit. Now, this smoothing may work to decrease noise on the cassette player or radio but is not quite enough for our purposes. All that is additionally required is to place a 100 microfarad electrolytic capacitor (C1) across the tachomotor output. This gives sufficient smoothing for the op-amp. See below for a suitably amended version of the circuit in the SCCC/SSERC Case Studies.

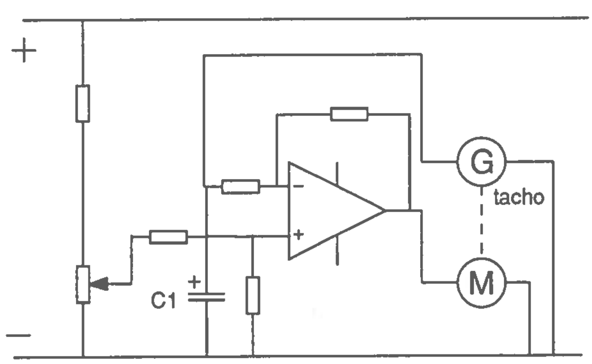

Fig. 1

Reference

1. *Investigation 4, Implementing feedback control*, p.27, Higher Grade Technological Studies, Case Studies, SCCC in association with SSERC, 1991.

Hill reaction

We have had a few enquiries on the technical details of this practical for biology at the Higher Grade and used also at CSYS. Some of these came from relatively new entrants to the profession unfamiliar with this demonstration of the photolysis part of the process of photosynthesis. Perhaps it should not suprise us that it is the younger teachers who have never set up Hill's procedures. The reaction was after all first demonstrated by him and his colleagues way back in the nineteen thirties!

Volume 3 in the *Biology by Enquiry* series [1] (now gae long in the tooth) provides a fair bit of information, but some of our enquirers and their students were puzzled by a few of the suggested steps in the procedure. The text is also somewhat imprecise as to what constitutes a *medium* and what a *high* speed for the centrifuge used to effect the separations. This true also of a number of other accounts.

One of our enquirers asked about the instruction to use "ice cold" 0.5 M sucrose solution for the extraction and why it was necessary to strain the ground up leaf tissues into a "cooled" tube and about the related further requirements for "cold" sucrose solution and later for "ice-cold" phosphate buffer. They also wondered whether the tubes had subsequently to be kept cold for the actual demonstration of the reaction in the light and its non-progression in the dark.

We advised that we had always assumed that the cold conditions were a necessary part of the extraction and isolation of chloroplasts. This would be to discourage and slow down any unwanted catabolic side reactions as cells were being disrupted and enzyme systems normally separated by membranes got jumbled up. Once the chloroplasts are isolated then the low temperature becomes less critical. Indeed it is almost impossible to maintain in the illuminated tube because of the heat from the lamp.

It emerged from other sources that some teachers demonstrate the reaction after centrifuging the leaf extract once only at a *medium* speed. We were asked is that "cheating" in any way? Well - 'fraid so - it is, and more than a bit. The idea of the first spin down is to get rid of gross cell debris and starch grains etc. The second at higher speed allows one to decant off other extracted metabolites and enzymes in the second supernatant. What is then re-suspended from the second pellet should be mostly chloroplasts. In the short cut method, the DCPIP could be being reduced by any amount of things other than an enzyme system retained within the chloroplasts.

Finally, what are *medium* and *high* speeds? Well, we sympathise with the several authors of texts which do not specify these. It depends to a large extent what you use as a source of chloroplasts. We found that the BBI suggestion of lettuce leaves meant using somewhat higher speeds or longer times than with other sources such as cress or mustard for example.

cont./over

Some varieties of green cabbage are supposed to be particularly rich sources of chloroplasts and the initial ground up extract may even have to be diluted before spinning it down.

As an example and rough guide : We found that with cress or mustard leaves as a source we centrifuged in a Merlin 505 model of centrifuge at a *medium* speed of ca. 2,700 r.p.m. for 5 minutes to successfully remove cell debris and then at a *high* speed of ca. 6,500 r.p.m. for a further 5 minutes to pellet out the chloroplasts. Lettuce, with its somewhat smaller chloroplasts, required at least 10 minutes at 6,500 r.p.m. for the second stage in order to obtain a satisfactory pellet. The smaller chloroplasts of lettuce also made for greater difficulty where chloroplasts were to be examined microscopically.

Note that the higher speeds suggested would not be obtainable on a run-of-the-mill school centrifuge. In that case you might get away with considerably extending the above times. It may be that with a simple model with only a swing-out head that even the highest available speed will not lead to pelleting out of chloroplasts in any acceptable time interval. More on this in a future issue in connection with DNA separations.

Reference

1. *Biology by Enquiry, Book 3*, Clarke, R.A. et al, Heinemann, 1971, ISBN 0 435 59173 8.

Iodine for starch tests - again

Bench iodine in potassium iodide reagents are typically made up in concentrations such as 2.5% I_2 in 5% KI w:v. Whilst this seems effective for straightforward tests on foodstuffs we have recently had yet more evidence that such reagents are far too concentrated for other biochemical purposes such as in monitoring the progress of enzyme mediated hydrolyses.

We have described previously the use of more dilute solutions (diluted as much as twentyfold v:v with water) in the study of diastase mediated hydrolysis of starch suspensions [1]. More recently we had a technical enquiry from a school on problems they were having in using iodine to monitor the progress of starch breakdown in immobilised enzyme systems (amylase) in a column. It was suggested that they try greatly diluting the iodine reagent as outlined above. This they duly did and reported back that they were then getting sensible results within reasonable times.

We now suspect that the relatively concentrated iodine reagents traditionally used for static food tests may even inhibit enzyme activity when applied to the more dynamic study of actual reactions. Fancy an investigation or project anyone?

Reference

1. *More on enzymes, Technical Articles,* Bulletin 179, December 1993, SSERC.

Surplus Equipment Offers

Items are arranged by similarity of application, or for other reasons, and not by stock number sequence. Often the item number serves only for stock identification by us in making up orders.

Newer stock items are underlined, so as to be more easily seen. Of particular interest is our limited stock of condenser lenses, which would ordinarily cost £80 each.

The prices quoted do not include VAT. However it is added to every customer's order. Local authority establishments will be able to reclaim this input VAT.

Postage and, where necessary, packing, will be charged for. It is therefore best not to send cash with an order, but wait for us to bill you. Official orders may be used. Please try and ask for at least £10 worth of goods because the administrative costs of handling orders are significant.

Don't send cash with orders

We repeat, please do not send payment with your order. Wait until you receive our advice note upon which payment may be made. This saves unnecessary complications e.g. when items are out of stock, failure to make provision for VAT, or if a delivery charge needs to be made. Items of equivalent value may be deducted from your order to balance any shortfall.

Motors

778 Stepper motor, Philips MB11, been stored in damp conditions but unused and retested. 4 phase, 12 V d.c., 100 mA per coil, 120 Ω coil per phase, step angle 7.5°, with 7 mm x 2 mm dia. output shaft. Dimensions 21 mm x 46 mm dia. on oval mounting plate with 2 fixing holes, diam. 3 mm, pitch 42 mm, at 56 mm centres. Circuit diagram supplied. £2.50

755 Pulley wheel kit comprising:
- plastic pulley wheel, 30 mm dia., with deep V-notch to fit 4 mm dia. shaft,
- two M4 grub screws to secure pulley wheel,
- Allen key for grub screws, and
- 3 mm to 4 mm axle adaptor.

The whole making up a kit devised for SSERC tachogenerators with 3 mm shafts. Specially supplied to SSERC by Unilab. £1.25

779 Miniature motor, 13.2 V d.c., smooth running, speed governor, no load current 24 mA at 12 V, dims. 36 mm x 39 mm dia., shaft 10 mm x 2 mm dia. £1.25

614 Miniature motor, 3 V to 6 V d.c., no load current 220 mA at 9600 r.p.m. and 3 V, stall torque 110 mN m, dims. 30 mm x 24 mm dia., shaft 10 mm x 2 mm dia. 45p

593 Miniature motor, 1.5 V to 3 V d.c., no load current 350 mA at 14800 r.p.m. and 3 V, stall torque 50 mN m, dims. 25 mm x 21 mm dia., shaft 8 mm x 2 mm dia. 30p

621 Miniature motor, 1.5 V to 3 V d.c., open construction, ideal for demonstration, dimensions 19 x 9 x 18 mm, eight tooth pinion on output shaft. 25p

739 Miniature motor, 1.5 V d.c., dimensions 23 mm x 15 mm dia., shaft 8 mm x 1.7 mm dia. 25p

732 Motor with gear box, high torque, 1.5 V to 12 V d.c., 125 r.p.m. at 12 V, dimensions 40 x 40 x 28 mm, shaft 10 mm x 3 mm dia. with key. Suitable for driving buggies, conveyor belt, or any other mechanism requiring a slow drive £6.00

773 Tachometer (ex equipment) £2.25

625 Worm and gear for use with miniature motors, nylon worm and plastic gear wheel. 35p

802 Motor, 9 V d.c., no load current 20 mA at 9 V. Back EMF constant 1.5 V/1000 r.p.m. Overall length 44 mm, dia. 37 mm. Shaft 8 x 2 mm dia. Suggested application - tachogenerator. £5.00

378 Encoder disk, 15 slots, stainless steel, 30 mm dia. with 4 mm dia. fixing hole. 80p

642 Encoder disk, 30 slots, stainless steel, 30 mm dia. with 4 mm dia. fixing hole. 80p

772 Encoder disk, 4-bit Gray code, stainless steel, 81.28 mm dia., 3 mm fixing hole, slots sized to register with components mounted on 0.1" stripboard. Applications: shaft position sensing, wind direction indicator.
For related electronic circuitry see Bulletin 146. £3.00

Precision motor stock

785 Precision motor with optical shaft encoder, 0.25 to 24 V d.c., no load current and speed 9 mA and 6,600 r.p.m. at 24 V, stall torque 23 mNm, 9 segments. Overall body length including shaft encoder 59 mm, dia. 23 mm with output shaft 20 x 3 mm dia. Back EMF constant 3.6 V/1000 r.p.m. Suggested application - tachogenerator. Data on shaft encoder section available on application. £15

786 Precision motor with attached but electrically isolated tachometer, 0.15 to 12 V d.c., no load current 20 mA and 5,700 r.p.m. at 12 V, stall torque 96 mNm, 13 segments. Overall body length including tachometer 99 mm. Output shaft 19.5 x 4 mm dia. Back EMF constant 2.1 V/1000 r.p.m. Offload output voltage from tachometer 11.73 V d.c. with 12 V applied to motor. £15

787 Precision motor with attached gearbox, 0.15 to 12 V d.c. With a supply of 3 V, the no load current is 25 mA and the output shaft turns at ca. 20 r.p.m. Gearbox ratio 1 : 365. Overall body length including gearbox 43.5 mm and diameter 16 mm. Output shaft 6 x 3 mm dia. with flat side to maximum depth of 0.3 mm along outer 5 mm length of shaft. Application - any system where a very slow angular velocity is required. £15

Miscellaneous items

791 Propeller, 3 blade, to fit 2 mm shaft, blade 55 mm long. 45p

792 Propeller kit with 10 hubs and 10 blades for making 2 or 3 bladed propellers. 130 mm diameter. Accepts either 2 mm or 3 mm shafts. £3.40

790 Buzzer, 3 V. 55p

629 Dual tone buzzer with flashing light, mounted on small p.c.b. The unit has a PP3 battery clip and two flying leads for switch applications. 55p

710 Sonic switch and motor assembly. First sound starts the motor, a second reverses the direction of rotation, a third sound stops the motor. Driven by 4 AA cells (not supplied). 45p

715 Pressure gauge, ca. 40 mm o.d. case, 25 mm deep and 33 mm dia. dial reading 0 to 4 bar (i.e. above atmospheric). With rear fitting for $^1/_8$" BSP. Suitable for use as indicator for pneumatic circuits in Technological Studies. 75p

313 Thermostat, open construction, adjustable, temperature range +10° to +65°C. Rated at 6 A, 250 V, but low voltage switching also possible. 60p

165 Bimetallic strip, length 10 cm;
high expansivity metal: Ni/Cr/Fe - 22/3/75
low expansivity metal: Ni/Fe - 36/64 (invar) 15p

166 Ditto, but 30 cm length. 40p

385 Pressure switch, operable by water or air pressure. Rated 15 A, 250 V (low voltage operation therefore possible). Dimensions 2" x 3" dia. 65p

753 Submersible pump, 6 V to 12 V d.c., 8 litres/min., 0.6 bar, dry operation protected. £5.50

758 Loudspeaker, 8 Ω, 0.5 W, 66 mm dia. 50p

771 Neodymium magnet, 13.5 mm dia. x 3.5 mm thick. £1.30

745 Sub-miniature microphone insert (ex James Bond?), dia. 9 mm, overall depth 5 mm, solder pad connections. 40p

781 Toggle switch, panel mounting, 2 Amp rating, SPST, mounting bush 0.468 inch, flattened white 10 mm lever. 35p

782 Toggle switch, panel mounting, 3 Amp rating, SPST, mounting bush 0.468 inch, flattened black 18 mm toggle. 50p

723 Microswitch, miniature, SPDT, lever operated. 40p

354 Reed switch, SPST, 46 mm long overall, fits RS reed operating coil Type 3. 10p

738 Relay, 6 V coil, DPDT, contacts rated 3 A, 24 V d.c. or 110 V a.c. 75p

774 Solenoid, 12 V, stroke length 30 mm, spring not provided. £2.25

742 Key switch, 8 pole changeover. 40p

382 Wafer switch, rotary, 6 pole, 8 way. 70p

688 Croc clip, miniature, insulated, red. 5p

759 Ditto, black. 5p

788 Crocodile clip leads, assorted colours, insulated croc. clip at each end, 360 mm long. £1.35

741 LES lamp, 6 V. 15p
770 ditto, but 12 V. 15p

690 MES lamp, 6 V, 150 mA. 9p
691 MES battenholder. 20p

692 Battery holder, C-type cell, holds 4 cells, PP3 outlet. 20p

730 Battery holder, AA-type cell, holds 4 cells, PP3 outlet. 20p

729 Battery connector, PP3 type, snap-on press-stud, also suitable for items 692 and 730. 5p

724 Dual in line (DIL) sockets, 8 way 5p
760 14 way 7p
776 16 way 8p

716 3-core cable with heat resisting silicone rubber insulation, 0.75 mm² conductors, can be used to re-wire soldering irons as per Safety Notes, Bulletin 166. Per metre. £1.35

756 Silicone coated, braided glass sleeving, yellow, 2.5 mm dia., gives both heat and electrical insulation to conductors (e.g. for autoclave rewiring). Price per metre. 55p

714 Sign "Radioactive substance" to BS spec., 145 x 105 mm, semi-rigid plastic material. Suitable for labelling a radioactive materials store. With pictogram and legend. £2.70

763 Sign "DANGER, Electric shock risk" to BS spec., rigid plastic, 200 x 150 mm. £2.70

764 Sign "DANGER, Laser hazard" to BS spec., rigid plastic, 200 x 150 mm. £2.70

727 Hose clamp, clamping diameter from 8 mm to 90 mm, 101 uses - securing hose to metal pipe, tree to stake, joining wooden battens for blueing, etc. 30p

731 Re-usable cable ties, length 90 mm, width 2 mm, 50 per pack. 12p

752 Shandon chromatography solvent trough. £1.00

803 Test tube rack, used. 10p

804 Evaporating basin, porcelain, 80 ml capacity. £1.00

805 Condenser lens, bi-convex, 200 mm focal length, 75 mm dia. Crown glass. £12.50

806 Condenser lens, plano-convex, 150 mm focal length, 75 mm dia. Crown glass. £12.50

Components - resistors

328 Potentiometer, wire wound, 15 Ω, linear, 36 mm dia. 30p

737 Ditto, 22 Ω, lin., 36 mm dia. 30p

329 Ditto, 33 Ω, lin., 36 mm dia. 30p

330 Ditto, 50 Ω, lin., 40 mm dia. 30p

420 resistors, 5% tolerance, ¼ W :
1R5, 4R7, 5R6, 6R8, 8R2, 10R, 15R, 22R, 33R, 47R, 56R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R, 1K0, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 150K, 220K, 330K, 390K, 470K, 680K, 1M0, 1M5, 2M2, 4M7, 10M. Per 10. 6p

421 DIL resistor networks, following values available: 62R. 1K0, 6K8, 10K, 20K, 150K. Per 10. 30p

BP100 Precision Helipots, Beckman, mainly 10 turn. 10p-50p

Components - capacitors

695 Capacitors, tantalum, 15 µF 10 V, 47 µF 6.3 V. 1p

696 Capacitors, polycarbonate, 10 nF, 220 nF, 680 nF, 1 µF, 2.2 µF. 2p

697 Capacitor, polyester, 15 nF 63 V. 1p

698 Capacitors, electrolytic, 1 µF 25 V, 2.2 µF 63 V, 10 µF 35 V. 1p

358 Capacitor, electrolytic, 28 µF, 400 V. £1.00

Components - semiconductors

807 Schools' Chip Set, designed by Edinburgh University, comprises the 4 chips and prototype board. £4.00

Edinburgh University support material :
Volume 1 : Teaching Support Material (+£2 p&p). £4.50
Volume 2 : Laboratory Work (+£2 p&p). £5.00

322 Germanium diodes 8p

701 Transistor, BC184, NPN Si, low power. 4p

702 Transistor, BC214, PNP Si, low power. 4p

717 Triac, Z0105DT, 0.8 A, low power. 5p

725 MC74HC139N dual 2 to 4 line decoders/multiplexers 5p

699 MC14015BCP dual 4-stage shift register. 5p

711 Voltage regulator, 6.2 V, 100 mA, pre-cut leads. 10p

Sensors

615 Thermocouple wire, Type K, 0.5 mm dia., 1 m of each type supplied: Chromel (Ni Cr) and Alumel (Ni Al); for making thermocouples, see Bulletins 158 and 165. £2.20

640 Disk thermistor, resistance of 15 kΩ at 25°C, β = 4200 K. Means of accurate usage described in Bulletin 162. 30p

641 Precision R-T curve matched thermistor, resistance of 3000 Ω at 25°C, tolerance ±0.2°C, R-T characteristics supplied. Means of accurate usage described in Bulletin 162. £2.90

718 Pyroelectric infrared sensor, single element, Philips RPY101, spectral response 6.5 µm to >14 µm, recommended blanking frequency range of 0.1 Hz to 20 Hz. The sensor is sealed in a low profile TO39 can with a window optically coated to filter out wavelengths below 6.5 µm. Data sheet supplied. For application see SG Physics Technical Guide, Vol.2, pp 34-5. 50p

751 Hacksaw blade with pair of strain gauges, terminal pads and leads attached. Suitable for impulse measurement as described in Bulletin 171. Delivery time 3 months. £12.50

501 Kynar film, screened, 28 µm thick, surface area 18 x 100 mm, coaxial lead and 4 mm connectors. Applications: Impulse (Bulletins 155 and 174), long wave infrared (Bulletin 155, SG Physics Technical Guide, Vol.2, pp 33-4) £20.00

503 Kynar film, unscreened, 28 µm thick, surface area 12 x 30 mm, no connecting leads. 55p

504 Copper foil with conductive adhesive backing, makes pads for unscreened Kynar film to which connecting leads may be soldered. Priced per inch. 10p

506 Resistor, 1 gigohm, ¼ W. £1.40

Opto-electronic devices

507 Optical fibre, plastic, single strand, 1 mm dia. Applications described in Bulletin 140 and SG Physics Technical Guide Vol.1. Priced per metre. 40p

508 LEDs, 3 mm, red. Price per 10. 50p
761 Ditto, yellow. Per 10. 60p
762 Ditto, green. Per 10. 60p

Other components

We also hold in stock a quantity of other electronic components. If you require items not listed above please let us know and we will do our best to meet your needs, or to direct you to other sources of supply.

Items not for posting

The following items are only available to callers because of our difficulties in packing and posting glassware and chemicals. We will of course hold items for a reasonable period of time to enable you to arrange an uplift.

Glassware

663 Flat bottom round flask, 250 ml. 50p

664 Flat bottom round flask, 500 ml. 50p

747 Quickfit vented receiver, 10 ml. 20p

768 Sodium lamp, low pressure, 35 W. Notes on method of control available on application. 85p

712 Smoke pellets. For testing local exhaust ventilation (LEV) - fume cupboards and extractor fans, etc. 50p

Chemicals

We have recently added about fifty other chemicals to our stock but have neither the space nor the time to complete a full listing here. Please send for a complete list of substances and prices.

SSERC, 24 Bernard Terrace, Edinburgh, EH8 9NX; Tel. 031 668 4421, Fax. 031 667 9344.

Alarm Express Ltd., Unit 1C, Port Dundas Industrial Estate, Glasgow G4 0LE.

ASE, (UK, HQ), College Lane, Hatfield, Herts., AL10 9AA; Tel. 01707 267411, Fax 01707 266532.

ASE, Scottish Region
Secretary, Mr S. Farmer, 28 Balfour Road, Alford, Aberdeenshire AB33 8NF Tel. 09755 63060.

Annual Meeting '95 Self-help Workshops :
Mrs E. Sinclair, 118 Claremont, Alloa, FK10 2EG Tel. 0259 213310.

British Standards Insitution, Linford Wood, Milton Keynes MK14 6LE.

Data Harvest (Educational Electronics), Woburn Lodge, Waterloo Road, Linslade, Leighton Buzzard, Bedfordshire, LU7 7NR; Tel. 0525 373666, Fax. 0525 851638.

Deltronics, Church Road Industrial Estate, Gorslas, Llanelli, Dyfed SA14 7NF; Tel. 0269 843728 Fax. 0269 845527

Economatics, Epic house, Darnall Road, Attercliffe, Sheffield, S9 5AA ; Tel. 0742 561122 Fax. 0742 439306.

Edinburgh International Science Festival, 1 Broughton Market, Edinburgh EH3 6NU; Tel. 0131 556 6446 Fax 0131 557 3743.

The Engineering Council,(TEP), Essex house, 12/13 Essex Street, London WC2R 3EG; Tel. 0171 240 7891 Fax 0171 379 5586.

Fisons (Griffin & George) Limited, Bishop Meadow Road, Loughborough, Leicestershire, LE11 0RG; Tel. 0509 233344, Fax. 0509 231893.

Gardiner Security Limited, Lutton Court Business Centre, Edinburgh (Head Office : Transpennine Trading Estate, Rochdale, Lancs., OL11 2PX; see also SenTecs).

Philip Harris Education:

2 North Avenue, Clydebank Business Park, Clydebank, Glasgow, G51 2DR; Tel. 041 952 9538;

Lynn Lane, Shenstone, Lichfield, Staffordshire, WS14 0EE; Tel. 0543 480077, Fax. 0543 480068.

HSE Books, Customer Services Department, PO Box 1999, Sudbury, Suffolk CO10 6FS Tel. 01787 881165 Fax. 01787 313995. (Cash with order if you don't have an account - and quote the ISBN of the publication).

Irwin-Desman Limited, 294 Purley Way, Croydon, CR9 4QL; Tel. 081 680 2058, Fax. 081 681 8429.

JJM Electronics, "The Hedges", Meft Road, Urquhart, Morayshire IV30 3LG.

Merck Ltd., Merck House, Poole, Dorset, BH15 1TD; Tel. 01202 669700, Fax 01202 666536.
Scottish Distributor : McQuilkin & Co., 21 Polmadie Avenue, Glasgow G5 0BB; Tel. 0141 429 7777 Fax. 0141 420 1223.

PASCO Scientific, Admail 394, Cambridge CB1 1YY; Tel. 0345 626055 Fax. 081 570 2682.

RS Components Limited, PO Box 99, Corby, Northamptonshire, NN17 9RS; Tel. 0536 201201, Fax. 0536 201501.

Rhone-Poulenc, Laboratory Products, Liverpool Road, Eccles, Manchester, M30 7RT; Tel. 0161 789 5878 Fax. 0161 788 8279. *Scottish Distributors* :
A.&.J. Beveridge Ltd., 5 Bonnington Road Lane, Leith, Edinburgh EH6 5BP; Tel. 0131 553 5555.
Refer Scientific, Harebrun House, Blackdog, Aberdeen, AB1 4LY; Tel. 0224 825394.
R.&J. Wood Ltd., 39 Back Sneddon Street, Paisley, Renfrewshire, PA3 2DE; Tel. 0141 887 3531/2.

SCCC, Gardyne Road, Broughty Ferry, Dundee DD5 1NY Tel. 0382 455053 Fax. 0382 455046.

Sensor Technologies (UK) Limited, (SenTecs), Birch Industrial Park, Heywood, Lancs. OL10 2SX Tel. 01706 64109 or 60647 Fax. 01706 625961.

Tait Components Limited, 20 Couper Street, Glasgow G4 0BR; Tel. 0141 552 5043 Fax. 0141 552 8826.

Unilab Limited, The Science Park, Hutton Street, Blackburn, Lancashire, BB1 3BT; Tel. 0254 681222, Fax. 0254 681777.