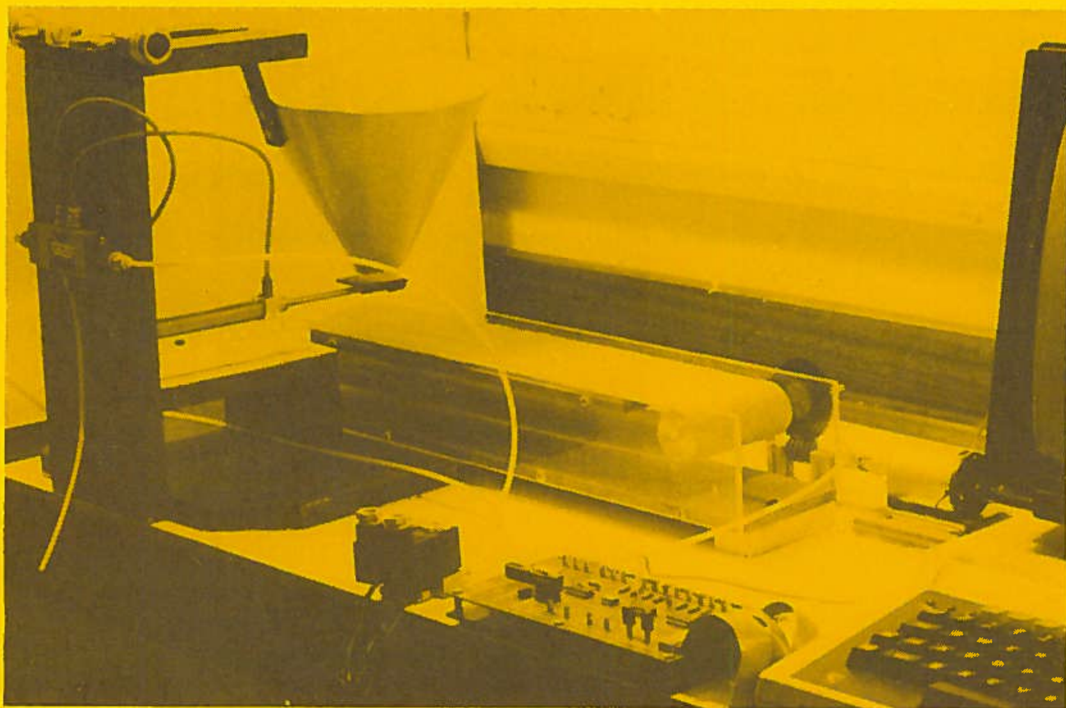
ISSN 0267-7474

SCOTTISH SCHOOLS EQUIPMENT RESEARCH CENTRE



For: Teachers and Technicians
in Technical subjects and in the Sciences

Science & Technology Bulletin

Number 164 December 1989

A D D R E S S   L I S T

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

J.Bibby Science Products Ltd., Tilling Drive, Stone, Staffordshire ST15 0SA; Tel. 0785 812121.

The Biochemical Society Book Depot, PO Box 32, Commerce Way, Whitehall Industrial Estate, Colchester, Essex CO2 8HP.

British Gas Education Service, PO Box 46, Hounslow, Middlesex TW4 6NF.

BSHS Edinburgh nominee: Dr John Henry, Science Studies Unit, University of Edinburgh, 34 Buccleugh Place, Edinburgh EH8 9JT.

Command Electronics Marketing Ltd., 189-191 London Road, Mitcham, Surrey CR4 2JB; Tel. 01 685 0088.

Electrocables Ltd., Unit 12, Henley Industrial Park, Henley Road, Coventry CV2 1ST; Tel. 0203 616644.

Griffin and George Ltd., Bishop Meadow Road, Loughborough, Leicestershire LE11 0RG; Tel. 041 248 5680 or 0509 233344.

Hampden Sports Ltd., Dunfermline College, Crammond Road North, Crammond, Edinburgh EH4 6JD; Tel. 031 336 7092.

Philip Harris Education:
2 North Avenue, Clydebank Business Park, Clydebank, Glasgow G81 2DR; Tel. 041 952 9538;
Lynn Lane, Shenstone, Lichfield, Staffordshire WS14 0EE; Tel. 0543 480077.

HMSO Bookshop, 71 Lothian Road, Edinburgh EH3 9AZ; Tel 031 228 4181.

Institute of Occupational Medicine, Roxburgh Place, Edinburgh EH8 9SU; Tel 031 667 5131.

continued on inside back cover

The Centre is an independent national advisory service, solely controlled and largely financed by Scottish Regional and Islands Councils as Education Authorities. It currently incorporates the Science Equipment Research Centre and the Scottish TVEI Joint Support Activity Project :

STERAC (Science and Technology Equipment Research and Advisory Centre).

[Cover photo : Hopper & Conveyor Belt - Technological Studies Project]

OPINION

"There is no such thing as a harmless substance. There are only harmless ways of using substances."

Wise words. They used to hang, on a wall poster, over a bench in the main lab of our old premises. Perhaps we should provide such posters for the office walls of all Local Government personnel charged with the implementation of COSHH. One of our current concerns is that by their actions some officers may put yet another nail in the coffin of pupil practical work. Anything which reduces pupil exposure to practical techniques and active learning may eventually diminish British science and technology. When it is largely done as an administrative convenience then that diminishes us all.

The "Safety Notes" of this issue carries a major article on COSHH implementation. I want to concentrate here on only two points - inventories and rationalisation.

As a first but only a first step with COSHH, there is a clear need for any EA to know what substances are held and used in its schools. There is a strong case, especially with cleaning materials and similar proprietary chemicals, for rationalising the range of products in use. Some school science departments might also benefit from a degree of rationalisation of their chemical stocks. In that context there is a place for centrally generated lists of substances needed to cover course practical work and a system of referral and approval for risk assessment and use of other "exotics" for 6th year and other project work.

The danger lies in the improper use of inventory control where substances may be eliminated on the strength of hazard data alone but where the actual risks in use could readily be controlled. Such misuse of inventories can unnecessarily restrict practical work. We have already heard of proposals from one EA area to eliminate all lead and its salts. This is a treble irony. Firstly, lead is not covered by COSHH but controlled under separate leglislation. Secondly the draft for the revised Higher in Biology suggests an activity on the effect on enzymes of heavy metals such as lead. That in our view not only could be acceptably safe but would be educationally desirable.

The final irony is that "Topics in Safety" was a response to such a traffic warden approach to safety. A major impetus for its publication was the banning, by some EAs, of certain chemicals which were then found to be required for examination courses. Re-adoption of such an approach would be a sick joke with "Topics in Safety" now identified by the HSE as a major source of risk assessment results and of advice on control measures.

Both "Topics" and COSHH include procedures for elimination of a few substances where the threats to health are unacceptable. In all other cases the emphasis is not on substances and hazards but on procedures and risks. These emphases are different. So long as administrators quickly learn such distinctions we might yet avoid retracing our steps to pre-"Topics" days.

* * *

INTRODUCTION

Christmas closure

The Centre will be closed for business from lunchtime on Friday, December the 22nd 1989 until 9 a.m. Wednesday 3rd January 1990.

Standard Grade Costings

Sciences

We were recently reminded by several enquiries on equipment lists that it has been our custom to publish start-up costs for new science courses. Such publication is overdue now that we have circulated, via the advisorate, equipment lists for the separate sciences at Standard Grade. We therefore include in this bulletin issue a feature article on estimated costs for Standard Grade Biology, Chemistry and Physics.

Technological Studies

Teachers of Technological Studies will no doubt be just as interested in our costings for that course. Our best estimates were provided some time ago in a joint SSERC/SCCC Project Report produced for, and funded by, the SED and IDS. The feature article also gives further detail on that report.

SSERC publications for Standard Grade

Most readers should by now be aware that as well as having prepared draft equipment lists the Centre is also engaged in a wider technical resource support programme for the sciences at Standard Grade. We have been asked to provide a short progress report on that programme.

Our move to new premises involved a great deal of self-help and much rolling up of sleeves. As a consequence publication dates have been much delayed. They also still depend very much on workloads from routine enquiries and in the evaluation and testing of equipment needed for the new courses. If the Standard Grade programme has taught us nothing else we have at least learned to be less than precise when giving deadlines!

Biology

a). Equipment Lists

Two first trial edition Equipment Lists have been produced for Topics 1-4 and 5-7 respectively. These were circulated to Science Advisers and nominated SSERC/EA correspondents where there is no such adviser. Second drafts with updated prices were distributed to advisers in September of this year.

b). Practical Guides

Early drafts of suggested practical work were produced by a team of teachers working with the Centre. Those drafts were but one set of resources among several identified by the NDO for use in preparing the national exemplar materials.

Some Centre staff are now looking both at that earlier material and the national exemplars and are beginning to prepare Volume 1 of a SSERC "Practical Guide" for the first few biology topics. The publication of that volume will be sometime in 1990.

Chemistry

a). Equipment Lists

A full draft equipment list was prepared and published in the Autumn of 1987. It has thus been openly available in some Scottish EA areas for up to two years now but possibly restricted in some areas to schools actually then doing the course. A version was also prepared as a database running on the BBC Master using Masterfile II software.

A Chemicals List has also been prepared but we intend amending that list in order also to provide hazard information as one aid to the implementation of the COSHH Regulations 1988 (see "Safety Notes" in this issue).

b). Practical Guides

The First Trial Edition of Volume 1 of the Chemistry Guides was published and circulated on a single copy per school basis towards the end of 1988. That volume covered Topics 1-5 and 7 (with 4 and 7 run together).

Volume 2 is in preparation and will be published sometime after the turn of the year. As in the first volume the procedures described therein have been bench tested. Safety information will again be given where necessary as "HAZCON"s within the text.

Physics

a). Equipment Lists

Three lists, covering Units 1 & 2 and 3 & 4 (both updated August 1989) and 5 to 8 (March '89) are available as detailed buying guides. Also available is a summary costing at prices ruling in August of this year. Lists were sent, as for other science subjects, in the first instance to advisers. In some EAs they have achieved much wider circulation. In others they may have only been copied to those schools which had actually started the course or were intending doing so at the beginning of this session.

b). Technical Guides

The guide for Units 1 & 2 : "Technical Guide, Volume 1" was published in proper printed and bound form towards the end of 1988. Since then the policy has been to produce draft guides as quickly as possible to cover all of the remaining six units of work. Only when that has been done do we intend tidying up those drafts for final, polished publications.

To date such Provisional Guides have been produced for Units 3 and 4 (both in 1988) and Unit 5 (in October 1989). These have all been sent to EAs for circulation at least to those of their schools following the course. A provisional guide for Unit 6 is in preparation.

*   *

MISAC Advisers

The National Centre for School Biotechnology (NCSB) has recently published [1] an updated list of Microbiology in Schools Advisory Committee (MISAC) Advisers. The entries for Scotland involve a number of changes and we have reproduced the Scottish section as an addendum to the address list on the inside back cover of this issue.

Reference

1. "NCSB Newsletter", No.7, Summer 1989.

*   *

No Comment

One of the currently fashionable preferences for student projects in technology courses is that they be placed in a proper social context. One such project we recently heard about surely meets that requirement. It was being done in a well-known and, it must be said, well-heeled independent school.

The project brief?

"Design and make an automatic pheasant-feeder"

*   *   *   *   *

SAFETY NOTES

Portable socket outlets

We draw your attention to a portable socket outlet having a design feature that is hazardous and places the user at risk. This appliance is made by a British company called Briticent. It is of the distribution board type with four socket outlets, switch and fuse, and is supplied in Scotland by Tait Components Limited. The maker's name and British Standard legend BS1363 are embossed on its base, but there is no model number marked on it.

The primary problem concerns the conductor between the switch and fuseholder. This is an assymetrical, dog-legged length of brass rod. The lengths of its three sections are 25 mm, 22 mm and 18 mm. The potentially unsafe design feature is that it is possible for the manufacturer to assemble the appliance with this conductor fitted the wrong way round. If this wrong fitment is made the conductor at live potential can make contact with the earth conductor.

This hazard became apparent after investigating the cause of an incident in a primary school. A survey of these socket outlets has found six out of the thirty four inspected to have this wrong fitting.

What action should you take if you have a Briticent socket outlet? We advise you to contact your supplier. If your appliance is new, return it and ask for your money back. If on the other hand you have used your appliance for some time ask your supplier to inspect it for correct assembly, or seek an exchange for one that he can assure you has been correctly assembled, or, preferably, one of another make.

You should not open the appliance yourself. Apart from it being your supplier's responsibility to check that he has not sold you faulty goods, it is tricky to reassemble correctly because the switch falls apart on opening.

Flexible cords - special types

Flexible cords - often called 'flexes' - are the cables that connect portable electrical appliances to socket outlets. We describe here two special types of flexible cord that you may need to use.

1. Heat resisting silicone cable

In Bulletin 163 we recommended you fit this type of cord to soldering irons. Since writing that article a check round local electrical wholesalers showed that suitable silicone rubber flexible cord is not widely available and it seems you may have to go to a specialist firm for supply. One such company is Electrocables of Coventry. They can supply both 2-core and 3-core cord of 0.75 mm^2 (24/0.2 mm) cross sectional area. Soldering irons are usually fitted with cord of 0.5 mm^2 cross sectional area. This cord would therefore be slightly heavier and less flexible. 3-core cord would be needed for a 240 V iron, and either 2- or 3-core for 24 V irons depending on type.

Electrocables normally sell cable by the drum in 100 m lengths - a drum costs about £100 with carriage being £10 extra. However they have indicated that customers should ask for the length they need rather than ordering by the drum and paying for wastage. They will try to help you out if they can.

Because there may be a difficulty in getting exactly what you need the Centre is considering buying this cable for resale to schools. Please let us know if you are interested in this service.

2. Flexible cord in non-standard colours

We sometimes get goods in for evaluation where a low voltage appliance is fitted to either another part of the equipment, or to an LT supply, through flexible cord. One example is the flexible cord connecting a 24 V soldering iron to the solder station power supply. Another is the Ross and Lamont model house. We usually find that the manufacturer has fitted flexible cord that is colour coded brown and blue. This places the user at risk. Either through carelessness, stupidity, or plain misadventure, he or she may connect a mains plug to one end of the cord and apply 240 V across what would have been, had it survived to tell the tale, the unfortunate appliance. These things have happened - and we warned you of such risks back in Bulletins 148 and 151.

This hazard can be removed by fitting flexible cord which uses neither the current European standard colours of brown and blue, nor the old British red and black standard. The only suitable substitute we have found is the American colour standard, black and white. Flexible cord in this standard is obtainable from Electrocables. They can at present only promise cord in p.v.c. insulation, but they hope soon to have samples in a heat resisting sort also.

If you would like to purchase a large quantity of this cable you should contact Electrocables directly. But for small lengths try us first please.

Philips spectral lamps - polarity checks

Earlier this year we received notice of an accident in which a school pupil had received an electrical shock when setting up a spectral discharge lamp. In response we issued a circular advising authorities to carry out several checks including one on the polarity of wiring to the Edison screw lamp fitting. Unfortunately we did not explain how such a check should be done. We are sorry if this omission has prevented you following our advice in practice.

Philips spectral lamps are powered by a step-up auto transformer, sometimes called a leak transformer. This comprises a single winding with the live input connected to a centre tap and the neutral input connected to one end of the winding (Fig.1). The lamp is connected across the whole winding. One terminal of the transformer is therefore commoned to both the neutral conductor and one side of the lamp. The polarity of the wiring clearly does matter with this type of controller.

This transformer gives a starting voltage of about 470 V, which automatically reduces when the lamp has struck, and regulates the current to roughly 0.9 A.

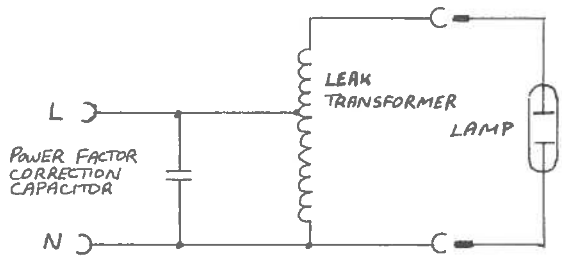


Figure 1 - Spectral lamp circuit

S9000 transformer

Present day equipment from both Griffin and Harris is fitted with leak transformers made by Philips, model number S9000. This transformer has two pairs of terminals at one end of the earthed screening box, and bears the wiring diagram shown in Figure 2.

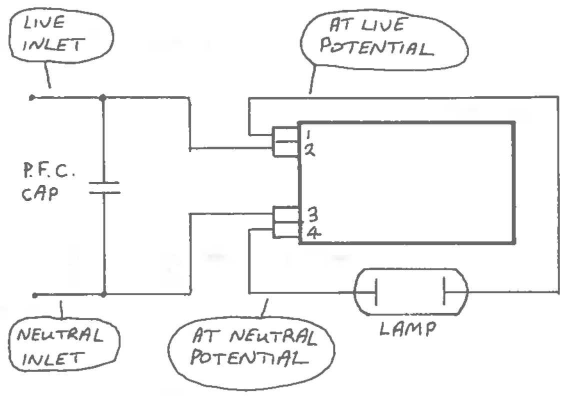


Figure 2

A polarity check should ensure that the conductors conform as follows:

terminal 1	outlet to lamp, live conductor
terminal 2	inlet from mains, live conductor
terminal 3	inlet from mains, neutral conductor
terminal 4	outlet to lamp, neutral conductor

L4140 transformer

Earlier lamp controllers contain the Philips leak transformer L4140, which would appear to operate in a similar fashion to the S9000. A polarity check on the L4140 consists of inspecting the conductors at the ceramic terminal block within the transformer enclosure. These should conform to:

terminal 1	outlet to lamp, live conductor
terminal 2	outlet to lamp, neutral conductor
terminal 3	inlet from mains, neutral conductor
terminal 7	inlet from mains, live conductor

Some updating of this lamp controller may be required to conform with presently accepted standards. It was originally supplied unfused with a Bulgin socket outlet on the enclosure. If this condition still pertains we suggest you replace the cable inlet with an IEC fused chassis plug (RS 489-122), and the Bulgin outlet socket with an IEC power outlet socket (RS 488-898). Our suggested improvements can be seen in Figure 3.

Edison screw (ES) lampholder

The purpose behind polarity checks on lamp controllers is to ensure that the Edison screw lampholders connected to them are correctly wired. For the sake of completeness we repeat here advice previously issued: the live conductor must be wired to the centre cap of the lampholder and the neutral conductor must be wired to the outer female thread.

Please note that traditional ES lampholders have been superseded by a new, improved design. This has a spring terminal sitting near the inside base of the lampholder that makes contact with the thread of a lamp fully screwed in, but does not make contact if the lamp is only partially inserted. This further helps prevent the hazard of lamp threads becoming live during the insertion process. Belts and braces, you might say - and no bad thing, too.

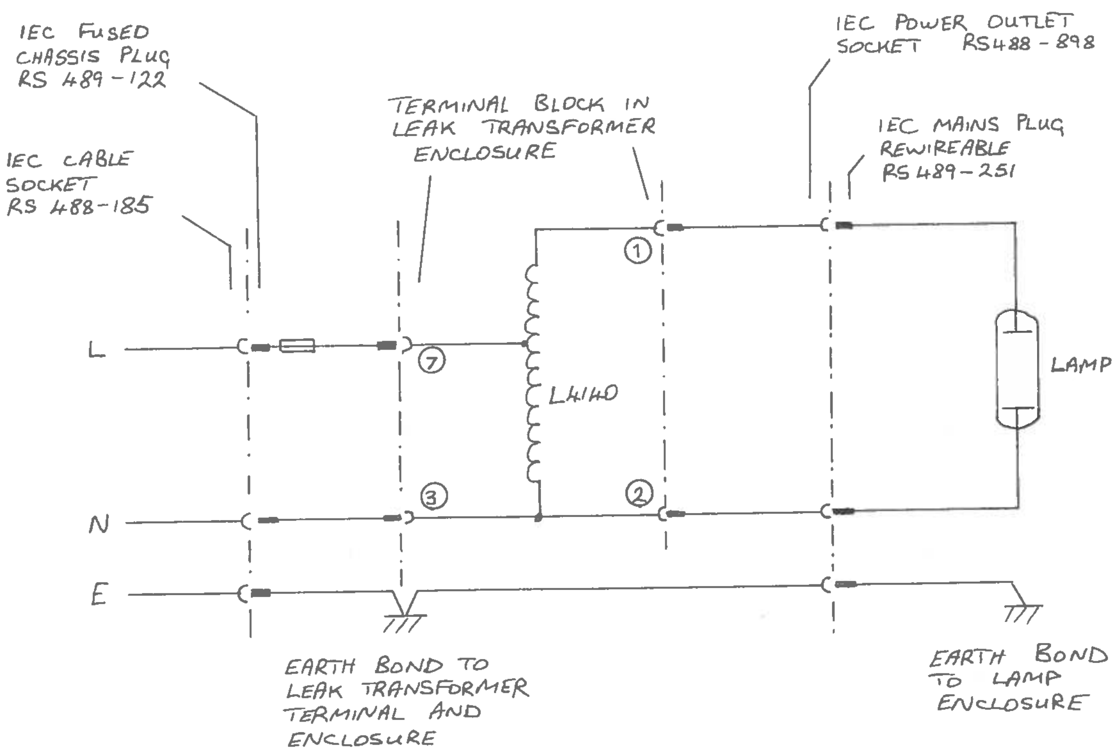


Figure 3

Eye Protection

Our article in Bulletin 163 on the precautions to take when soldering included stating the requirement that eye protection must be worn. We would like expand on this to make explicit what is required. This comment pertains to any such hazardous activity, not just soldering.

If a person is engaged in an activity where there is a foreseeable risk of injury to eyes then the requirement to wear eye protection affects all persons in the area where the hazardous activity is being undertaken. The need to wear eye protection depends therefore not on what you do, but on where you are.

How should this be managed? Either an area of a classroom should be designated such that everyone therein wears eye protection while the hazardous activity is undertaken, or the entire room should be so designated.

Microwave apparatus - HT Hazard

Early microwave apparatus, not that which is on the market now, used a klystron which was supplied with a +250 V d.c. supply with respect to the system ground, and a variable negative HT voltage applied to the klystron's reflector. The power supply and klystron were in separate enclosures with interconnecting conductors (Fig.1). In some versions these conductors connected to the power supply and klystron using 4 mm plugs.

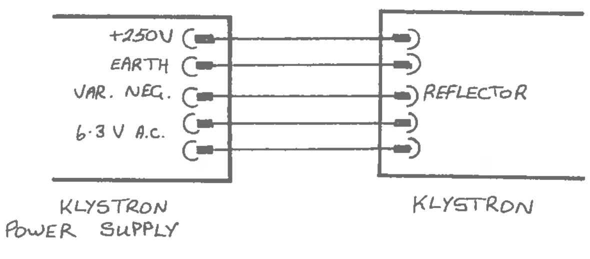


Fig.1 - Power supply and klystron connectors

There is clearly a risk of harm through being able to remove unshrouded plugs at high voltage potentials. Pupils should not be allowed to work with this older apparatus in its original state. Were they to do so this would contravene guidance contained within HSE GS23: "Electrical safety in schools".

The minimum requirement for dealing with this hazard would be labelling the apparatus: "High voltage hazard - not to be used by pupils".

A better means would be the replacement of the existing interconnecting leads having 4 mm connectors with new leads having plugs with retractable shrouds. This should remove the hazard - and pupils could then allowed to use this apparatus.

A third course would be replacing such old apparatus with new.

Harris protactinium generator

We understand that a number of bottles containing this radioactive source have leaked. The manufacturer Philip Harris are therefore withdrawing all sources already supplied. They hope to replace these with a modified model as soon as they are satisfied that there is no risk of leakage from their new version.

How might we be assured as to this? Harris have informed us that they have now had a large batch of the new version under test for several months.. Provided that no leakage occurs from any of this test batch they may now have an acceptably safe product.

Storing and using

We are concerned by reports from schools that storage of the generator is not always by the book.

Means of storing and using this source are contained in "Protection against ionising radiation in science teaching: Explanatory notes etc." published by SSERC. That publication contains a number of rules which must be followed:

cont./

Storage

1. Store the bottle upright - the flat-topped cap should then be sitting uppermost!

2. Store the bottle in a glass beaker - were leakage to occur this provides for containment; by using glass you have the assurity that the generator's contents will not react with your final line of defence.

Usage

1. Take normal laboratory precautions for handling an open radioactive source - wear a lab coat, eye protection and disposable gloves.

2. Pupils also should wear eye protection, or should view the decay experiment from behind a safety screen.

3. Work over a drip tray, which has a lining of absorbent paper.

4. Keep to a minimum any handling of the bottle - five seconds should be adequate shaking.

*　　*　　*　　*　　*

COSHH in Schools

Introduction

Since Bulletin 162 was published the picture surrounding the COSHH Regulations has become a little clearer; the Health and Safety Commission (Education Service Advisory Committee) has published its very readable booklet :

"COSHH : Guidance for schools".

Others have put their heads together and the results of such deliberations have now appeared in print [1,2]. This article further elaborates on the responsibilities of both employers and employees.

Those who may handle or be exposed to the effects of "substances hazardous to health" (see Figure 1) will include technicians, cleaners and teachers as well as pupils. Pupils are not employees but clearly belong to the class of "other person" referred to in the COSHH Regulations. Both COSHH and the Health and Safety at Work Act place a duty on the employer to provide for the health and safety of both his employees and of other persons.

Technicians and cleaners may be exposed for longer periods than either teachers or pupils; technicians often have to work in ill-ventilated prep rooms preparing solutions and decanting from bulk; cleaners may be handling polishes containing solvents or cleaning agents with corrosive materials as ingredients.

Pupils on the other hand will often experience exposures of only 5 or 15 minutes, but against that must be set the higher susceptibility of younger persons to some chemicals and that more of their life remains. Teachers will have longer exposure times than pupils and in some instances longer than technicians. In a poorly resourced school they may have to do some of a technician's job as well as their own.

Substances or Processes?

We have noticed that some authorities seem hell bent on issuing requests to all their schools not only to prepare inventories of the chemicals and materials on their premises but also to consult learned texts and append a variety of data relating to the hazards and the safety precautions for each chemical.

WHAT IS A SUBSTANCE HAZARDOUS TO HEALTH ?

A substance should be regarded as hazardous to health if it is hazardous in the form in which it occurs in the work activity. In particular, the regulations define the following substances as hazardous to health :-

(a) Substances defined as *very toxic*, *toxic*, *harmful*, *corrosive*, *irritant* } as dangerous for supply in Part 1A of the Approved List under the CPL Regulations [1]

(b) Substances which have an *MEL* (Maximum Exposure Limit) or an *OES* (Occupational Exposure Standard) } as listed in HSE Guidance Note EH40/89 "Occupational Exposure Limits"

(c) *Micro-organisms* which create a hazard to the health of any person, where the the hazard arises out of or in connection with work which is under control of the employer. For example, contracting a disease from a laboratory animal is included, but catching a cold from a co-worker is not.

(d) *Dust* of any kind when present at a *substantial concentration* in air (where there is no indication of the need for a lower value).

> *Substantial concentrations* are :
> - 10 mg/m^3 total inhalable dust
> - 5 mg/m^3 respirable dust

and

(e) any other substance which creates a comparable risk to health to any of the above.

However, the Regulations do *not* apply to activities where the Control of Asbestos at Work Regulations or the Control of Lead at Work regulations apply, or where the risk is solely from radiation, noise, pressure, flammability, heat or cold.

1 The Classification, Packaging and Labelling of Dangerous Substances Regulations 1984

Figure 1

Those authorities are facing a massive collation, an enormous task for both them and their schools. It is not necessary to do it this way and in any case it does not meet the requirements of COSHH.

We do not think it useful for Abersnecky Regional Council to know the exact total tonnage or grammage of hexane held collectively by its schools; it may be useful to know if a particular school possesses an unreasonably large amount. As for the information on hazards, this can simply be found by referral to the Hazardous Chemicals Manual, Hazcards or to a supplier's hazard data sheets.

A second and more important objection to this preparation of long lists is that a significant aspect of COSHH is neglected. It is not the chemical itself which is assessed, but rather the intended or current mode of use (see the famous aphorism quoted in the "Opinion" section of this issue).

A simple and obvious example is a block of mahogany in the form of a table top - there is neither hazard nor risk in terms of COSHH, but as soon as you start sanding it a real risk to health may exist. The details and circumstances of any activity have to be examined in order to make an assessment of what quantity of each substance might escape. It then has to be considered how each such substance, if absorbed by those present, might affect their health.

Responsibilities

Figure 2 provides a simple summary of the main requirements of the COSHH Regulations. These are amplified in the following paragraphs. The emboldened reference at the end of each such section indicates the pertinent regulation(s).

Most responsibilities under the regulations, though not all, lie with the employer. An employer may delegate certain duties downwards to headteachers and eventually to other members of staff. All persons so involved will bear some responsibility.

<u>The employer has a responsibility to:</u>

- carry out or arrange for the carrying out of suitable and sufficient assessments of the risks to health posed by substances defined as being hazardous to health. This must be done before any work is started. He has to ensure that the person appointed by him is competent to carry out that task. If a teacher has been appointed then the employer must provide adequate time and training to enable that teacher to (i) become competent and (ii) carry out the task. Regulation 12 refers to this need for training.

(**Regulation 6 ASSESSMENT**)

- set up control measures which will prevent exposure or will adequately control it. This means, for those substances for which an Occupational Exposure Limit [3] has been assigned, reducing the level of exposure below the Maximum Exposure Limit (MEL) as far as reasonably practicable. Other substances are assigned an Occupational Exposure Standard (OES); ideally atmospheric levels of such a substance should be below the OES, but this may be exceeded if the employer is aware of the situation and is taking steps to remedy it. [MELs and OESs have replaced the Threshhold Limit Values (TLVs)].

(**Regulation 7 CONTROLS**)

- ensure that the control measures he has set up under Section 7 are being properly used; again employees may need some small amount of training in the use of control measures. There is also a duty on employees to make full and proper use of any control measures and to report forthwith any defects.

(**Regulation 8 USE OF CONTROLS**)

- arrange for the regular testing of any local exhaust ventilation (LEV) system. This means a thorough examination (using an anemometer) at intervals of not more than 14 months and a visual check every week. In schools LEV usually refers to fume cupboards or to extract systems fitted to saw benches or power sanders. In practice, "not more than 14 months" will mean annually.

(**Regulation 9 MAINTENANCE**)

SUMMARY OF THE MAIN REQUIREMENTS OF THE REGULATIONS

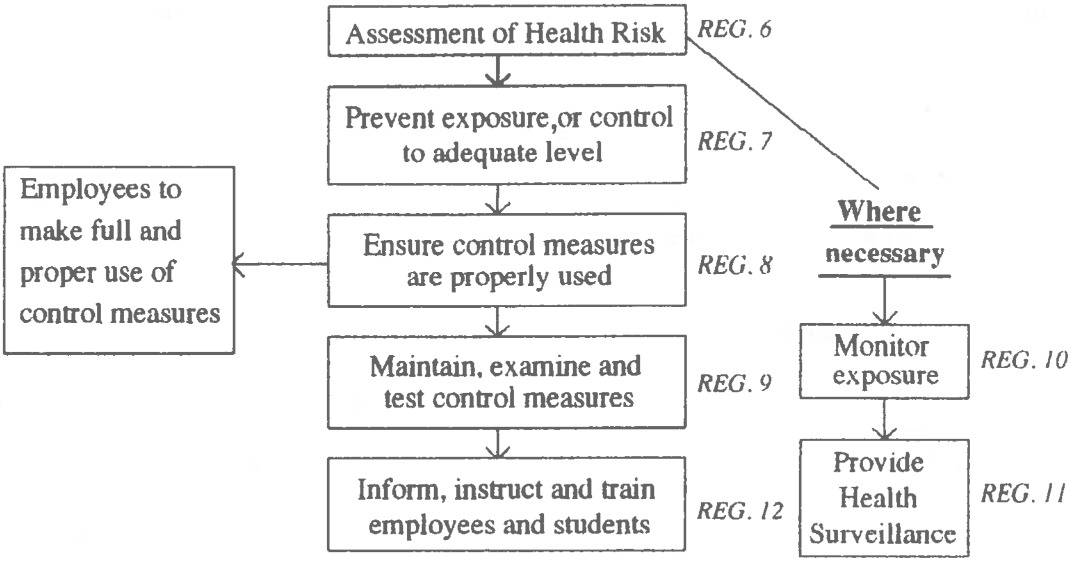


Figure 2

- provide information, instruction and training to employees and to others so that they:

(i) are aware of the risks to their health caused by the exposure to the substances concerned and of the precautions which should be taken;

(ii) are competent to carry out any duties or tasks the employer may have delegated to them, e.g. testing an LEV system or carrying out an assessment or monitoring exercise.

(**Regulation 12 INFORMATION,INSTRUCTION & TRAINING**)

It is unlikely that a situation will arise in schools where either monitoring or health surveillance has to be implemented by the employer. Monitoring means the quantitative measurement of exposure of persons to substances hazardous to health and usually means sampling in the breathing zone of the person concerned. The situation could possibly arise if a technician spent most of a working day in an small ill-ventilated prep room which doubled as a chemical store.

(**Regulation 10 MONITORING**)
or 11 (**HEALTH SURVEILLANCE**)

The management systems used for the carrying out of these duties will vary from one authority to another. Three identifiable points in any EA's structure are:

- Regional Directorate and Safety Officers who will carry the main responsibilities;

- Regional Advisors or Officers covering a variety of subjects - home economics, technical, sciences, janitorial services - these persons will almost certainly be delegated responsibilities by the employer;

- School-based staff, i.e. headteacher, school safety officer and other persons who may be delegated to carry out specific tasks, e.g. preparation of initial assessments at the local school level, or examination of LEV systems.

Making assessments

An assessment of the risk posed to the health of EA employees and to pupils by a process involving substances hazardous to health must be carried out before any work is started. Note that a reaction product could be hazardous but the starting materials relatively inoccuous. (The possibility of the formation of hazardous products reinforces the inadequacy of any annotated list.)

It seems that assessments can be at three levels:

1. Simple assessments

At one end of the scale the assessment may be nothing more than reading the risk phrases on the bottle of the starting materials and taking the appropriate precautions. The equivalent information for the products of a reaction could conveniently be found in a supplier's catalogue. For example, if the risk phrases indicate that a substance is highly corrosive, gloves and eye protection should be worn during the preparation of a solution.

In another example the most hazardous step in a class polymerisation experiment might be the technician dispensing from a bottle into test tubes ten 5 cm^3 portions of methyl acrylate. The risk phrases indicate that this substance is harmful by inhalation or swallowing and is irritating to the skin, eyes and respiratory system. The wearing of eye protection and gloves of suitable material and carrying out the task in a fume cupboard will provide adequate control.

Such an assessment need not be written down as it is easily understood and can be repeated at any time. If one aliquot only were to be dispensed it might be permissible to do this in an open lab which was well ventilated, since the monomer is not very volatile (b.p. 80^{o}C).

2. Standard activities

A number of results of general assessments for activities in school science have been available for some time, e.g. Topics in Safety (ASE) and Hazcards (CLEAPSS/SSERC).

"COSHH : Guidance for schools", the HSC booklet states that for science subjects employers may if they wish adopt these general assessments and if necessary adapt them to particular circumstances. This action should cover the bulk of the science activities in schools. Other publications such as SSERC Practical and Technical Guides for Standard Grade contain assessed activities and may also be used. Therein the HAZCON sections contain the results of such assessments.

What then is required after referral to either the Topics or Hazcards?

Provided that the employer has recorded centrally that he has adopted certain specified assessments and has overtly informed teachers that these are the assessment results and attendant control measures which are to be used, then little more requires to be done except to ensure that such controls are indeed used. This will depend greatly on the professionalism of individual teachers and particularly on the management skills of PTs.

Two further points on general assessments deserve mention.

(i) We expect that most authorities will adopt for science subjects the results of existing general assessments, namely Topics in Safety and Hazcards. But there is nothing sacrosanct about these and it is open to authorities, if they wish, to develop their own general assessments.

(ii) Unfortunately no such body of general assessments exists for technical subjects. This is an omission that needs acting on. Clearly we at the Centre may have a role to play in assisting with these general assessments.

3. Non-standard Activities

3.1 Introduction

Where the activity is novel, perhaps a project, and there exists no ready-made general assessment package on which to lean, then there is nothing for it but to carry out a full assessment. Each employer will need to set up a system to deal with projects and similar activities. For CSYS projects it is useful in the first instance for the pupil and teacher jointly to carry out the assessment. This will serve two purposes :

(i) The promotion of awareness in the pupil of the hazards and of sensible ways of dealing with them. Pupils will be entering a world where COSHH applies and skills and attitudes formed here can be viewed as an important part of education.

(ii) The initial assessment can be used to inform the employer of the details and nature of the intended work so that he can in turn make a full assessment of it.

In at least one large Scottish EA the system will be to pass the problem firstly from class teacher to PT. If the case proves too difficult to be resolved at that level it will be referred to a panel of expert assessors made up of experienced teachers, regional safety office appointees and advisers. It is unlikely that any of these persons will be trained occupational hygienists and outside help may occasionally need to be sought or bought in.

3.2 Starting an assessment

Two useful, succinct booklets should be of great assistance to those tackling such assessments from first principles. They are:

"COSHH making an assessment"
(Institute of Occupational Medicine)

The first half of this 20 page booklet puts forward some general ideas about assessments, making good use of the question and answer approach. In the second part the reader is led step by step through an actual assessment on the use of a caustic oven cleaner. It reads more like a friendly mentor talking you through the process. The approach can readily be transferred to other situations.

"COSHH in Laboratories"
(Royal Society of Chemistry)

The approach used here is very practical and the most striking feature is that purely subjective conclusions are replaced by quantifiable ones.

STEP 1 Numerical values are assigned to the following aspects of the activity:

- the quantity;

- how easily it is disseminated in a room, i.e. is it on one hand a volatile or a fine dust, or at the other extreme an involatile block of solid? - applying a varnish by brushing rather than by spraying would be an example of one way of reducing the degree of dissemination;

- method of operation, i.e. is it in an open vessel, or contained in a flask fitted with a reflux condenser?

The assigned numbers are multiplied together. The bigger the score the higher will be the "exposure potential" in that operation.

STEP 2 Using the matrix provided this exposure potential is then married to the "hazard category" (four point scale) of the substance. The calculated score then indicates whether the process can be carried out on an open bench or whether it requires a fume cupboard or other special facility. The process sounds complex, but is in practice quite easy and rapid. It is a 'lab based' method and immediately focuses attention on that flask and its contents on the bench.

- the hazard category of the substance. To assign a degree of hazard to a substance the RSC approach does not use parameters like LD50s, which in any case are not usually readily accessible to schools. Categories of hazard are decided mainly by reference to the risk phrases as defined by the Classification, Packaging and Labelling Regulations (CPL) 1984. The original source of such information is the 'Approved List' issued under the above Regulations, but since the same regulations require suppliers of chemicals to place such warnings on their bottles, a supplier's catalogue is a more convenient source of such information. Note that many manufacturers will add risk pictograms or phrases to chemicals even though the 'Approved List' does not require such signs. We can look on this apparent anomaly with gratitude in that such suppliers are saving us extra work (see the last catch-all clause in the definition of a substance hazardous to health in Figure 1).

3.3 Concluding an assessment

The final part of any assessment is deciding if there is a risk to health. The HSE suggest that we may arrive at one of five possible conclusions. The first two are extremes and are usually easy to reach and to deal with:

(i) risks are insignificant;

(ii) risks are high and current control measures are inadequate.

Nothing needs to be done in the first case (i) where the risks are judged to be insignificant provided that the substances are always used in the same way. In the second case (ii) where the risks are judged to be high, immediate action is needed to set up adequate controls.

The next three conclusions contain uncertainties of varying degree:

(iii) the risks seem to be controlled now but there is some doubt about this remaining so;

(iv) the nature of the hazard is known, but there is some uncertainty about the degree of exposure, i.e. about how good the method and equipment are at containing the material, or about the length of the exposure;

(v) there is insufficient information about the hazards to permit the evaluation of the risk.

For conclusion (iii) we need to keep a careful watch on the situation. If either of conclusions (iv) or (v) are reached then clearly more information is needed before a proper assessment can be made.

What is SSERC doing to help schools with COSHH?

a. The two publications, CLEAPSS chemicals "Hazcards" sets and "Topics in Safety", are available from the Centre at discount prices. Most EAs will be making bulk purchases for distribution to their schools. If desired, extra copies of both are available for £4 each plus p & p, (60p for Topics in Safety and £1 for Hazcards).

b. We are in the process of preparing a list of those substances likely to be found in schools and annotating that list with a simple coding for the several hazards.

c. Each of the Practical and Technical Guides for the three separate sciences will contain the results of assessments and the recommendations for adequate control measures. These have the advantage over Topics in Safety and Hazcards of being tailored exactly to the activity or experiment in Scottish courses.

d. The Centre Director has been acting as consultant to the Strathclyde Regional Working Group on Safety in School Microbiology. That group's report has recently been printed. It is our opinion that it provides an excellent model for other EAs to adopt or adapt as a Code of Practice to meet many of the reguirements of COSHH. SSERC is at present actively encouraging the Scottish Science Advisers Group to consider such adoption. Procedures are still to be developed for referrals and risk assessment of more novel activities or open ended project work in microbiology.

e. A booklet offering help with the non-standard activities is in preparation. The IOM and RSC booklets are excellent in dealing respectively with the more general situation and with the chemistry laboratory in particular. The SSERC booklet will contain worked examples from different school subject areas up to and including CSYS level.

f. If there were a demand we could assist with advice on proposed monitoring procedures, where quantitative measurements of the concentrations of contaminants in the laboratory atmosphere need to made.

g. Advice is available on methods and protocols acceptable to HSE for testing fume cupboards and other LEV systems. The fume cupboard procedure is relatively simple and can be carried out by school technicians. If there were a demand for training from an EA then a simple practical course could be arranged. Copies of the SSERC booklet published two years ago, "Fume cupboards in schools", are still available from the Centre.

Prices quoted by commercial consultants for an examination of fume cupboards are typically £200 to £400 for the first cupboard, with smaller unit costs for testing additional cupboards. A simple anemometer costs in the region of £200 to £300 and will only require regular calibration. One anenometer could be shared between a number of schools.

h. Presently being considered is the feasibility of setting up a test rig in the Centre which would provide a low-cost secondary calibration service for anemometers. The commercial cost quoted by one manufacturer for such calibration without a certificate is £28.70. With a certificate the price would rise to £58.40.

i. We are currently co-operating with a large Scottish EA in exploring practical ways of managing the implementation of COSHH and will be in a position to pass on the results of that experience to others.

j. Copies of the proceedings of a SSERC COSHH seminar are available at a cost of £4. This seminar was held in the Centre at the end of August for science and technical advisers and regional safety officers.

Summary

The whole process may seem off-putting and you may be questioning if practical work is now worth doing at all. Remember however that the bulk of activities presently carried out in school workrooms and laboratories can be covered by the results of a general assessment. Many other assessments, the ones relating to the simplest types of activities, will be as easy as reading the label on the bottle. For non-standard activities, the less simple ones, you will have to carry out an assessment yourself. But help for that is available from the Centre.

The Health and Safety at Work etc. Act has been with us for thirteen years. Those who systematically meet its broad requirements will in general also meet the spirit of COSHH. How many of us to-day worry about the Act in the way we did ten years ago? To some extent it's like driving a car - a lot of the steps become automatic after a while. The whole system of administering and implementing COSHH must be made simple and workable. If it is not, everyone will be intimidated by the mountains of paper in the form of assessments, records of assessments, the results of testing LEVs, etc.

The answer must be to use as simple devices as possible for managing and implementing assessments. Risks and precautions (controls) for any particular activity are essentially the conclusions of assessments. If, for any particular activity, they are integrated with course materials (teachers' guides and pupils' worksheets) at the point of use then these count as a record of the assessments. The HAZCONs in the Practical Guides are one example of this. Annotation of Schemes of Work by Principal Teachers is another obvious ploy.

Where no general assessment from 'Hazcards', 'Topics in Safety' or 'Practical Guides' can be adopted it would good practice to keep a log showing that each activity has been considered. A copy of this should be kept by both the school and employer.

References

[1.] COSHH in laboratories (Royal Society of Chemistry) £7.50 to non-members, or £5.00 to members

[2.] COSHH - making an assessment (Institute of Occupational Medicine) £5.00

[3.] Guidance Note EH 40/89 Occupational exposure limits (HMSO)

* * * * *

STANDARD GRADE COSTINGS

Technological Studies

As indicated in the "Introduction" to this bulletin our estimates for equipping Technological Studies are to be found in the joint SSERC/SCCC project report to the Scottish Education Department. That report was circulated, with copyright waived, to technical education advisers and nominated SSERC/ EA correspondents. It was snappily entitled :

> "Standard Grade Technological Studies Resource Review : Technology Room and Equipment Guidelines : Final Report"

In addition to other information and advice on room layouts, sources of supply etc. it contains several sections with detailed estimates for various parts of the course. A number of advisers reproduced versions of the report and circulated them to teachers. If you have not seen a copy then somebody, somewhere, in your Regional or Islands Authority should have at least one. We now have a short form version in preparation and this should be available before the turn of the year. If you would like a copy please phone or write and ask.

Estimates for the Sciences

Estimates for purchasing equipment to support practical work in Standard Grade Biology, Chemistry and Physics courses are given in Table 1 below.

Headings such as 'Total Lab.1 tie in with those used in our equipment lists. A figure entered under 'Total Lab.1' is the cost of equipping the first specialist laboratory in one of the three sciences. A figure entered under 'Total Lab.2' is the cost of equipping a second, third, or fourth specialist laboratory. Lab.2 figures are lower than Lab.1 figures because we assume that laboratories are not resourced independently of one another, but only partially so.

We base our costs on the assumption that if an item of equipment is used frequently then every specialist laboratory should be provided with one or several of them. Such items are incorporated in the costs of both the Lab.1 and Lab.2 columns. If on the other hand an item is used infrequently, or is expensive, then it is costed for Lab.1 alone.

The Lab.1 and Lab.2 totals are the totals of purchasing basic items of equipment to undertake all the suggested practical activities in the Standard Grade sciences. The fourth column 'Supplementary' used for Biology and Physics contains items which supplement or complement core items. Such supplementary items might be included to show the diversity of experimental techniques, or as modern substitutes of traditional items of equipment. Supplementary items should be looked on as enhancements of core items. They are not necessarily dispensible and their presence can be expected to raise the impression pupils have of the sciences. For Chemistry no attempt has been made to tease out from the Lab.1 or Lab.2 estimates the costs of equipment which might be classed as supplementary.

Subject	Total Lab.1 (£)	Total Lab.2 (£)	Supplementary (£)	Chemicals (£)
Biology	6,834	4,744	5,602	-
Chemistry	8,150	5,891	-	2,000
Physics	13,462	4,394	6,655	-

Table 1

How should the estimates be used? Subject to the qualifications below, which we must stress have a great bearing on their worth, a sample application is shown :

Example - estimated cost of equipping a school with three specialist physics laboratories:

Total = Total Lab.1 + 2 x Total Lab.2
= £(13,462 + 2 x 4,394)
= £22,250

The cost of basic equipment for the three physics laboratories is £22,250. If this basic equipment were to be enhanced then the total would rise by a maximum of £6,655 to £28,905.

Qualifications

In so using these estimates the following points should be considered:

1. The figures given are for resourcing practical work for class sizes of 20 pupils.

2. In the Biology and Physics lists the estimates do not include costings for basic items such as Bunsen burners, tripods, or common glassware or laboratoryware, that would be used with S1/S2 practical work. However the costings for Chemistry include such basic items.

3. The estimates provide for carrying out every suggested piece of practical work in the SCC Exemplar Materials. Obviously schools can be selective in their choice of using these suggestions.

4. The estimates provide for resourcing a science department from scratch. They may not therefore be directly applicable, but are the only practicable way we can make our estimates because (1) we have no knowledge of levels of provision in any specific school, and (2) it is not part of our function to decide which parts of the syllabus will actually be covered by practical work and which will not.

5. Considerable savings on equipment may be achievable by managerial decisions on timetabling or course sequencing.

6. The estimates for Biology and Physics are based on current catalogue prices, which are often subject to discounts. Those for Chemistry are based on October 1987 prices with the totals adjusted for inflation.

7. Our figures thus represent maximum amounts. Anyone requesting more than our estimates, even if they are starting with little or no up-to-date equipment, would be unquestionably chancing their arm. Obversely, where departments have not received any injections of cash for capital equipment in the last five to ten years, funding requests which are an order of magnitude lower than our totals might be questioned as being unrealistically low.

8. The estimates do not include costs of consumables, textbooks, or audio-visual material.

We have costed the chemicals needed in Chemistry. The total comes to about £200 a year with a once and for all cost of about £2,000 for purchase of the initial stock in standard sizes of containers. Please note that neither of the Lab.1 nor Lab.2 totals for Biology or Chemistry includes the costs of stocking with chemicals. The cost of stocking with chemicals for Biology has yet to be worked out. The Lab.1 total for Physics includes the cost of stocking with the few chemicals that this course requires.

The provision of adequate audio-visual material for Biology may be a considerable additional expense to our estimated costs.

* * * *

STANDARD GRADE TECHNOLOGICAL STUDIES
PROJECTS FOR THE MAIN UNIT

Introduction

In Bulletin 163 I discussed the systems approach and I gave an example of how it could be used to help design a course. This led to the course structure illustrated below in figure 1.

Readers may be aware of the conflict which may exist between this project or process based course and the overtaking of the required learning outcomes which relate to the knowledge and understanding part of the course. This article looks at this possible conflict.

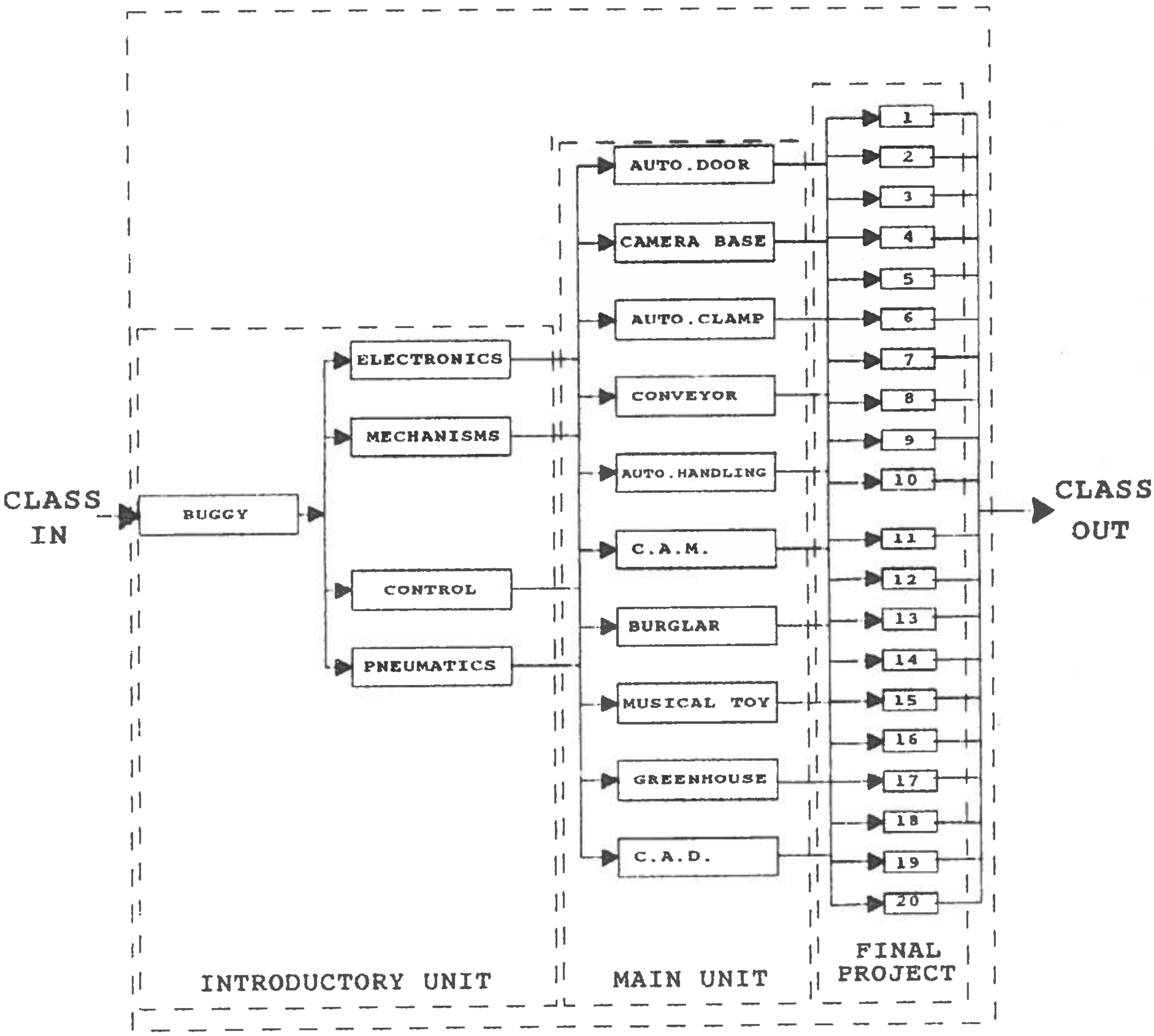


Fig.1 - Course structure in S.G.Technological Studies

Course Structure

The proposed course structure is such that in the early stages pupils are guided towards desired solutions and kept under close teacher control. As the course develops this control is relaxed. The pupils are given greater freedom of choice and are expected to work independently as well as within a group. However it must be stressed that although this is a pupil centred, project based course learning is too important to be left to chance and prescribed course content must be covered. Therefore there is a conflict between overtaking the learning outcomes of the course, in terms of content, and using projects as the learning medium. The systems approach can be used to overcome this difficulty. With most projects a variety of solutions is possible. Pupils can be guided in their research and investigation to consider possible solutions and represent them as subsystems. Subsequently the pupil must make a technological decision and choose the subsystem which he or she thinks is most appropriate. In other words, and this is the important point, the final solution is left OPEN . The pupil can accept or reject or offer her own solution but she must consider the options available. This approach also allows for differentiation of materials since the options available will present the pupil with different intellectual challenges and only the most able of pupils could be expected to consider all of the options and perhaps to offer one herself.

The Final Project

It is difficult to predict what final project a pupil will eventually tackle since this activity is to reflect the interests of the individual pupil. However the Main Unit projects can provide a safety net in that most of them can be developed further and therefore can provide a pupil with a problem solving context on which to base her project.

Summary

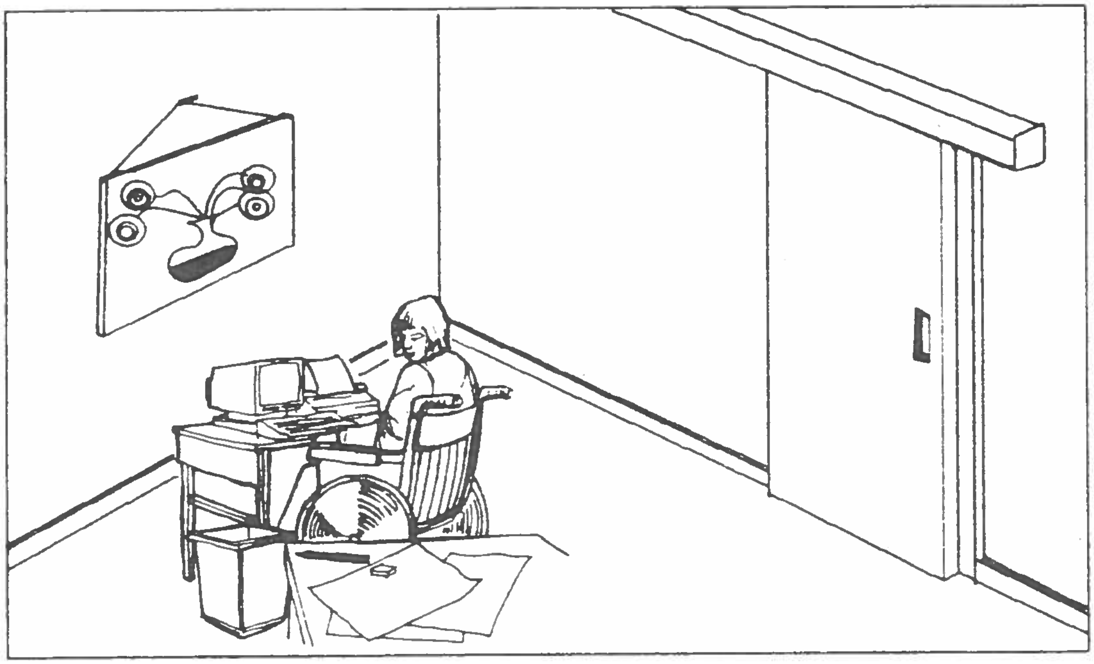
In order to cover the content of Standard Grade Technological Studies pupils need to be guided in their research and investigation. However this does not necessarily mean that projects cannot be open ended. As part of the technological design process a pupil will investigate alternative solutions to a perceived problem and choose that solution which he or she considers the most suitable. But which solution will a pupil choose ? The choice will be made on the basis of subjective (value) judgements and objective (educated) judgements. In other words there will be no right or wrong solution - only a chosen solution - and the difficult task of choosing is left OPEN.

Pupil material over/

MAIN UNIT PROJECT

AN AUTOMATIC DOOR SYSTEM

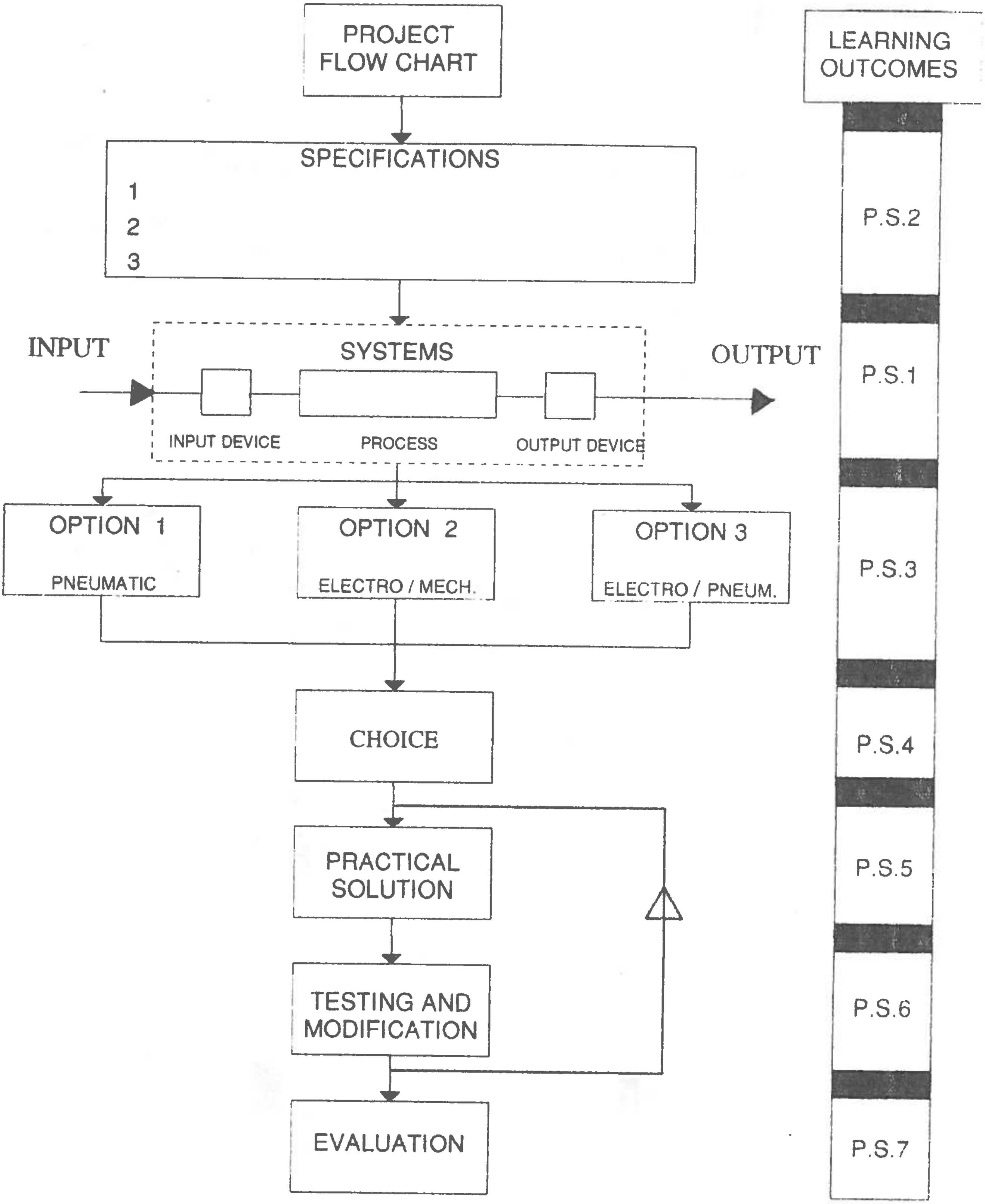
You have been asked by the Severely Disabled Persons Action Group (the SDPAG) to design and prototype an automatic door system whereby a disabled person will be able to open a door in their home by simply moving a hand, arm or other limb over a sensor. Of course the door must be able to be opened from either side and it must close a short time later.



ADVICE

You may use any of the resources with which you are familiar i.e. resources you have worked with in the Introductory Unit or other Main Unit projects.

In addition you may find the resources shown in the projects Resource File useful.


PROJECT FLOW CHART
SPECIFICATIONS
1
2
3
INPUT
SYSTEMS
OUTPUT
INPUT DEVICE
PROCESS
OUTPUT DEVICE
OPTION 1
PNEUMATIC
OPTION 2
ELECTRO / MECH.
OPTION 3
ELECTRO / PNEUM.
CHOICE
PRACTICAL SOLUTION
TESTING AND MODIFICATION
EVALUATION
LEARNING OUTCOMES
P.S.2
P.S.1
P.S.3
P.S.4
P.S.5
P.S.6
P.S.7

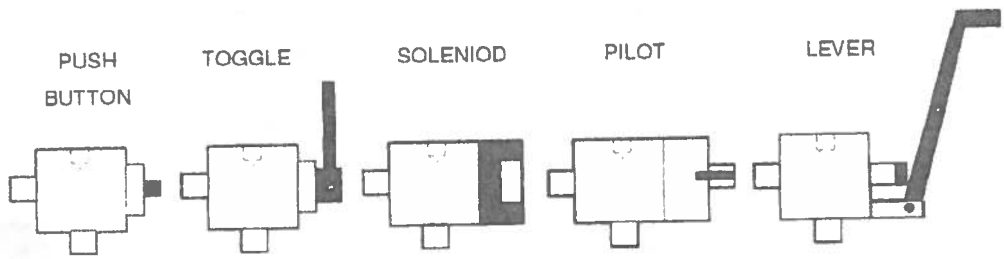
OPTION 1

To satisfy the specifications using pneumatic systems you may use any of the components with which you became familiar during the Introductory Unit.

The knowledge and experience you gained during the Introductory Unit should allow you to select, from the components shown below, input and output devices.

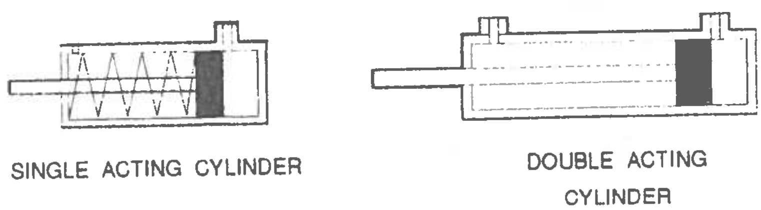
Refer back to earlier work if you have a problem.

PNEUMATIC COMPONENTS



3 PORT VALVES

5 PORT VALVES



PNEUMATIC CYLINDERS

FURTHER DETAILS

Your stated specifications for this project should have included the following:

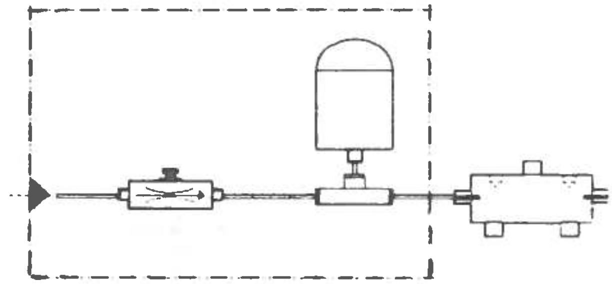
a) the system must have a logic device so that the door can be opened from either side.

b) the system must have a device to delay the closing of the door (to allow time for a person to pass through).

The diagrams below show how these specifications can be satisfied pneumatically.

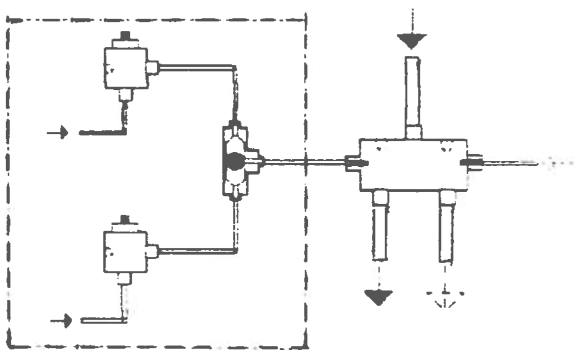
DELAY TECHNIQUE : how it works

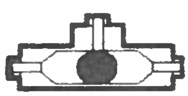
The air signal, coming from a 3-port valve positioned elsewhere in the system, enters the flow restrictor. This reduced air signal gradually fills the reservoir. As the reservoir fills up the air pressure in the line after the reservoir also builds up and when this pressure is great enough the pilot valve is activated.

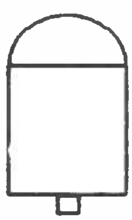


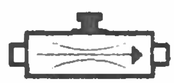
PNEUMATIC LOGIC : OR

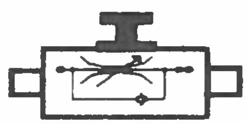
The shuttle valve provides the logic. As the air signal enters the shuttle valve from either 3-port valve the ball is pushed against the opposite wall. This means that the air can only exit through to the pilot valve.




shuttle valve

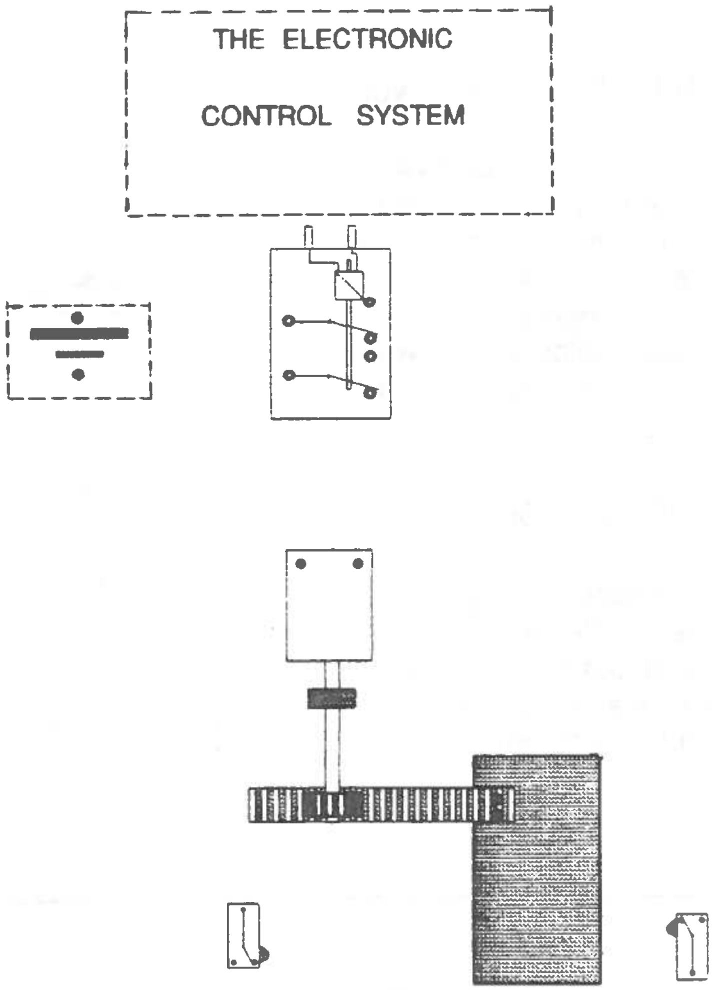

reservoir


flow restrictor


uni-directional flow restrictor

OPTION 2

You should have little difficulty in selecting systems boards to build an electronic system which can give an output signal when EITHER of two input sensors are activated. The output device that should prove most useful is the RELAY UNIT. This relay unit could be used to act as a switch to drive the electro-mechanical device shown below. The circuit diagram has been left for you to complete.



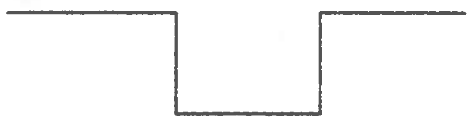
FURTHER DETAILS

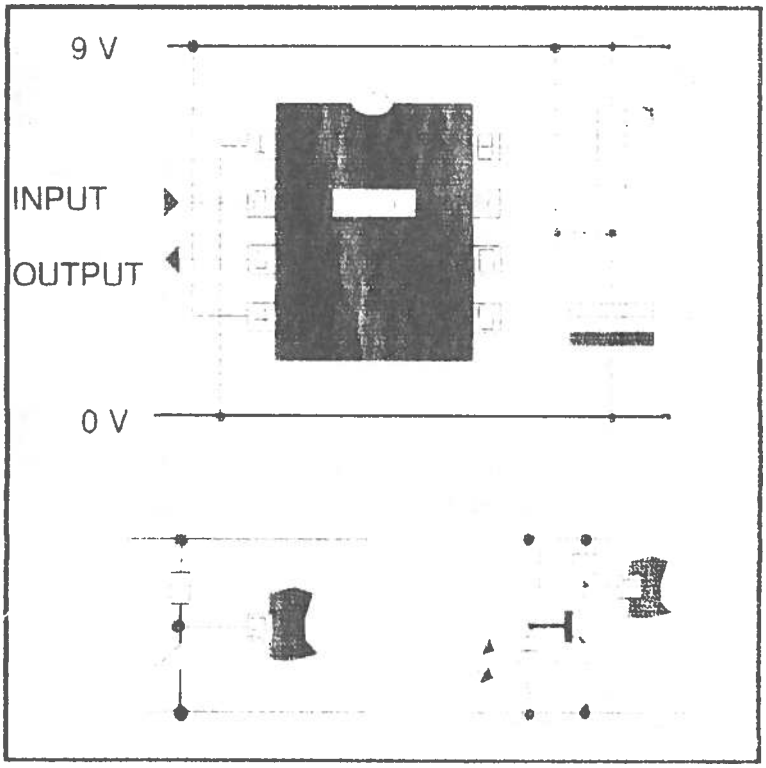
However if you build an electronic system like that suggested above then the door will simply open when the input sensor is activated and close immediately it is de-activated. In other words there is not enough time for a person to get through the door. A hold circuit like that shown below needs to be included in the electronic system.

The I/O Unit (E&L) and the Mother Board (ALPHA) allows you to do this.

The Trigger

To start the timing period **PIN 2** must be brought from **HIGH to LOW and then back to HIGH** again. As shown below.





Setting the Timing Period

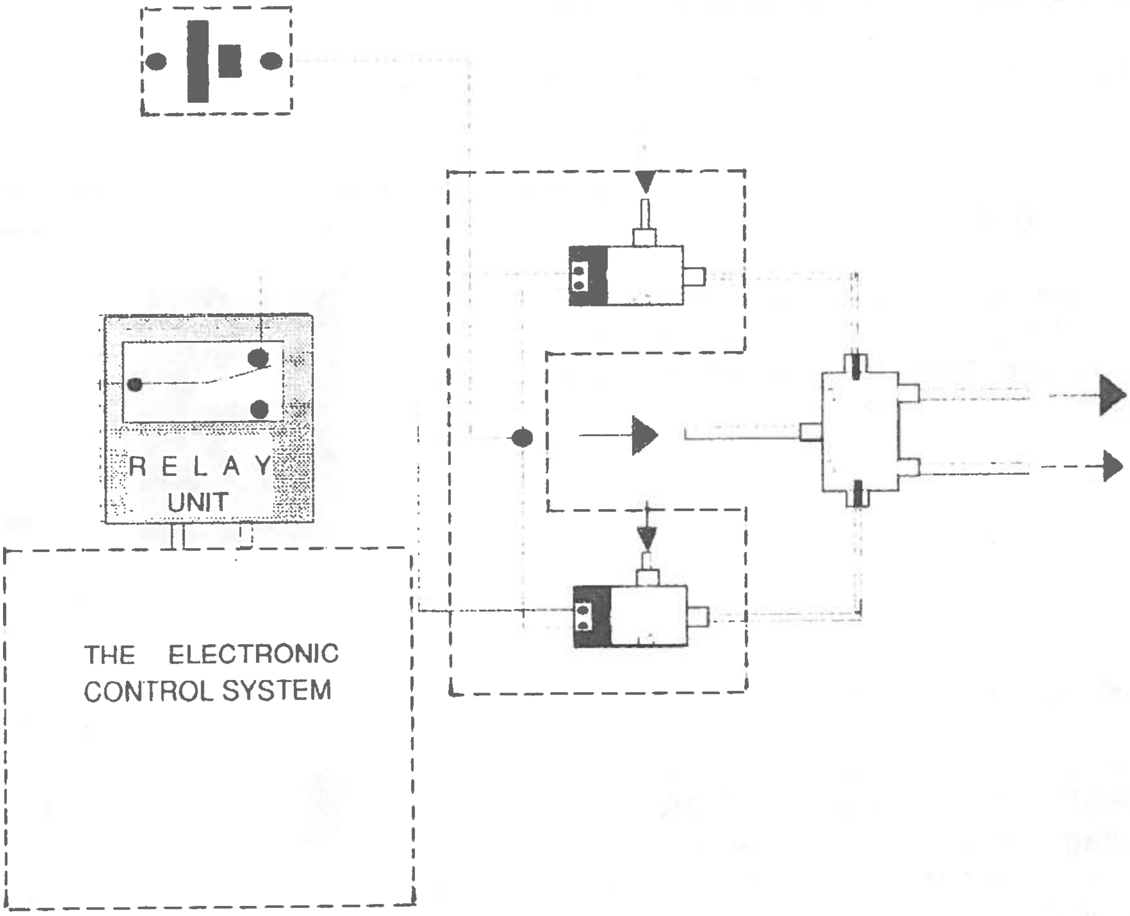
The timing period is set by the **RESISTOR / CAPACITOR voltage divider.** The greater the value of either the greater the timing period.

OPTION 3

The electronics part of the electro-pneumatic option is identical to that of option 2 refer to this if you need to.

The difference between the two options is in the choice of output device.

The problem you are faced with is how to interface the electronic system with the pneumatic system. The diagram below illustrates how this can be done.



Power Supplies

For Electronics and Technology Courses

Abstract

The choice of suitable power supply types for electronics and technology courses is discussed and proper usage described. The article should be of interest to anyone using electronic circuitry for instrumentation and control.

Problems

We've had a number of enquiries arising out of difficulties caused by poor choice of power supply units (PSUs) for electronics. There's more to it than merely ensuring that the voltage is right and that there's enough current.

One of the common problems is a misguided attempt to economize by using single PSUs for systems which require two. Electronic circuitry requires a steady voltage, which can either be provided by a smoothed PSU under light load, or by a regulated PSU (see Fig.1). Motors, heaters, lamps, relays and solenoids are all fairly heavy loads - that is, they require relatively large currents (see Table 1).

Logic IC1	1 - 100 mA
Miniature bulb	50 - 500 mA
LED (Light Emitting Diode)	10 - 50 mA
7 segment LED	25 - 500 mA
LCD (Liquid Crystal Display)	1 - 50 mA
Model motor	10 - 500 mA
(starting)	0.2 to 2 A
Relay coil	25 - 250 mA
Solenoid	0.1 to 5 A

Table 1 - Typical current consumption of some common components

Solutions

Only a heavy duty regulated power supply can provide both. This is no economy - such supplies are very expensive. It isn't even a very satisfactory solution, as the large voltage spikes produced by switching inductive components (stepper motors, relays and solenoids) are still transmitted to the electronics by the power lines. Ordinary d.c. motors draw much more current when they are starting than when running - enough to overload all but the heaviest regulated PSUs.

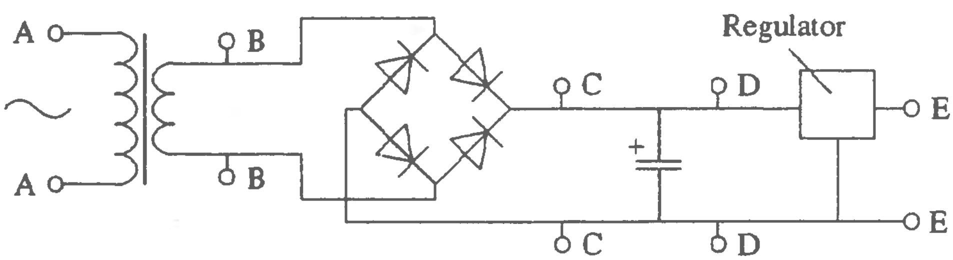


Figure 1 - Generalised LT Power Supply Unit (PSU)

There is a further reason for not using heavy duty regulated PSUs. The steady voltage is achieved by starting with a smoothed supply at a higher voltage, and dropping a varying amount of this voltage in a regulator circuit, to leave a controlled, steady output (see Fig.2). The output current multiplied by this dropped voltage is wasted energy. Conservation is not the issue here - it's only a few watts - but the dissipation of the energy as heat can make external heat sinks uncomfortably hot, or possibly even cause burns.

The best solution is to use a regulated PSU for the electronics, and a smoothed PSU for the rest, as in Fig.3.

Note especially the component forming the bridge between the two parts of the system - in this case a power transistor. Unavoidably, this poor creature is connected to both PSUs. This means that it is vital that the heavy current PSU is smoothed. It is also vital to have one supply rail common to both parts of the system. The two supply voltages may or may not be the same, but thought needs to be given to this, and to the polarities. The polarities will almost always be the same, as in this example.

Alternative solutions

If a regulated supply is not available, you could use a second, independent, smoothed PSU for the electronics. To keep the ripple voltage down, this would need to have a much larger current rating than the electronics would actually consume. But note, if you are still at the purchasing stage, that suitable regulated PSUs are cheaper than suitable smoothed PSUs, because the current rating of regulated supplies only needs to cover the actual consumption.

You can save a lot of money by buying fixed voltage regulated PSUs. You will only need two types: 5 V for digital logic, and +/- 12 V dual rail for op-amp circuits. For very occasional use, primary batteries (zinc-carbon or alkaline-manganese) can be used as a good, smooth supply for very light current electronics (CMOS) - don't use rechargeable batteries except for heavy current portable applications. Always use a fuse with rechargeable batteries - they can deliver enough current to set fire to bits of wire.

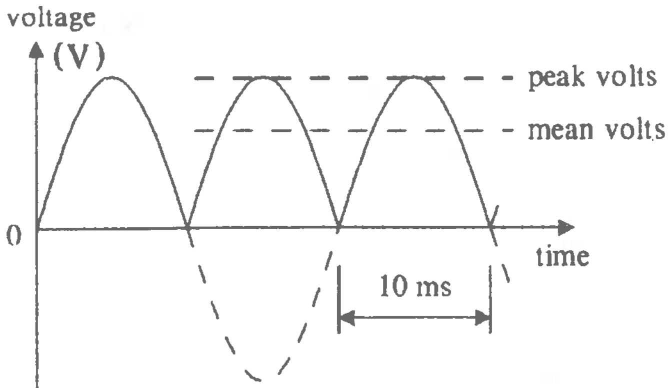


Figure 2a Full wave rectified, unsmoothed

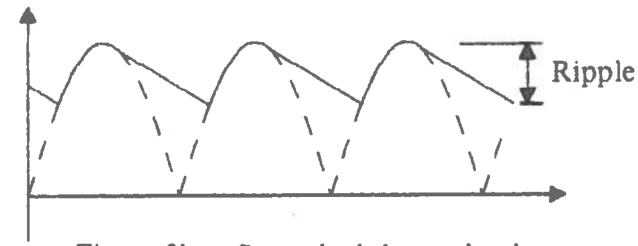


Figure 2b Smoothed, heavy load

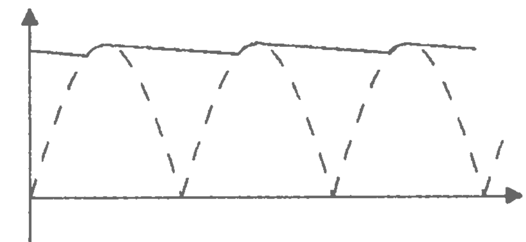


Figure 2c Smoothed, light load

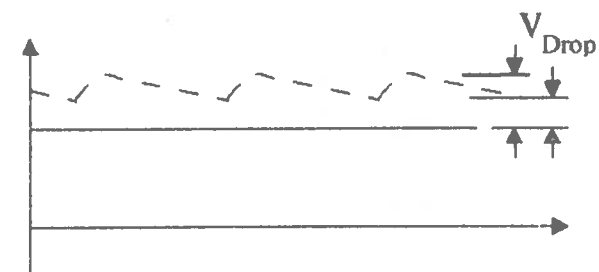


Figure 2d Regulated

Figure 2 - Output types

PSU Type	Typical Applications	Typical Voltages	Typical Current	Circuit Diagram	Output Waveform
A.C.	Soldering irons, lamps heaters	6, 12, 24 V or variable	1 to 10 A	Fig 1 AA - BB	
Full-wave rectified, unsmoothed	As above, and motors, relays, and solenoids	6, 12, 24 V or variable	1 to 10 A	Fig 1 AA - CC	Fig 2a
Smoothed	As above, OR simple electronics (NOT both)	6, 12, 24 V or variable	1 to 10 A	Fig 1 AA - DD	Figs 2b and 2c
Single Rail Regulated	Electronics	5, 12 V or variable	0.1 to 0.5 A	Fig 1 AA - EE	Fig 2d
Dual Rail Regulated	Op-amps	+/- 3 to 15 V or variable	0.1 to 0.5 A	Fig 4	
Rechargeable batteries	Portable apparatus	1.2 - 12 V	0 to 5 A		
Primary batteries	Portable apparatus, simple electronics	1.5 V per cell	1 to 100 mA		

Table 2 Low voltage (LT) power supplies - functions and typical ratings

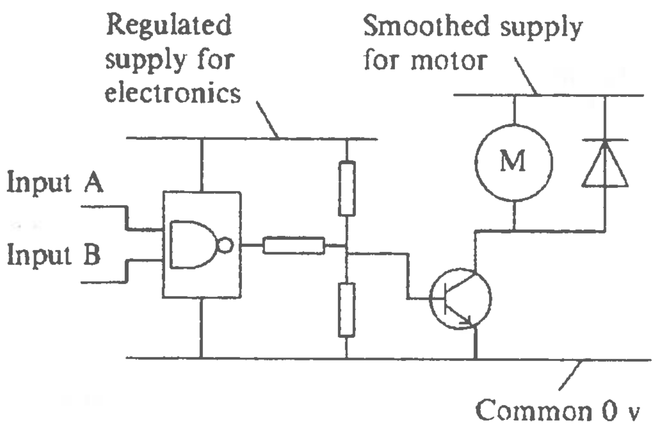


Figure 3 - A system with two PSUs

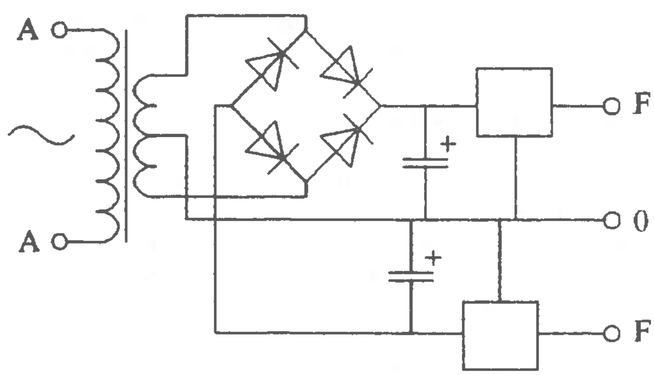


Figure 4 - Dual rail PSU

Switched mode PSUs deserve a brief mention. These have output characteristics similar to regulated PSUs, but avoid the heat dissipation problem by a special, much more complex, circuit. Sometimes they are available cheap on the surplus market, but otherwise they would be an expensive option for schools. Equipment manufacturers often use them to power large quantities of electronics.

Summary

The main point of this article bears repetition: you need both low current regulated PSUs and heavy current smoothed PSUs. The heavy current PSUs should ideally provide variable voltage. You ideally need one of each for each pair of pupils, and probably at least half the regulated PSUs should be dual rail. Table 2 summarizes the common types of PSUs.

* *

Load Characteristics

Abstract

Most loads draw a current from their power supply which varies with time. The voltage provided by the supply may itself be affected by the current drawn. As the supply voltage is usually a major factor in determining the current in the load, a complex inter-relationship exists.

Resistive Loads

The simplest kind of load is purely resistive. Such a load will draw a constant current from the moment of being switched on, until the moment it is switched off. Low temperature heaters, such as immersion heaters, are like this.

Heaters operating at higher temperatures draw a large current at first, dropping rapidly to the steady state value. Filament bulbs are an extreme example.

Figure 1 shows a graph of current against time for these kinds of loads.

Resistive loads behave in this way whether they are supplied with a.c. or d.c.

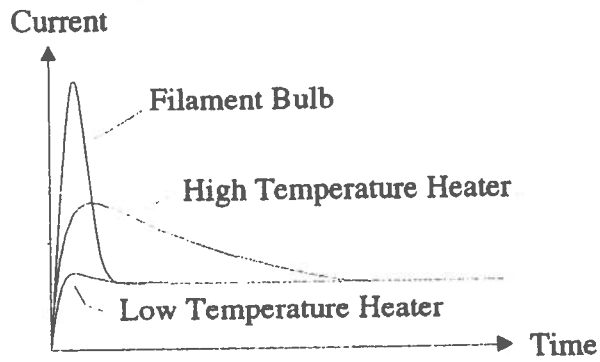


Figure 1 - Switch on - resistive loads

Inductive Loads

When a simple inductive load is connected to a d.c. supply, it draws a current which rises rapidly at first, then more slowly, finally reaching some steady state. Relay coils, electro-magnets, and solenoids fall into this class.

Figure 2 shows the current time relationship for these loads.

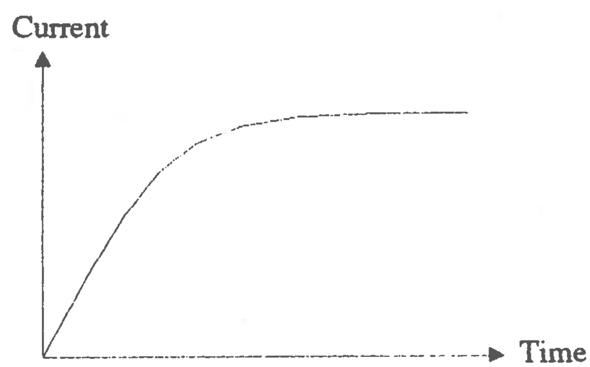


Figure 2 - Switch on - inductive loads

Motors behave in a markedly different way. Permanent magnet motors and stepper motors are even totally different from each other.

Permanent Magnet Motors

Permanent magnet motors draw a large starting current while the motor accelerates, which drops to a much lower value as the motor reaches a steady speed. The running current depends on the mechanical loading - the heavier the load, the slower the speed, and the larger the current drawn.

On a shorter timescale the commutator is switching individual windings on and off. This results in rapid fluctuations in the current drawn. Figure 3 shows the overall effect.

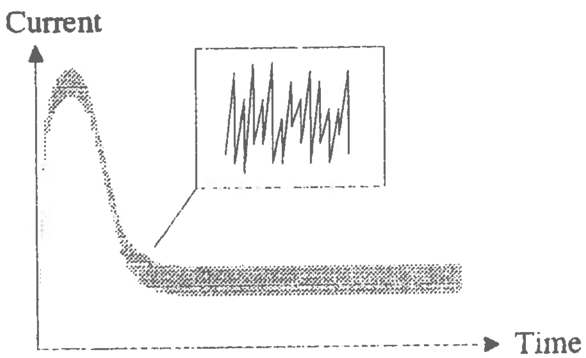


Figure 3 - Permanent magnet motor

Stepper Motors

Stepper motors won't work at all without fairly complex electronic circuits to drive them. Fortunately these circuits are available ready made!

A graph of the current drawn looks very like that for a permanent magnet motor, when the motor is running at speed - the electronics are effectively acting as a commutator.

However, major differences become obvious when the motor is running slowly, as often it will be. Here the speed is determined not by the supply voltage and the load, but by some signal controlling the electronics. As each winding is switched on or off, there is a step change in current drawn. Figure 4 shows this.

Figure 4 - Stepper motor - running slowly

When the motor is stationary it draws a steady current.

As the speed INCREASES, the current consumed DECREASES (see Figure 5). The load also has little effect on the current consumption. Heavy loads will cause some increase in current, particularly at higher speeds; but stepper motors are not designed to operate under heavy loads at speed, when they are liable to miss steps.

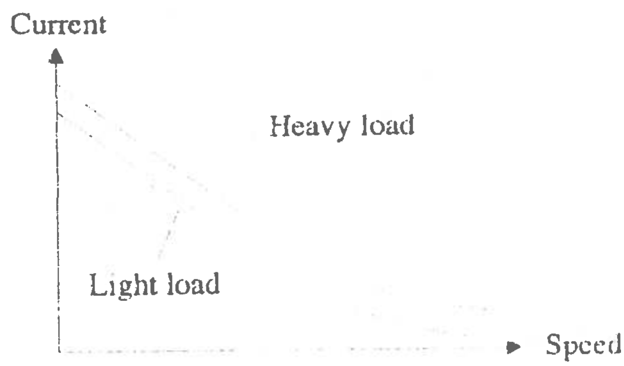


Figure 5 - Stepper motor (current/speed)

Capacitive loads

A capacitive load would draw a large initial current, and then none at all. However, no ordinary load which you might attach to a d.c. supply has any significant capacitance. The only exception might be a smoothing capacitor for an electronic circuit, but this should be part of the supply, not part of the load. Certainly do it this way in your own designs - particularly always be sure to put all smoothing capacitors (also called reservoir capacitors) BEFORE any regulators.

Switching Off

So far we've really only dealt with start up and steady state. When you switch off a load, the current from the supply stops immediately, regardless of the nature of the load (Figure 6).

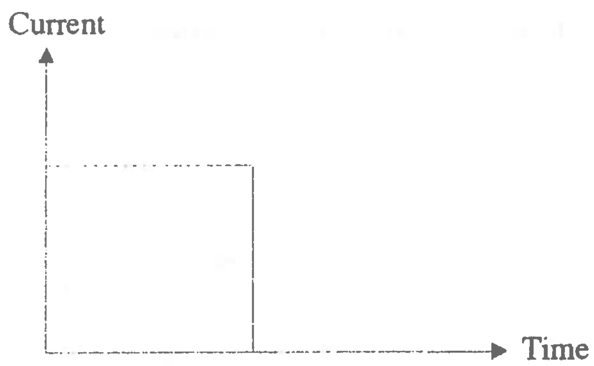


Figure 6 - Idealised switch - off

Well, nearly. With resistive loads, that really is the whole story. But with inductive loads, current will continue to flow for a short time even after the switch opens. If no provision is made for this current, it will flow as an arc across the switch contacts - in brief bursts of very high currents, rather than a continuous flow (Figure 7).

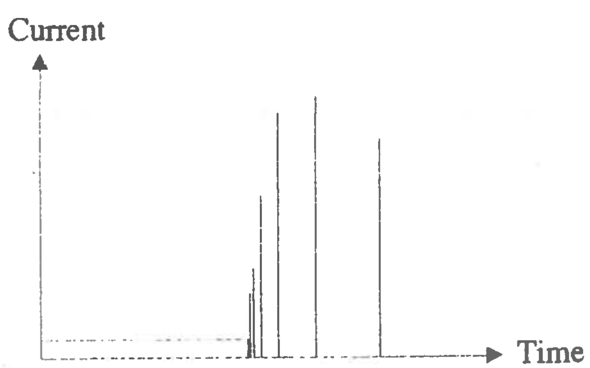


Figure 7 - Switch-off : inductive load

Even when running, permanent magnet motors show this effect. The commutator interrupts the current through each winding twice per revolution.

Voltage effects

We've now reached the real point of all this. Whenever there is a change in the current drawn from a supply, the voltage delivered by the supply is affected. If the current increases, the voltage will decrease, and vice versa. The extent of the change depends on the type and rating of the supply, and the size and speed of the change in current. Figure 8 shows the effects of the various current change patterns on the voltage delivered by different supplies.

Scales on the graphs

We've not put scales on any of the graphs because they are so dependent on the particular hardware. Table I shows roughly the range of the timescales; see the article on power supplies for some idea of the currents involved.

Feature:	Timescale:
Start-up transients:	
Filament Bulb	10 - 100 ms
High Temperature Heater	1 - 20 s
Low Temperature Heater	1 s - 8 hr
Inductive Loads	1 - 100 ms
Permanent Magnet Motor	10 - 500 ms
Motor Winding Fluctuations	0.3 - 30 ms
Individual Current Spike	0.1 - 10 s
Series of Spikes	0.1 - 5 ms

Table 1 - Timescales for figures 1 - 8

Normally only spikes (see below) actually reverse the polarity of the supply or produce such high voltages that damage is caused, but the dips in supply voltage caused by other transients commonly cause temporary malfunctions in circuits.

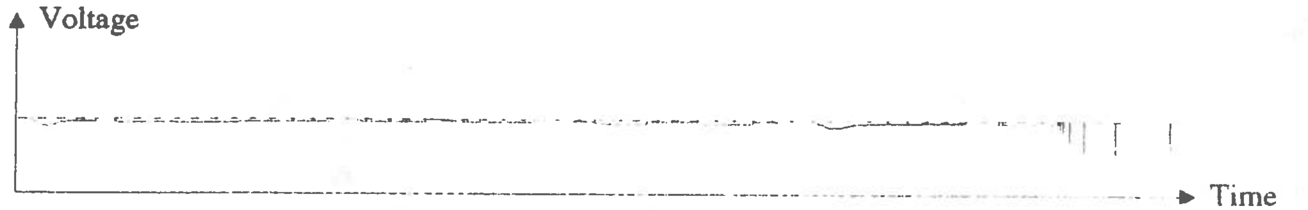


Figure 8a - Effect of currents shown in 8f, on voltage supplied by a battery with low internal resistance.

Figure 8b - Effect on voltage supplied by a battery with higher internal resistance.

Figure 8c - . . . . a battery with high internal resistance.

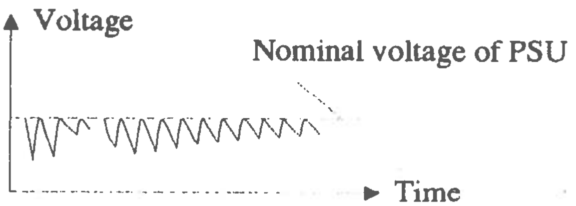


Figure 8d - . . . . a smoothed PSU

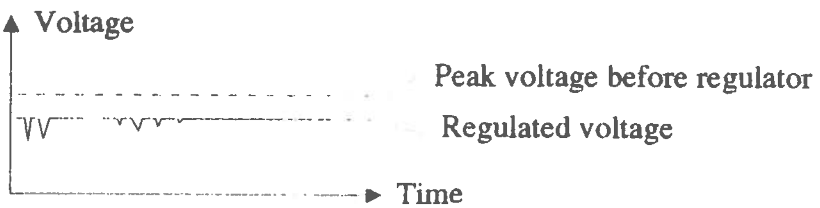


Figure 8e - . . . . a regulated PSU

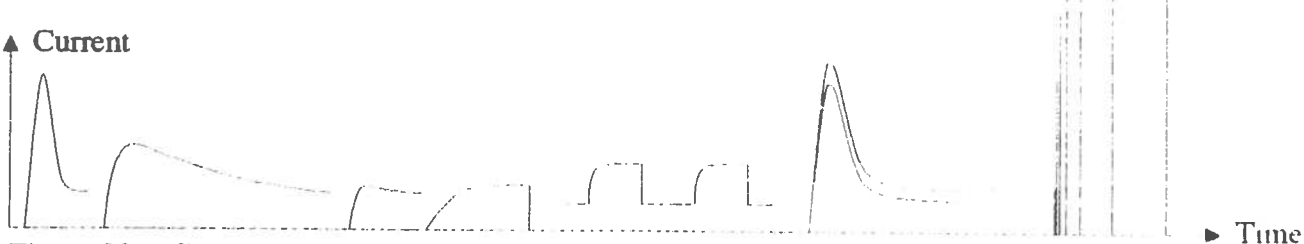


Figure 8f - Current drawn by various loads.

Figure 8

Spikes

The very large, brief current spikes caused by interrupting currents through inductive loads, cause large, brief voltage spikes on any practicable supply. These may be many times the voltage of the supply, and are often in the opposite direction.

They transmit electromagnetic pulses which induce voltages in other conductors - this is the cause of the interference on your radio or television when your neighbour uses an electric drill.

Arcing can also damage the surfaces of contacts.

Connecting a capacitor across contacts is an effective remedy for fairly small inductances. These capacitors are usually called suppressors. For large inductances unreasonably large capacitors would be required.

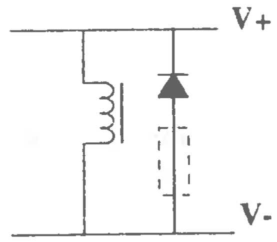


Figure 9 - Protection diode

A better solution for large inductances is a diode connected as in Figure 9. This is usually called a protection diode, but sometimes, illogically, a flywheel diode. The resistor, shown dotted, may sometimes be necessary to reduce the current more quickly - a relay or solenoid may need to drop out rapidly, or the diode may be unable to withstand the current for long.

*   *   *   *   *

EQUIPMENT NOTES

Soldering Stations Tested

Introduction

With the development of electronics courses more and more schools will need to equip rooms with a class set of solder stations, and possibly provide a smaller number of different stations for staff use.

You will need to budget at least £500 for a set of ten; its not worth trying to find anything significantly cheaper. If you already have, or will have, bench PSUs with 24 volt soldering iron sockets, then £300 will suffice.

Safety

The first consideration when selecting equipment must be safety. The standard of all the stations we tested appeared satisfactory in this respect - the only quibble is about the colour of the inner insulation on low voltage flexible cords. This is covered under Safety Notes.

All the stations we tested use 24 volts, with a transformer in the 'station'. They all use burn-resistant flexes to the soldering iron; but with low voltage irons this is to protect the flex, not the user. The mains leads to the transformers are NOT burn-resistant and must be carefully routed to avoid risk - as must mains leads to other equipment! - see Bulletin 163.

Our Specification:

- Low voltage at iron (essential)
- Burn resistant cable (highly desirable)
- Stand to guard hot iron (essential)
- Wet sponge and holder (essential - could be DIY)
- Minimum power 30W (at least)
- 1.5 - 2.5 mm wide chisel bit, iron plated copper (also called screwdriver bit)

Time and Temperature

The time a soldering iron takes to cool down has some relevance in that burns to either people or wiring may occur after the iron is switched off. In practice in a classroom irons are likely to be left on for long periods, so it is important to establish working practices which avoid such risks anyway. The extra risk due to the extra minute or two after switch off is probably negligible.

The fact that irons may be left on for long periods brings us to another issue. Deterioration of the bit (and of the iron) is largely determined by the temperature of the bit.

In a basic iron, this temperature is determined by the power, and the dissipation of heat. The power has to be sufficient to maintain a working temperature even when heat is being dissipated to (and by) the solder and components. The temperature will rise considerably when the iron is left in its stand, resulting in rapid deterioration.

A thermostatically controlled iron avoids this problem by switching itself on and off as necessary, reducing considerably the rate of deterioration.

Another issue is the time taken to reach working temperature. This is not important for an iron left on for long periods, but could be so for an iron in occasional use, switched on and off as needed.

In most cases, you can't rely on any great accuracy in the setting of bit temperatures. Where the adjustment is preset with a small screwdriver, this doesn't matter very much. Just ensure that the bit is hot enough for the job, and leave it. The important thing is that the bit won't overheat when not used for a while.

It's perhaps more serious where the adjustment is by choice of bit - you have to ensure that the choice gives plenty of leeway. Remember we've only tested one example of each; other sets might be more or less accurate.

Static

You are likely to be working on CMOS circuits quite frequently. These are susceptible to damage by static electricity, or indeed any high voltages, even if there is very little current and the voltage is only present very briefly. The best preventative measure is a 'local' earth. The 24 V system is isolated from the mains earth, and provided with a connector which can be clamped to benching or an equipment chassis. Good practice would dictate that the operator wear a (locally) earthed conductive wrist strap. A mains earth on the iron tip is a very poor second best. Switching spikes from thermostats could conceivably also cause such damage, regardless of earthing arrangements.

An alternative strategy is to use sockets for all CMOS chips, and not to insert the chips until soldering is complete - this is as effective as any but the best 'local earth' practice, and much easier to achieve. It's well worth the cost of the sockets.

Stations Tested

The most expensive station we tested was an Antex TCSU-D provided by RS. This has a digital display of the bit temperature, which is accurate to the nearest 5 degrees C. It's slightly confusing that when the bit is cold, or nearly so, it displays the set temperature rather than the actual temperature.

RS also provided an Antex TCSU1 power supply unit (PSU) with an Antex CSTC iron. This satisfactorily controlled the temperature of the bit in the sense that it kept it constant, but it has a complicated table to work out to set the temperature. The slider control could well defeat the object of temperature control, in that it might tempt fiddling fingers to set the temperature to maximum.

It is also possible to mix-and-match items from RS. We selected a likely combination (stock numbers 591-297, 544-594, 544-601 and 545-216). This combination was perfectly satisfactory for continual use, but was much slower warming up or cooling down than any of the other stations. In continual use its high thermal mass is actually an advantage in that it can bring joints to soldering temperature very rapidly, without undue heating to surrounding components and joints; but perhaps ten minutes is too long to wait at the beginning of a class!

STC provided two Weller irons and a suitable Weller PSU. The TCPZ minimises voltage spikes by ensuring that the thermostat always operates when the mains voltage is passing through zero. There is probably little merit in this in school. High value CMOS chips (if ever used) should certainly be fitted in sockets. We always use sockets for all chips; but damage is actually quite rare even when minimal care is taken, and what there is is mostly caused by static.

STC also provided an Adcola 1444 iron with Adcola 1500 PSU. This is temperature controlled, adjusted by a preset control built into the handle of the iron.

The cheapest station that we examined was from Rapid Electronics. It has an analogue display of the bit temperature. Although it is adjusted by a potentiometer on the PSU, it can be locked in any position with a hexagon socket key. The bit is connected to mains earth via a track on a printed circuit board in the PSU, which was destroyed by a current of a few amps in the course of one of our tests. This does not compromise the safety of the station, as it is constructed to double insulated standards. If this track were destroyed in actual use, the static protection for CMOS would be ruined.

We also examined a Weller soldering gun from RS. This has no separate PSU, with the mains lead going direct to the hand held unit. The mains lead is not burn resistant. It is not really suitable for electronics work as its bit is much too large. It is also rather heavy in the hand for delicate work.

Best Buy?

Probably the Rapid Electronics XY9A, this being the cheapest and perfectly adequate.

The Adcola 1444 with 1500 also seems a good buy. If you already have 24 volt a.c. outlets, the 1444 alone would be the best buy at about £30.

Don't be tempted by cheap low wattage or mains irons! Low power irons are useless for the work, and mains is hazardous!

/see summary in Table 1

* *

Supplier	Model	Cat. No.	Maker	Rough Price £	Accuracy of Set Temp (degrees C)	Time to heat up (s)	Time to cool down (s)	Power (W)	Feature
RS	TCSU-D (Digital Temperature Display)	603-340	Antex	90	-5	45	200	50	SLT
RS	(Iron) (St n)	608-749 +608-727	Antex	80	-40	70	180	30	PLF
RS	See text (Assembly of items sold separately)			70	-15	600	480	50	BMT
STC	TCPZ +PS-2D (Zero-crossing switched thermostat)	45482X 65867X	Weller	70	-30	60	220	45	BLA
STC	(Iron) (St'n)	95926B 95927X	Adcola	7D	-20	60	280	50	SLT
STC	TCP +PS-2D (Not temperature controlled)	51968R 65867X	Weller	60	N/A	45	280	45	NLA
Rapid	XY9A	85-0800		50	-30	90	350	60	P*MT
RS	"Gun" containing transformer	548-675	Weller	20	N/A	30	50	100	NIF?

Features:

S - Screwdriver adjustment of thermostat
P - Potentiometer adjustment of thermostat; easily adjusted without tools
P* - as above, but lockable
B - Thermostat temperature set by selection of iron tip (bit)
N - Not thermostatically controlled
L - Local earth arrangements (isolated from mains earth)
M - Iron tip connected to Mains earth
I - Isolated from mains earth - no arrangements to protect CMOS
T - Wet sponge on Top of PSU
A - Wet sponge Attached to side of PSU
F - Wet sponge Free (not attached)
F? - Sponge not supplied

Wet Sponges

Wet sponges on top of PSUs are probably not a good idea in school. We recommend that you make your own substitute holders.

Iron Plated Bits

All the recommended irons are fitted with iron plated bits. It is very important that these are tinned as soon as they reach a high enough temperature to melt solder, the first time they are heated. Otherwise they will be ruined! They should not be filed clean, but wiped on a wet sponge while hot.

Table 1 - Soldering station evaluation report

Pulse monitor update

Introduction

Bulletin 145 carried a comprehensive report on pulse rate measurement, with evaluation of ten monitors available at the time. This area of the market has remained dynamic and the intention here is simply to give a summary of the results of more recent evaluation work.

Basic methods for monitoring heart rate electronically, equipment formats and essential health and safety considerations were discussed in Bulletin 145. The reader is directed to that issue for further information.

Evaluation procedure

Three measurements of pulse rate were made using each monitor: pulse rate before, immediately after, and finally three minutes after exercise. This procedure was performed twice on each subject using as the two forms of exercise a) 20 deep knee bends in 40 seconds and b) 20 step-ups in 40 seconds. During each measurement period, pulse rate was obtained by manual direct measurement from the radial artery and compared with the monitor reading. The percentage difference between the two was then calculated.

Equipment configurations

The monitors reviewed in this article, with the exception of the Minimonitor, each employ one of four ways for measuring pulse rate. The four possible methods are:

- wristwatch type with optical finger electrode (Fig. 1)

- sensor box which connects to a computer interface (Fig. 2)

- wireless transmitter belt and wristwatch receiver (Fig.3)

- chest/back electrode belt with connecting wires (Fig.4)

Evaluation report

A summary report of our evaluation is tabulated overleaf (Table 1). Please note the following:

1. The data printed under the heading "Accuracy" are the manufacturers' quoted accuracies.

2. All of the devices tested are powered by low voltage batteries. There is therefore no risk to the user of high voltage shock provided that these units are powered as designed. On no account should devices like these which make skin contact be supplied by mains powered units such as battery eliminators, laboratory LT supplies, or low voltage computer output lines.

3. Fuller individual reports on all of the devices shown are available on application to the Director of SSERC. These reports include test results for resting pulse rates and those after a set exercise routine. Direct radial measurement was used as a relative standard in place of the ECG measurements previously utilised as a secondary standard.

Best buy?

The **Pulsecoach 3** from Solex came out top for performance and value for money. Second came the **PU801** from Philip Harris (equivalent to **Wristwatch 2** from Solex).

The monitor which came out tops was the **Sport Tester PE3000** from Hampden Sports, or Griffin and George. The cost of this monitor is probably too much for most school science departments, but may be within the budget of a school as a whole school resource, or region as a resource centre purchase.

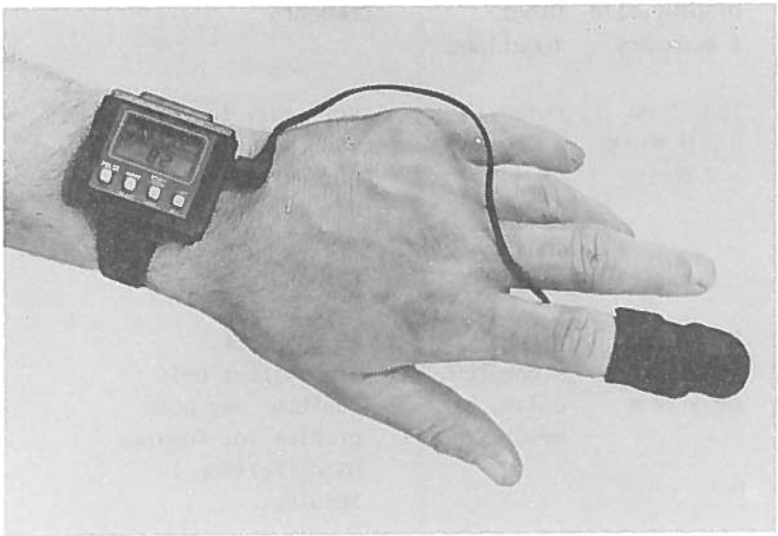


Fig.1

Fig.2

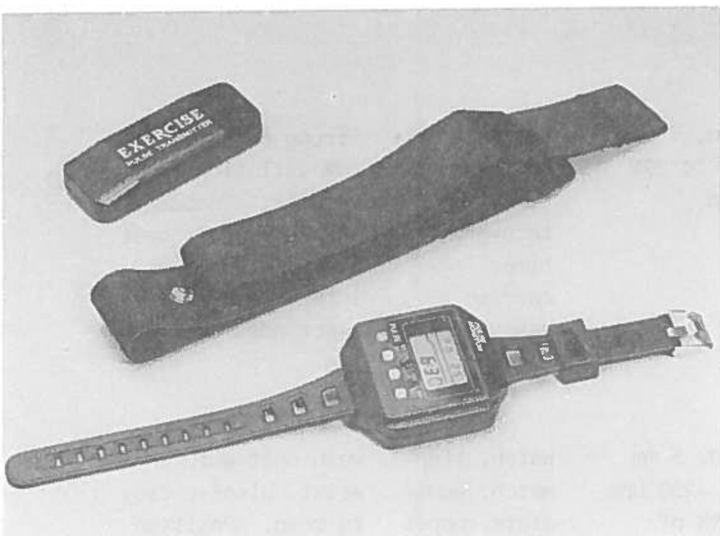


Fig.3

Fig.4

Model	Supplier/price & cat. no.	Type	Sensor	Display, size & accuracy	Other functions	Comments
Minimonitor	Griffin & George £66.98 YTH-590-J	Bench instrument 9V batt.	Inflatable finger cuff	lcd, 5 mm 0-300 mm Hg ± 2 mm Hg	Pulse, systolic bp	Very easy to use, bp and pulse results displayed together <2% difference in results
Sportstester PE3000	Hampden Sports £210 or Griffin & George £296.37 YTH-200-E	Wrist-watch type. (wire-less) Watch batt.	Transmitter attached to belt, worn around chest	lcd, 5 mm transmitter range 1 m	Watch, stopwatch, pulse, memory recall	Robust unit. Transmitter belt position may pose problem for females 0% difference in results.
Sportstester Interface	Hampden Sports £595 or Griffin & George £868.34 YTH-230-510G	BBC computer version (IBM version available)		40T 5 1/4" disc.		Versatile software, excellent graphics "user friendly"
Microsports Lab Computer 1180 series	Command Electronics £140 or Philip Harris £42.14 B72888/9	Handheld or bench/ belt instrument. batt. 9V (PP3)	2 electrodes on chest belt or via sensor pads on main unit	lcd, 7 mm up to 299 bpm	Ave bpm for programmable time, recovery time, cardiac assessment	Strong construction <3% variation in results. Computer software poor, best to buy without interface. Wrist electrodes avail £14
Wristcoach 2 PU801	Solex International £69.50 or Philip Harris £77.45 B72893/3	Wireless monitor. (wrist-watch type) battery CR2025	Transmitter attached to belt, worn around chest	lcd, 5 mm 15 -250 bpm ± 5% of reading	Watch, stop-watch, audio alarm, upper & lower limits programmable	Main unit worn on wrist. Display easy to read. Position of belt a problem as before. <1% difference.

Model	Supplier/price & cat. no.	Type	Sensor	Display, size & accuracy	Other functions	Comments
Pulse monitor	Philip Harris £42.05	Wrist-watch batt. LR44	Optical detector glove	lcd, 5 mm 15-250 bpm	Watch, stop-watch, audio & lower limits	Comfortable to wear. Results higher rates (<14%) Average diff. <5%
Pulse sensor	Philip Harris £52.22 T12320/2	Bench instru-ment. batt. 4 x AA size	Evaluation sample used finger probe. To be sold with ear lobe detector	analogue 0-1V, 250 mV, & pulse sockets		Due out in January. Linear output 0-200 bpm corresponding to 0-1V. Actual use may be limited.
Pulsecoach 3	Solex International £49.50	Handheld, bracket for cycle	Optical detector in fingertip unit	lcd, 8 mm 0-199 bpm ± 1 bpm	100 h timer 1 s resol'n audio signal upper & lower progammable	Robust unit. Instruction sheet <1% difference in results.
Pulsestick MPM-2	Solex £15.50 PS-100	Handheld	Optical detector in unit	lcd, 5 mm 30-200 bpm ± 1 bpm	watch audio signal stopwatch	Easy to use but performance poor, position of thumb critical. When measurement was possible - <3% difference
Bodysense Heartsensor	Griffin & George £104.03 YTH-100-M	Computer Inter-face batt. 9V	Optical detector in ear-lobe clip	40 T 5 1/4" disc	Pulse rate Recovery Mean/Min/Max bpm Event marker	Problems: See full report

Electronic thermometers - more models tested

Scope of report

We report on seven models of digital thermometer. This supplements the eighteen summarized in Bulletin 162. Again our main criterion for what to test has been suitability for classroom usage. Of the seven here reported on three models cover no more than our minimum, appropriate range of -10°C to +110°C, and are commendably cheap. Two thermometers use type-K thermocouple probes whose range extends to +1200°C. One is a precision thermometer containing a platinum film resistance sensor. The seventh is a temperature probe containing a signal conditioning circuit and battery in its handle, and requires an external digital voltmeter to display temperature. Something for all - as they say?

The report ends with a summary that homologates the buying advice issued in Bulletin 162 with the outcome of tests on these additional seven meters.

Test reports

The findings of the tests are tabulated below. Readers should refer to pages 16 and 17 of Bulletin 162 for definitions of the comments 'good', 'poor', etc. Descriptions of the cryptic codes used in the table are repeated here:

- d probe detachable
- D display on instrument
- F fixed probe on body
- G contains upper and lower temperature alarms
- J temperature probe not included, suitable probes are standard laboratory items
- K has standard type-K thermocouple socket
- L probe on lead
- M contains clock
- X electrical output, requires an external display

Best buy?

1. Basic range Tying together this report's findings with those of Bulletin 162 the thermometers that cover the basic range of -10°C to +110°C with good to middling accuracy are:

TemPen (Bibby,Harris)	ESMI Mk2 (British Gas)
THV-120-010B (Griffin)	THV-200K (Griffin)
THV-280-A (Griffin)	158-430 (RS)
650-419 (RS)	ST-4000 (Solex)
ST-4050 (Solex)	0900.0125 (Testoterm)
TA 138F (Zeal)	

Supplier	Model, cat. no., maker	Price (£)	Design	Range (°C)	Resoln. (°C)	Accuracy
Griffin	THV-280-A, Theta range platinum resistance	79.00	dL D	-100.0 to +199.9	0.1	good (excellent)
Griffin	THV-290-Q, Theta range Type-K thermocouple (K)	70.00	dL D	-20 to +1200	1	poor (2°C offset)
RS Components	158-430 (multimeter extra)	37.00	F X	-30 to +150	0.1	fair
Solex	ST500 (J K)	54.50	dL D	-50 to +1200	1	poor
Solex	ST-4000	12.50	F D	-10 to +110	0.1	good
Solex	ST-4050 (G M)	13.50	L D	-10 to +110	0.1	fair
Zeal	TA 138F	11.45	F D	-10 to +110	0.1	good

Our recommended best buy in the last report was the RS thermometer 650-419. We can this time round add two further instruments, both of them cheap, which match this RS model for accuracy and which do not have any adverse comments recorded in Table 1. Our three recommended best buys are now:

RS	650-419	£14.60	probe on lead
Solex	ST-4000	£12.50	fixed probe on body
Zeal	TA 138F	£11.45	fixed probe on body

Some reservations about these recommendations need stating:

- sample size: the Solex and Zeal reports are based on a sample of one each; the RS report on a sample of three;

- robustness: the hinged battery lid and flimsy probe lead on the RS thermometer are points of weakness;

- water penetration: both the Solex and Zeal thermometers and one of the RS batch were affected by prolonged immersion in condensing steam; we recommend you do not subject these instruments to this type of treatment.

2. Accuracy and robustness The platinum resistance thermometer in the Griffin Theta range THV-280-A excels in two respects: (1) its accuracy is exceptionally good, never differing by more than 0.1°C from our laboratory standard; and (2) the instrument, lead and probe are all sufficiently robust to withstand the normal rough usage of school laboratories. Adverse features are price, short battery life (we estimate 100 h), and slow response (30 s to read to within 0.1°C of the eventual reading). But you may want to pay for the qualities which this meter has and we think it too is a good buy:

Griffin THV-280-A	£79.00	platinum resistance probe on lead

3. High temperatures If you want a thermometer that reads up to +200°C the two evaluated we can recommend are:

British Gas	ESMI Mk2	£40.00
Griffin	THV-280-A	£79.00

None of the instruments reading higher than +200°C can be recommended as being good buys. At these temperatures you are advised to use a home-built type-K thermocouple, which is simple to make, cheap and reasonably accurate. Details of constructing these are to be found in Bulletin 158.

* *

Accuracy meets spec.	Response time	Sampling period (s)	Depth of immersion test	Thermal inertia	Chemical resistance	Physical robustness	On/off switch	Battery life
yes	slow	0.4	middling	fair	satisf.	good	yes	poor
no	fair	0.4	good	fair	satisf.	good	yes	fair
yes	slow	<1	middling	-	poor	-	yes	good
yes	good	0.3	n.a.	n.a.	n.a.	n.a.	yes	poor
yes	fair	10/1 *	middling	fair	satisf.	satisf.	no	good
no	fair	1/10	middling	good	satisf.	satisf.	no	good
doubtful	fair	10/1 *	fair	fair	satisf.	satisf.	no	good

SURPLUS EQUIPMENT OFFERS

Please note that items are not arranged according to the item number sequence. They have been grouped by similarity of application, or for other reasons. Often the item number serves only for stock identification by us in making up orders. Please also note that you will be charged for postage.

Acknowledgements

The Centre is grateful to the companies Griffin and George, and Racal-Guardall, who have donated goods for distribution to schools through our surplus sales.

Motors

* - runs off a lemon cell

Item 590 Stepper motor, single phase, 5 V manufactured for clock or other timing device. Delicate gearing with 40 tooth plastic wheel as output. Suitable for demonstration, or as a method of digital input for control or timing. Unidirectional. Dimens. 30 x 25 x 10 mm. Circuit diagram supplied. £1.20

Item 591 Stepper motor, 4 phase, 12-14 V d.c., 400 mA, 27.5 Ω coil. Step angle 7.5 degrees. Powerful motor with 15 mm, 6 mm dia. output shaft. Dimens. 40 mm long, 70 mm diameter on 70 mm square mounting plate with fixing holes at 56 mm centres. Circuit diagram supplied. £4.50

Item 627 Precision motor tacho unit, consists of motor unit with integral generator. 0.5-15 V d.c.. 55 mm long, 24 mm dia., output-shaft 10 mm long, 3 mm dia.. £6.00

Item 628 Precision motor, 0.1-6 V d.c., no load current & speed, 35 mA 5200 rpm, stall torque 46 mN m, 40 mm long, 28 mm dia., output shaft 8 mm steel spline. £3.50

Item 651* Precision motor with gearbox, 0.2 - 3 V d.c., 27/1 speed reduction, max. input speed 7500 rpm, output torque 30 mNm. £5.00

Item 652* Precision motor, 0.05 - 9 V d.c. no load current and speed, 5 mA 7500 rpm, stall torque 10.6 mNm, 30 mm long, 22 mm dia., output shaft 5.9 mm long, 1.5 mm dia., shaft encoder. £5.00

Item 653 Precision motor, 0.2 - 12 V d.c. no load current and speed, 20 mA 7800 rpm, stall torque 14.9 mNm, 34.1 mm long, 23 mm dia., output shaft 10 mm long, 3 mm dia. £5.00

Item 654 Precision motor, 0.15 - 12 V d.c. as item 653, but with shaft encoder. £6.00

Item 655 Precision motor, 0.15 - 24 V d.c. no load current and speed, 9 mA 7000 rpm, stall torque 22 mNm, 39.5 mm long, 26 mm dia., output spline 8 mm long, 7 mm dia. £5.00

Item 592 Miniature motor, 2.5 to 9 V d.c., smooth running, speed governor. No load current 30 mA. Dimensions 35 x 40 mm dia. 8 mm shaft 2 mm dia. £1

Item 593 Miniature d.c. motor, 1.5 - 3 V No load current 60 mA, speed 4,500 - 3,700 r.p.m. Stall torque 7 mN m. 30.5 mm long by 23 mm dia. 5 mm x 2 mm dia. shaft. 35p

Item 621 Miniature d.c. motor, 1.5 - 3 V Open construction, ideal for demonstration. Dims. 19 x 9 x 18 mm, double-ended output shaft, 5 mm x 1.5 mm dia. 20p

Item 625 Worm and gear for use with miniature motors. Brass worm with plastic gear wheel. 35p

Item 378 Encoder disk stainless steel with 15 slots, 30 mm dia. with 4 mm fixing hole. 75p

Item 642 Encoder disk stainless steel with 30 slots, 30 mm dia. with 4 mm fixing hole. £1.30

Miscellaneous items

Item 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. 40p

Item 313 Thermostat, open construction, adjustable, range of operation covers normal room temperatures. Rated at 10 A, 250 V but low voltage operation also possible. 60p

Item 165 Bimetallic strip, 10 cm length or 30 cm for 40p, 15p
high expansivity: Ni/Cr/Fe - 22/3/75
low expansivity: Ni/Fe - 36/64 (invar)

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

Item 419 Humidity switch operates by contraction or expansion of membrane. Ideal for greenhouse or similar control project with items 348 and 344.Rated 3.75 A up to 240 V. 75p

Item 507 Optical fibre, plastic, per metre single strand 1 mm dia. Used for the optical transmission of sound. See Bulletin 140 for one such application. 40p

Item 612 Beaker tongs, metal, not crucible type, but kind which grasps the beaker edge with formed jaws. £1.20

Item 348 Submersible pump, 6 - 12 V d.c. Corrosion free nylon construction. £6

Item 371 Ferrite rod aerial, two coils MW & LW, dimens. 10 X 140 mm. 85p

Item 511 Loudspeaker, 8R, 2 W, 75 mm, resonant frequency 250 Hz. 50p

Item 333 Microphone inserts, high impedance, 23 mm dia. 12 mm depth. 40p

Item 631 Microswitch, miniature, SPST, normally closed, push to break. 40 mm long actuating arm, 4 mm spade connections. Dims. 20 x 10 x 16mm. 25p

Item 700 Microswitch, as item 631, but push to make. 25p

Item 632 Microswitch, standard, SPST, normally closed, push to break. 28 mm long angled actuator arm. Dims. 27 x10 x 16mm. 25p

Item 354 Reed switch, s.p.s.t., 46 mm long 10p

Item 508 l.e.d.s, red, green, yellow: each 6p
or 10 for 50p

Item 645 Ceramic magnets, assorted sizes and shapes. 7p

Item 688 Croc clip, miniature, insulated, colours: red and black. 5p

Item 689 Test leads, 2 mm, red, white, black. 5p

Item 690 MES lamp, 6 V, 150 mA. 9p

Item 691 MES battenholder. 20p

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

Item 693 power supply, LT d.c. to 5 V regulated, switched mode. £2

Item 694 Orienteering compass, Suunto. £3.20

Components - resistors

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

Item 329 As above but 33R. 30p

Item 330 As above but 50R and 40mm dia. 30p

Item 331 As above but 100R and 36 mm dia. 30p

Item 421 d.i.l. resistor networks per 10 30p
following values available:
62R; 100R; 1K0; 1K2; 6K8; 10K;
20K; 150K; 125/139R and 1M0/6K0

Item 420 5% carbon film, ¼ watt 6p/10
resistors values as follows:
1R5; 10R; 15R; 22R; 33R; 47R;
68R; 82R; 100R; 120R; 150R;
180R; 220R; 270R; 330R; 390R;
470R; 560R; 680R; 820R; 1K0;
1K2; 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.

N.B. If anyone is interested in purchasing other values in the E12 range between 1R0 and 10M which are not listed above please let us know so that we can consider extending our stock list.

Item BP100 Precision Helipots, Beckman 10p
mainly 10 turn, many values to 50p
available. Please send for
a complete stock list.

Item BP2017 Precision Helipot, Beckman 50p
10 kΩ, 10 turn, 6mm dia.shaft

Components - capacitors

Item 695 Capacitors, tantalum, 1p
4.7 uF 35 V; 15 uF 10 V;
47 uF 6.3 V.

Item 696 Capacitors, polycarbonate, 2p
10n; 47n; 220n; 470n; 1u; 2.2u.

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

Item 698 Capacitors, electrolytic, 1p
2.2 uF 63 V; 10 uF 35 V.

Components - semiconductors

Item 322 Germanium diodes. 8p

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

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

Item 699 MC14015BCP dual 4-stage 5p
shift register.

Sensors

Item 615 Wire, for thermocouples, 1 m £2
of each of 0.5 mm dia.; Chromel
(Ni Cr) and Alumel (Ni Al); makes d-i-y
thermocouple - see Bulletin 158.

Item 633 Infra-red sensors, emitter and 45p
detector, spectrally matched pair.
Data sheet supplied. Priced for pair.

Item 640 Disk thermistor with flying 30p
leads, resistance at 25°C 15 kΩ,
beta = 4200 K

Item 641 Precision R-T curve matched £2.60
thermistor; accuracy +/-0.2°C

Kynar film items

See Bulletin 155 for details of applications such as force/time plots and detection of long wave infra red radiation.

Item 502 Kynar film, screened, 28 um thick, £20
surface area 18 x 100 mm; with co-
axial lead and either BNC or 4 mm
connectors (please specify type).

Item 503 Kynar film, unscreened, 28 um th., 55p
12 x 30 mm, no connecting leads.

Item 504 Copper foil with conductive ad- 10p
hesive backing, 1" strip; makes
pads for Kynar film to which
connecting leads may be soldered.

Item 505 Sensifoam, 0.25" thick, 6" X 6" £1.00

Item 506 Resistor, 1 gigohm, ¼ W £1.20

We also hold in stock a quantity of other electronic components. If you do have requirements for 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.

*   *   *

The following items, numbered 656 to 687 inclusive, are only available to callers; you will appreciate our difficulties in packing and posting glassware and chemicals. We will of course hold items for a reasonable period of time to enable schools to arrange to uplift.

Glassware

Item 656	Screw cap storage jar, plastic cap, 4 oz.narrow neck.	10p
Item 657	Screw cap storage jar, plastic cap, 4 oz, wide neck.	10p
Item 658	Screw cap storage jar, plastic cap, 8 oz, wide neck.	10p
Item 659	Assorted rubber bungs, one or two hole, per pack.	50p
Item 660	Test tubes, 75 x 12 mm, rimmed, 144 per box.	£1
Item 661	Pyrex side arm flask, 1 litre.	£1
Item 662	Dessicator.	£2
Item 663	Flat bottom flask, 250 ml.	50p
Item 664	Flat bottom flask, 500 ml.	50p
Item 665	Flat bottom flask, 800 ml.	50p

Chemicals

Note that: chemicals are named here as described on the supplier's labels.

Item 666	500ml N.H propane-123 triol (glycerol) AR [Analar]	50p
Item 667	250 ml N.H carbamide (Urea)	25p
Item 668	500 ml dodecan-1-ol	50p
Item 669	1 Kg glucose lump, technical.	40p
Item 670	500 g Keiselguhr acid, washed	25p
Item 671	25 g L-Leucine	25p
Item 672	500 g Magnesite native lump	25p
Item 673	250 g manganese metal flake, 99.9%	50p
Item 674	250 g manganese (II) sulphate AR	25p
Item 675	250 g nickel (II) sulphate AR	25p
Item 676	500 g quartz, native lump	25p
Item 677	100 g sodium butanoate	25p
Item 678	500 g strontium chloride AR	25p
Item 679	500 g strontium nitrate AR	25p
Item 680	500 g tin metal foil alloy, wrapping quality, 50% lead	50p
Item 681	zinc acetate AR	25p
Item 682	2.25 litre ammonia solution	50p
Item 683	500 g carborundum powder, 180 - 620 mesh.	25p
Item 684	100 g cobalt sulphate AR	25p
Item 685	500 ml N-decanoic Acid	25p
Item 686	250 g iron (III) nitrate AR, (ferric nitrate)	25p
Item 687	2.5 litre 3.2 methanol, dried	50p

*   *   *   *   *

The Biochemical Society

The Biochemistry Across the School curriculum Group (BASC) was set up by the Biochemical Society in 1985. It has produced a series of booklets designed to help teachers of CSYS/A level biology to teach the sections of the syllabuses that contain biochemistry.

We have nine sets of booklets to give away. Each set is composed of three booklets:

- 1. Essential Chemistry for Biochemistry;
- 2. Enzymes and their Role in Biotechnology;
- 3. The Structure and Function of Nucleic Acids.

If you would like a set of booklets, phone and let us know so that we reserve you a copy. Please then send stamps to the value of 42p and we will post out to you your set. If you find you are not in the lucky first nine, further copies of the booklets are available from The Biochemical Society Book Depot (see address list). Booklet 1 costs 50p, booklets 2 and 3 cost £1 each.

* *

B S H S

The initials stand for The British Society for the History of Science.

We have had a letter from the Society telling us about their new scheme to assist teachers with the teaching of the historical and social aspects of science. The Society has nominated a Regional Co-ordinator. This person may be approached by a school to help find a suitable speaker who would be willing to visit them.

The name and address of the Scottish nominee can be found in the address list under BSHS.

* *

'Biotechnology Education'

Pergamon Press have recently brought out a new journal, 'Biotechnology Education', for schools, colleges and universities. Its purpose is to address the need for students, as well as the public, to be more informed of biotechnological developments, both to gain consensus in the direction which present and future work should take, and to provide the personnel to carry it out. Particular emphasis is placed on tried and tested laboratory protocols which illustrate the principles and techniques used in research and development.

The journal has an international perspective. The Editor is Paul Wymer of the National Centre for School Biotechnology. The Associate Editor is David Micklos of the DNA Learning Centre, USA.

There are four issues a year at an annual subscription of £35.00. If you would like to inspect a sample copy, or take out a subscription, please contact the publisher.

* *

Rapid Electronics Ltd., Heckworth Close, Severalls Industrial Estate, Colchester, Essex CO4 4TB; Tel. 0206 751166.

Royal Society of Chemistry, Burlington House, Picadilly, London W1V 0BN; Tel 01 437 8656.

RS Components, PO Box 99, Corby, Northants. NN17 9RS; Tel. 0536 201201.

Solex, 95 Main Street, Broughton Astley, Leicestershire LE9 6RE; Tel. 0455 283486.

STC Electronic Services, Edinburgh Way, Harlow, Essex CM20 2DF; Tel. 0279 626777.

Tait Components Ltd., 20 Couper Street, Glasgow G4 0BR; Tel. 041 552 5043.

Testoterm Ltd., Old Flour Mill, Queen Strret, Emsworth, Hampshire PO10 7BT; Tel. 0243 377222.

Unilab Ltd., The Science Park, Hutton Street, Blackburn, Lancashire; Tel. 0254 681222.

G.H.Zeal Ltd., Lombard Road, Merton, London SW19 3UU; Tel. 01 542 2283.

MISAC Adviser List

Dr G.W.Gooday & Dr N.A.R.Gow, Department of Microbiology, Marischal College, University of Aberdeen, Aberdeen AB9 1AS.

Dr M.P.W.Smith, Department of Nutrition & Microbiology, West of Scotland College, Auchincruive, Ayr KA6 5HW.

Dr C.S.Morgan-Jones, Department of Agriculture and Fisheries Scotland, Russell House, King Street, Ayr KA8 0BE.

Dr J.F.Lowe, Department of Microbiology, University of Edinburgh, School of Agriculture, West Mains Road, Edinburgh EH9 3JG.

Professor J.E.Smith, Department of Biosciences and Biotechnology, Strathclyde University, Royal College, George Street, Glasgow G1 1XW.

Mr M.S.Davidson, Microbiology Department, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen AB9 2AJ.

Dr S.G.Deans, Department of Microbiology, West of Scotland College, Auchincruive, Ayr KA6 5HW.

Dr L.P.Macham, Department of Biolcgical Science, Glasgow College of Technology, Cowcaddens Road, Glasgow G4 0BA.

Mr R.M.McLarty, Department of Bacteriology, University of Edinburgh, School of Agriculture, West Mains Road, Edinburgh EH9 3JG.

Dr D.E.S.Stewart-Tull, Microbiology Department, University of Glasgow, Alexander Stone Building, Garscube Estate, Bearsden, Glasgow G61 1QH.

S.S.E.R.C.

BULLETIN 164

CONTENTS

December 1989