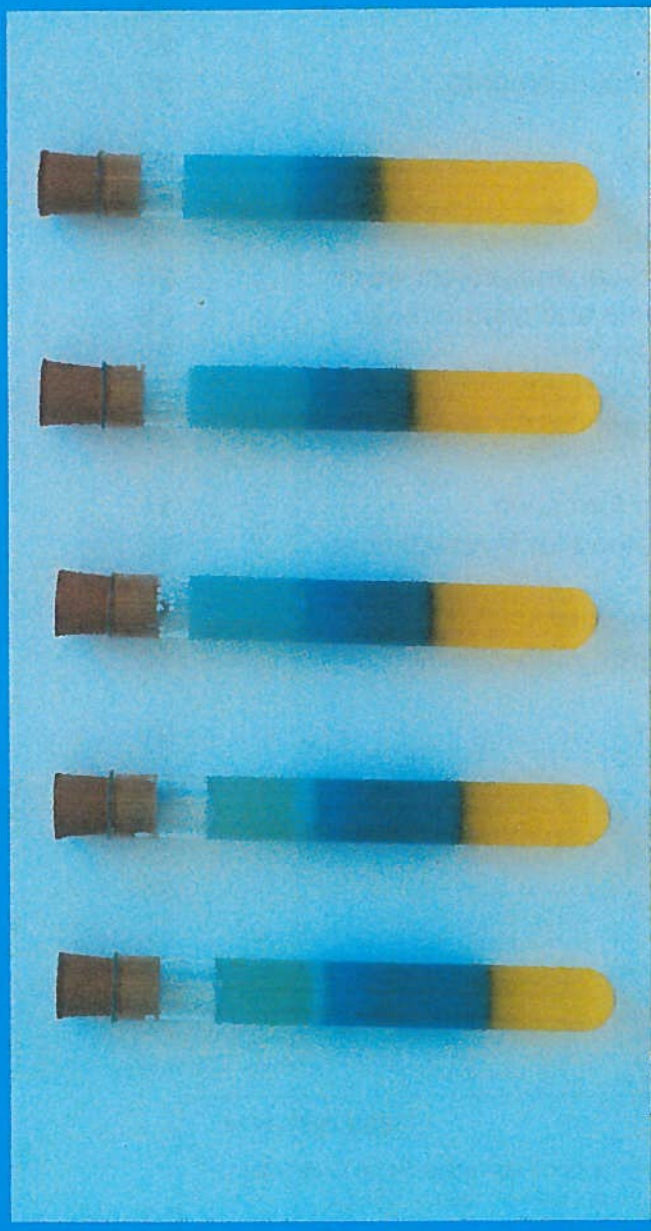
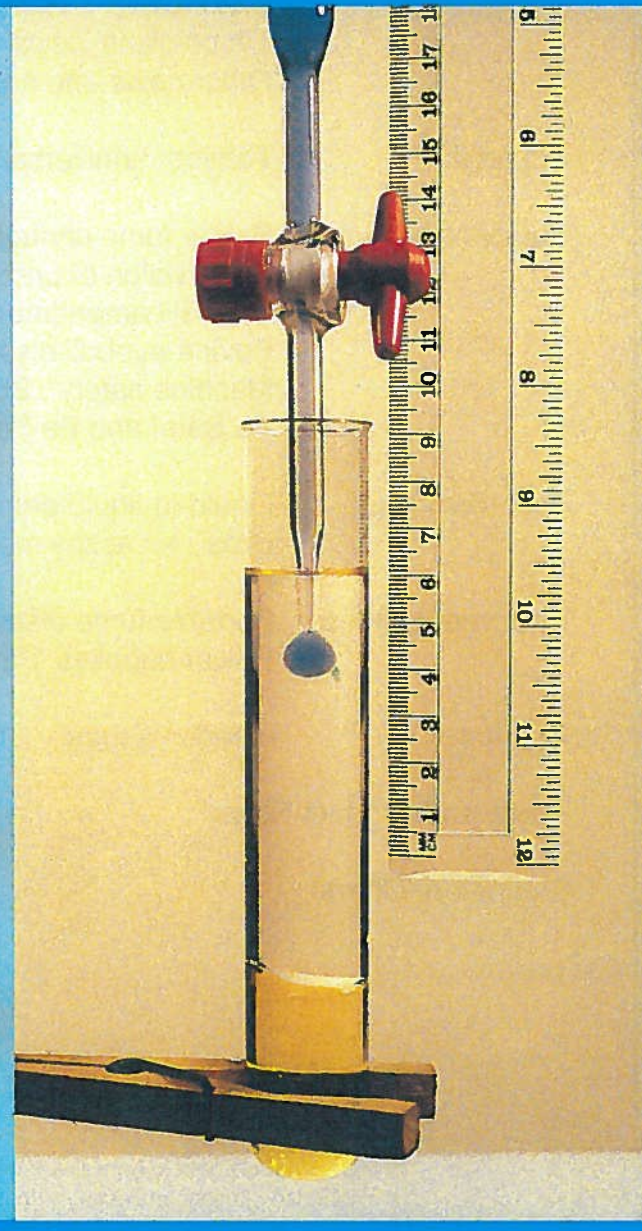
SCOTTISH SCHOOLS EQUIPMENT RESEARCH CENTRE





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For: Teachers and Technicians in Technical Subjects and the Sciences

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NEWS AND COMMENT

Rising accident trends

Conventional wisdom has it that schools and colleges are safe places in which to work or study and that within them the practical subject facilities are amongst the safest areas. This is still broadly true, especially the latter. But it would seem that, overall, schools and colleges are now not quite as safe as once they were. Earlier this year the Health and Safety Executive issued a Press Release based on a speech by the Principal Inspector of the National Interest Group for Education. Copies of this paper have since been circulated more widely but we doubt that many have been seen by individuals in Scottish schools or colleges. Because the HSE's figures and the conclusions they have drawn from them are likely to be of great interest to many of our readers, we shall attempt a précis here.

The Principal Inspector in question was Dick Hill, Secretary to the Health and Safety Commission's Education Service Advisory Committee (ESAC). He expressed concern that the total number of accidents reported by the UK education sector had risen steadily over the latest three year period to a total of more than 11,000 in the last year and that these included 12 deaths.

Mr Hill was reported as saying that, based on inspections in educational contexts :

". . . *resources put into health and safety management are inadequate. They are inadequate because not enough people are being delegated to do the job of managing health and safety. Often when people are delegated they do not have the time or support to do it properly. In some cases they are not being allowed to go on proper training courses and even when they produce reports requiring work to be done there is often no money to carry out the recommendations*".

He concluded that the only way to reverse the recent steadily rising trend of accidents in the education sector is for each establishment to make immediate special efforts to properly manage the health and safety of their staff and students.

Over the years the good safety record in education has meant that schools and colleges weren't assigned a high priority for HSE inspections or visits unless a serious accident had occurred. Over the 20 odd years since the Health and Safety at Work Act came into force there have been relatively few improvement notices issued compared with other sectors, and remarkably few prosecutions. All that could change if the accident figures don't start to fall or at least begin to rise more slowly.

Further reading

Health and Safety Management in Schools, HSE Books, ISBN 0 7176 0770 4 £5.95

Health and Safety Management in Higher and Further Education, HSE Books, ISBN 0 11 886315 0 £5.00

Safety policies in the Education Sector, HSE Books, ISBN 0 7176 0723 2, £5.00

Revised HSE freebies

We have before praised much of the simple guidance published as free leaflets by the Health and Safety Executive. New, to us at least, is an excellent eight page revised guide entitled "*Introducing The Noise at Work Regulations : A brief guide to the requirements for controlling noise at work*". It is coded IND(G)75(L)(Rev) and is available free from HSE Books.

Similar new or revised leaflets published last year or earlier in this (but unfortunately not all are free) include : "*Workplace health, safety and welfare : a short guide for managers*". This was published by HSC and coded IND (G) 170(L). It is priced at £5 for a pack of ten from HSE Books.

We also have obtained the latest free leaflet summarising the requirements of *The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR)*. This is encoded HSE 24. It incorporates and supersedes all of the three previous incarnations of RIDDOR leaflet (HSE 11, 17 and 21).

Give us a sign!

The Association for Science Education (ASE) has this Summer published a useful A4 volume of a hundred pages or so entitled :

Signs Symbols and Systematics : The ASE Companion to 5-16 Science

This title, thankfully, is largely self-explanatory else the next page or two of the Bulletin might be taken up just detailing the contents and coverage. You will gather then, that a lot of the former are packed into the 100 pages and that the latter is wide. The eleven sections or chapters cover, amongst others, the following topics : SI and other units; constants and data; safety signs and colour codes; electrical and electronic symbols; rules for naming chemical compounds; definitions and conventions including some of mathematics. Perhaps inevitably in such diverse and potentially troublesome subject matter, a number of small errors have crept into the text. Since the writing team remembered to include SSERC in the final section - a glossary of acronyms - it would be churlish of us to catalogue their few mistakes here.

Signs, Symbols and Systematics is available from ASE Booksales at £12 per copy. Quote ISBN 0 86357 232 4.

Technology Teachers' Association

The Association's Annual Meeting and the usual talks and exhibition will this year take place in Woodhill House, Grampian Regional Council's headquarters, in Aberdeen on Saturday 4th November. Congratulations also to the TTA on their excellent new look journal.

Prosecution : Crown v. Bird, 1995

This recent prosecution was raised by the Health and Safety Executive against a Supervisor who was also a Safety Officer in the Chemistry Department of King's College, London University. The case was brought under the Health and Safety at Work Act. It essentially hinged on whether or not a student who lost a thumb in an azide related explosion had received instruction, information and training based on the results of a suitable and sufficient risk assessment. The case had a number of interesting aspects. Firstly the individual employee was brought to trial and not the College authorities as employer. This was something at which the judge himself expressed surprise. Amongst the other points raised were whether or not a risk assessment form is always needed, and if the control measures suggested by it have always necessarily to be passed on in writing. At times, lots of side issues made both the prosecution and the defence cases somewhat hard to fathom. Comment from the trial judge didn't necessarily clarify matters. In the end the case never went to a decision by the jury. It was brought to a close by the judge who awarded costs against the HSE.

Already we have seen a number of reports and briefing papers on this case. Some were entirely journalistic - 'farce' being a typical bit of vocabulary. Others were merely imbalanced in over-stressing certain points. Partly because of the somewhat unsatisfactory nature of the trial itself, these accounts have generated more heat than light. Some have merely added to the confusion. Because of that, and because HSE may be appealing[1] - at least against the award of costs - we have decided to await more considered and authoritative professional and legal opinion before commenting further on this specific case.

Such further comment may prove unnecessary. This may not have been the landmark judgement on the matter of student supervision that some observers had forecast. Sadly, proper clarification of the issues may have now to follow another accident and a more considered prosecution. Meantime we have done our best to provide some relevant advice and guidance in the Safety Notes section of this issue.

". . the Law is an ass!"

Staff have again been trying to interpret various Acts and Regulations for the purposes of drafting health and safety guidance. While this was going on, one of the team overheard a radio interview with Menzies Campbell - the Hon., Learned, Lib.Dem. M.P. - *Ming*, to his mates. Yet again the Great Ming was busy putting his finger on a nub. His thesis was that we the public have to comply with 'the Law' even if we don't know what it is (ignorance being no defence). Lawyers, in contrast, are not supposed to know what 'the Law' is, since only a Court may decide.

So, if you are ignorant that's a crime. If lawyers be ignorant that's a virtue. Neat, isn't it?

1. No pun intended

James on education

Suffering intense withdrawal symptoms from my (oh too brief!) Italian holiday, I have been reading the third volume in Clive James' trilogy of *Unreliable Memoirs*. This was partly out of nostalgia but mostly for its funnies many of which are set in Italian airts such as Florence and Venice. For example, try James' quote from Benchley's telegram home on his first arriving in the latter city:

"Streets full of water STOP Please advise STOP".

At about the same time, scribblers educational such as those who toil for TESS and mammon were re-telling tales of woe which issued first from some of our Scottish Institutions of Higher Education. Apparently there are rumblings on the campuses (should that, I wonder, be campi?). It seems that some establishments are claiming that a few of their courses are being treated unfairly by the assessors from the Scottish Higher Education Funding Council (SHEFC). The dreaded *deliverers*, obviously see themselves as under-valued (literally). On the other side of that nine bob note, the SHEFC were saying that far too many institutions are continuing grossly to over estimate the quality of their learning and teaching.

All of this is being done in the name of that great modern God - efficiency. It might be no bad thing if higher education management and funders alike were all forced to read what our Clive has to say on the subject. According to the educational gospel of James, stripped only of its Oxbridge references :

"I had become a tolerated eccentric. This had been, was, and probably still is, one of the undeclared side-benefits of the system. Within broad limits you can make as big a fool of yourself as you like, and still be put up with. In that respect, on the day when the . . universities become efficient they will cease to be productive. Misfits and failures should have room to flourish. The proposition is made no less valid by the haste with which the misfits and failures spring forward to agree with it".

How true that is!

Reference

May Week was in June, Unreliable Memoirs III, James, C., 1990, Jonathan Cape. ISBN 0 224 02787 5.

Pedants revolt

Soon to be published is *The Plain English Guide* from the Oxford University Press. It's not yet in the bookshops and the defenders of the infinitive already have been out in force.

The Guide's advice is that to occasionally split an infinitive is acceptable if it aids meaning and so understanding or is more natural stylistically. And, it allows sentences to be begun with a conjunction.

Single sentence paragraphs also are *non-U* no longer.

Phew, that's a relief!

EDITORIAL

Thirtieth anniversary

SSERC was founded in September 1965 thirty years to the month of preparation of this Bulletin issue. Happy birthday to us! That's it. The staff are too busy and anyway we can't afford a party. Sorry!

We have had cards and a letter from Mrs Kathleen Stewart, widow of Joe the first Director of SSSERC as it was then. Kathleen's message summed it all up. I cannot better it. "Best wishes for the future! May you continue to stagger on from strength to strength!"

Attribution

Of late there have been a number of correspondents who have commented on the anonymity attached to this publication. I have had letters addressed to "Dear Editor (whoever you are)" or "Dear Sirs/Madams". The latest epistle on these lines began: "Dear Colleague - I hope you will allow me to refer to you as colleague - it seems less remote than "Sir or Madam", and I cannot find your name in the Bulletin. Why is this I wonder for I would be pleased to have my name associated with such a publication, but perhaps it is not SSERC policy?"

It's not so much a SSERC policy as a tradition. We have always taken the view that almost everything we produce is the result of a team effort. No boaking out there! It's true, I tell you, even if only recently has it become managerially and lip-servicingly trendy. Not the smallest part of the team over the years has been that diffuse collective of teachers and technicians who have sent in ideas, comments and accident reports. Rarely have even *Opinion* articles (love 'em or hate 'em) presented a singular view. With care even stirring can be developed into a communal activity. In any case, the articles that have caused the biggest stooshies have often been a case of SSERC printing in public what consenting adult professionals had long been saying in private. Since on the heels of attribution may follow the retri- sort, collective authorship, and thus responsibility, may provide some protection to all.

No-one can resist flattery forever. Thirty years seems a decent enough interval. If it's good enough for Official Government Papers it's good enough for us. Past editors of and major writers for this august rag have included :

The late *Joe Stewart* (editor of the early Bulletins when they were just that, who started the tradition of *Opinions* and wrote better, more incisive interjectory pieces than most of ours).

The late *Hugh Medine* Assistant Director and one-time Acting Director of the Centre, gentleman, house-builder, and chemist.

Dennis Belford, he of the fertile imagination and a thousand wee inventions, one-time Assistant Director, then back to teaching as PT Biology at Liberton High School and now actively retired (very actively). I had to add that last bit because when I 'phoned Dennis to ask his permission to name him, he reeled off a great list of all the things he was still doing. This included just having celebrated his seventieth birthday in between his folk dancing, metal-working and jewellery making, bird watching and now, he tells me, gold-panning.

When I suggested he was taking trips up to Sutherland he said "No, not Sutherland". When I asked where else in Scotland he was finding gold (quite a few grams to date apparently) he just laughed and rang off.

And, last but etc., *Colin Weatherley* who also had the good sense to tunnel out and get back into the classroom when he had the chance, leaving yours truly stuck in here. He's a heidie now! Ah well, maybe working for SSERC's not's so bad after all.

More recent SSERC delvers and scribblers have included members of the ill-fated Joint Support Activity and earlier project teams. These were : *Moira Aitchison* seconded from Dunbarton Division SRC, Standard Grade Project Officer (currently an Assistant Health and Safety Adviser, Education, Glasgow Division); *George Amos*, PT Chemistry, Kelso High (now retired); *Danny Burns*, one time Senior Technology Education Project Officer (now at Moray House Institute); *Ian Downie*, SSERC BP Research Fellow, Microelectronics and Computing in the Curriculum Project (currently of Northern College, Aberdeen Campus); *Phil Strange* (then of Argyll TVEI), now Business Development Manager at SCET, Glasgow; *Derek McLaughlan* Biotechnology Project Officer and latter day dandy (now reading Medicine at Nottingham); *Eric Pirie* (then of Kyle Academy, Ayr); *Clive Semmens*, Senior IT Project Officer (currently an Editor with the Cambridge University Press - posh eh!); *Tom Harrison*, then of Inveralmond High (now Science Adviser, Central Region) and *Bob Tennant* (now an IT adviser, Renfrew Division, Strathclyde).

Sorry folks! You couldn't have really thought you would keep getting away with it.

The inside front cover also lifts the semmit hems of the current staff team. Be warned though of our other strategy for self-protection. Our bushels get moved around over our lamps faster than the cards in a game of *Find the Lady*. Ye cannae whack a moving target!

Probably our greatest debt remains to all of those practitioners who over the years have sent in so many ideas, practical tips, hints, wrinkles and moans. As those last two wax ever deeper and stronger, to all of those anonymous contributors, we can only say -

"May the farce stay with you!"

SAFETY NOTES

Solder fume control

The health risk from solder fume in soft soldering is assessed. A possible strategy for instigating control measures is suggested.

It is six years or so since the Centre last published guidance on this subject [1]. In the interim there has been growing concern over the incidence of respiratory sensitisation and other allergic conditions (see "Further reading" at the end of this article). We have had also a number of recent enquiries on the need for measures other than good general ventilation of the workroom. Many industrial concerns and a number of higher education establishments have adopted special control measures for soft soldering.

All of these developments have led us to look again at our earlier advice. An initial risk assessment based on likely rates of solder usage allowed the calculation of release rates (Table 1). These were used to make theoretical estimates of the build-up of concentrations of fume over time. The results suggest that our earlier advice, that local exhaust ventilation (LEV) at the soldering station was unlikely ever to be needed in schools, now has to be re-examined.

Background

Soft soldering is the process whereby conductive connections are made in electrical and electronic circuits. The solder consists normally of a 60/40 alloy of tin and lead together with several cores of flux. The typical percentage by weight of flux is 3%. The relative percentages by weight of the metals are 60% tin and 40% lead. The main constituent of flux is rosin, a natural product, being the residue remaining after the removal of volatiles from exudations of pine trees. Another name for rosin is colophony, after Colophon the ancient Greek name for a coastal region in western Asia Minor. This was famous for its production and supply of rosin. Some fluxes contain modified or synthetic rosin and other synthetic substances.

Construction task	Rate of solder usage ($g\ h^{-1}$)	Rate of colophony fume production ($mg\ h^{-1}$)
Connecting small components to 0.1" stripboard	2.6	75
Connecting 55/0.1 mm extra flexible leads to 4 mm connectors (banana plugs)	6.5	189

Table 1. Rate of usage of 22 s.w.g. 60/40 tin/lead rosin core solder, 2.9% rosin content, using a 50 W hand iron with 1.6 mm diameter tip. Tip temperature varied between 320°C and 360°C.

During the soldering process the tip of a hand soldering iron may reach a temperature of 350°C. The solder flows to form a joint fillet. Fume and gas are emitted, seen as a vertical plume rising from the tip. This is known as colophony fume. The main component is particulate rather than gaseous. The mean diameter of particulate fume is typically 1.1 μm. Particles are sufficiently small to reach the alveoli, or gas exchange region of the lung. Colophony fume is a known irritant of the eyes, nose and respiratory tract, a respiratory sensitiser causing asthma and is capable of causing allergic contact dermatitis. The specific agent in the fume has not been identified. This risk from exposure to colophony fume is therefore significant. Exposure to lead by inhalation will be minimal because the solder is unlikely to reach a sufficiently high temperature for lead to evaporate. The risks from the toxic effects of lead are insignificant therefore.

The rate of fume emitted depends on many variables such as the nature of the work (Table 1), solder wire diameter, metal/flux ratio, flux composition and solder temperature. The values given are for a constant rate of work by a competent person such as a trained technician or pupil. They allow for intermissions taken to cut and prepare wire between making each solder joint, for positioning components and for other routine tasks typical in constructing a circuit.

The build-up of fume concentration in an enclosed space has been calculated for different rates of ventilation (Fig. 1) (the method should be familiar to readers of our book on making a COSHH risk assessment [2]). The conditions underlying the calculation should be noted. The number of air changes per hour, N, depends on many factors. For any enclosed area the value of N could lie between 0.5 and 10, and vary considerably from one occasion to another. For instance a room with tightly sealed window units might typically have just one air change an hour whereas a room with poorly sealed window units might typically have two air changes an hour. These values vary with weather conditions. Typically the value of N might rise to 4 by opening several windows and a door. It can be seen (Fig. 1) that the occupational exposure standard (OES) short-term limit (15 minute reference period) for the pyrolysis products of rosin core solder of 0.3 $mg\ m^{-3}$ is liable to be exceeded between 20 minutes and 40 minutes after the commencement of soldering.

The calculation of fume concentration was based on the assumption that there is uniform mixing within the workspace air. By making such an assumption, it was

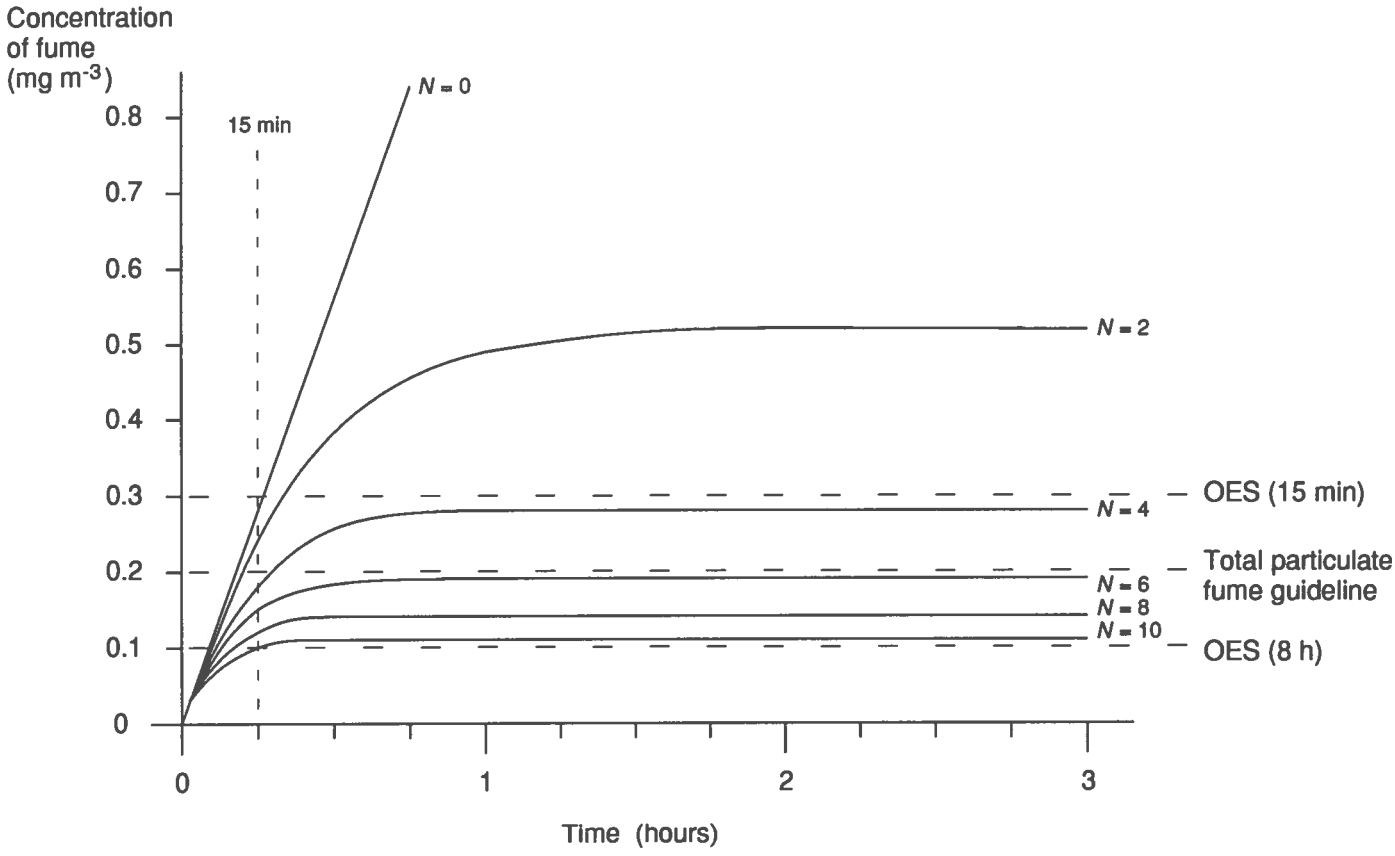


Figure 1. Build-up of solder fume concentration in a typical classroom for different rates of ventilation.
$N \equiv$ number of air changes an hour.
Conditions :
Room volume = 8 m x 7 m x 3 m = 168 m^3
Task : connecting extra-flexible wire 55/0.1 mm^2 to 4 mm banana plugs
Soldering iron : one iron, rated 50 W, tip temperature 320°C to 360°C
Solder type : 22 s.w.g. 60/40 tin/lead with 2.9% rosin
Rate of solder usage : 6.5 g h^{-1}
Uniform mixing of fume in air (ideal condition - actual concentrations may locally be 10 times greater)

possible to predict the rate at which incoming fresh air dilutes the fume. If allowance is taken for the vagaries of mixing within the room, fume outwith the plume may concentrate locally to a level up to ten times greater than the uniform mixing value. High concentrations can be expected in the air near to the source - that is in the breathing zone of the solderer. It is therefore likely that the OES levels cannot be met by natural ventilation alone or solely by simple organisational procedures such as limiting the period of work.

Health effects

A causal link has been established between exposure to colophony fume and respiratory sensitisation. This can come about after repeated or prolonged exposure. Inhalation of the peak concentrations of fume is thought to be particularly hazardous because it may be one important factor in initiating sensitisation. All persons are at risk of becoming sensitised. However sensitisation is unpredictable. Only some individuals at risk will become sensitised. Atopic persons (those with a history of childhood eczema or asthma, etc.) may be at greater risk. The prevalence of asthma associated with occupational exposure to colophony may be as high as 21%. (For a fuller description of sensitisers and allergenic substances see our book on making a COSHH risk assessment [3].)

Initial symptoms of harm include rhinitis (runny or stuffy nose), irritation of the eyes, irritation of the upper respiratory tract (sore throat), or bronchospasm (difficulty in breathing). If exposure continues, the person may become sensitised, the symptoms being rhinitis or asthma, characterised by periodic bouts of wheezing, chest tightness and breathlessness resulting from constriction of airways.

Once a person is sensitised, allergic symptoms can recur on any re-exposure to colophony fume, even to very low levels. Asthma attacks may also be triggered by other things, such as tobacco smoke, cold air and exercise. They may also be caused by exposure to colophony substitutes such as modified or synthetic rosin.

Exposure of skin to rosin or colophony fume may cause a rash to form. Repeated exposure may cause the skin to become sensitised, thus developing into allergic contact dermatitis.

Assessment

The COSHH Regulations require that exposure to substances hazardous to health should be prevented or, where this is not reasonably practicable, should be controlled. As soldering is a process that schools find necessary to undertake - for curricular and technical reasons - it would be operationally impossible to prohibit. Control measures are therefore required which are aimed at preventing sensitisation. There are no means of finding out which persons are predisposed to being sensitised. Therefore all soldering operations should be controlled so as to minimize exposures to solder fume.

Measurement of fume concentration is difficult and complex. As a guide to where good standards of engineering control have been established, HSE advise that the concentration of particulate solder fume should not exceed 0.2 mg m^{-3} over the sampling period.

Calculations (Fig. 1) indicate just how readily the OES levels and guideline for the pyrolysis products of rosin can be exceeded. However it should be appreciated that OES levels apply to occupational situations and are primarily concerned with healthy adults who may be exposed over the large part of a working life. They cannot necessarily be applied to children or to persons in poor health in schools. Indeed there is no recognised approach to setting acceptable indoor concentrations of pollutants for these groups.

More than 3 million persons in the UK have asthma. Between 10% and 15% of school children have asthma and 80% of children with asthma will continue to have it in adult life.

Taking aboard these issues, schools must ensure that children, and staff also, are not unnecessarily exposed to solder fume. The pool of persons suffering from asthma should not be increased because of any additional hazards encountered in school. It becomes necessary therefore to develop health and safety management strategies to deal

Solder type	Suitability or purpose	Flux	Supplier	Relative cost	Test results Coarse	Fine
Multicore 362 flux cored 60/40 solder wire	General soldering	Natural rosin 2.9% with halide activation	Farnell 419-345 RS 555-235	1.0 1.0	5	5
Multicore X38B low residue solid flux cored 60/40 solder wire	Repair operations No cleaning Leaves clear residue	Modified rosins 1% Acid activators Halide free	Farnell 289-826 RS 685-033	1.2 1.0	2	4
Multicore X39B low residue solid flux cored 60/40 solder wire	Repair operations No cleaning Aggressive flux giving turbid residue	Modified rosins 1% Acid activators Halide free	Farnell 289-863	1.2	3-4	5
Multicore X32C low residue flux cored 60/40 solder wire	General soldering with low fuming	Modified rosins 0.67% Halide free	Farnell 419-515	1.2	2	4
Multicore X42B low residue activated flux cored 60/40 solder wire	General soldering with low fuming Halide activator improves solderability to dirty surfaces	Modified rosins 0.45% Halide activator	Farnell 419-527 RS 567-531	1.2 2.1	4	4-5
Multicore Crystal 400 no clean clear residue flux cored 60/40 solder wire	General soldering No cleaning Leaves clear residue	Modified rosins 3.4% Halide free	Farnell 609-985 Hawnt D622R 400	1.2 1.0	5	5
Multicore Hydro-X flux cored 60/40 solder wire	Water-washing procedures to avoid using CFCs Unsuitable for schools	Citric acid-type	RS 185-0115	1.0	-	-

Table 2. Comparison of low rosin, modified rosin or rosin-free fluxes with natural rosin-based flux (first row). Test results indicate relative solderability with 22 SWG solder wire on unused components. The coarse test consisted of connecting a component with relatively large thermal inertia (2 A bridge rectifier) to stripboard. The fine test consisted of connecting parts with low thermal inertia (DIL socket, 0.25 W resistors and 30 AWG wire) to stripboard. The relative scale should be interpreted as follows :

5 ≡ performs as if using natural rosin-based flux

4 ≡ performs slightly less well than if using natural rosin-based flux

3 ≡ performs markedly less well than if using natural rosin-based flux

2 ≡ very difficult to work with, time consuming, solder not flowing properly

1 ≡ impossible to work with

with exposure to allergens and sensitisers - of which solder fume is a significant example. All that can be suggested here is a general range of possible controls. It is a matter for educational employers and each establishment to assess risks in specific situations and to put the instigation of control measures into an overall set of priorities for action.

Suggested control measures

Substitution : Substitution of natural rosin with synthetic or modified rosins has been developed as one control to attempt to reduce the risk of sensitisation to solder fume. Often, but not always, synthetic or modified rosin concentrations will be lower than that of natural rosin in conventional soft solders. However there is evidence that modified rosins play a major role in contact allergy and may even have a stronger sensitising potency than natural rosin. We are not aware of any evidence that modified rosins are less potent. Reliance on substitution should not therefore be used as the sole control measure, although substitution itself may reduce the overall level of risk.

Solders with modified rosins are generally less easy to work with than is solder with natural rosin. Soldering to components with a large amount of thermal inertia, or with dirty legs, or to tarnished copper track, may be difficult. A comparative review (Table 2) shows the relative difficulty. In order of preference with respect to ease of use, the following types of solder wire containing modified rosin flux are recommended, all products of Multicore : Crystal 400, X42B, X39B. Our recommendations are tentative because of the cautionary remarks already made.

The percentage by weight composition of rosin in Multicore X42B flux cored solder wire is only 0.45%, six times lower than traditional solder wire containing natural rosin, such as Multicore 362. Fume concentrations can be reduced sixfold by substituting X42B for 362 flux cored solder.

Local exhaust ventilation (LEV) : In view of the knowledge we now have about how potent a sensitiser colophony is, and having made estimates of likely fume concentrations, we have reviewed the advice given some years ago [1]. We are now of the opinion that local exhaust ventilation has to be seriously considered for soldering operations in schools and further education. LEV may provide the only effective way of removing colophony fume from the breathing zone and preventing persons, whether persons soldering or others in the vicinity, from exposure. Information on LEV can be found at the end of the article.

Natural ventilation : This cannot be relied upon to remove or to sufficiently dilute colophony fume from school workplaces. In order for natural ventilation to be considered to be an adequate control measure in itself, the place would need to have about eight complete air changes an hour together with effective air mixing and the following administrative controls : one soldering iron per 80 m^3 of space, a limitation of the hours spent soldering to two hours, and a prohibition on persons with asthma entering the workspace. By substituting X42B solder, which contains only 0.45% rosin by weight, for solder with natural rosin, a higher iron density of one per 15 m^3 of space could be attained. However since this type of general ventilation simply does not exist in school work areas - except possibly by mishap - control measures based solely or mainly on natural ventilation probably cannot be relied upon. In work areas with LEV, natural ventilation is used as a secondary form of control. Typically this might be achieved by opening several windows and a door. The provision of an air extraction fan to ventilate the room is also recommended.

Personal protective equipment (PPE) : Although colophony is a skin irritant it is unlikely that gloves would be needed to prevent exposure because the period of risk is likely to be low and because the plume rises. Also, the use of gloves leads to loss of manipulative sensitivity. It may increase the risks of burns or other physical injuries as well as making the work itself difficult.

Health surveillance : Because of a growing awareness of problems with sensitisation and allergy, many employers have put systems in place to identify those thought to be at particular risk. In this present context persons at risk can be categorized as children and employees, the second group comprising technicians and teachers who solder, and teachers who supervise classes where pupils are soldering.

In any effective scheme, new employees and existing employees at the onset of their health surveillance programme are initially screened using a short health questionnaire and also, possibly, spirometry if that were advised by an occupational physician contracted to give advice by the EA. Persons reporting active eczema or bronchial asthma are directed not to work with known respiratory sensitisers and these would include solder fume. Existing employees are screened annually by way of a simple health questionnaire. Any employee at risk who develops signs of asthma or allergic dermatitis is instructed to report such symptoms to the employer for investigation.

A school's guidance system should identify, record and inform teachers - in confidence if need be - of those pupils who have active eczema, asthma or other history of respiratory problems. Pupils with active eczema or asthma should not undertake soldering operations without the advice of the school health service or family doctor. If LEV has not been provided, asthmatic pupils should be asked to inform the teacher if neighbourhood exposure to a soldering process upsets their chest.

Information, instruction and training : Exposure to colophony fume can cause irritation to the eyes, the lungs, or the skin. Allergy to colophony appears as asthma, or as dermatitis. Persons at risk need to be informed of these symptoms, of the control measures provided and be told to use them. If training is required, this should be given.

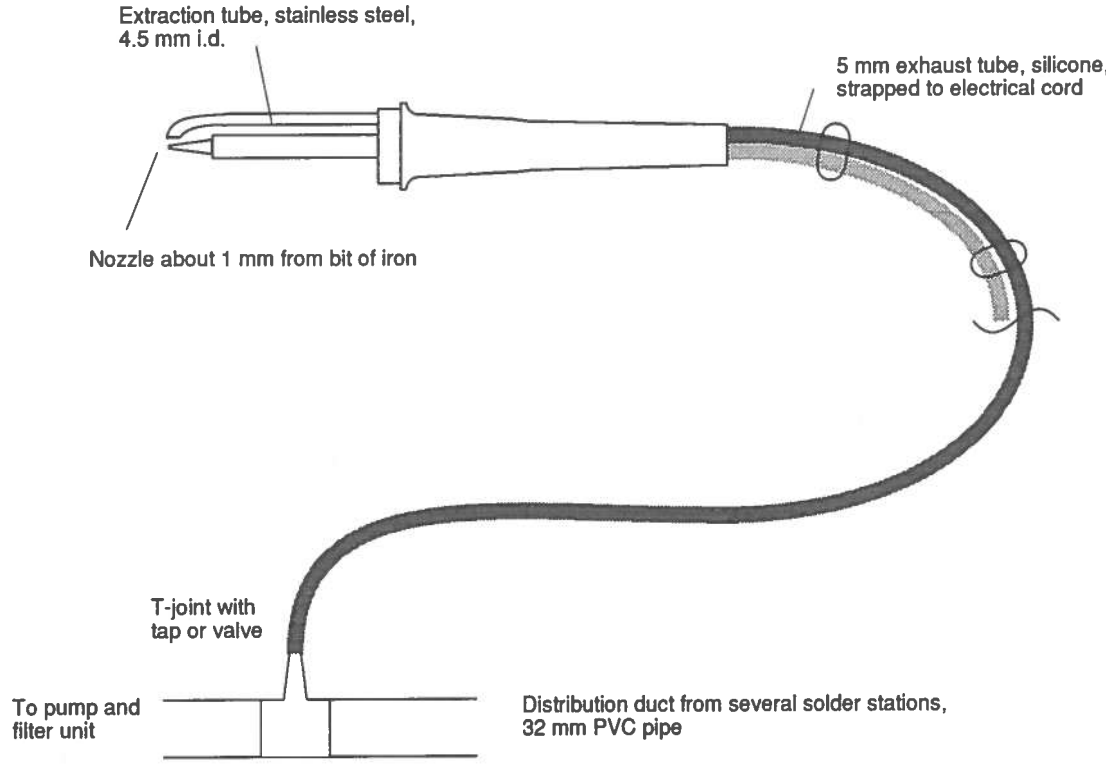
Provisional controls : At present it is uncommon for schools to make use of LEV to capture solder fume. Since LEV is expensive the priority for its provision will have to be examined against a number of other pressing needs for improvements in health and safety. It can be presumed that there will be a delay before it is installed. Interim steps to minimize exposure and risk of harm thus need to be taken. These might include combinations of any of the following :

- curtailing soldering operations to the necessary minimum;
- using solder wire with a relatively low percentage of rosin in the flux, such as Multicore X42B flux, but which is relatively easy to work with;
- limiting the number of solder stations per unit volume of work space, for example but only as a rough guide:
  - one solder station per 80 m^3 if using natural rosin based flux, or
  - one solder station per 15 m^3 if using X42B flux cored solder wire;
- minimizing the period spent soldering by any one person and limiting it to about 1 hour a day;
- not using a work area which has poor natural or forced ventilation;
- opening windows and doors;
- ventilating the work area with an air extraction fan provided that the source of fume is between the person soldering and the extraction fan;
- using a fume cupboard;
- checking by means of a bright lamp and Tyndall effect that the draught does not blow solder fume into the breathing zone of either the person soldering or other persons nearby;
- instructing persons not to directly breathe in fumes from the solder plume;
- not allowing persons with asthma or acute eczema into the work area (see Health surveillance).

Local exhaust ventilation

There is a statutory requirement to maintain LEV in good working order. Maintenance includes inspection and testing. The filters in systems returning filtered air to the workplace atmosphere need to be replaced as per the manufacturers' directions. Of the many different types of LEV, the following may find application in schools :

Soldering iron with tip extraction : A small nozzle fitted very close to the tip of the iron is linked via flexible tubing to an exhaust fan (Fig. 2). The fumes are then either expelled from the building, or are removed by being drawn through a filter of activated charcoal. This system would seem to be the most effective arrangement for removing colophony fume. It can be very effective at capturing fume and it operates continuously. Not only does it remove fumes during soldering, it also operates whilst the iron is at rest. It may not be necessary to buy special irons with fume extraction tips because conversion kits are available. There are systems for connecting several irons to the one pump and exhaust or filtration unit. Multiples of 2, 5, 10, 15, or 30 irons may be so connected. Several benches in a classroom could be piped up to the one pump. Since some pumps and filtration units



are transportable, several rooms could have fixed installation piping, being serviced by the one pump taken from room to room on demand. The noise level from such a pump can range from 50 dB to 65 dB depending on type. If the pump is to be sited in a classroom, select one that does not exceed about 58 dB.

The main disadvantage of tip extraction is that fume tends to be deposited within the narrow bore sections of the tubing, which are therefore prone to blockage. This can and should be overcome by routine preventive maintenance. Another problem for schools, as affects other fixed installation services, is that this type of LEV would be prone to vandalism. The obstruction to line of sight caused by the tip and inertia of the tubing are not generally thought to be over-troublesome.

Portable extraction units with fume absorbers : These consist of a box comprising a fan and filter. Those with a captor hood (Fig. 3) which draw in fume largely by natural convection would seem to be more effective than fume displacement units (Fig. 4). The circuit being soldered must be positioned carefully so as to ensure that fume is captured. The zone of effective capture may be quite small and may vary with draughts. Solder fume generated outwith this zone is unlikely to be captured. Some captor hood units include illumination. This helps to direct where the work should be positioned.

Another disadvantage is that these units may not be able to capture fume from a soldering iron in its rest position. Ideally both the workpiece and soldering iron stand should be sited together in positions where fume is effectively collected. The noise from the fan should not exceed about 58 dB.

LEV buying advice

At the time of writing, the Centre has begun formal testing of this type of LEV system. It would seem that tip extraction is effective, but would be expensive to install in several rooms. A 10-station system including conversion kits for irons costs around £2000. Portable extraction units with captor hoods would therefore seem to be the better buy. Although not as effective in capturing fume, they can be bought in small numbers to provide LEV in any location. Since soldering is a relatively infrequent occupation for most persons in school, this type of LEV may provide adequate protection to those at risk. Two portable fume displacement units are reviewed overleaf. One was found to be quite ineffectual. The other was reasonably effective.

References

1. Soldering - what precautions to take, Safety Notes, Bulletin 163, SSERC, 1989.
2. Calculation of the level of contaminants in the general atmosphere of the workroom or laboratory, Appendix 6, Preparing COSHH risk assessments for project work in schools, SSERC, 1991.
3. Sensitisers and allergenic substances, Appendix 5, Preparing COSHH risk assessments for project work in schools, SSERC, 1991.

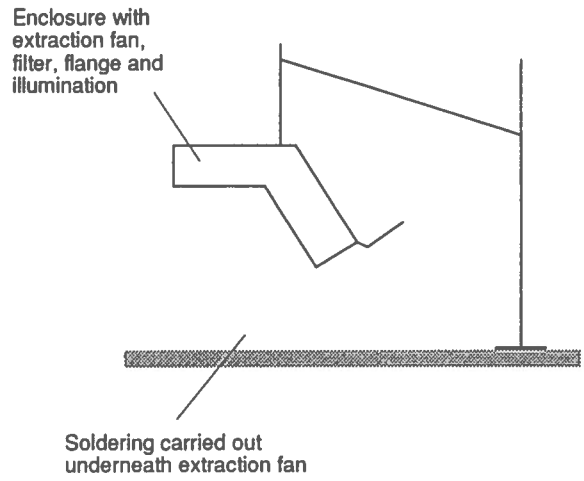


Figure 3. Portable extraction unit with fan, fume absorber and captor hood. Fume capture aided by convection. Vertical section.

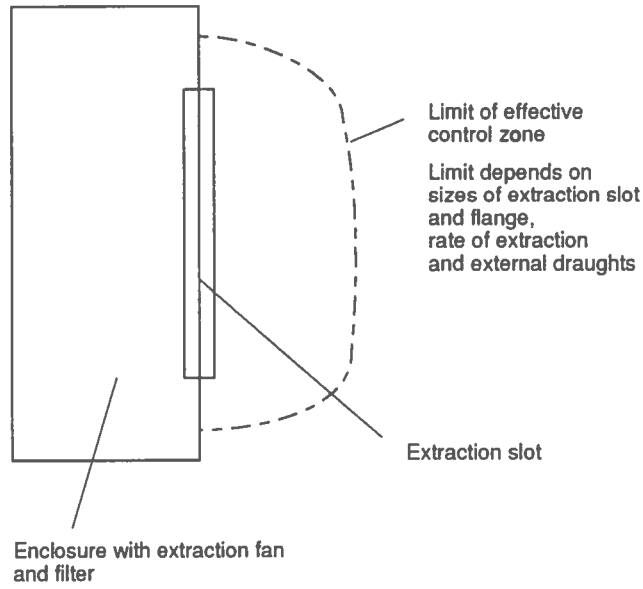


Figure 4. Plan view of portable fume displacement unit with fan and fume absorber. Capture is only effective if source of fume is very close to extraction slot. Convection resists effective capture.

Further reading

EH40 Occupational exposure limits 1995 (revised annually), HSE, ISBN 0 7176 0876 X.

Rosin (colophony): a review, Specialist Inspector Report Number 42, HSE, 1993.

Preventing asthma at work : how to control respiratory sensitisers, HSE, L55, 1994, ISBN 0 7176 0661 9.

EH22 Ventilation of the workplace, HSE, 1988, ISBN 0 11 885403 8.

Guidelines on the use of colophony (rosin) solder fluxes in the electronics industry, The Federation of the Electronics Industry (originally published by The Association of the Electronics, Telecommunications and Business Equipment Industries, now part of FEI), 1991.

EQUIPMENT NOTES

Portable fume displacement units

Farnell Fume Displacement Purifier Unit 501-529 — *£68.44*

Description : This unit is designed to stand on the bench adjacent to, and immediately behind, the workpiece. A fan draws the fumes away from the solder tip across an activated charcoal impregnated filter. In the absence of draughts, fume is reliably captured in a region extending to 200 mm x 100 mm at bench height. There is reasonable room at the side of the work area where a solder stand may be placed such that fume is reliably captured when the iron is in the stand. The figure opposite illustrates the location of an iron at rest.

Supply : 230 V AC. Detachable lead with IEC connector. Single pole illuminated switch on enclosure.

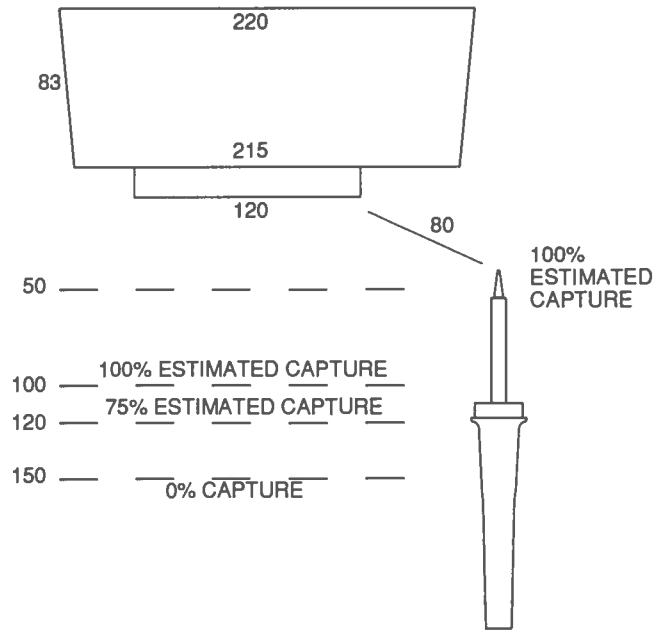
Electrical safety : Complies with IEC 1010-1. Class 1.

Enclosure : Strong plastic enclosure surrounding metal fan housing. Papst fan with metal blades. Protective earth conductor bonded to fan housing. Enclosure can be vandalised if hot tip of iron were used to melt holes in plastic.

Noise level : 58 dB at head while soldering. 50 dB at 1 m.

Extras :

	IEC lead with plug	152-575	£4.80
	Filter 120 x 120	501-530	£1.89



Plan of Farnell Fume Displacement Purifier Unit showing region of reliable capture in absence of other draughts. Dimensions in mm.

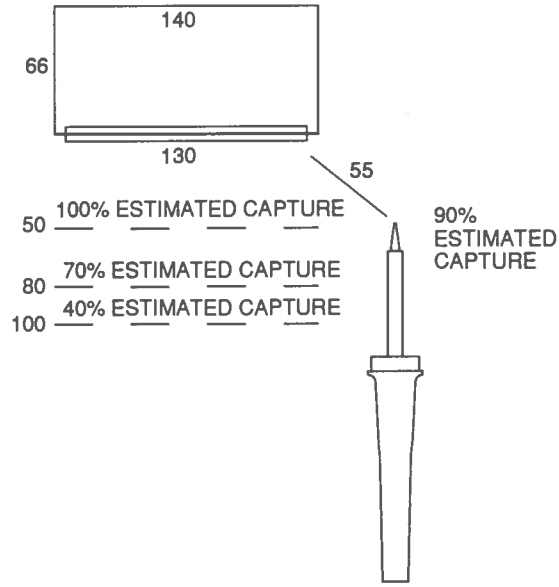
Rapid Fume Extractor SFE/1 85-1035 — *£49.50*

Description : This unit may be set up in two ways. It may either be placed on the bench behind the work being soldered, or it may be raised on a wire cradle above the workpiece. A fan supposedly draws the fumes away from the solder tip across an activated charcoal impregnated filter. The sketch opposite delineates the capture zone when the unit is set up on the workbench behind the workpiece. However as the sketch indicates, the region of reliable capture extends to no more than 50 mm from the captor face, which really is too small to be of use. The effective capture area is only about 130 mm x 50 mm. If an iron is stored in a stand alongside this workarea, as shown opposite, perhaps 90% of the fume is captured. But in transferring the iron from the workpiece to its stand, some fume is not drawn into the extractor because the iron moves out of capture range. The above findings relate to still air. In the presence of a draught, less fume will be captured.

If the unit is raised above the workpiece on its wire cradle, we could find no place at bench level in still conditions where fume is reliably captured.

Supply : 230 V AC. Attached lead. Double pole switch on enclosure.

Enclosure : Plastic enclosure surrounding plastic fan housing. Sunon fan with plastic blades. Front and back of enclosure secured to fan housing by 4 studs each. Studs removable by fingers. Enclosure can be vandalised if hot tip of iron were used to melt holes in plastic.



Plan of Rapid Fume Extractor showing region of reliable capture in absence of other draughts. Dimensions in mm.

Electrical safety : Does not comply with IEC 1010-1. Class 2. No cut-out apparent.

Noise level : 57 dB at head while soldering. 51 dB at 1 m.

Extras : Pack of 5 filters 85-1037 £8.50

Note : Named in catalogue as Fume Displacement Purifier.

TECHNICAL TIPS

Liquid-in-liquid drop formation

Alternative methods and substitute solvents for demonstrations which at one time utilised phenylamine are described.

Many years ago I used to demonstrate liquid in liquid drops to S1 classes. This was as part of a simple introduction to the idea of intermolecular forces. It hopefully generated 'mind pictures' such as of the skin of balloons stretching as they were filled with air or water. In such demonstrations, phenylamine (aniline) was slowly run into water from a burette. The forming drop of the slightly more dense phenylamine (S.G. 1.02) was well supported by the water and could grow to a good size until its weight caused its necking to a pear-shaped drop before it detached to reform a sphere which slowly fell to the bottom of the water.

This was a nice wee demonstration and it could be back projected quite easily. The fact that phenylamine darkens with age, made the droplet visible without the addition of any dye. However it is desirable now to replace phenylamine on account of its toxicity and the fact that it is readily absorbed through the skin. Other possible heavier than water solvents of suitable density range are also quite toxic. Some, eg chlorobenzene with a specific gravity of 1.11, are just a bit too dense to be well supported in water and it is necessary to add some salt to the aqueous fraction. And, unlike with phenylamine, a water insoluble dye is needed to render visible the droplet of solvent.

Some of the new alternative safe solvents offered by suppliers to replace our old friend, 1,1,1-trichloroethane, can be used instead of phenylamine or chlorobenzene. In Bulletin 183 [1] we gave some details on these solvents.

Rhodiasolv Also known as RPDE, this has a specific gravity (S.G.) of 1.09 (Prolabo Cat no. 27.290.297). It is not quite as satisfactory as phenylamine, the drops detaching at a smaller size, but again the density of the water could be increased by the addition of sodium chloride. Typical S.G.s for a number of brine concentrations expressed as a w:w percentage at 20°C are as follows :

1.065 for 9%; 1.080 for 11% and 1.0876 for 12%.

In our trials both 11% and 11.5 % w:w solutions worked well giving drops with estimated maximum diameter of 8 mm or so. It is possible to further fine tune the brine solution concentrations in order to make the drop seem almost weightless or just float. The drops, of course, look even larger if viewed through the sides of a beaker, because of the lens effect. This magnification will only be lateral and will thus have the unfortunate effect of de-emphasising the vertical elongation of the drop. In the absence of the elusive square beaker, cubical glass cells used for optics in Physics (for example see Griffin XGB-600-010A) would be satisfactory.

Solvents less dense than water

Here the trick is to reverse the phases, running water into the solvent. *Lotoxane*, (Griffin L/25550/15) is not so suitable for this application on account of its low S.G. of 0.77. The three *Volasil oils* (Merck) also mentioned in Bulletin 183 [1] are somewhat more suitable. With specific gravities of 0.951, 0.952 and 0.956 for the 244, 344 and 245 oils respectively, in water they all give a good size of drop. This is just a little smaller than that obtained with Rhodiasolv in brine. To reduce the amount of solvent required, use a boiling tube rather than a beaker. Three-quarter fill this tube with Volasil and place the tip of the burette filled with water below the surface (see colour illustration on the front cover).

A benefit of reversing the phases is that water soluble dyes, eg fluorescein, methylene blue or an indicator, such as bromothymol blue, can be used. These water soluble dyes have two advantages over water insoluble types:

- they are ubiquitous in school science departments.
- water soluble dyes are much less likely to be carcinogenic than are water insoluble dyes.

Most titration indicators are fine. If you try some other dyes first do a small scale check that they are insoluble in the Volasil solvents. It is easy to re-cycle the solvents. At the end of the demonstration, decant off the Volasil and store in a stoppered bottle labelled : *Wet Volasil, only to be used for surface tension demonstrations.*

Extension

An added little observation concerns the fallen drops. The first half dozen or more will lie on the bottom of the beaker like coloured frog spawn. Sometimes they will stack on one another before bursting and coalescing to form larger globules. You can add even more colour to this phenomenon by the following device; but be warned that it may prove a distraction which will be remembered instead of the object of the exercise.

Use an acid-alkali indicator, adding it to the aqueous solution for the burette. Make it very slightly acidic. Place at the bottom of the Volasil a little water containing the same indicator but with a trace of alkali. If you use bromothymol blue the falling acid drops (pardon the pun) are yellow. They will sit for a while on the lower flat aqueous surface which is blue. When the first two or three drops finally burst and mix with the blue aqueous layer, they will adopt its colour.

Reference

1. Alternative solvents, Safety Notes, Bulletin 183,SSERC, Winter 1994.

Urea : an assay method for practical investigations

A method for estimating concentrations of urea in aqueous solution is described

The procedure to be described was devised by Tony Sellars, Principal Teacher of Biology, Monifieth High School. It was further developed and tested by some of his senior pupils. It is as at least as reliable as methods described in earlier Bulletin issues and elsewhere, but seems far more colourful and interesting. We are very grateful to Tony and his pupils for sending us this tip.

Background

In Bulletin 179 [1] we published material intended to iron out reported technical snags with a TAPS 3 Investigation (C30) and in a compulsory practical for Human Biology at the Higher Grade. Both relied on indicators to estimate the amount of ammonia released by the action of the enzyme urease on urea; the TAPS method using the rate of change of an indicator to a standard colour and the Human Biology practical relying on titration against acid. We followed up the article on the TAPS investigation in the next issue [2] publishing just in time for the whole thing to have been dropped as an assessable investigation for Standard Grade Chemistry!

In a number of respects urease is a somewhat unusual enzyme. We described a number of its peculiar features in an earlier article [1]. It catalyses the hydrolysis :

$CO(NH_2)_2$	+	H_2O	=	CO_2	+	$2NH_3$
urea		water		carbon dioxide		ammonia

This is the basis of several methods for the estimation of urea concentrations in samples such as those of urine. Interestingly, although the papers on the TAPS investigation and the Human Biology compulsory practical go into detail on their different methodologies, the purpose of such measurements is not mentioned nor is any biological or medical context given. There is however a clinical rationale behind such assays. The concentration of urea in the urine together with a measure of the rate of flow, provide a means of assessing kidney function [3]. In a normal patient the urea clearance is a constant (C) which is independent of the rate of flow. It is calculated as :

$$C = ([U_u] \times F) / [U_p]$$

Where $[U_u]$ is the concentration of urea ($mgcm^{-3}$) in the urine; F is the rate of flow (cm^3min^{-1}) and $[U_p]$ is the concentration of urea in the plasma. A value for C of 70 to 80 is indicative of normal kidney function in this respect.

Materials and method

The Monifieth procedure, like most of the others, uses the amount of ammonia produced in the urease catalysed reaction as a measure of the original concentration of urea present in the sample. Where it differs is in the use of a diffusion limited system. The ammonia is released inside a sealed tube above a column of acidified agar gel to which has been added a pH indicator. At the outset the gel columns are bright yellow since they contain bromothymol blue and have been acidified using citric acid. The urea sample is introduced at the top of this column and urease from an active soya bean or Jack bean extract added. The ammonia released then diffuses into the agar causing the indicator to change from yellow to blue. After a standard time has elapsed (usually 48 hours) the length of the blue section is measured. It is assumed that the distance diffused by the ammonia is related to its concentration in the liquid above the agar. Using different concentrations of urea; a calibration curve can be produced and from which estimations of urea in unknown samples may be made.

Materials

For each entry "water" read "deionised or distilled water" :

120 cm^3 of agar sol (using 1g agar-agar per 100 cm^3 of water)
6 cm^3 bromothymol blue stock solution (0.1 g dissolved in 50 cm^3 ethanol or IMS made up to 250 cm^3 in water)
0.5M urea solution (7.5 g per 250 cm^3 or 30 gl^{-1} w:v water)
1M aqueous citric acid (2-Hydroxypropane-1,2,3,-tricarboxylic acid) solution
6 test tubes, 125 x 15 mm with bungs to fit

For the urease preparation : take 10 g of freshly ground soya bean or Jack bean meal and suspend it in 100 cm^3 of water, separate the active aqueous suspension from the solids by decanting or crude filtration through muslin or similar. Avoid the use of purchased soya flour as a source of urease. Invariably it will have been treated and won't work [1].

Procedure

Prepare the agar sol in the usual manner : adding the agar to the cold water and bringing carefully to the boil with constant stirring. Allow to cool somewhat, but not to the gel stage, before adding the 6 cm^3 of indicator. Again whilst stirring, add the citric acid dropwise until the sol turns yellow (it will first go green). When it is cool

enough (ca. 55°C) dispense 10 cm^3 aliquots of this yellow agar sol into into each of the six test tubes. Take care to ensure that the agar columns so formed, especially the surfaces, are free from air bubbles. Allow the agar columns to set. Meanwhile, dilute the urea stock solution so as to provide a series of other concentrations :

0.5M; 0.25M; 0.125M; 0.0625M and 0.0312M.

These will give us our calibration curve. Prepare the active urease extract as described above. Into each of 6 of the test tubes dispense 2 cm^3 of the urease preparation. For 5 of the tubes follow the 2 cm^3 of urease with 2 cm^3 of the appropriate serial dilution of the urea solution. Into the sixth tube will go another urea solution of unknown concentration (Figure 1). Stopper each tube and leave at room temperature for approximately 48 hours. Results will however be apparent after 24 hours or so although the differences between tubes may not be so apparent. The qualitative, semi-quantitative effect is quite striking and the effect of concentration is obvious even to a casual observer. For example, see the colour illustration on the front cover of this Bulletin issue. This was the result of one of several pre-publication trials of the method carried out here in the Centre.

For more strictly quantitative results the length of blue agar is measured from the bottom of the agar meniscus to the point at which the column ceases to be blue. Making such judgements and measurements is eased by holding the tubes against a bright light source. For example, the platen of an overhead projector has been used with some success but take care to avoid being dazzled by too intense a source. Note that the least concentrated sample may only change, or fade, to green after more than 24 hours or so as the limited amount of ammonia produced by this sample diffuses into the agar. Typical results obtained by students at Monifieth High are shown in Table 1 with means from these observations displayed graphically in Figure 2.

In our own trials we included unknowns and found that their concentrations could be estimated fairly reliably by interpolation from such calibration curves.

Conc. of urea (mMol.)	Length of blue gel produced (mm)	Mean
500	58, 57, 58, 58, 59, 56, 57, 57, 57, 57	***57.4***
250	55, 53, 54, 56, 53, 52, 54, 54, 54, 52	***53.7***
125	48, 48, 47, 48, 47, 47, 48. 48, 46, 46	***47.3***
62.5	40, 40, 39, 41, 40, 42, 40, 40, 39, 40	***40.1***
31.35	30, 30, 30, 33, 31, 33, 30, 30, 30, 30	***30.7***

Table 1

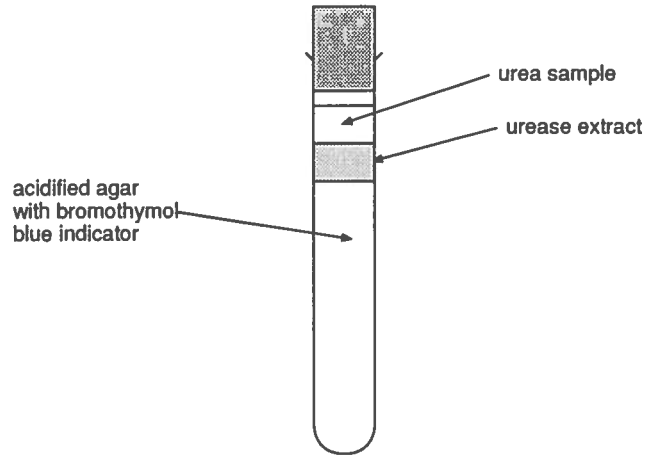


Figure 1 Assay tube showing the sequence of reagents etc.

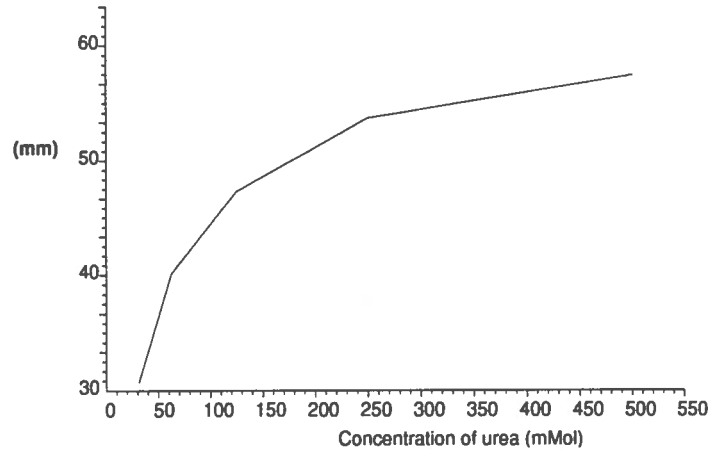


Figure 2 Calibration graph, length of blue column in mm against urea concentration in millimoles.

Other practicals using urease

Whilst we were trialling this, essentially quantitative, procedure we received an updated version of Central Regional Council's TVEI Project Materials on interfacing in biology (editions are also available for chemistry and physics). These were originally written for Acorn's microcomputers running *Datadisc* but have now been updated to allow the use of the *Insight* software package. Amongst several trialled activities is one which follows the progress of the urease mediated hydrolysis of urea by logging and graphing pH change.

References

1. *More on enzymes*, Bulletin 179, December 1993, SSERC, pp. 6-8.
2. *Hydrolysis of urea : TAPS 3 Chemistry Investigation*, Bulletin 180, Spring 1994, SSERC, p.22-24.
3. *An Introduction to Human Physiology*, J.H. Green, 4th S.I. edition, 1991 reprint, OUP. ISBN 0 19 263328 7.
4. For more detail on the Central TVEI materials see p32 of this issue.

EQUIPMENT NOTES

Laboratory power supplies

In the start of a series of articles on laboratory power supplies we review a selection of products from two manufacturers, Electrosound and Unilab.

There are too many power supplies on the market to review in one article. Indeed to review the range of products from some individual manufacturers would tax us in time and space. What we therefore intend to do is publish a series of articles. In each we will make detailed comments on what we trust is a representative sample of that manufacturer's newer products. In this first article we write about power supplies made by Electrosound and Unilab (Table 1).

Electrosound was established in 1985 and specialize in making power supplies. We obtained from them in 1992 a sample of three models which we report on in this article. In response to our comments, Electrosound redesigned these products and this is noted in our test reports which follow. This year they resubmitted to us a 4A AC/DC Unit, together with a new product, the 6A Keylock, which is the fourth of their models we have inspected.

The Centre has tested nearly every product in the Unilab power supply range. The six selected for inclusion in this article are relatively new models, introduced, we believe, in the 1990s.

Test findings

Power supplies are reported on individually on pages 16 to 24. The ABC key used in the summary (Table 2) is explained below. In general it stands for :

A Good B Fair C Poor

Electrical safety :

A Complies fully with IEC 1010-1 as far as our tests are able to indicate, except for some very minor infringements; has no appreciable risk for use in schools.

B Complies in general with IEC 1010-1, but has one or more features where there is a very small risk of harm.

C One or more features present an unacceptable risk of harm.

Electrical design :

A Sound design using good quality components of sufficient strength. Adequate mechanisms to protect against some single fault conditions. Able to meet specified voltage and current outputs.

B Minor weaknesses in design. May not deliver current and voltage to specification.

C Major weaknesses in design. One or several of the following may occur: liable to malfunction; components liable to get destroyed; gross underachievement of performance.

Product code	Product name	AC voltage (V)	DC voltage (V)	Maximum current (A)	Voltage selection	Voltage locking	Price (£)
Electrosound power supplies							
	4A AC/DC Unit	2, 4, 6, 9, 12	2, 4, 6, 9, 12	4	Rotary switch	None	63.95
	6A Keylock	2, 4, 6, 8, 10, 12	1, 4, 7, 10, 13, 15 smoothed	6	Key switch	Key lock	89.95
	1AMD Dual Rail Regulated	-	±5, ±12, ±15 reg.	1	6 separate terminals	None	61.50
	Spider	-	1.5, 3, 4.5, 6	1.5	Rotary switch	None	36.95
Unilab power supplies							
022.111	Beaver Power Supply	-	1.5-6 continuous	1.5	Rotary, continuous	None	39.90
022.107	12V Stepped Transformer	2, 4, 6, 8. 10, 12	-	8.5	Captive link	None	50.99
022.112	2V/12V Power Supply	2, 12	2, 12	10, 5	Key switch	Key lock	74.39
022.113	Student Power Supply	2, 12	2, 12	10, 5	Key switch	Key lock	126.67
			0-9 reg., continuous	1.5	Rotary, continuous	-	
			5 regulated	1	Key switch	Key lock	
022.116	5V Regulated Power Supply		5 regulated	0.5	Fixed value	Not applicable	35.18
022.114	Dual 15V Regulated Power Supply		±15 regulated	0.1	Fixed values	Not applicable	36.00

Table 1. Power supplies from Electrosound and Unilab reviewed in this article : specifications and prices.

Product code	Product name	Electrical safety	Electrical design	Mechanical design	Operational design	Performance	Protection mechanisms	Assessment
Electrosound power supplies								
	4A AC/DC Unit	A	C	B	A	B	B	C (B)
	6A Keylock	A	B	B	C	B	B	B
	1AMD Dual Rail Regulated	A	B	B	B	B	A	B
	Spider	C	C	B	B	C	C	C
Unilab power supplies								
022.111	Beaver Power Supply	A	A	A	A	B	A	A
022.107	12V Stepped Transformer	A	A	A	A	A	B	A
022.112	2V/12V Power Supply	A	A	A	A	A	A	A
022.113	Student Power Supply	A	A	A	A	B	A	A
022.116	5V Regulated Power Supply	A	A	A	B	A	A	A
022.114	Dual 15V Regulated Supply	A	A	A	B	A	A	A

Table 2. Power supply performance and assessment.

Mechanical design :

A Robust enclosure and parts. Secure fitment of parts. No significant mechanical weakness.

B Minor significant weaknesses identified.

C Major weaknesses identified.

Operational design :

A Controls and outlets clearly and adequately marked. Operation is simple, clear and obvious.

B Minor weaknesses identified.

C Awkward to work with, or misleading to operate.

Performance :

A Electrical outputs perform to specification. Voltage does not fall away steeply with current. Temperature rise is not excessive.

B Significant minor underachievement found.

C Significant underachievement, or excessive temperature rise.

Protection mechanisms :

A Overcurrent and short circuit protection operates reliably and to specification. Adequate protection of primary circuit.

B Minor weaknesses.

C Significant weaknesses. Because of inadequate protection, fault conditions may lead to destruction of parts. Electrical safety may then be compromised.

Assessment :

A Most suitable for use in Scottish schools and non-advanced FE

B Satisfactory for use in above.

C Unsatisfactory.

Comment

Each Electrosound product we have examined has had significant weaknesses - some major. These have included design defects, components of inadequate strength, problems stemming from poor quality control and skimping on protection. Three of the four products reviewed are reasonably safe. Nevertheless the Spider, which is marketed at Primary Schools, is not of a sufficiently sound construction or design to be declared safe. We counsel schools against buying a Spider.

Despite all this, and to say something nice about Electrosound, they do respond to criticism and do try to put things right. If only they could get their act together! In sorting one problem with the 4A AC/DC Unit, another fault, just as potentially damaging as the original, was introduced.

The Unilab models are all basically very sound. Although we found a few minor weaknesses, none prevented the award of an A assessment. One weakness did concern us, but in practice is unlikely ever to cause trouble. This relates to the voltage selector on the 12 V Stepped Transformer. It uses a captive J-link which connects different transformer taps. The weakness in the system is the chance that separate taps are shorted together, thus leading to the destruction of the transformer. (This weakness is common to several types of Unilab power supply.) In point of fact the transformer takes perhaps 5 minutes to fail, giving the operator plenty of time to switch off power. We understand from Unilab that they have never had a transformer returned with a winding damaged in this way. Because the isolating transformer has a split bobbin construction, the risk of the primary winding shorting to the secondary winding is remote. There would not seem to be any risk of electric shock.

Electrosound 4A AC/DC Power Supply — *£63.95*

Function : This power supply has been designed for general laboratory use for relatively light loads where it is sufficient to set voltage levels imprecisely. It can supply two raybox lamps in parallel and should meet the needs of electrochemistry, but the maximum current that can be drawn is rather low for some electromagnetism experiments.

Specification : AC and DC from separate pairs of 4 mm terminals. Nominal voltage outputs : 2, 4, 6, 9, 12 V. No locking mechanism on voltage selector. Maximum current 4 A. Outputs floating with respect to earth. Earth terminal not provided. DC supply unsmoothed.

Circuit : Low voltage is drawn from a step-down isolating transformer. The outlets are connected by a bank of 5 relays to separate taps on the secondary winding. A sample we tested in 1992 had been fitted with 3 A relays, some of which had burnt out in our tests because the maximum current output is higher than this. After receipt of our test report, Electrosound redesigned the circuit. The sample tested this year has 10 A relays. These seem to be sufficiently robust. The relays are controlled by the Voltage Select rotary switch. The switch in this year's sample was make-before-break, causing the secondary winding to short across a relay while it was in the process of being switched. More relays therefore burnt out in our second sample. Electrosound admit to a failure in quality control and inform us that the switch type in their specification is break-before-make.

The secondary outlet is protected against overload by a thermal cut-out. This was found to work reliably and seems to prevent the relay contacts from being over-stressed.

Construction : Relatively lightweight metal enclosure which is reasonably sturdy. Threads on securing screws are prone to stripping.

Layout and markings on front panel are reasonably clear and simple.

Performance : On DC the actual voltage is 1 or 2 volts lower than specified. Electrosound are to change the circuit design, which should raise the DC voltage by about 2 V.

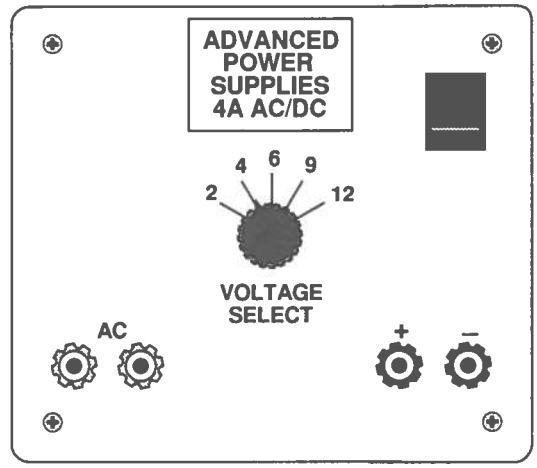
The current performance is good. The supply can deliver 4 A continuously over a period of several hours. The cut-out operates at 7 A.

The slope of the voltage output versus current has been compared with power supplies from other manufacturers. The performance on DC is typical. The AC performance is worse than met with in most other supplies.

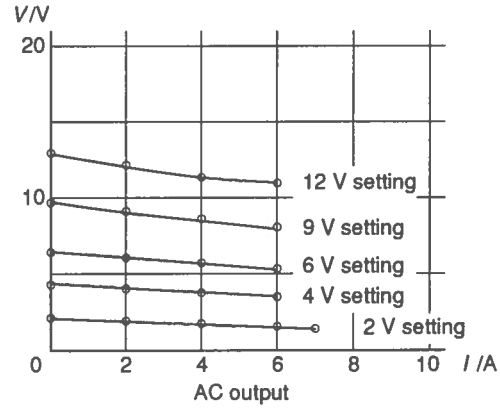
Verdict :

C (unsatisfactory) in present form.

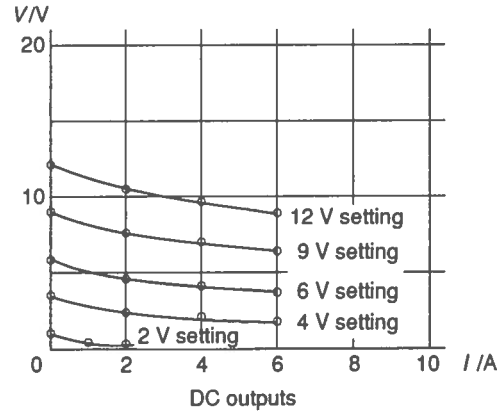
B (satisfactory) provided that manufacturer's declared improvements are implemented and found to be effective.



Enclosure : Black stove-enamelled steel. White markings.
Dimensions : Width 133 mm, depth 176 mm, height 117 mm.
Weight 2.6 kg. No carrying handle.
Mains cord attached. Mains fuse internal.
Outlets : 4 mm insulated terminals, accepts 4 mm plugs and unterminated wire.



AC output



DC outputs

Electrosound 6A Keylock Power Supply — *£89.95*

Function : This power supply has been designed for general laboratory use where voltages need only be set imprecisely. It can supply three raybox lamps in parallel (AC) and should meet the needs of electrochemistry, but the maximum current that can be drawn is rather low for some electromagnetism experiments.

Specification : AC and DC from separate pairs of 4 mm terminals. Nominal voltage outputs : 2, 4, 6, 8, 10, 12 V AC and 1, 4, 7, 10, 13, 15 V DC. Maximum specified current 6 A. Outputs floating with respect to earth. Earth terminal provided. Capacitive smoothing on DC outlet. Keyswitch voltage selection.

Circuit : Low voltage is drawn from a step-down isolating transformer. 6-way keyswitch connects to 6 taps on secondary winding of transformer for voltage selection.

The secondary outlet is protected against overload by a thermal cut-out and series relay switch. The relay is contrived to latch whenever the thermal cut-out operates, making the output dead. The output can only be reactivated by switching off and on the mains supply switch. The cut-out activates a buzzer and warning light.

Construction : Relatively lightweight metal enclosure, which is reasonably sturdy. Threads on securing screws are prone to stripping.

Layout and markings on front panel are unsatisfactory because of three factors :

- ambiguity of key switch: it indicates two directions, the arrowhead marking being obscure;
- values not marked voltage or equivalent;
- AC and DC not marked as such.

Electrosound will redesign the switch markings in response to our criticism. They point out that they have never received a complaint about these. It may be that the markings become obvious with familiarity.

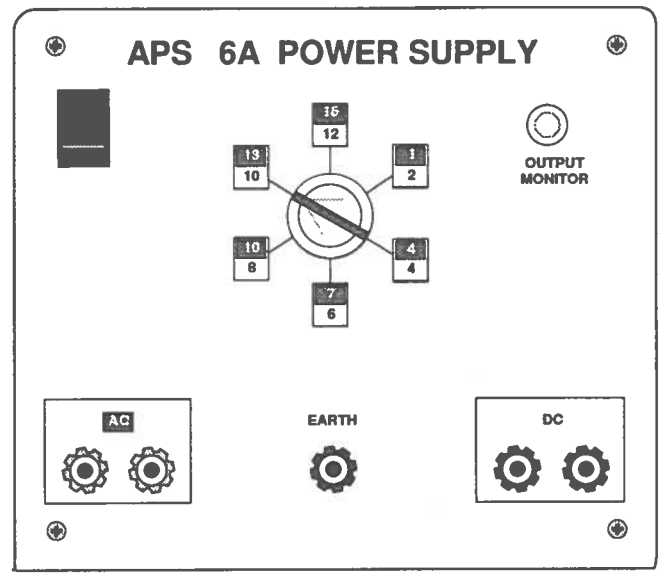
Performance : On DC the actual voltage is 1 or 2 volts lower than specified. Electrosound are to change the DC specification and DC markings on the keyswitch to register the actual mean voltage values. Ripple does not exceed 3 V.

The performance of the cut-out deteriorated with time. When brand new, the power supply could deliver 6 A continuously on both AC and DC. After a period of intermittent testing and use it cut out within minutes on trying to draw 5 A DC but can still maintain 6 A AC continuously. It would seem to be influenced by heat from the bridge rectifier. Electrosound admit to fitting too sensitive a cut-out. One that is less sensitive will be fitted in future.

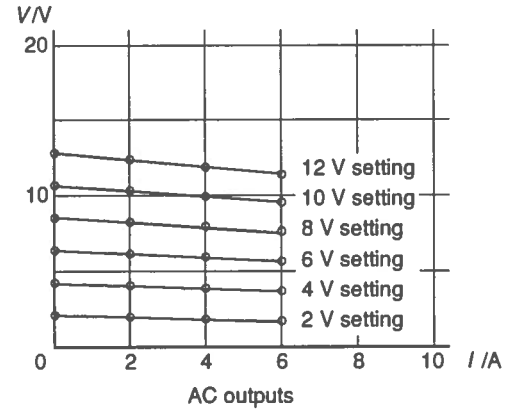
The voltage output versus current slopes are typical of many types of educational power supply.

Verdict :

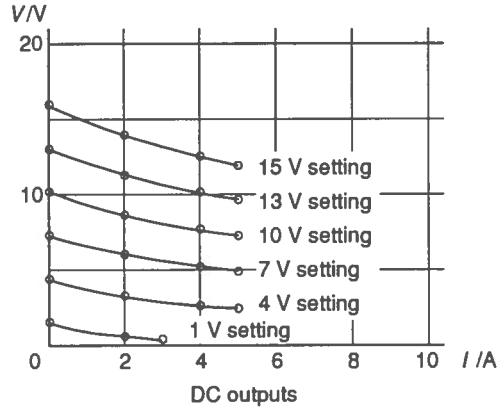
B (satisfactory) provided that manufacturer's declared improvements are implemented and found to be effective.



Enclosure : Black stove-enamelled steel. Gold markings.
Dimensions : Width 158 mm, depth 270 mm, height 153 mm.
Weight 3.7 kg. Carrying handle.
Detachable mains cord with IEC connector.
External mains fuse on IEC chassis plug.
Outlets : 4 mm insulated terminals, accepts 4 mm plugs and unterminated wire.



AC outputs



DC outputs

Electrosound Multi-output Dual Rail Power Supply (1AMD) *£61.50*

Function : Supply for an electronics workstation. Provides six standard voltage values from regulated supplies. Versatile power supply that should meet most needs in electronics.

Specification : Six power rails : -15 V, -12 V, -5 V, +5 V, +12 V and +15 V, all voltage regulated. Each rail specified to deliver 1 A. Outputs floating with respect to earth. Earth terminal not provided.

Circuit : Low voltage is drawn from a step-down isolating transformer. There is voltage regulation on each output.

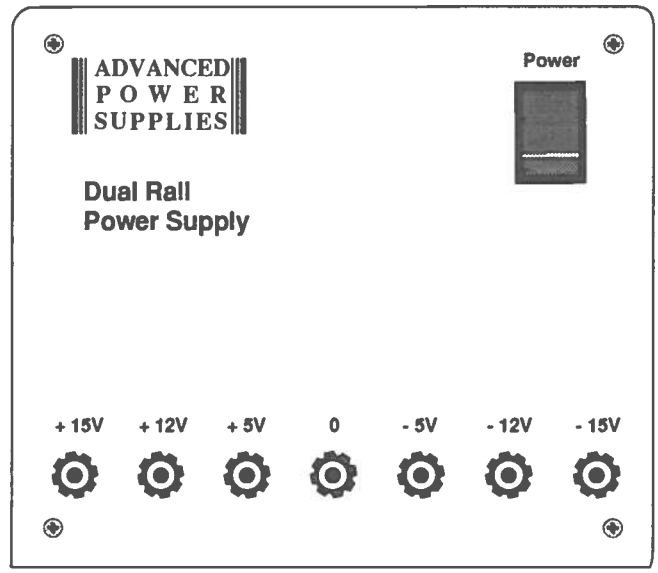
Construction : Relatively lightweight metal enclosure, which is reasonably sturdy. Threads on securing screws prone to stripping. Layout and markings on front panel clear and simple. Should indicate that outputs are voltage regulated and state maximum current limits.

Internal conductor found pinched between transformer core and enclosure. Electrosound have turned transformer to prevent this fault condition from recurring.

Performance : Voltage regulation holds for currents up to 1 A on every rail except for the -5 V rail. Electrosound have redesigned circuit to overcome this problem. Should be able to deliver 1 A aggregate from the positive outlets and 1 A aggregate from the negative outlets. Peak to peak ripple and noise negligible.

Verdict :

B Satisfactory provided that deficiencies have been put right.



Enclosure : Black stove-enamelled steel. White markings.
Dimensions : Width 158 mm, depth 270 mm, height 153 mm.
Weight 3.3 kg. Carrying handle.
Detachable mains cord with IEC connector.
External mains fuse on IEC chassis plug.
Outlets : 4 mm insulated terminals, accepts 4 mm plugs and unterminated wire.

Electrosound Spider — *£36.95*

Function : A power supply for Primary Schools. Offers 4 fixed voltages stepped at equal value intervals. Has 4 commoned outlets to allow 4 groups of pupils to draw power independently, but all at the same voltage. Designed to drive small lamps or motors, or some electronic circuits. Might be useful for introduction to electricity.

Specification : 4 outlets : 1.5 V, 3 V, 4.5 V and 6 V DC, voltage regulated, floating with respect to earth. Maximum current 1.5 A from outlets (1.5 A from one, or 375 mA from all together). No locking mechanism on voltage selector.

Circuit : Low voltage is drawn from a step-down isolating transformer. Supply comes from an adjustable voltage regulator. Rotary switch selects from a bank of potential dividers to set the regulator's output. All the black terminals are commoned. All the red terminals are commoned. The regulator has internal over-current protection. There is no overcurrent protection on primary side of transformer except for fuse in mains plug. This is unsatisfactory. There is no on/off switch.

Construction : Lightweight ABS plastic enclosure of doubtful strength. Base, top and sides flex with finger pressure. Deformation of the ABS plastic is apparent on the base under the transformer flange. This is caused by an excessive temperature rise. Electrosound say they have not had any returns due to broken cases.

Terminal posts can provide leverage on side panels. This may cause the enclosure to fracture if dropped, or from other abuse. Electrosound now mount the posts lower to reduce the likelihood of damage.

The sample we have has been constructed to Class 2 with respect to electrical safety - though not marked as such. We have found a problem with this design. In response, Electrosound have fitted a protective earth conductor and have reclassified as Class 1.

Voltage selector markings should indicate volts.

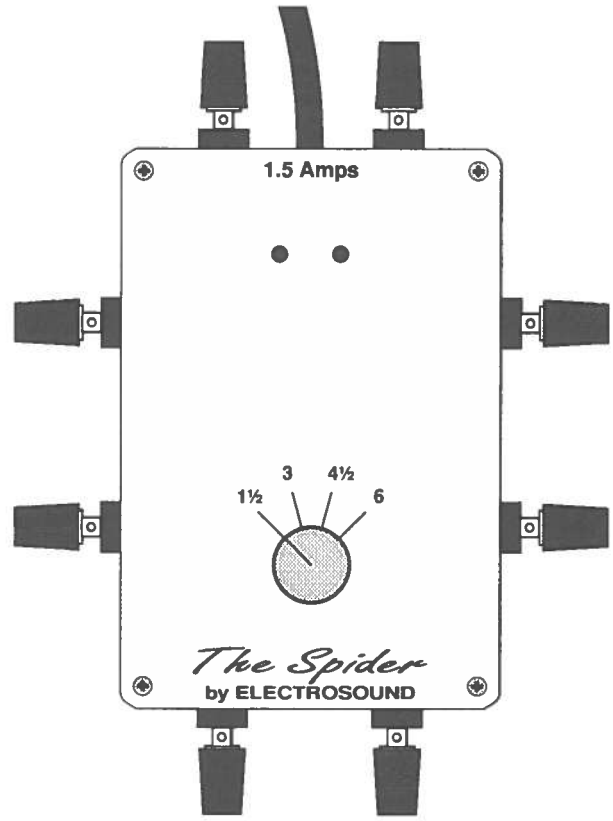
Performance : Voltage regulation is satisfactory under short term operation. However the output folds back at 1.0 A after an operating time of 5 minutes. The performance does not therefore meet the specification, which is 1.5 A.

Under continuous operation, the Spider cannot sustain a current greater than 0.7 A for an hour.

This poor performance is caused by an excessive temperature rise. Because of the circuit design, there is a lot of internal heating. Mechanisms for dissipating this heat are inadequate. As well as affecting the enclosure, internal fitments also show heat damage. The temperature of the exterior can rise by 45°C. This is not satisfactory on equipment intended for use by young children.

Verdict :

C (unsatisfactory)



Enclosure : Black ABS plastic. Yellow markings.
Dimensions : Width 98 mm, depth 150 mm, height 59 mm (not including projections).
Weight 1.0 kg. No carrying handle.
Attached mains cord.
Overcurrent protection provided by fuse in mains plug.
Outlets : 4 pairs of 4 mm insulated terminals accepting 4 mm plugs and unterminated wire.

Unilab Beaver Power Supply 022.111 — *£39.90*

Function : A power supply for Primary Schools in substitution for a battery of 4 dry cells. Designed to drive small lamps or motors, or some electronic circuits. Might be useful for introduction to electricity.

Specification : 1 outlet : 1.5 V to 6 V DC continuously variable, voltage regulated, floating with respect to earth. Maximum current 1.5 A. No locking mechanism on voltage selector.

Circuit : Low voltage is drawn from a step-down isolating transformer. Supply comes from an adjustable voltage regulator. Variable resistor in a potential divider network sets the regulator's output. The regulator has internal over-current protection. There is an internal fuse in series with the primary transformer winding. No on/off switch.

Construction : Lightweight ABS plastic enclosure of reasonable strength. Base, top and sides flex slightly with finger pressure.

Electrical safety standard of construction is Class 1.

Performance : Voltage regulation is satisfactory under short term operation. Can deliver an output current of 1.5 A for short periods at all voltages.

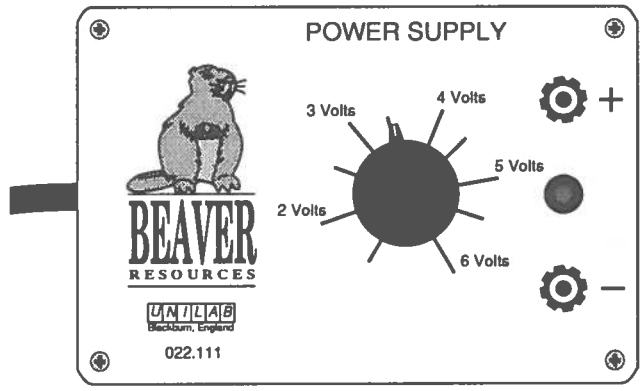
Under continuous operation at 1 A initially, internal self heating causes the output current and voltage to reduce by about 10% each after about 15 minutes. After 3 hours running in this condition the highest exterior temperature rise was 36°C, which is tolerable, if uncomfortable. Full power can be restored only by allowing the supply to cool down.

Verdict :

A (Very satisfactory in most respects, but unable to maintain maximum specified current. Temperature rise of enclosure can be uncomfortable.)

Comments :

The performance would seem to be adequate for Primary School purposes. By compromising on performance, but not on safety or standard of construction, Unilab have acted to keep the price down.



Enclosure : Off white ABS plastic. Blue markings.
Dimensions : Width 150 mm, depth 100 mm, height 60 mm (not including projections).
Weight 1.3 kg. No carrying handle.
Attached mains cord.
Overcurrent protection provided by internal fuse and by internal electronic mechanisms within voltage regulator.
Outlets : pair of 4 mm insulated terminals accepting 4 mm plugs and unterminated wire.

Unilab 12V Stepped Transformer 022.107 — *£50.99*

Function : A stepped voltage power supply for general laboratory use where an AC supply will suffice. Can deliver currents of up to 10 A.

Specification : 1 outlet : 2 V to 12 V AC by 2 V steps. No locking mechanism on voltage selector. Maximum current 8.5 A.

Circuit : Low voltage is drawn from a multi-tap, step-down isolating transformer. Captive J-link wire voltage selector.

Construction : Strong 2-piece metal enclosure with plastic end-panels.

Electrical safety standard of construction is Class 1.

Performance : Output voltages agree with settings. Lower than average voltage drop-off with current.

Able to deliver 8.5 A continuously at each setting, or at least 10 A on each setting for short periods. Temperature rise on enclosure after continuous operation is 24°C at worst, and therefore of no concern. However the captive wire J-link switch can get hot because of switch contact resistance between the link and sockets. Rate of self heating depends on how link sits in sockets. Sleeved part of link can reach 63°C. Bared part gets to 77°C (in ambient temperature of 20°C). Minor risk of finger burn. (Unilab are puzzled by this finding. We understand from them that the link is bent slightly so that it always provides a scraping contact, thereby never getting warm.)

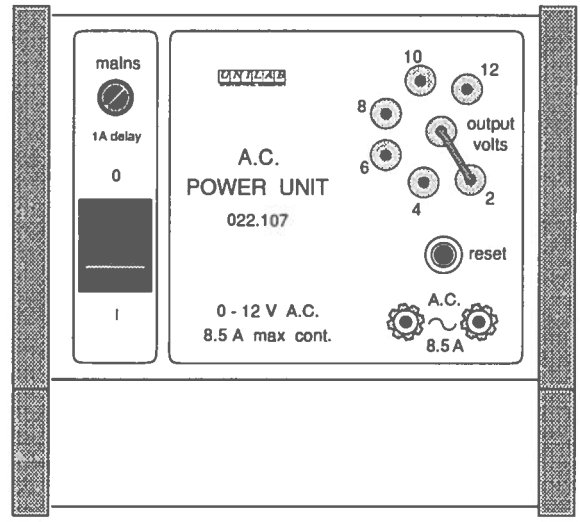
Overcurrent protection does not cause nuisance tripping.

There is no overcurrent protection between taps on the secondary winding and outlets 2 to 12 on the voltage selector. If a wire link shorts 2 to 12 the 1 A delay fuse trips the primary current. If however two adjacent outlets (say 6 and 8) are shorted, the power drawn is insufficient to blow the primary fuse, letting the secondary winding overheat. Toxic fumes and gas are emitted. Eventually after about 5 minutes the transformer secondary winding burns to destruction. Because of the unpleasant fumes which warn of trouble, it is very likely that power would have been switched off before the transformer became badly damaged.

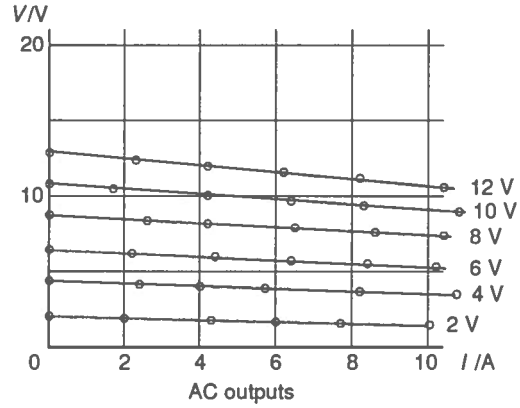
Verdict :

A (Very satisfactory, although there is a of lack of protection on the secondary windings)

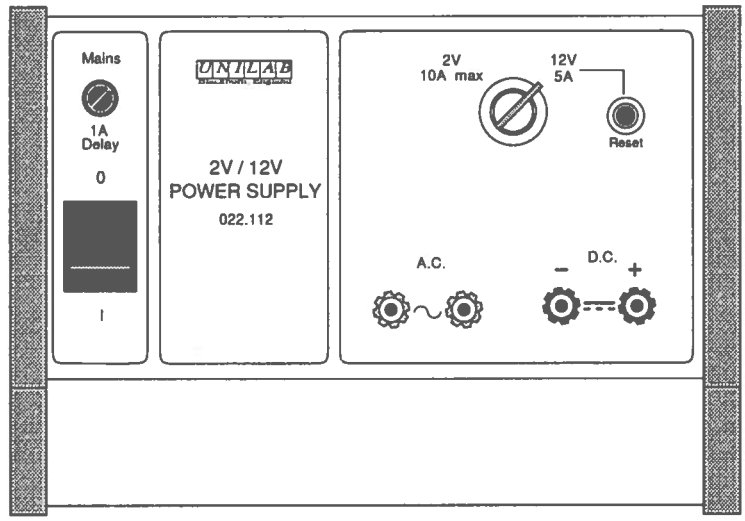
Comment on verdict : Perhaps our verdict is too soft. The proof is in the eating. Because this type of voltage selector has been in widespread use for many years, yet the Centre has received few if any notifications of damage to transformers caused by pupils shorting voltage selector outlets, and because Unilab have never had a supply returned with a winding damaged in this way, it may be that the risk of damage is negligible. In which case, *caveat emptor*, the product merits an A rating.



Enclosure : orange, epoxy coated, aluminium front panel; thick, ABS plastic, moulded, end panels in brown; other panel beige, plastic covered, folded steel.
Dimensions : Width 185 mm, depth 162 mm, height 162 mm (not including projections).
Weight 1.3 kg. No carrying handle. Depressions in ends for two-handed carrying.
Stackable if stored on end.
Attached mains cord with wrapping brackets.
Overcurrent protection provided by external delay fuse on primary and thermal cut-out on secondary.
Outlets : pair of yellow 4 mm insulated terminals accepting 4 mm plugs and unterminated wire.



Unilab 2V/12V Power Supply 022.112 — *£74.39*



Function : A switched voltage power supply giving two set values, 2 V and 12 V, both frequently required in science laboratory work. Designed for electromagnetism experiments, and for supplying rayboxes and 50 W heaters.

Specification : 2 V AC and DC at 10 A max.; 12 V AC and DC at 5 A max. Keyswitch locking mechanism.

Circuit : Low voltage is drawn from a multi-tap, step-down isolating transformer. Keyswitch voltage selector.

Short circuit protection afforded by series resistor on 2 V output and 5 A thermal switch on 12 V output. Primary overload protection consists of a delay fuse in series with a thermal trip.

Construction : Strong 2-piece metal enclosure with plastic end-panels.

Electrical safety standard of construction is Class 1.

Performance : Output voltages agree with settings excepting 12 V DC, which registers about 1 V low. Lower than average voltage drop-off with current on DC. Average drop-off on AC.

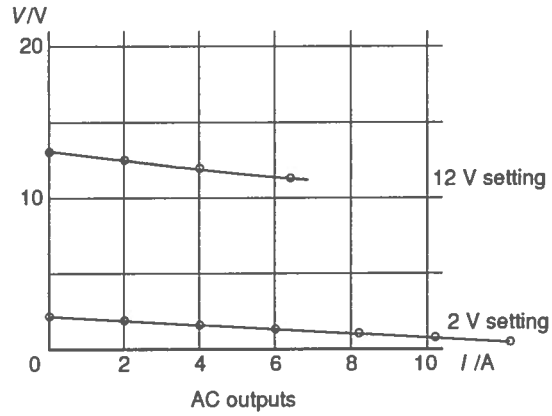
Able to deliver continuously 10 A on 2 V setting and 5 A on 12 V setting. Secondary thermal cut-out operates at 6 A or above. Enclosure temperature rise does not cause concern.

Overcurrent protection does not cause nuisance tripping.

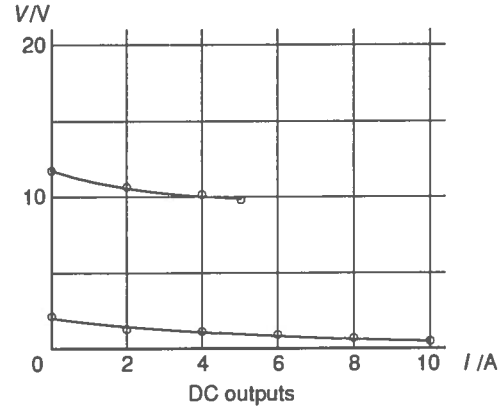
Verdict :

A (Very satisfactory)

Enclosure : orange, epoxy coated, aluminium front panel; thick, ABS plastic, moulded, end panels in brown; other panel beige, plastic covered, folded steel.
Dimensions : Width 240 mm, depth 162 mm, height 162 mm (not including projections).
Weight 3.1 kg. No carrying handle. Depressions in end panels for two-handed carrying.
May be stored on end panel.
Attached mains cord with wrapping brackets.
Overcurrent protection provided by external delay fuse and thermal cut-out on primary and thermal cut-out and series resistors on secondary.
Outlets : 2 pairs of 4 mm insulated terminals accepting 4 mm plugs and unterminated wire.

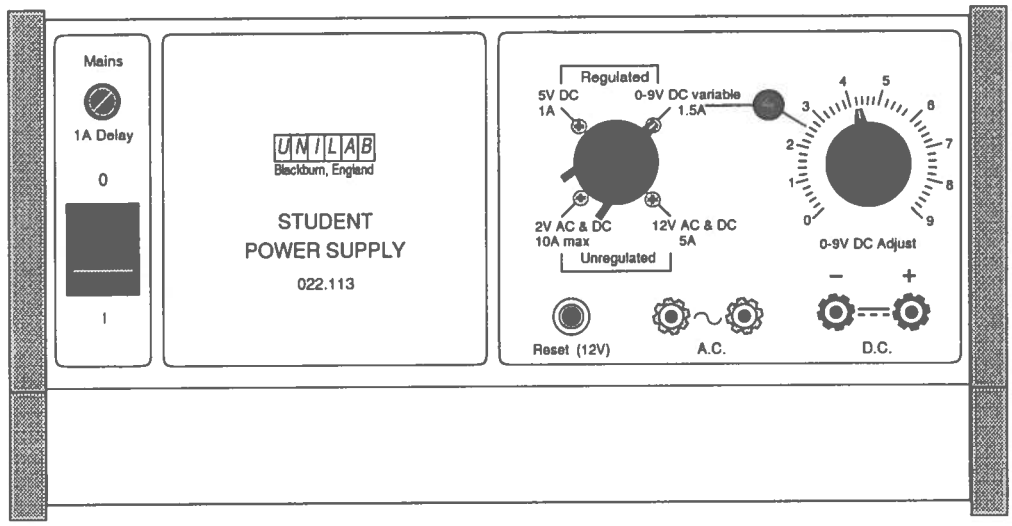


AC outputs



DC outputs

Unilab Student Power Supply 022.113 — *£126.67*



Function : A switched voltage power supply giving the two set values, 2 V and 12 V, that are most frequently required in science laboratory work. These supplies are designed for electromagnetism experiments, and for supplying rayboxes and 50 W heaters, etc.

Supplementing this provision are two further supplies mainly of use in electronics. Both have voltage regulation. One will drive most types of digital logic, as well as kits such as Alpha. The other has a continuously variable voltage for fine control applications.

Specification :

2 V AC and DC at 10 A max.
12 V AC and DC at 5 A max.
5 V DC voltage regulated, 1 A max.
0 to 9 V voltage regulated, continuously variable, 1.5 A max.

Function locking mechanism. Outputs floating with respect to earth. No earth terminal provided.

Circuit : Low voltage is drawn from a multi-tap, step-down isolating transformer. 4-way function selector.

Short circuit protection afforded by series resistor on 2 V output and 5 A thermal switch on 12 V output. Regulated outputs have in-built electronic overload protection. Primary overload protection consists of a delay fuse in series with a thermal trip.

Construction : Strong 2-piece metal enclosure with plastic end-panels.

Electrical safety standard of construction is Class 1.

Performance : Because the AC 12 V output is about 1 V higher than its setting, this can reduce the life expectancy of raybox lamps by three quarters. The DC 12 V output is about 1 V lower than its setting. There is lower than average voltage drop-off with current on both AC and DC.

Able to deliver 10 A continuously on 2 V setting and 5 A on 12 V setting. Secondary thermal cut-out operates at 6 A or above. Enclosure temperature rise generally does not cause concern (at worst, a rise of 37°C on a small part of the enclosure).

Overcurrent protection does not cause nuisance tripping.

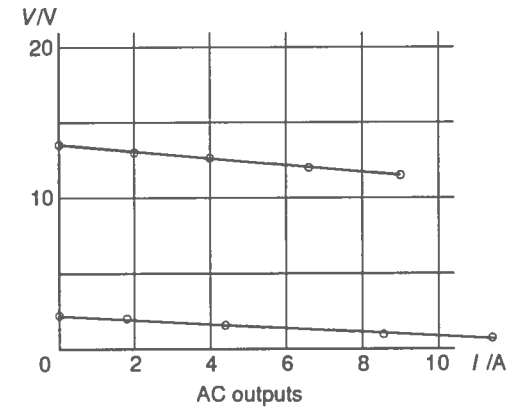
Both regulated outputs perform to specification. There is good registration between the variable voltage and scale.

Verdict :

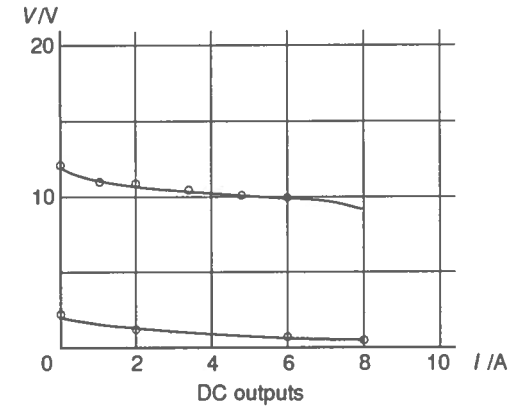
A (Very satisfactory in most respects : There is one minor, but significant defect, which is that the 12 V AC outlet delivers 13 V.)

Note : The model we tested has been redesigned. The voltage selector is now a key switch which operates relays inside the power supply to switch the taps.

Enclosure : orange, epoxy coated, aluminium front panel; thick, ABS plastic, moulded, end panels in brown; other panel beige, plastic covered, folded steel.
Dimensions : Width 345 mm, depth 162 mm, height 162 mm (not including projections).
Weight 4.2 kg. No carrying handle. Depressions in end panels for two-handed carrying.
May be stored on end panel.
Attached mains cord with wrapping brackets.
Overcurrent protection provided by external delay fuse and thermal cut-out on primary and thermal cut-out and series resistors on secondary.
Outlets : 2 pairs of 4 mm insulated terminals accepting 4 mm plugs and unterminated wire.



AC outputs



DC outputs

Unilab 5V Regulated Power Supply, 0.5A 022.116 *£35.18*

Function : A power supply for most forms of logic, or for many electronic kits such as Alpha.

Specification : 2 outlets : 5 V DC regulated. Maximum current 500 mA. 0 V outlet at earth potential.

Circuit : Low voltage is drawn from a step-down, isolating transformer. The secondary connects to rectifiers, a smoothing capacitor and regulator. The regulator has internal over-current protection. There is an internal fuse in series with the primary transformer winding. No on/off switch.

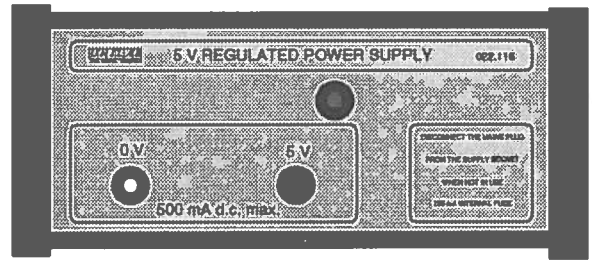
Construction : Strong 2-piece metal enclosure with plastic end-panels.

Electrical safety standard of construction is Class 1. The transformer is securely fastened by 4 screws to a printed circuit board which itself is securely held in place by slots in channelling. Strain relief on the mains cord is ungainly, but effective.

The 0 V terminal should be marked Earth, in word or symbol.

Performance : Voltage regulation holds at 4.9 V for currents up to 500 mA. Ripple and noise are negligible. Internal self-heating is insignificant. Overload and short circuit protection is effective.

Verdict : A (Most satisfactory)



Enclosure : grey, plastic coated, steel front panel secured in robust, black aluminium channelling. Plastic end panels.
Dimensions : Width 163 mm, depth 70 mm, height 50 mm.
Weight 0.7 kg. No carrying handle.
Attached mains cord.
Overcurrent protection provided by internal delay fuse on primary and internal electronic mechanisms within voltage regulator.
Outlets : two 4 mm insulated sockets accepting 4 mm plugs.

Unilab Dual 15V Regulated Power Supply 022.114 *£36.00*

Function : A dual rail power supply for operating most types of op-amp.

Specification : 3 outlets : +15 V DC regulated; -15 V DC regulated. Maximum current 100 mA per rail. 0 V outlet at earth potential.

Circuit : Low voltage is drawn from a step-down, isolating transformer. The secondary connects to rectifiers, smoothing capacitors and regulators. The regulators have internal over-current protection. There is an internal fuse in series with the primary transformer winding. No on/off switch.

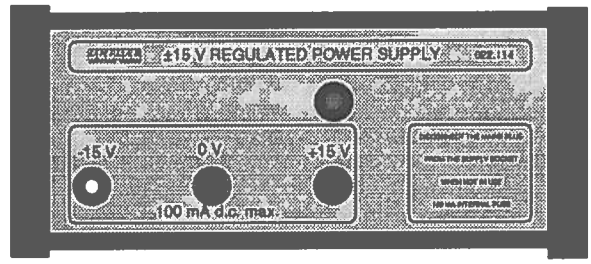
Construction : Strong 2-piece metal enclosure with plastic end-panels.

Electrical safety standard of construction is Class 1. The transformer is securely fastened by 4 screws to a printed circuit board which itself is securely held in place by slots in channelling. Strain relief on the mains cord is ungainly, but effective.

The 0 V terminal should be marked Earth, in word or symbol.

Performance : Voltage regulation holds for currents up to 100 mA. Actual values are +14.6 V and -14.9 V. Ripple and noise are negligible. Internal self-heating is insignificant. Overload and short circuit protection is effective.

Verdict : A (Most satisfactory)



Enclosure : grey, plastic coated, steel front panel secured in robust, black aluminium channelling. Plastic end panels.
Dimensions : Width 163 mm, depth 70 mm, height 50 mm.
Weight 0.7 kg. No carrying handle.
Attached mains cord.
Overcurrent protection provided by internal delay fuse on primary and internal electronic mechanisms within voltage regulators.
Outlets : three 4 mm insulated sockets accepting 4 mm plugs.

Supervision of practical and project work

Appropriate levels of supervision for senior school students are discussed in the context of the management of health and safety. Much of the advice may be applicable also to projects in further education.

COSHH requirements

For Sixth Year Studies (SYS) projects and practical work within schools we originally gave advice in Section 5 of our 1991 publication *Preparing COSHH Risk Assessments for Project Work in Schools*. In essence this interpreted the legal requirement for supervision as one measure to control the risks. We advocated that the degree of supervision be matched to the level of the risks determined by the assessment. The phrase "supervision at an oscillating distance" was coined. Health and Safety Executive officers had the opportunity to comment on this advice. They did not demur nor seek to disassociate themselves from it. More recently we have had a number of enquiries on suitable arrangements for the control and supervision of project work in Sixth Year Studies and of other practical work being carried out by senior students both in and outwith schools. Particular reference was made in some of this correspondence to the effects of the *Management of Health and Safety at Work Regulations 1992* (the Management Regulations). These were introduced after the publication of our original COSHH related guidance.

For one Education Authority, wherein these matters seemed to be particularly contentious, we drafted a reasonably closely argued case iterating but expanding on our earlier advice. The Authority in question seemed to find this paper useful. It may also prove helpful to others. We are therefore reprinting the substance of it here.

Overall control

In our opinion, the principles behind our original advice remain sound and the advice itself reasonably authoritative. The main effect of the Management Regulations would seem to be to provide more detailed prescription of the broader requirements of the Health and Safety at Work Act 1974 (as amended). In particular, the underlying requirements of our advice were that overall control should be exercised through :

- ensuring that students are sufficiently responsible and have had adequate instruction and training;
- a suitable and sufficient COSHH Risk Assessment with one of the controls being planned closer supervision wherever the assessment results point to degrees of risk which merit it.

Because of the Management Regulations, this advice has now to be extended beyond the COSHH Regulations to take in many other categories of hazard and risk.

Beyond COSHH

Before looking at the more detailed requirements of the Management Regulations, it is useful first to establish educational aims and objectives for such practical activities. Only when there is a defensible educational rationale on one side of the equation, can we weigh on the other the degree of risk and so come to a judgement as to what is "reasonably practicable". One of the declared aims of sixth year studies, or of projects in FE, is to allow students to begin to develop those skills and attitudes which lead to disciplined, self-motivated learning in the adult worlds of further or higher education and of work. There thus needs be some loosening of reins. It seems to us that this process has to include independent, practical and investigational activity.

In matters of civil liability, there is a principle that the nature of the duty of care held in respect of pupils or students is partly dependent upon their age and maturity. The degree of responsibility which might reasonably be expected of a sensible, seventeen year old student is clearly different from that which we might afford to a seven year old pupil. We may have to anticipate also the possibility that not every senior student is to be so trusted and plan accordingly. Statute law on employment also usually reflects this principle. It underpins our argument that practical work by senior students need not always be directly and continuously supervised by a teacher who is physically present in the same room.

That is not the same thing as saying that any part of the work is entirely without supervision. The activities must always be subject to overall monitoring and control. In turn that means hazards have to be identified and risks assessed (*COSHH Regulation 6* and *Management Regulation 3*). Controls (*COSHH Regulation 7*) or preventive and protective measures must be planned, organised, controlled, monitored and, as necessary, reviewed (*Management Regulation 4*). These steps were included in our earlier advice but there the context was limited to COSHH. The main effect of the Management Regulations has been a greatly broadened scope to cover a much wider range of hazards and risks. Most of these duties are of course laid upon the employer although, given time and training, some of the tasks associated with them may be delegated to employees.

There are other requirements of the Management Regulations which are relevant and which parallel those of COSHH and hence also our earlier advice. For example, Regulation 8 of the Management Regulations requires that "employees" be informed as to the nature and degree of the risks identified by the assessment. They are also to be told of the preventive and protective measures which are to be taken. Regulation 11 parallels to some extent Regulation 12 of COSHH (inform, instruct and train). It calls for capabilities and training to be taken into account when allotting tasks to anyone. It is relevant also to our earlier advice as well as to the educational rationale outlined above.

A possible misinterpretation of the HSE guidance on Regulation 11 of the Management Regulations may well be the basis also of a serious misunderstanding. The guidance in the Approved Code of Practice, but not the Regulation itself, makes specific reference to "the needs of young workers" and of the "particular attention" to be paid to these. We find it hard to push any interpretation of that guidance so far as to equate "supervision" with the continuous presence of a teacher in the same room or other space as the student.

Defining terms

Although it may at first seem pedantic, precious even, it may be useful when establishing acceptable levels of supervision, precisely to distinguish between the words *constant*, *continuous* and *continual*. The kinds of control or monitoring we envisage are constant but they are exercised through supervision which is continual rather than continuous. This implies control which is unceasing but which is exercised through a series of discrete interventions. These are made only when they are needed. As far as is reasonably practicable, such interventions are pre-planned and organised on the basis of a risk assessment. For supervision to be continual such intervention may occur repeatedly and if need be may be frequent. But it is not ongoing and unbroken in which case it would be continuous. In many instances such continuous intervention by, and direct involvement of, the teacher would be neither educationally desirable nor necessary in the context of SYS or similar project work. Because of timetabling and other constraints often it just isn't practicable.

Reservations

Before summarising our guidance there are a number of minor caveats to be made. Firstly the advice is based mainly on the requirements of regulations in so far as these apply to employees. Senior students are not employees. They are but others who may use the premises or who may be affected by the activities of an employer. We have assumed that what would be reasonable provisions to safeguard "young workers" would be reasonable also to apply to students of similar age. This is in line with the relevant general duties laid on employers by the Health and Safety at Work Act (in particular by Section 3).

There is also the matter of a general duty of care in civil law. There are other questions of liability in which an EA's insurers (if any) might take an interest. SSERC staff are neither lawyers nor expert in insurance matters. It may well be that a Council's own legal and other specialist officers would wish to express a view (or possibly, and unfortunately, several views) on such matters.

Summary

Putting aside such reservations: We can see no reasoned argument for not continuing to apply both spirit and substance of our original advice, given in the context of COSHH, to the wider considerations of safe systems of work which meet the requirements of the Management Regulations. In summary then, supervision should :

- be planned and organised, based on the results of a risk assessment (however simple and when in not a few instances the conclusion may well be that the risks are insignificant and that no special or additional measures are necessary);
- take account of :
  - any particularly hazardous or other operations which might require direct supervision i.e. the teacher's physical or direct involvement;
  - the relative maturity and capacity for self-discipline of the student(s);
  - any specialist training in particular techniques or operations;
  - the possibility of an emergency such as gross spillage, fire, a need for first aid etc.
- be systematic and overt with named individuals identified as persons with whom to consult, liaise or call upon in the event of difficulty, take account of their possible absence and name a substitute;
- ensure adequate communication to all concerned as to the measures to be taken and
- ensure that where sensible and necessary oral communication is repeated, reinforced or recorded in writing.

It is our belief that such analogue arrangements are infinitely preferable to an unthinking, digital or traffic warden style of management. They would better meet the needs of students. They would have more to teach them about safe systems of work than would either continuous, direct supervision or a blanket ban on practical work in the absence of a teacher. A moment's thought as to some of the kinds of activities which would thereby be ruled out should be enough to convince anyone of these arguments. Such a ban, in our opinion, would be in the long term interests of no-one - least of all those of the students. (cont./over)

Security and systems of work

Sometimes safety may be managed appropriately by directly controlling access to some hazardous facility, substance or material. A system is put in place whereby only authorised persons may gain access at certain times or in specific circumstances when systematic procedures have earlier made the place, procedure or apparatus safe and maintain it in that condition until the work is completed. This is commonly known as a *permit to work* system. Some teachers have set up such systems, intuitively or otherwise, for example to manage chemistry projects by controlling the students' time, route or place of access to one or more of the key substances for a potentially hazardous procedure. Such systems may work well. But, some recent reports and our own experience suggest that some practitioners haven't fully grasped the need for the provisions of such systems of work to be fully communicated to, and understood by, all of those who may become involved.

For example, we know of cases where systems of controlled access to chemicals were subverted. This was simply because not everyone who needed to know about the details of the arrangements had been informed. The system then may break down. Persons are allowed access when it should be denied to them. This may be merely because even a single staff member hasn't been told about or hasn't recognised a place or time at which students should or shouldn't be, where and when they see them. As with control measures so with management systems - communication is important and to be effective it has to be complete.

Away from home

Increasingly, students are pursuing some of their project work within the premises of third parties. We know of some EAs where school students may use the laboratory facilities of hospitals, universities, public research institutes and private science-based industry. In these circumstances responsibilities for the health and safety of the students may be a complex matter involving both statutory duties and civil liabilities. It helps to have clearly set out, systematic, arrangements as to who is to do what, where and when. For example, who does the risk assessment - school or research establishment? Who provides supervision and who monitors it? Who indemnifies whom in the event of accident or injury?

In consultation with an adviser in one EA we have drafted a provisional scheme to cover some of these eventualities. We understand that it is undergoing trial and refinement at present. We would be most interested to hear from anyone else who has faced these problems in practice and who has ideas on how they may be coped with.

Further reading

Management of Health and Safety at Work, Approved Code of Practice, Management of Health and Safety at Work Regulations, 1992, Health and Safety Commission, 1992, ISBN 0 11 886330 4, £5.00

Health and Safety Management in Schools, HSE Books, ISBN 0 7176 0770 4 £5.95

Health and Safety Management in Higher and Further Education, HSE Books, ISBN 0 11 886315 0 £5.00

Safety policies in the Education Sector, HSE Books, ISBN 0 7176 0723 2, £5.00.

COSHH amendments and microbiology

In this section of Bulletin 185 (page 11) we drew readers' attention to the 1994 edition of the three Approved Codes of Practice (ACoPs) bound in the one volume. We now understand that HSE may soon also publish guidance on the detailed interpretation of the *Biological Agents ACoP* as it effects microbiology and biotechnology activities within Higher Education. From what we have seen to date, it is unlikely that this new guidance will have any significant effects on micro-biology and biotechnology in schools or on non-advanced courses of study in FE colleges. Parts of it however may affect Higher Education courses in such institutions.

The categorization system used in the ACoP for grouping organisms, both naturally occurring and genetically transformed, bears great resemblance to that used earlier in documents issued by the various advisory committees on dangerous pathogens. All of the organisms generally recommended in the past by ASE, SSERC, DfE etc, for use in schools or non-advanced work in FE still fall into the lowest category - Hazard Category 1.

Containment levels are also recommended as in the earlier schemes. It remains important not to confuse either of these categorization systems with that most widely used in schools and FE - *Levels of Work*. The three levels originally defined in SSERC Bulletin 126 as adopted by ASE in *Topics in Safety* and by the DfE (in *Microbiology in Schools and FE : An HMI Guide*) still provide a useful set of control measures. These are all applied to meet the requirements of COSHH within the contexts of education and training using organisms of the lowest hazard class - ie Category 1 organisms.

This advice also applies equally to the Code of Practice drawn up by Strathclyde Regional Council and widely adopted or adapted by the majority of other Scottish EAs. So, despite the advent of the COSHH amendments, of the Biological Agents Directive and ACoP, the earlier guidance and codes for schools and FE should continue to apply.

Bovine eyeball dissection

In March 1990 the Scottish Office Education Department issued guidance in the form of a circular letter on this subject. SOED, advised that it would be desirable to discontinue the practice of dissecting bovine eyes in science lessons. In any case earlier legislation [1] had already prohibited the sale of certain kinds of offal from cattle more than six months old. Although bovine eyes were at that time not specifically covered by the regulations, several abattoirs which had previously supplied eyes to schools ceased to do so. The background to this legislation and the SOED's advice was discussed at some length in an article on laboratory acquired infection in SSERC Bulletin 178 [2].

In July of this year the Ministry for Agriculture, Fisheries and Food announced additional measures which further strengthen the controls on specified offal. These new arrangements mean that soon bovine eyeballs will effectively be unavailable for use in schools since they will be disposed of at source as specified bovine offal.

No-one who previously carried out such eyeball dissections in the past has reason to feel concerned. Good laboratory practice and simple hygiene measures associated with these activities resulted in controlled conditions specifically intended to prevent the transmission of any disease. There continues to be no evidence for the transmission of bovine spongiform encephalopathy (BSE) to humans via such a route.

References

1. *The Bovine Offal (Prohibition) Regulations, 1989* [as now amended], S.I. 2061, HMSO, ISBN 0110980611.
2. *Laboratory acquired infections*, Safety Notes, Bulletin 178, SSERC, September 1993.

Safety of Machinery : BS EN 292

Bulletin 182 carried a number of articles relevant to the safety of equipment and machinery. Particular reference was made to the Provision and Use of Work Equipment Regulations, 1992. In a piece entitled "Machine Safety", which looked at designing for safety as a vehicle for teaching in technology courses, mention was made of British Standard 5304, a *Standard Code of Practice : Safety in Machinery* which despite its being published in 1988 remains a useful and highly readable document. BS 5304 is still extant and would remain our recommendation to anyone looking for a general overview of the subject.

We have recently obtained copies of two more specialised BS documents which also have the status of European Standards. Whilst these are hardly likely to interest the general educational reader they could well be useful to Safety Officers, equipment designers and similar specialists.

cont./next col.

British and European Standard BS EN 292 (1991) is entitled *Safety of machinery - Basic concepts, general principles for design.* Part 1 deals with basic terminology, and methodology whilst Part 2 covers technical principles and specifications. This all good stuff for insomniacs seeking insights into some of the deeper mysteries of the Machinery Directive.

Be Safe! : Scottish edition

The fairly imminent publication of this ASE (Association for Science Education) booklet in a Scottish edition was announced in Bulletin 185. For once, the "imminent" was no exaggeration. In mid-August ASE HQ in Hatfield took delivery of the final printed and bound versions of the document. At the time of writing we believe that a number of Scottish EAs are obtaining bulk supplies with the intention of providing at least one copy per primary school. Secondary teachers may find it provides useful insights to safety in typical science and technology activities in the primary phases of 5-14. The full title of this edition is *Be Safe! : Some aspects of health and safety in the Scottish Curriculum : Environmental Studies 5-14* (ISBN 0 86357 234 0).

SSERC has agreed to act as Scottish agent for bulk orders (more than 50 copies) and currently holds stock. For those wishing to purchase individual or small numbers of copies they need to order from ASE Booksales. The single copy and small order price is to be £4.75 including post and packing although ASE members will qualify for their usual 10% discount.

Be Safe! : INSET pack

The Writing Group convened by ASE Scotland to prepare the Scottish version of the Be Safe! booklet has agreed to stay together to tackle a second, related task. The ASE has already published an INSET pack which supports simple, in-school, in-service based on the original version of Be Safe! which relates to the science and technology curriculum in England, Wales and Northern Ireland. There were a number of issues, neither covered in Be Safe! itself nor in the in-service pack, which the Scottish task group thought were worthy of attention and which would best be tackled as part of the staff development package. The intention therefore is to produce a Scottish version which includes additional workshop materials and case studies. Some of these will allow primary teachers to examine and discuss matters such as health and safety aspects of classroom management and of group practical activities in science and technology at 5-14. SSERC remains a member of the ASE Scotland task group working on this project. We shall do our best to keep readers informed as to progress.

TECHNICIANS' NEWS

New EiS Section for technicians

"Calm your jets! Wax your board!"- as my offspring are wont to say. No, this is not a rival Union bid. It is but a specific section for technicians in the Association for Science Education's Official Journal "Education in Science". Entitled "*The prep room*[1]" it reports on issues likely to be of specific interest to science technicians. It is intended to cater for the new category of technician member. This costs £10 a year and is thus a bargain when you consider the journals and the range of benefits it covers. It's more than a little disappointing that the last count of signed-up ASE Technician members in Scotland could have been done on the fingers of two hands. "The prep room" is just one of the new ASE services for technicians. It has arisen from the work of various ASE Technicians' Task Groups. Pauline Anderson, of Earlston High School and Technician's Development Officer for Borders Regional Council, is a member of the latest clone of ASE technicians' group. Our next note reports on another important ASE development arising from the work of such groups.

1. Am I getting too young or is this title a bit naff?

Vocational qualifications

For a number of years SSERC has been trying to stimulate and promote the development of both a proper national career structure for educational technicians and a set of competence based practical qualifications to go alongside it. In 1992 we tried to set up a Task Group to develop a set of standards for an SVQ at appropriate levels. A group of senior technicians from across Scotland met in a National Technicians' Forum to discuss such issues. Unfortunately the time wasn't ripe. There appeared to be no appropriate employers' group to form a lead body. The most likely group to take a lead would have been CoSLA but they appeared less than interested. The Forum was disbanded which was a source of great disappointment to most of its members including those from SSERC.

It gives us great pleasure therefore to report that, as the result of initiatives by the ASE, the Council for Science and Technology Institutes - and now a wide range of other bodies - there is to be a specific NVQ and thus also an SVQ for educational technicians. The work began with a mapping exercise by the Science, Technology and Mathematics Council. This functional analysis exercise looked across a wide range of science, technology and mathematics based occupations. It soon became clear that there were huge gaps in the provision of vocational qualifications across large sectors of science and technology based employment. In many cases no suitable Employers' Lead Body existed. Educational Technicians were one such grouping so identified as not provided with an appropriate Lead Body. Thus there are no longer any widely recognised vocational standards for their profession nor is there any applicable NVQ or SVQ.

The ASE now has been appointed to manage a Laboratory Technicians' Project Group which is to develop Standards for such vocational qualifications for technicians. The Steering Group which is to oversee the work includes amongst its members a star studded cast of acronyms : ASE, CSTI, IST, ST&M, the English Local Government Associations, - AMA and ACC, FE group FEFC, CLEAPSS, DfE, OFSTED and not to forget NCVQ and SCOTVEC. It's hard to know whether that is intended to be a list of members or if its translation is to be the first educational technicians' assessment exercise.[1]

SSERC has also been invited to contribute to the work of the Steering Group. We shall do our best to keep you informed on this important initiative. One of our worries has probably not escaped sections of our readership. This is - where do the technology and workshop specialists, the AV and IT technicians or the general, school based technical resource support staff fit in to all of this?

Perhaps it's time for the Technology Teachers Association to grasp the final nomenclature nettle and change its name again, this time to the Scottish Association for Technology Education or something similar. They also could then recruit technicians into their ranks to the mutual benefit of all?

Comments and correspondence would be welcome on this and on any other matters related to technicians' problems.

1 Judging by the number of abbreviations in this issue of the Bulletin we may soon need an SVQ in acronyms.

Gender issues

Despite recent, minor celebrations and the odd set of congratulations ("Editorial" page 3) it's not been bouquets all the way. I've had the odd incoming brick as well.

Issue number 6 of *Science and Technology News*, our newsletter for 5-14, got me into deep, deep trouble. The complaint came too late for us to seek to put matters right in Number 7 of the News itself. Something needs however to be said on the complaint because: at first it left me gob-smacked (see - it can be done) and it raised much wider questions to which I haven't seen any satisfactory answers.

The opening sentence of Issue 6 (mainly about sundials, water clocks etc.) began "*From the earliest times man has used some form of time measurement . . .*" Editing this I thought, "Aye, aye that could get us into bother". So, into the introductory box at the head of the first page I inserted, in parenthesis, "*A note for the obsessively, politically correct : In all of the following "man" is taken to mean "humankind*".

Big mistake, and I mean BIG. When the inevitable complaint came in I tried, admittedly without much conviction, to explain that I was attempting to defend the English language rather than some untenable chauvinistic position. Look up any decent dictionary and the definition of "man" will be much the same as given in News number 6. Chambers Science and Technology Dictionary so defines it as a zoological term : "*The human race, all living races included in the genus Homo*". The retort to all that had a ring of inevitability. It was to the effect that, given the male dominated nature of the disciplines, it wasn't surprising that 'man' should be so defined in the Chambers Science and Technology Dictionary. It had, no doubt, been written by a man.

The complainant was equally unimpressed by my other defence which was that recently, in commenting on third-party curricular papers we had got heartily sick-fed-up with stilted, politically correct phraseology. You know the sort of thing "he/she", "him/herself" etc. when there are more elegant ways to avoid sexist slants. "Gotcha!" the complainer said. You didn't need to use "man" in the context in which you did. Elsewhere you wrote "people" or "peoples". A similar ploy would have saved you from yourself and your self-destruct definition of "man". Touché!

The next item was more easily rebutted but only superficially so. Towards the end of the newsletter we had included two poems one about a clockmaker and the other a clock's owner. You guessed it. Both of these characters were male. "Why couldn't we have had a better balance?" Which brings us, at last, to the point of all this waffle. We can't have a better balance. Not yet we can't.

It is in the nature of science and technology that 16th century clockmakers were, by and large, men. That's not my fault and I'm not going to take any blame for it.

It is also the case, to a limited extent, that Chambers Science and Technology Dictionary "was written by a man". More accurately its General Editor is male and out of forty two named contributors only three are identifiable from the credits as female. Interestingly out of the twenty odd[1] Directors or Corporate Managers of Education appointed so far to the new unitary authorities, only five are female. And that's not my fault either. Both sets of statistics worry me a lot more than does my slip-up in so using and defining "man". Closer to home it worries me also that, despite our best efforts, only two of the eight of our own full-time staff are female. So male dominated are science and technology that even our specialist architect ran true to stereotype and installed the toilets in the Centre on a ratio of 4 : 1 in favour of the males.

I concede the initial point about reasonable care in the choice of words with gender connotations. We promise to be even more careful in future. I do not wholly agree on the point about avoiding male-dominated historical references. That is the reality and we have to recognise and live with such a history. We can't be writing about Marie Curie every week. Far more important are the present and the future. The other obvious ploys of setting science and technology in contexts seen somehow to be more 'female oriented' may be simply to patronise women. Examples of good practice based on such strategies and which still avoid stereotypical contexts remain somewhat thin on the ground.

Much of the research to date had suggested that only two kinds of measures have had any appreciable effects on the numbers of women entering science, technology and engineering related courses and employment. The first is sympathetic, effective and enthusiastic female teachers, and other females, as role models. The other, supposedly, is single-sex schooling or at least single sex teaching - unfortunate, but true.

The Engineering Council more recently has published an analysis of essays submitted for the 10th Anniversary Competition of the *Women into Science and Engineering (WISE)* Campaign. Twelve key issues were raised by the girls' essays, ranging from the influence of teachers (or rather the lack of it), through peer group and media pressures to the ambivalent attitudes of many women themselves. Politically correct language did not appear as such as one of the top twelve issues. We would be pleased to hear from anyone else who has other effective ideas on to how to break this vicious circle (for example see page 32 of this issue).

Careful choice of words as an outward sign of changing attitudes is fair enough - as far as it goes that is. Sadly, it goes not very far.

* * *

1 Merely for the removal of any doubt : "odd" refers to the number "twenty".

NEWS AND ANNOUNCEMENTS

ASE Scotland Newsletter

Scottish Science Issues is the title of the new style, newsletter from the Association for Science Education (ASE) Scotland. Stuart Farmer, Secretary of ASE Scotland, and apparently Editor of 'Issues' is to be congratulated on this new look publication as are the whole ASE Scotland Committee. Although the dreaded *Pink Sheets* had a somewhat homely and couthy air, the revamped newsletter is nevertheless a great improvement.

We have the impression that something of a renaissance may be underway for the ASE in Scotland. This possibly started with the 'ASE 2000' seminar last year. Certainly there are a number of signs that ASE HQ in Hatfield has begun again to take seriously the distinctive features of our separate Scottish educational system and to recognise the somewhat different needs of Scottish science teachers and technicians. This could be a good time to join (or rejoin if ever you left).

CREST - congratulations!

So numerous now are Scottish pupil and teacher winners of various UK-wide science, technology and engineering education competitions, that we have seriously discussed the possibility of having an editorial policy of not mentioning anybody. I do hope that you follow that last bit! This is lest we offend those we haven't heard about. Given the substance of our 'Opinion' article on gender issues we feel it important though to offer our special congratulations and best wishes to Emma Murray of Forres Academy who recently was adjudged *UK Young Life Scientist of the Year*.

Emma's project was originally undertaken as part of her CSYS course but was registered also in the CREST award system at the platinum level. The work involved the design and manufacture of slow release aspirin tablets which are currently of interest since recent research has shown that low, daily doses of aspirin can protect some patients from various forms of heart disease. Dr Dale Munday of Robert Gordon's School of Pharmacy in Aberdeen and Dr Ray Rowe of Zeneca Pharmaceuticals kindly acted as Emma's outside advisers. The project eventually became a Regional Finalist in the Zeneca Life Science Programme's UK-wide competition and led to Emma's Young Life Scientist of the Year Award. She subsequently represented Great Britain on the United States Department of Energy High Schools Honours Programme in Berkley, California.

Teachers of technological subjects might like to enquire about the CREST Platinum Awards. In addition to the Life Sciences Programme in which Emma was engaged there is also a motor industry study programme sponsored by the Society of Motor Manufacturers and Traders. For further information contact Alan West at the address given on the inside rear cover.

Lone engineer

Congratulations too are due to Debora Smith until lately of the sixth year at Musselburgh Grammar and who is probably about now enjoying freshers' week as a student of Engineering Design at Huddersfield. Rumour and my local paper have it that Debora is the only female student in Scotland to have gained an CSYS award this year in engineering.

Her success is particularly well deserved since she has had to overcome a spinal condition which can cause her considerable pain and which meant that she missed quite a lot of time at school. A gymnastics accident at the age of 11 revealed the spinal problem which was probably present at birth. The accident led to Debora eventually having to give up competitive gymnastics but it didn't stop her qualifying, at the age of 15 or so, as a gymnastics coach. Adding English gymnastics coaching qualifications to her Scottish ones is something she hopes to do whilst at University.

More to come . . ?

As Debora Smith has demonstrated, it would seem that you have to be a fairly determined young woman to do well if you choose to study engineering. It really shouldn't be that hard (see "Gender issues" on the previous page).

Nonetheless it appears that more females are readily following on. Two thirteen year olds, Fiona Little and Jennifer Thompson, from Blantyre High School Young Engineers' Club recently won four major prizes in the UK Finals of the *Young Engineers for Britain* competition. This had attracted 1,200 entries out of which were chosen 180 finalists.

Three other Scottish Young Engineers' Clubs made it to the finals, in addition to Blantyre High congratulations also are due to : *Castlebrae High* in Edinburgh, *Kingussie High School* and *Springburn Academy* in Glasgow.

Laboratory design

It's some years since anything of real substance was published on the design of science accommodation in schools. We have had a number of enquiries lately and have been embarrassed (but only, I might add, on behalf of the SOED) at the age of some of the key documents to which we had to refer. It will do little to relieve any such embarrassment that the recently published "*Science Accommodation in Secondary Schools : A Design Guide*" is a Department for Education (DfE? but now DFEE? [we jist cannae keep up with a' the acronymic shooglin, ken]). As such, some of the recommendations on suitable floor areas are wide of the mark for Scottish class sizes. Otherwise it looks a very useful document. It's available from HMSO at £11.95 a copy (ISBN 0-11-270873). Didnae SOED yince hae folk whae kent a' aboot sic a thing?

TRADE AND PRODUCT NEWS

Fermenter vessel repairs

The Stirling firm of *Scotia Glass Technology* has been mentioned before in these pages as a source of bespoke scientific glassware and as a skilled repairer thereof. More recently we have asked them to repair or reattach ports to an expensive bioreactor (fermenter) vessel. This they have carried out quickly, skilfully and inexpensively (relative to the cost of a new vessel). For example, fitting a replacement port to a Philip Harris bioreactor cost us about £50 compared to well over £100 for a new vessel.

Also of interest was an offer to fabricate short-form versions of such vessels. These would have the same number and sizes of ports but would need smaller volumes of media. Care is needed not to take this too far else you will hit snags because heaters aren't properly covered etc. See inside rear cover for details of Scotia Glass Technology's location.

Repairs - to body if not spirit

Also recommended before is the firm of *ESP Ltd.* as folk to whom you may entrust your broken bones. No, we're not yet that desperate for money, this is not a plug for private medical insurance. The bones in question being those of skeletons, real or plastic, used in biology teaching. We continue to receive favourable comment from technicians and teachers whom we have pointed in the direction of ESP (make up your own jokes if you wish). The firm has been praised not only for the general quality and thoroughness of its work but also for its reasonable pricing policy.

Mini-video cameras

At the request of an Adviser in Science we had been evaluating the educational potential of a single chip, miniature camera designed and made by *VSLI Vision* (known as the *Peach* camera). At under £100 for the simple monochrome model this seemed a very attractive resource. Apart from one or two discrete components and power from an external 9 V source (which can be just a battery) the entire camera is contained on a single chip. The lens is normally of fixed focus more suitable for middle distance work (widespread applications being in video entry phones, as electronic rear view mirrors etc,). It is however a simple matter to loosen the grub screw and convert the assembly to variable focus with the lens being moved in and out of the camera body on its mounting thread. We added a drilled out plastic gear-wheel fitted fairly tightly over the lens. This gave greater sensitivity to the focusing action. In this mode we certainly judged it most useful for 'macro' applications as a sort of electronic hand lens in demonstrating detail in small objects to a group or class.

It is a relatively easy matter also to couple the camera to a microscope eyepiece. We made a simple metal collar to fit over the eyepiece at one end and into which was fitted the camera lens (focused at infinity). This assembly gave acceptable results with a high resolution monochrome monitor. We have reports from several teachers who also trialled samples that they felt the resolution needed to be improved somewhat for really useful video-microscopy. Some also found the lack of full colour a serious drawback, especially and not surprisingly with stained specimens. These shortcomings have to be set against a very low price for a complete system.

Last time we checked we were told that VSLI Vision were still developing a colour version of the *Peach* camera. Already on the market however is *Videolab's Flexcam Teaching* desktop colour camera from the USA. At £900 this, literally, is an order of magnitude more expensive than VSLI's monochrome Peach. However we were very impressed when recently we were given a demonstration of Flexcam by its importer, Pyser SGI. Developed originally with video-conferencing in mind, the Flexcam is mounted on a flexible, swan-neck type stand. This increases its overall dimensions which strangely is an advantage since like the VSLI Peach, the camera itself is little bigger than a matchbox and eminently nickable.

Flexcam is very impressive in use either as an electronic hand lens or fitted to a microscope eyepiece. The latter operation is simple and requires nothing more than a simple collar fitting over the eyepiece itself which remains in place. In use for video-microscopy it meets our major criterion in that it is simple and slick to transfer the camera onto a pupil's microscope to allow the whole group to see a particular feature or an unusually good fresh preparation. (If you wish to project an image of a commercially prepared specimen then buy a 35 mm transparency photomicrograph). Resolution is impressive.

Pyser is currently appointing a number of agents or distributors throughout the UK. Schools in Scotland wishing more information on, or a demonstration of, the Flexcam Teaching system should contact Philip Harris in the first instance.

Weather station

'Weather Reporter', an automatic and data logging weather station has been launched by *The Advisory Unit : Computers in Education* (see Address List). This is available as a package of roof mast with sensors, cables, instruction manual and software. The system can record temperature, pressure, wind speed and direction, daylength and hours of sunshine plus rainfall and humidity levels. Detailed values can be routinely stored up to a maximum of 60 hours prior to downloading or to cover holiday periods daily information may be stored for up to 58 days. The system may be linked to more than one screen (up to six) in a school. Basic systems start at just under £400 plus VAT.

Surplus Equipment Offers

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

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

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

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

Don't send cash with orders

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

Motors

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

755 Pulley wheel kit comprising:
- plastic pulley wheel, 30 mm dia., with deep V-notch to fit 4 mm dia. shaft,
- two M4 grub screws to secure pulley wheel,
- Allen key for grub screws, and
- 3 mm to 4 mm axle adaptor.
The whole making up a kit devised for SSERC tacho-generators with 3 mm shafts. Specially supplied to SSERC by Unilab. £1.25

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

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

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

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

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

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

773 Tachometer (ex equipment) £2.25

811 Worm and gear for use with miniature motors, 34 : 1 reduction ratio plastic worm and gear wheel. 35p

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

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

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

Precision motor stock

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

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

Miscellaneous items

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

792 Propeller kit with 10 hubs and 20 blades for making 2 or 3 bladed propellers. 130 mm diameter. Accepts either 2 mm or 3 mm shafts. £3.40

790 Buzzer, 3 V. 55p

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

710 Sonic switch and motor assembly. First sound starts the motor, a second reverses the direction of rotation, a third sound stops the motor. Driven by 4 AA cells (not supplied). 50p

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

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

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

166 Ditto, but 30 cm length. 40p

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

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

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

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

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

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

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

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

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

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

742 Key switch, 8 pole changeover. 40p

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

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

759 Ditto, black. 5p

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

809 Wire ended lamp, 3 V 10p

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

789 MES lamp, 3.5 V, 0.3 A 9p
690 MES lamp, 6 V, 150 mA. 9p
691 MES battenholder. 20p

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

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

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

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

808 Electrodes for making lemon or other fruit cells etc. 1 pair, comprising 1 of copper, 1 of zinc, each approx. 60 mm square, per pair 50p

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

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

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

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

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

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

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

752 Shandon chromatography solvent trough. £1.00

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

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

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

Components - resistors

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

737 Ditto, 22 Ω, lin., 36 mm dia. 30p

329 Ditto, 33 Ω, lin., 36 mm dia. 30p

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

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

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

Components - capacitors

813 Capacitors, polystyrene: 4p
180 pF, 220 pF, 330 pF, 560 pF, 1000 pF, 2400 pF, 3000 pF, 3300 pF, 3900 pF & 4700 pF

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

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

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

698 Capacitors, electrolytic, 1 µF 25 V, 2:2 µF 63 V, 10 µF 35 V. 1p

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

Components - semiconductors

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

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

322 Germanium diodes 8p

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

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

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

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

699 MC14015BCP dual 4-stage shift register. 5p

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

Sensors

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

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

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

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

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

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

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

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

506 Resistor, 1 gigohm, ¼ W. £1.40

Opto-electronic devices

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

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

Items not for posting

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

Glassware

663 Flat bottom round flask, 250 ml. 50p

664 Flat bottom round flask, 500 ml. 50p

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

810 Watch glasses, assorted sizes 20p

Chemicals etc.

712 Smoke pellets. For testing local exhaust ventilation (LEV) - fume cupboards and extractor fans, etc. large, 50p, small 35p

NB : Other chemicals are named here as described on supplier's labels. Please order according to our description. Unless coded "A" substances are not Analar grade. Must be collected.

amino acids, sugars,various for chromatography etc. (prices range from 25p to £1 depending on quantity)	p.o.a
ammonia sol'n, 27% w:w 2.5 l :	50p
ammonium ferric sulphate 500 g	25p
barium chloride, 500 g	25p
barium sulphate (soil tests), 500 g	50p
buffer, universal sol'n	25p
caffeine. 100g	75p
casein, 500 g	25p
copper sulphate crystals, 500 g	50p
decanoic-n-acid (lauric), 500 ml	25p
diastase from malt, 100 g	50p
dodecan-1-ol, 500 ml	50p
glycerol monostearate, 500 g	25p
indol-3-ylacetic acid (IAA), 25 g	10p
iron filings, 3 kg	75p
Keiselguhr acid, washed, 500 g	25p
magnesite, native lump, 500 g	75p
manganese, metal flake, 99%, 250 g	50p
ninhydrin powder, 5 g	5p
oxalic acid, 500 g	25p
potassium dihyd. orthophophate, "A", 200 g	50p
pyrogallol, var.pack sizes, from 25 to 500g	p.o.a.
resazurin tablets, 100 tabs.	25p
sodium n-butyrate, 100 g	25p
sodium malonate, 100g, sodium molybdate 100 g	10p
strontium chloride, "A", 500 g	25p
sulphur, 1 kg	75p
urea, 1 kg	1.00

SSERC, 24 Bernard Terrace, Edinburgh, EH8 9NX; Tel. 0131 668 4421, Fax. 0131 667 9344.

Advisory Unit : Computers in Education, (Weather Reporter); AU Enterprises Ltd., Great North Road, Hatfield, Herts AL9 5JZ; Tel. 01707 266714.

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

ASE, Scotland, Secretary and Editor of 'Science Issues' : Stuart Farmer, 28 Balfour Road, Alford, Aberdeenshire, AB33 8NF; Tel./Fax 019755 63060.

BSI Standards, 389 Chiswick High Road, London, W4 4AL; Tel. 0181 996 9000, Fax. 0181 996 7400.

Dept. for Education and Employment (DFEE), Unit 1, Publications, East Cross Centre, Waterden Road, Stratford, London, E15 2HF; Tel. 0181 533 2000.

Educational & Scientific Products Ltd., A2 Dominion Way, Rustington, Littlehampton, West Sussex, BN16 3HQ; Tel. 01903 773340 Fax. 01903 771108.

Electrosound, Unit 7A, Enterprise Trading Estate, Station Road, Rayne, Essex, CM7 8TY; Tel. 01376 340506, Fax. 01376 340506.

Farnell Electronic Components Limited, Canal Road, Leeds, LS12 2TU; Tel. 0113 263 6311, Fax. 0113 263 3411.

Griffin & George Limited, Bishop Meadow Road, Loughborough, Leicestershire, LE11 0RG; Tel. 01509 233344, Fax. 01509 231893.

HMSO Bookshops - see 'Yellow Pages'

HSE Books, PO Box 1999, Sudbury, Suffolk, CO10 6FS; Tel. 01787 881165, Fax. 01787 313995.

Philip Harris Education:

2 North Avenue, Clydebank Business Park, Clydebank, Glasgow, G51 2DR; Tel. 0141 952 9538;

Lynn Lane, Shenstone, Lichfield, Staffordshire, WS14 0EE; Tel. 01543 480077, Fax. 01543 480068.

Hawnt Electronics Limited, Firswood Road, Garretts Green, Birmingham, B33 0TQ; Tel. 0121 784 3355, Fax. 0121 783 1657.

Prolabo, Diamond House, Peel Cross, Eccles New Road, Salford, Manchester, M5 2RT; Tel. 0161 925 1900, Fax. 0161 737 2001.

RS Components Limited, PO Box 99, Corby, Northamptonshire, NN17 9RS; Tel. 01536 201201, Fax. 01536 201501.

Rapid Electronics Limited, Heckworth Close, Severalls Industrial Estate, Colchester, Essex, CO4 4TB; Tel. 01206 751166, Fax. 01206 751188.

Scotia Glass Technology, Kaimes Farm, Dumbarton Road, Stirling, FK8 3AB; Tel. (& Fax) 01786 473305.

Society of Motor Manufacturers and Traders Ltd., Forbes House, Halkin Street, London, SW1X 7DS; Tel. 0171 344 9222 or Alan West, Director CREST Awards, Tel. 0171 294 3098.

Technology Teachers' Association :
Secretary - Jimmy Johnston, 49 Queen Victoria Drive, Glasgow G14 9BT;
Editor TTA Journal - Brian Dziennik, Apolonia, Middle Terrace, Kingussie, PH12 1EY; Tel. 01540 661 638 (home) 01540 661475 (school).

Unilab Limited, The Science Park, Hutton Street, Blackburn, Lancashire, BB1 3BT; Tel. 01254 681222, Fax. 01254 681777.

VLSI Vision Ltd., 31 Pinkhill, Edinburgh EH12; Tel. 0131 539 7111.