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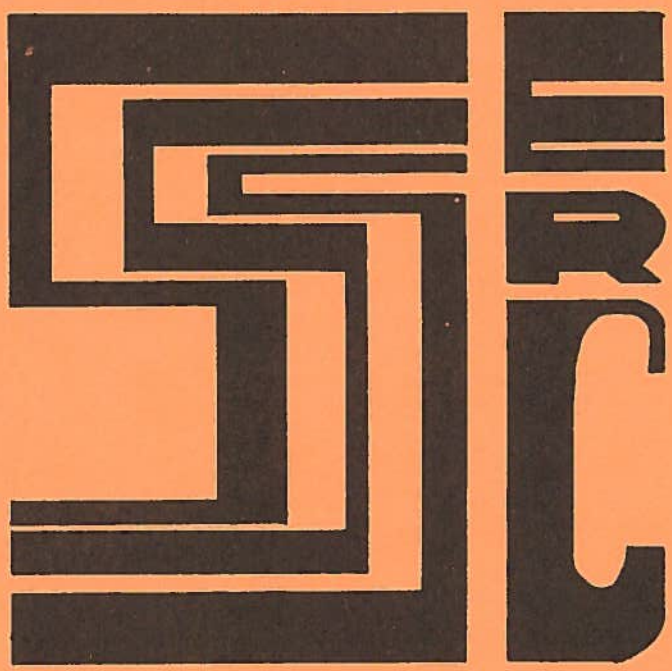

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INTRODUCTION

Surplus equipment & publications offers

This issue contains details of a number of offers for sale of equipment, publications or materials. Unless explicit instructions to the contrary are given in this bulletin then our general conditions of sale, set out in Bulletin 116, will apply. We would entreat customers to read carefully those conditions as well as any information given herein, for example on items subject to ballot etc. This is in order that unnecessary paper and telephone work may be avoided.

"SIR" and "Interfacing Extracts"

Our Science Interfacing Register (SIR) launched in Bulletin 129 has been discontinued (see "Interfacing Notes", Bulletin 140 for the reasons for closure). Latterly the main function of the register, now in its 4th issue, has been as a mailing list for our "Interfacing Extracts". The latest version of this compilation of abstracts of interfacing articles, equipment reviews and electronics projects is being prepared as this bulletin goes to press.

"Interfacing Extracts" are printed and distributed by SMDP to whom we are grateful for assistance and co-operation in this venture. Further copies can be made available through SSSERC. So although SIR is now formally closed, let us know if you wish to receive a copy of "Interfacing Extracts, No.4." and please indicate if you wish to have your name added to the distribution list for future issues.

Periodic tables

We have recently been informed of a likely price increase in the 'Time-Life' periodic tables available through the Royal Society of Chemistry. We referred in Bulletin 139 to the availability of these to non-member teachers. Current prices are £2-70 per copy when purchased by a non-member (as against £1.36 to RSC members). There is a special price of £6-79 for 10 copies purchased by teacher members of RSC. Prices include VAT. Cheques in payment should be made out in favour of "The Royal Society of Chemistry".

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OPINION

School Animals and Weekends

"What's grey with a big trunk?
- A mouse going on holiday!"

Please forgive the flippancy, it is perhaps a sign of slight nervousness in having to raise the issue in these pages, in the present climate.

It **is** a serious issue. The nervous humour arises because we have no easy answers, no trite global solution. There are those who see these matters simply, in crusading clear black and white. We see them as a more complex set of interacting educational and managerial issues, somewhat like that "trunk" in all its varying shades of grey.

The problems of caring for school animals over weekends are not new. What is novel is a growing climate of opinion which continually calls into question the varying rationales behind the educational use of living organisms. We welcome the questioning and think it healthy. We welcome less some of the confused thinking behind much of it. We have silently watched this growing muddle with growing concern. A number of more recent events, some of which have been sensationally reported elsewhere and none of which are helpfully catalogued here, have prompted us to comment. A clearer setting out of the various elements of the argument might, we thought, be timeous. Any advice we offer must strike an appropriate balance between:

-what is essential in terms of law

-what is reasonable with regard to sound biological and educational principles and curricular factors

-what is practicable in operational terms.

We are not lawyers, although we have sought legal opinion, but in any case resort to law is perhaps a last resort of the unimaginative. More helpful are constructive suggestions leading to the discovery of shared aims and common ground. We hope that the advice given in the "Biology Notes" of this bulletin may make some contribution to such progress.

* * * * *

Animals in Schools - Weekends

It has been jocularly suggested that the biggest threat to the conservation of some animal species may be the educational literature. The threat arises from loss of habitat, so many trees having been cut down for all that paper. It is not our intention to add significantly to any threat in repeating that wealth of previously published detail. However a list of useful references is appended.

This article seeks merely to apply established principles with hopefully a dash of commonsense, to a specific operational problem. This problem has lately occupied the minds of a number of teachers, technicians and advisory staff and we have received several enquiries on this topic.

It is not all that uncommon for cases to come before the courts arising from complaints of cruelty to animals through "abandonment". Holiday periods particularly, lead to eventual reports in the popular press of fines administered on owners for failing to make proper arrangements, during their absence, for their domestic pets. The classic cases usually involve a cat or dog left alone for a week with seven dishes of food having been put out on day one.

Of more relevance to schools are a tiny number of, as yet isolated, complaints on the basis that animals were left "unattended" over one weekend. To date there have been no actual court cases to decide the matter.

The most likely legislation referred to in such complaints would be the "Abandonment of Animals Act, 1960". This Act defined an additional type of offence involving cruelty to animals to the list of such offences contained in the Protection of Animals (Scotland) Acts, 1912 to 1954. The specific offence set out in Section 1 of the 1960 Act is in the following terms:

> "If any person being the owner or having charge or control of any animal shall without reasonable cause or excuse abandon it, whether permanently or not, in circumstances likely to cause the animal unnecessary suffering, or cause or procure or, being the owner, permit it to be so abandoned, he shall be guilty of an offence of cruelty within the meaning of the principal Act ....."

The definition of "animal" as contained in the legislation is very wide. "Animal" is defined as meaning any domestic or captive animal and in turn "captive animal" is defined as meaning "any animal (not being a domestic animal) of whatsoever kind or species, and whether a quadruped or not, including any bird, fish, or reptile, which is in captivity, or confinement....." Such is the width of this definition that it seems any member of the Kingdom likely to be kept in biology departments will come within the ambit of the legislation.

However -"Don't panic!", we are advised that the key issue as regards the 1960 Act seems to lie in the part of the offence which refers to the circumstances being likely to cause the animal any unnecessary suffering. What if effective arrangements are made which ensure that animals will be properly fed and watered and protected from any hazard over the weekend? This could, with considerable justification, be argued as less likely to cause suffering than the very real risks of stress and infection arising from the alternative arrangement of allowing pupils to take animals home.

Aside from these, somewhat sterile, legalistic arguments what are the operational and broader educational consequences of too literal an application of "abandonment? If keeping animals becomes too operationally onerous for schools, their administrators and finances, then they might be forced to consider ending the maintenance of animals for educational uses. Surely this is unthinkable? We would be back in the days when the only living things to come through the classroom door would be the pupils and (sometimes) the teacher. Is that all we are to look forward to - "Core Necrology"?

There is an obvious paradox here. Surely common-sense should tell us that schools have a duty to teach pupils a proper respect for other

living things. In practice that means teaching, sometimes directly, sometimes by silent example proper handling, housing, feeding and other aspects of care. How are schools to meet effectively that responsibility if their pupils are to be denied ready access to animals on the premises?

Fortunately there are a number of reasonably practicable measures that teachers, and Education Authorities as deemed "owners" of animals in their schools, can ensure have been adopted in order to avoid the presently remote possibility of a "no animals" ruling becoming a reality. In all of the "cruelty" offences contained in the legislative code, the "owner" of any animal is deemed to have permitted cruelty if he has failed to have exercised reasonable care and supervision in respect of the protection of the animal from cruelty. The onus of proof is placed upon the owner.

In order that such proof of care and supervision may be readily furnished, the following general principles are always best attended to in formulating any school policy on the educational use of animals.

(a)Educational rationale

There should always be some explicit educational reason(s) for keeping any animal in a school. Needless maintenance problems may arise through not adhering to this fundamental principle.

(b) Choice of species, numbers and sex.

The number and variety of animals maintained in a school is always of less importance than the educational uses to which they are put. In this context it is a case of "never mind the width, feel the quality!". Species that meet a variety of educational aims are preferable to, and more easily and properly managed, than a very wide variety of species covering much the same range of uses. Similar considerations apply to the keeping of more than one of any species. They become even more important where mixed pairs of animals of breeding age are to be kept.

(c)Experience of staff

This is related to the previous principles. Standards of care may slip if staff lack the necessary knowledge and experience of teaching techniques enabling them to properly integrate the use of animals into their teaching. The same is true if the range of species kept is too demanding of time to build knowledge of use and husbandry.

(d)Suitability of available facilities

Special facilities to ensure adequate food, water and warmth etc. may be needed in particular circumstances. Again this problem may become especially acute if breeding pairs of animals are maintained.

The application of these basic principles leads us to proffer the following advice, most of which results from hard-won practical experience:

(i) Teachers, especially in the primary and nursery sectors, should not be asked to accept animals into classrooms because of a vaguely formulated school policy based on a belief that the mere presence of animals is of educational value. In the absence of explicit curricular guidance and practical help in the integration of the use of animals into the curriculum, teachers may lack committment. This in turn may be a disincentive to the building of knowledge and experience of good husbandry and sound practice in the educational use of living organisms. The end result may be less than perfect standards of care through, literally, ignorance.

(ii) Because it takes time and effort to build up knowledge of proper care and use, it is better for the inexperienced to start with very few of the less demanding species and build up the necessary expertise. For much the same reasons, the maintenance of pairs, especially breeding pairs, should similarly be postponed.

In the specific context of weekend and holiday maintenance problems:

(iii) The available facilities for, and committment to, such maintenance should be a **major, initial** consideration in formulating any policy for animals in any school.

These factors should be considered at the outset before finally deciding on:

-what species and numbers are to be kept

-if there are to be any breeding pairs

-the type of accomodation required,e.g. caging, sizes and types of drinking bottles and food hoppers.

We can illustrate the application of this advice to two hypothetical yet, we hope, realistic, situations.

Firstly, consider say an urban secondary school to which the majority of staff commute and where regular weekend inspection of animals by teaching, technician or janitorial staff would be impracticable on social and economic grounds. In such a situation any school animals should be of the less demanding species, mainly invertebrates, fish and/or certain amphibia. Aquaria can be serviced by automatic feeders and amphibia such as Xenopus laevis are only to be fed two or three times a week at most.

Any mammalian species should be those biologically suited for short periods of 'automatic husbandry'. For example, the Mongolian gerbil (Meriones unguiculatus) as an animal of semi-arid regions, has a specially adapted urinary system and naturally spends long periods without access to liquid drinking water. Water is mostly obtained from the plant material in the diet. This is not to say that gerbils should ever be left without a full drinking bottle. However it does mean that they are most unlikely to exhaust the whole of even quite a small supply. In common with the golden or Syrian hamster (Mesocricetus auratus) that other relatively undemanding species, gerbils are also natural hoarders. Unless a cage has been very recently cleaned, animals of both species will always have at least one hoard of food tucked away in a corner of the cage. Again this does not mean that adequate feeding arrangements should not be made prior to a weekend! It does mean that there is little or no likeliehood of them having raging, unsatisfied appetites every Monday morning.

Because of their pugnacious nature, hamsters are best kept as singletons. Equally, care is needed in introducing gerbils into the same cage when they have not always been kept together as litter mates. Precautions, such as initial physical partitioning of the cage, may be needed. As for timing of such introductions, a Friday afternoon is probably not the best time. Security of cage fastenings should always be checked last thing every night. This is especially important with hamsters. It is not merely for alliterative reasons that a favourite pet name for school hamsters is Houdini!

Our hypothetical school would be ill-advised to keep the slightly more demanding species such as Guinea pigs (Cavia porcellus) or rabbits (Oryctolagus cuniculus). These animals can drink large volumes of water over one warm weekend. The author's experience has been that they are very adept at blocking up drinking bottle nozzles with saliva/food particle mixtures or bits of bedding. They are also quite good at jamming up poorly designed and sited food hoppers by soaking the pellets with spilled water! Even more ill-advised would be the setting up of breeding pairs of such species if litters cannot be inspected at weekends.

On the other side of the coin is a school with at least one biology teacher living locally who is very enthusiastic and knowledgeable about the educational use of living organisms. The school also has interested and sympathetic janitorial staff. Even here though it has to be realised that enthusiasm has to be matched by committment when the need arises. Keeping animals is a bit like marriage, not be entered into wantonly nor lightly! Given such enthusiasm and committment then a wide variety of animals may be kept and bred, to the enrichment of the life of the whole school community.

In summary, and in some contrast to the optimism of the previous paragraph, the other, worst possible, options appear to be:

-too great a variety of animals, housed and managed in less than the best conditions, a poor example to pupils

-that external social, political, operational or administrative considerations force a significant number of schools to abandon the maintenance of any living organisms on the premises, which possibly means no formal educational example at all for pupils.

Finally we would mention the role of the animal welfare agencies. We must stress that we see no real conflict between the overall aims of such agencies and those of the sensitive and sensible teacher. Despite recent overblown controversy over issues such as dissection (adequately discussed elsewhere, and in any case generally little done in Scotland) there is much common ground.

It is this common ground that we should continue to explore. Goodness knows, we hear enough about the politics of conflict these days. The desire to instil a sense of wonder at, and aesthetic appreciation of, all living things and their environment is, surely, a common aim. Such exploration could begin with more schools making contact with, and regularly consulting, folk like the local SSSPCA inspector. Schools should have nothing to lose nor fear by so doing. One hopes they have a great deal to gain.

Some useful references

"Recommended practice for schools relating to the use of living organisms and material of living origin", 1974, Schools Council, English Universities Press.

"Animals in Schools- A Practical Approach to their Educational Value and Welfare",1979, RSPCA, Sound Education (Publishers).

"Keeping Animals in Schools - A Handbook for Teachers", 1971 (and thus dated in parts [Ed.]) DES, HMSO.

"The Educational Use of Living Organisms: Small Mammals",1974, J.D. Wray, Schools Council, English Universities Press.

"The Educational Use of Living Organisms: Animal Accommodation in Schools", 1974, J.D. Wray, Schools Council, English Universities Press.

"Animals in Schools, Vol.1: Vertebrates", 1977, M.E. Hogg, Heinemann.

"Animals in Schools, Vol.2: Terrestial Invertebrates", 1979, L.C. Comber & M.E. Hogg, Heinemann.

"UFAW Handbook on the Care and Management of Laboratory Animals", 1976, Universities Federation of Animal Welfare, Churchill Livingstone.

"Hazcards", 1981, CLEAPSE/SSSERC.

"The Use of Animals and Plants in School Science Lessons", 1984, A joint statement by the Association for Science Education; the Institute of Biology and the Universities Federation for Animal Welfare.

* * * * *

SAFETY NOTES

Ionising radistions

Earlier this year Parliament gave approval to the "Education (Amendment) (Scotland) Act, 1984". This event did not receive a great deal of publicity, despite the subject matter - two normally controversial issues, education and nuclear hazards. However, Regions have received notification of the new legislation and we have dealt with a number of enquiries on the matter. In order to avoid having to repeat the same explanation, by letter or over the telephone, we give below an outline of what the Act means for Scottish schools. It is perhaps important to also state at the outset, that in the immediate future it will mean very little. Schools will have until at least 1986 before making any significant changes in their working practices with sources of ionising radiations.

The act begins thus: "An Act to enable the Secretary of State to control the use of dangerous materials or apparatus in educational establishments in Scotland". By "dangerous materials or apparatus" the act means, quite specifically, sources of ionising radiations such as radioactive substances and X-ray emitters. In general, outwith school education, work with ionising radiations is controlled by a tangle of legislation. Some of this is specific, such as the "Radioactive Substances Act, 1960" and some is more general and indirect, for example the "Health and Safety etc. at Work Act, 1974". Unravelling this tangle in order to discover what is and is not permitted is a complex task. Fortunately for schools the burden of interpretation, of at least the direct legislation, rests not with them in this instance, but with the Scottish Education Department.

In 1963 we had the "Schools Exemption Order". This essentially was a simplified code of practice derived from the 1960 legislation. This exemption order was subsequently fleshed out with a set of working rules in "Circular 689", issued in 1968. These were then extended, in a note entitled "Circular 882" issued in 1973.

The current need for legislative change stems from a Euratom Directive and the issuing of revised United Kingdom Regulations by the Health and Safety Commission. The ramifications of any new requirements are still largely unexplored territory. This is in part because the Health and Safety Executive has yet to finalise the detail of the "Regulations"; this work will not be complete until 1986 at the earliest; and in part because SED and HSE will have to develop detailed, practical interpretation of these, as yet unfinalised, regulations. The outcome of these discussions is unlikely to cause fundamental changes in the presently approved use of sealed sources. Any changes toward increased stringency are more likely to involve certain uses of unsealed sources. Time will tell.

So, what is the present state of play?

The SED has its new Act. This enables change in SED issued regulations which control work with ionising radiations in schools. The Department will effect any such necessary changes in due course. In practice this may mean waiting until two or three years from now. In the interim, schools have Circulars 689 and 882 which they should continue to follow.

Safety Publications from SSSERC

Some time ago we arranged bulk purchases of two CLEAPSE School Science Service publications. These were for distribution via Regional Science Advisers or nominated SSSERC/EA correspondents. In the case of one publication, **"CLEAPSE/SSSERC** Hazcards" sets we sold out and had to order more to meet individual orders. With the other publication **"CLEAPSE Physics Safety Notes"** we have a few of the original order remaining.

We can offer these remaining copies at prices which reflect our original costs. Our current "Hazcards" sets contain many cards which are from a new printing. Consequently we have had to increase the price of a complete set (chemicals, processes & biology cards with a comprehensive index) to £5 including postage and packing.

Our few remaining sets of "Physics Safety Notes" we can offer at £1 per copy including postage and packing. This is a little higher than our original bulk purchase price to Education Authorities but is still largely made up of a proportion of our contribution to the original printing charges. The increase reflects the higher costs of handling single copies.

Please note that this offer only extends to **Scottish** Education Authority schools and colleges and independent schools in current membership of SSSERC. Orders totalling £5 or less (i.e. 1 set of "Hazcards" or up to 5 sets of "Physics Safety Notes") should be accompanied by payment. Cheques or postal orders should be crossed and made payable to "SSSERC".

FOUNDATION SCIENCE NOTES

Materials testing rig

A Review

The device reviewed is a multi-purpose rig developed and marketed by the Scottish firm of **Ross & Lamont**. The rig was designed to carry out a range of tests and so allow the one device to meet the needs for such testing in the "Foundation Science" Core Topic "Materials". Currently there are two national examplars for this topic which have been made available through the "Refer" system. These are both from Strathclyde Region, one being from Dumbarton division the other from Lanark. We examined the Ross & Lamont apparatus against the background of the requirements for these particular examplars.

Summary of findings

We found the device to be sturdy and with small exceptions of detail, well made and effective in operation. We concluded from our own tests that it would be extremely useful in Scottish schools. At the current price of only £19-95 for the kit, it would be excellent value if it only performed one or two functions. In fact it actually allows up to five different tests to be carried out. This advantage is partially cancelled where a 'stations' approach is used, because one kit can only perform one function at any one time. However by choosing an appropriate sequence, two or three different tests may be fairly rapidly carried out with very little re-arrangement of the rig.

If we have a serious complaint about this apparatus it has to be that if anything it is too successful and inexpensive (Ssh!). We had to wait some considerable time for our sample. Ross & Lamont were working so hard, just making the things to fulfill back orders, we had to join a queue!

General description and comments

The apparatus consists of a framework of black painted, small dimensioned angle-iron (see Fig.1.). This is welded together and fixed to a wooden base which is given a non-slip finish of cloth on the underside.

Some dismantling and re-jigging is necessary when changing from one test to another. For example, the wearwheel has to be removed to allow the impact test to be performed and the weighted arm for that test has to be removed if the tensile strength test is to be carried out. The only tool necessary to effect these changes is a screwdriver.

Fit and finish were generally good with the exception of slight mis-alignment of the arm and of the axes of the rotary parts - wear wheel and wire twisting spindle. None of these quality control weaknesses seriously affected the performance of our sample.

Comments on particular tests

The five test procedures possible with this rig are:

1. Hardness testing by impact.
2. Wire twisting.
3. Tensile strength of threads or thin wires.
4. Fatigue failure of metal strips by bending.
5. Wear testing of fabrics using abrasive surfaces.

Each of these functions will be described and commented upon in turn.

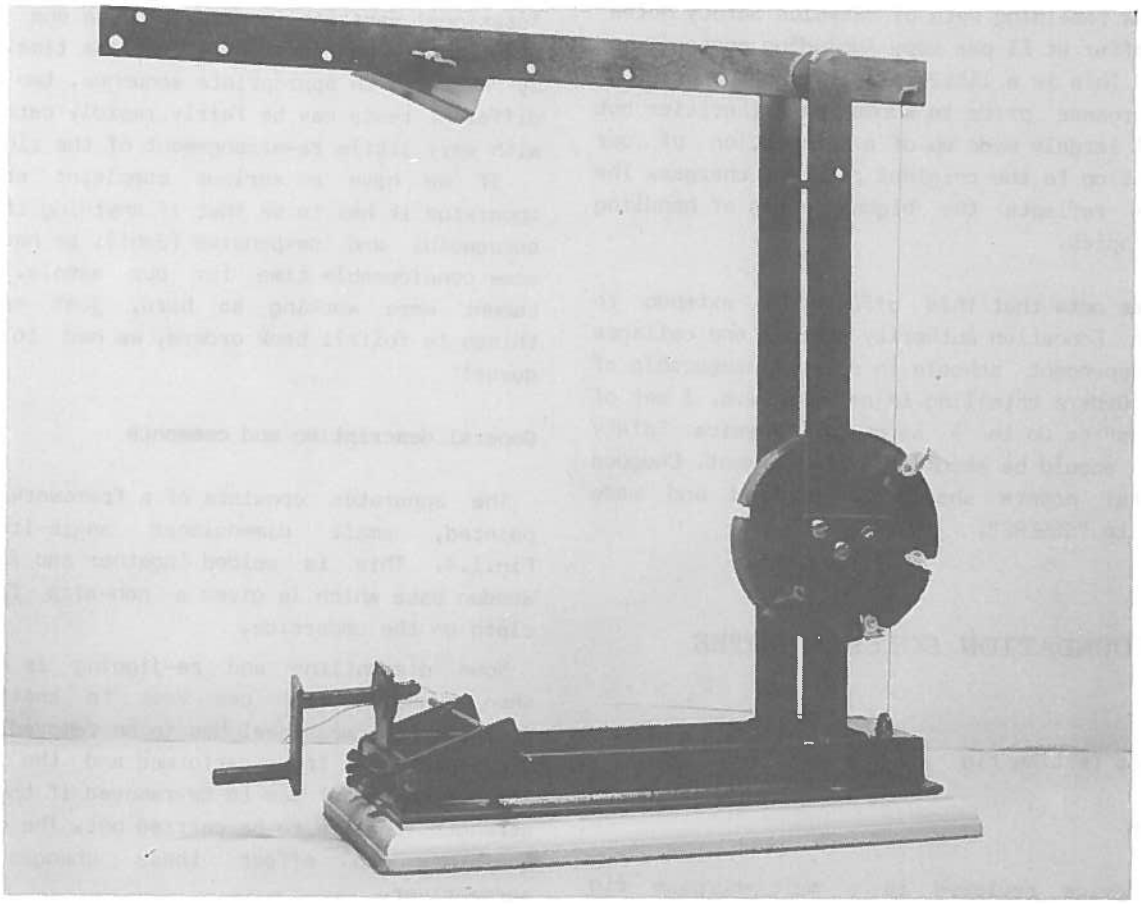

Fig.1.

Hardness testing

This procedure was fairly simple and straightforward. A hinged, pendulum like arm, is fitted with a weight which has a small pointed protrusion. This arm is lifted to a preset height and allowed to fall, impinging the point on the sample. The method for holding the sample metal plate is elegantly simple and very effective. The sample is held very firmly between two spring loaded discs. This arrangement avoids the wasting of time fiddling about undoing bolts or threaded clamps. Fairly small samples are needed with restriction to ca. 30mm width. However thicknesses of up to ca.6mm can be accomodated.

Our particular sample seemed to be very slightly mis-aligned with the hammer missing the test piece and striking one of the securing discs. When the rig was very slightly tilted the target was 100% successfully, successively struck.

Wire twisting

Here the weighted arm is swung over to the other side of the frame and its mass used to apply continuous tension to the wire as it is twisted. Many other commercially available designs only tension the wire at the outset and then clamp it. This is a mistake, a neglecting of elementary physics. As the wire is twisted the heat generated causes linear expansion of the wire. If the slack is not taken up, secondary twists or coils form in the wire and it takes much longer to break. We paid attention to this point in our own design based on a twist drill (see Lanark examplar) and are glad others have seen the need to take it into account.

The wire is attached at one end to two pegs on the swinging arm and at the other by wrapping it round an eye. This eye is at the end of a spindle the other end of which is cranked to form a handle. Turning this handle twists the wire. A

recurring problem in all twisting or stretching rigs is avoiding additional stress at points of attachment. That the methods of attachment used here were satisfactory was demonstrated by the wire repeatedly breaking at about the mid-point. The loading is somewhat greater than in our own d-i-y version and fewer turns to failure are required.

Tensile strength

Here the swinging arm is used as a lever. A short length of the wire under test is fixed to an L-shaped bar in the framework and to one end of the lever. Slotted weights (not included in the kit) are moved progressively out along the lever away from the acentric fulcrum. Equidistant holes are provided for the suspension of these weights.

This applies an increasing turning moment and load to the length of wire. For 26swg copper wire we found that 7 X 400g (i.e. 400g, 7 holes out from the fulcrum) began to stretch the wire before actually breaking it. The Ross & Lamont literature is in slight error here. It should be noted that the actual breaking strain is not 2,800 grams force (2.8N). This is because the method of attaching the wire results in it not pulling at right angles to the lever. However the figure 2800 is useful if applied as a relative measure for comparative purposes with different materials.

Fatigue failure by bending

This aspect of the rig was excellent, the metal strip bender being one of the best we have seen. The sample strip is clamped only at the base, the top being allowed some movement. This allows for any thermal expansion so preventing buckling at the point of bending. This results in a very clean break.

Wear testing of fabrics

Strips of cloth are fitted to the wheel by placing the ends in shaped grooves. The ends are then held by short lengths of plastic tubing pushed into these grooves. Some initial difficulties were encountered in fitting these tubes. However once achieved the fixing was very firm and cloth samples did not slip out. We had the impression that once the tubes hade been used a few times they would become more pliable and somewhat easier to fit. In our own tests with wool and cotton strips, little or no wear was produced after 20 turns when the unweighted arm was fitted. When the weight was affixed to the arm a further 20 turns produced some definite signs of wear.

Safety

Our own safety advice on these activities has been to stress the need for eye protection whenever materials are bent, bashed, twisted or stretched. Eye injuries from backlashing wires and flying particles are too well documented for anyone to ignore this necessity to protect the eyes. The manufacturer's instructions also stress this aspect but only in specific instances. We would be more cautious and suggest use of protection for each and every test, including the stretching of threads, because even here there is a "forseeable risk" of injury to the eyes.

The only other obvious risk is of injury to hands or other soft tissue from the swinging arm, especially when the pointed weight is fitted. It is not easy to see how the apparatus may be adequately yet simply guarded without unacceptably adding to the price. We must confess to having similar problems with our "standard hammer" mortar test rig. Adequate warning and clear instructions to keep the hands well away from the target area should suffice. After all we don't guard normal handtools (yet?!).

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Offord microscope booklet

We seem to spend a fair bit of time dissuading folk from buying microscopes inappropriate to the needs of their pupils. The problem is particularly acute at primary level. Here a powerful monocular microscope is bought often as a sort of educational status symbol rather than for any real value in its use. Explaining a number of fundamentals to such purchasers is often a long uphill task. Examples of such central ideas include:

-the greater importance of resolution and minimal optical quality over simple magnification

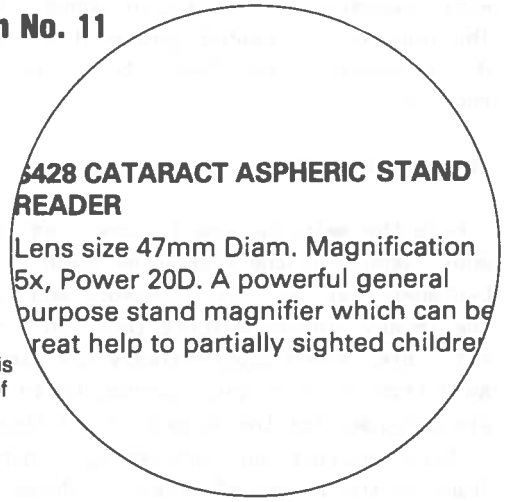
-the need for young pupils to examine three dimensional specimens, to which they more readily relate.

Such explanation is a necessary prerequisite for developing understanding and in persuading primary teachers to avoid cheap 'toy' microscopes with claimed "600X magnification!" and of the need to concentrate on buying good quality, hand magnifiers and/or long arm stereomicroscopes. One good buy which looks like a 'proper microscope' but which aims at reasonable optical quality, simplicity of controls, and sensible levels of magnification is the Offord "Scientist x20"

If anyone doubts the wisdom of sticking with simple instruments at this level, then they should buy a copy of Offord's recently published booklet, "A world to discover with a microscope - Book 1, Making a Start". Written with primary pupils in mind, it is an object lesson in effective explanation. The booklet has clear, simple text and very effective photographs, many of them taken through the inexpensive X20 Scientist (see, for example Figs.1 & 2) It explains the fundamentals of microscopy, possibly more succintly than any other publication we have seen.

The booklet is very short, only 16 pages in all. However being in colour it obviously was not

Photograph No. 11



Photograph 11 is of a few lines of printing.

Photograph No. 12

Photograph 12 is of the same lines seen through a lens magnifying 3 times.

Fig.1 & 2.

inexpensive to produce. Nonetheless at £1.35 per copy or £1 each for 10 or more (both prices post free) it offers excellent value. Not suprisingly, since Offord both produced and published the booklet, it does contain heavy plugs for their "X20 Scientist" model. However we will forgive them that. So too did the expert College of Education lecturer to whom we had sent a proof copy. He said that it should be compulsory reading for every teacher of science - secondary as well as primary! We have to admit he might have something there.

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PHYSICS NOTES

Switching

Abstract

In March of this year two documents on switching were published by the Microelectronics, Computing and the Curriculum (MCC) Project. These were "Switching and Logic" by Bill Jeffrey and "Applications of Switches" by Jim Muir. A detailed equipment list based on the devices described in these documents has been drawn up by SSSERC. In addition the Centre has made some special purchases of equipment for resale to Scottish schools at low cost. Further technical guidance on some of the projects and devices mentioned in the two publications is also given.

Introduction

Both MCC documents merit attention as sources of enrichment material for the teaching of electricity in the S1/S2 Integrated Science course. "Switching and Logic" is written as a stand alone course, but whether it is taught on that basis in addition to, or as a replacement of sections 7 or 15 is up to the class teachers and schools concerned. Alternatively teachers might wish to poach ideas from "Switching and Logic" and "Applications of Switches" and fit them into section 7 perhaps and/ or use them as extensions or for project based work.

Talking of project work, the teaching strategy adopted in "Switching and Logic" presents children with a series of problems to be solved in order to develop abilities in circuit design. We would suggest mixing with such an approach a 'Meccano-type' strategy, letting pupils invent, devise and construct in a more original way. In other words they should occasionally be looked to for formulation of the problem and not always be asked for answers to someone else's pre-packaged questions.

In "Applications of Switches" the author introduces a range of devices such as motors; bells; thermostats; heaters; float switches; pumps and pressure switches etc. Isn't it refreshing to come across an electricity course which doesn't use light bulbs and meters with, for light relief and further excitement, yet more bulbs with yet more meters? It is our opinion that there could be a great deal more problem solving work in S1/S2 science, very much more than seems to take place in most schools. Such work is nothing new to many pupils coming from our better primary schools. Work in electricity is as well or better suited to a technology based as to a purer scientific approach. The principles of electricity are possibly more easily picked up from model railways, fluid pumping and model go-carts. The trouble is that these things look too much like fun. Circuit boards are no one's idea of fun and therefore must be the ideal thing for secondary schools.

Equipment list

An equipment list based on both documents is available on application to the Centre. Please let us have 30p to cover copying and postage costs. Many of the items on the list are in stock in our surplus store. This we have deliberately stocked in order to assist schools obtain, at low prices, some of the materials they need for this work. (See "Surplus Equipment Offers").

Surplus store policy

Traditionally our store has largely been stocked in an ad-hoc manner with the miscellaneous cast-offs of others - colleges, schools, industry, Ministry of Defence etc. It has been very much a white elephant stall with teachers left to pick out, of a whimsical collection of bric-a-brac, items for which they would find a use for projects etc. We have recently however, changed the emphasis of our surplus buying policy. We always have supplied specific items for which we knew there was steady demand. Examples of such include photographic materials, bimetallic strip, batteries etc. We are now developing this idea and bulk buying, at large discounts, items for which we are fairly sure there is a demand in schools. A large proportion of any discounts we so obtain are passed on to the schools.

We should also point out that most items we sell are neither available from the usual educational suppliers nor the principal distributors of electrical and electronic equipment. We do not intend entering into competition with either of those sectors. What we are offering, we hope, is doubly valuable in that some off-beat items have been researched, found suitable for use and made available at very reasonable prices.

At the same time we must also say that whilst it is probably in the interests of an individual school to order through SSSERC this is not necessarily true for a Region seeking large numbers of some items. It would be in the interests of a local authority to buy directly from our suppliers. They would then take full advantage of their bulk buying power to obtain very favourable discounts. We will therefore gladly advise any Adviser, EA official or group of science teachers who might wish to pursue such a course.

Specific items and applications

The remainder of the article deals with some of the devices and applications specifically mentioned in the MCC documents, adds a few of our own and describes ways of avoiding some possible snags.

Light dependent resistors (LDR)

Both publications refer to these devices as "photoswitches". However this is a generic term covering a multitude of components and is best not used as though it were the name of a specific device. A common type of light dependent resistor is the ORP12, which nearly all distributors seem to stock. Prices for ORP12s range from 84p upwards and as simple, basic components go they are relatively expensive. We recently bought in a batch of another type of LDR (unfortunately unspecified), which we are able to sell at 55p (Item 386). We have tested samples of our purchase and so far all have passed our tests.

Whilst the general behaviour of LDR's is well known, i.e. low resistance in the light, high resistance in dark, it is not generally appreciated that individual devices, of whatever model or type, each have their own specific characteristics. This may be a result of low quality control in production. For example, one LDR may have a resistance of 1K in a certain light level whilst another from the same batch has 5K under similar lighting conditions. This may well lead to cries of "it disnae work" in practice because whereas one circuit may be triggered by exposure of the LDR to daylight, another may not. So, where does this leave us?

Firstly you have to expect differing thresholds of light triggering, daylight for some LDRs, close up to a 40W bulb for others. Secondly, it seems wise to keep a stock of several LDRs ("Switching and Logic" recommends 8) so that you are not relying on one, which might just happen to have an unsuitable sensitivity, and so that the described overall pattern is apparent.

Another point to watch for is the different component ratings in the two switch documents.

Document	LDR	bulb	supply
"Switching and Logic"	ORP12	12V, 0.1A	12V
"Applications of Switches"	ORP12	6V, 0.04A	6V

Both configurations of bulb and supply work. We would however recommend using a third configuration, that of 6V, 0.06A bulb and 6V supply (Fig.1).

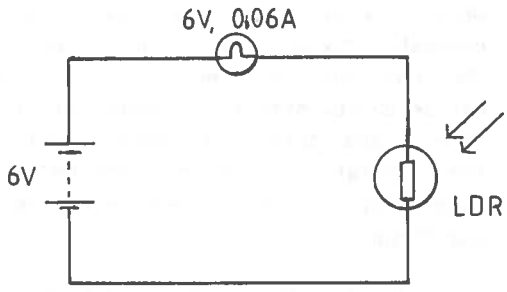

Fig.1. Photoswitch circuit

Distributions of sensitivities to light levels for two LDR's are shown in Table 1. A bench lamp is a necessary accessory in this work.

LDR type	sample number	light level		
		40W bulb	room lighting	covered
ORP12	7	6 on	1 on	nil on
SSSERC type	10	10 on	6 on	nil on

Table 1

Multiway switches

Some terminology used in distributors' catalogues, though not in the MCC documents, may be unfamiliar and leave that uneasy feeling of not being sure what to order. The unfamiliar terms we refer to are

"make before break" which is equivalent to "shorting"

"break before make" which is equivalent to "non-shorting"

Diagrams (Fig.2) should clear up any misunderstanding.

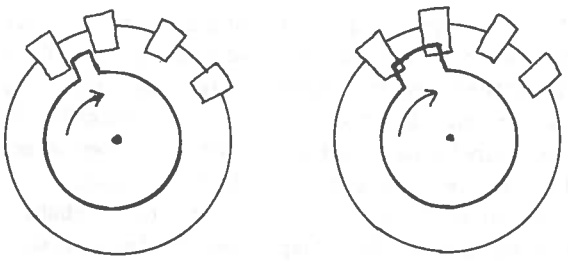

Fig. 2.

Both versions of multiway switch are suitable in applications outlined in the documents. Our equipment list refers to the non-shorting version.

10-way multipole switches have to be bought in kit form. Assembly is straightforward and should not cause any problem. Parts required are switch mechanism, 1-pole 12-way wafers, spacers and knob, all catalogue item numbers being specified in our equipment list.

Please note that we stock 6-pole 8-way wafer switches (item 382), already assembled, in our surplus store.

Relays

A large choice of relay is available from distributors. The SSSERC surplus relay (item 316) is double pole, double throw with 12V, 700 ohm resistance coil. Contacts and coil are housed within a perspex case, height 30 mm. Lugs, which are the electrical connectors to contacts and coil, protrude from the base and will fit into 0.1" stripboard. Mounting is thus quite simple.

If buying the RS "Continental" type relay (348-908) you will find the job of mounting it on plastic rainwater pipe can be made easier by purchasing

1. relay socket, RS no. 349-080
2. mounting plates, RS no. 349-119

8 BA nuts and bolts are needed also.

Reed switches

The large reed switch (item 353) that we stock is particularly useful because of its largeness to demonstrate the principle of operation. Miniature reeds by way of contrast should also be obtained. Two kinds of magnet can be supplied by us (items 317 and 318). They both operate our reed switches.

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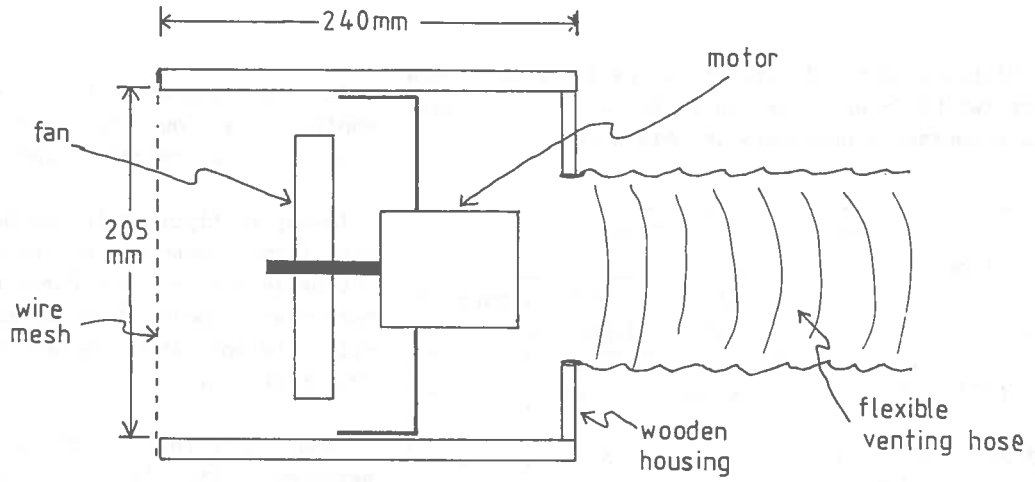

Fig. 3. Fan housing

Thermostats

There are two sorts in our surplus store. The skeleton type (item 313) has an open construction, useful for demonstrating the principle of operation. This thermostat is not particularly sensitive but can be operated in an airstream from a hair drier. The thermostat with 20" capillary (item 380) is rather more sensitive. Its capillary tube can be immersed in liquids.

Fan

The fan (item 344) has 18 cm diameter and is driven by a quietly running Smith's 12V dc motor. This motor has mounting brackets with flanges which protrude out on two opposite sides of the fan. The fan is unguarded and as supplied is unsafe. It is therefore essential to construct a guard. This might be done by enclosing the entire mechanism, fan and motor, in a wooden box (Fig.3) with wire mesh at the front and flexible venting hose at rear.

Dimensions of a suitable box are 230x230x240 mm using 12 mm blockboard. Five pieces are required.

2 pieces at 230x240 mm
2 pieces at 216x240 mm
1 piece at 230x230 mm with central hole to suit diameter of flexible hose.

Fix the pieces together with nails and glue.

Wire mesh can be obtained from United Wire Ltd. Specify 10 mesh in galvanised steel or non ferrous form. Mesh dimensions should be 227x218 mm.

Flexible venting hose is available from dealers and service agents for tumble driers.

An application of the fan would be a model hot air ducted central heating system with thermostat and low voltage air heater such as a radiant heater.

Pumps

Our submersible pump (item 348) operates off a low voltage dc supply, nominally 12V. At 12V it exhibits strong pumping action and is capable of lifting water a considerable height at fast flow rate. If interested in quantitative details, in Imperial units, its performance is roughly 1 gallon per minute per vertical yard. The pump also runs off a 6V bell battery at which voltage the operating current is 600 mA. It is probably desirable to operate the pump from battery power to remove the hazards associated with having mains supplies and water works together on the same bench.

The bilge pump (item 384) is not yet in stock at the time of writing and has not been tried out by us. The supplier assures us however that it has a stronger pumping action than the submersible pump and is of more robust construction. It is designed to sit partially submerged with the top electrical part kept dry.

An application of the submersible pump is given in the following section.

Pressure switch

We have tried out two air pressure switches. RS Components stock a device (316-951) which is designed to be operated by a foot actuator (316-945) to which it is connected by 2 metres of plastic tubing. This pressure switch is in fact two s.p.d.t. microswitches and the pressure setting of each of these can be independently adjusted. It is thus possible to have one switch operating before the other.

We have experimented with this device as a water pressure sensor by removing the foot actuator and holding the plastic tubing under water. That it could not be activated by depths up to 40 cm, the likely maximum depth of water convenient for laboratory work, points to this device being unsuitable for this sort of use.

A more sensitive air pressure switch is SSSERC surplus item 385 which can sense water depths of the order of 30 cm. To achieve this fit a short stub, 20 mm long, of rubber tube, internal diameter 3mm, outer diameter 8 mm, on to the air nozzle of the pressure switch. Over this stub fit a long length of rubber tube, internal diameter 8 mm, outer diameter 13 mm, and position the free end of this longer tube at the required depth in the water tank. Marked hysteresis is displayed in that the switch closes at, say, a depth of 21 cm and opens at a depth of 13 cm, these levels and the amount of hysteresis being adjustable.

Our pressure switch and submersible pump were connected together in the set-up shown in Figure 4. Two tanks are required, each of depth of about 30 cm. 1.5 litre measuring cylinders are suitable, but rather than run the risk of breakage of expensive glassware, we suggest using plastic sweetie jars or 2/3 litre juice bottles with their tops cut off.

When the depth of water in vessel A exceeds 21 cm the pump is switched on and transfers water into vessel B until the level in A drops to 13 cm. Thereafter water syphons back through the pump to A. Note that the water level in B must be able to rise to at least 8 cm higher than A. B can if desired be placed on a pedestal to achieve a height differential with respect to A.

The circuit wiring is shown in Figure 5.

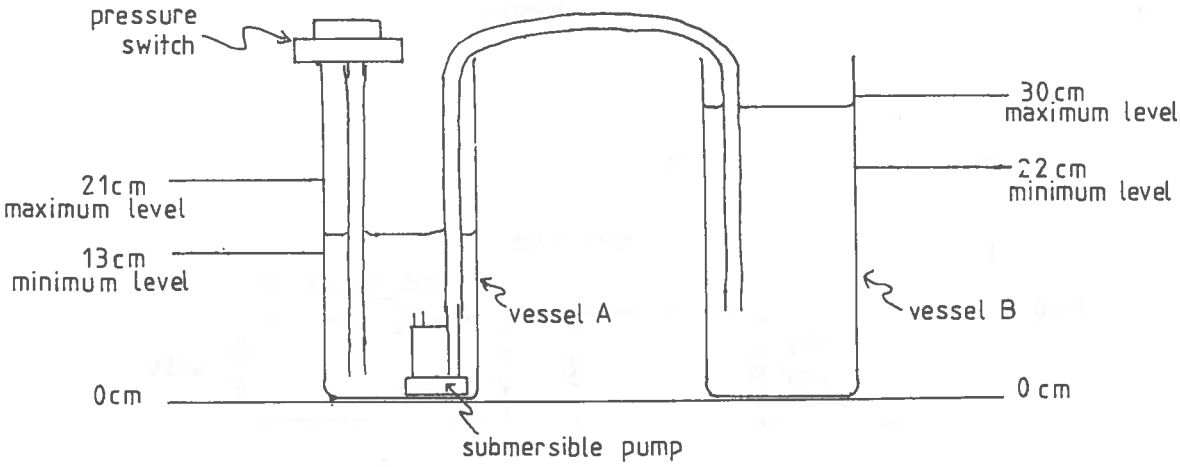

Fig. 4. Application of pressure switch and submersible pump

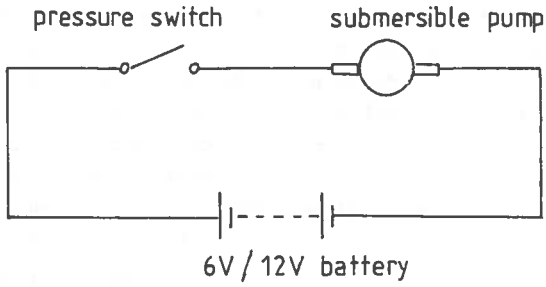

Fig. 5.

Motors

Our stock consists of two types of small motor. They are both of low quality construction, consume relatively high current (100-200 mA), are electrically noisey, but have the redeeming feature of being cheap. Model BM6 (item 389) is the larger. There are two holes in the end plate through which leads should be poked to fit into a spring grip on the brushes. Normally this is a simple operation, but should it cause difficulty prise off the end plate and attach leads directly on to the spring grips. Our second cheap small motor, model BM1 (item 351) has an open construction showing armature, yoke and commutator.

Other motors in stock include three fairly powerful models (items 214, 215 and 372) which would be suitable for go-kart construction and precision motors described in Electronics Notes.

One final application is given (Fig.6) using three devices mentioned above, the skeleton thermostat, relay and small motor, model BM6. Other items required are 12V supply, 4.5 or 6V battery, raybox lamp, 12V,24W and crocodile clips. A simple fan should be constructed, perhaps by making a Savonius rotor (for details of this please see Bulletin 135). An even simpler fan can be fashioned with a serrated cap from a plastic bottle. Drill a hole in the centre of the cap such that it makes a tight fit on the motor drive shaft. When the motor runs the bottle top causes a fair amount of air disturbance. Mount the fan close to the lamp and use a croc clip to attach the thermostat to the lamp housing. The system as shown in the wiring diagram goes into oscillation. The lamp heats up till the thermostat switches it off and switches on the fan to cool everything down.

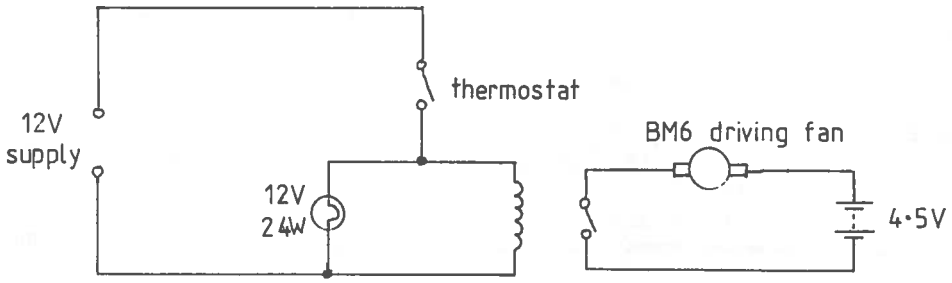

Fig.6. Application of switches

SURPLUS EQUIPMENT OFFERS

In general these offers are subject to the conditions and arrangements laid down in Bulletin 116. In addition your attention is drawn to the following specific points:

(a) Items with numbers greater than 355 are new lines.

(b) Items with numbers less than 356 have previously been advertised and are either remaining or newly acquired stock. Some of this new stock replenishes lines which were sold out as a result of the Bulletin 140 offer.

(c) Items 357 to 371 **only** are subject to our ballot procedure. Some of these items are evaluation samples which were released too late for the Bulletin 140 offer and thus are available for a small handling charge.

(d) For many items we have abandoned sequential numbering. This is an experiment, and we would be grateful for customer reaction to this lay-out (adverse or favourable comments will be equally informative!). The aim has been to group similar items and/or items that are used together. In some cases a grouping will include items all having applications in a particular course. It thus becomes more important than ever that correct item numbers and descriptions are entered on any orders. This will be a great help to SSSERC staff and will minimise mistakes and inconvenience to customers.

Video cassettes

We have received a large number of VCR cassettes which are surplus to the requirements of a school. The cassettes are of various makes including BASF, Scotch, Phillips etc. and are suitable for use with the **Phillips 1500** system. Machines using this particular system are no longer made but we believe there are still some schools using such models of VCR.

We are offering the cassettes on a first-come, first-served basis. Most have recordings on them but we will not be attempting to sort them on this basis. Therefore they will have to be wiped or over-recorded unless by serendipity you receive a programme you particularly want.

Item 356 Video cassette £2

Consumer unit meters

We have received a gift of a batch of 50 of these through the generosity of the SSEB. We quickly realised, from the number of enquiries already to hand, that we cannot even begin to meet the likely demand for meters. We have requested the release of more and when they become available, we will put these also in the bulletin. Meantime, regretfully, we will have to ballot what stock we have. For now, the meters will be restricted to one per successful school.

Because there is more than one type of meter and there are alternative safe mounting and wiring arrangements we will supply a full set of instructions with each meter. Please note that the £3 charge merely reflects our costs in providing instructions and in handling and sorting these items. The meters themselves cost us nothing. The only condition mentioned by the electricity board personnel was that teachers discourage experimentation likely to encourage fraudulent interference with a meter. The designs for d-i-y mounts which we will supply should assist in this matter.

Item 357 KWh meter £3
(ex. consumer unit)
240V a.c., 50Hz.

Instrumentation

Please note that <u>all</u> of the items in this Section [items 358 - 371] are <u>subject to ballot.</u> Items 358 - 360 inclusive are ex-evaluation samples subject only to a nominal handling charge.

Item 358	Colorimeter, 'Foxall' Open University model,6V	£1
Item 359	pH meter, Unilab 093.613 9V battery operated, battery not supplied, probe not supplied.	£1
Item 360	Oxygen meter, Griffin & George. 9V battery operated (battery not supplied) (probe not supplied)	£1
Item 361	Control transformer (2) for Phillips discharge lamps, also suitable for use with sodium street lamps.	£5
Item 362	Demonstration voltmeter, Russian, 25 x 30 x 9cm., ranges: d.c. 5V, 15V,5-0-5V. a.c. 15V, 250V.	£2
Item 363	Demonstration ammeter, Russian, 25 x 30 x 9cm., basic movement 400µA fsd ranges: d.c. 3A, 10A, 5-0-5A. a.c. 3A, 10A.	£2
Item 364	Microprojector,by Harris 2 objectives on 3 place nosepiece. x4 & x6.4. lamp not tung./halogen. but 8V, 50W, A1/185 (now superseded by A1/17, not supplied).	£5
Item 365	Scaler, type 901, Research Electronics, Contains 1 decatron & a 5 digit mechanical counter. 2 in working order [365a] 1 requiring repair [365b]	£5 £1
Item 366	Signal generator by Griffin/Clarksmith a.f. output 20Hz - 50kHz. r.f. output 150kHz - 20MHz.	£5
Item 367	Valve voltmeters (2) by Griffin/Clarksmith (old cat.no. L97-160) 6 ranges, a.c./d.c.	£5
Item 368	Grundig 'Stenorette' dictation machine for audio typing, complete with microphone, earpieces, and footswitch. Mains operated, 28 x 25 x 12cm, reel to reel type.	£5
Item 369	Overhead projector by Fordigraph, 240V, 650W.	£15
Item 370	OHP by Elite, 240V,650W (no lamp supplied).	£10
Item 371	Aldis projector, Tutor 500 with carrying case & film -strip attachment, but no lamp (A1/205, 500W needed).	£15

End of ballot section

Miscellaneous, ex-stock items

This next group of items are repeats from Bulletin 140 (see para. b. of Surplus Equipment introduction).

Item 317	Ceramic magnets,poles on faces, 26 x 11 x 9mm.	15p
Item 318	Mini magnets, bar type 18 x 6 x 3mm.	20p
Item 321	BC108 transistors,low power, NPN	5p
Item 322	Germanium diodes (for use with next item for a d-i-y radio?).	8p
Item 371	Ferrite rod aerial, 2 coils MW & LW, dimensions 1x14cm.	40p
Item 323	Panel meters 1mA f.s.d. centre zero, circular case, 48 divisions.	£1.00

Item 325	**Correction** Panel meters 100µA f.s.d. 50 x 44mm rect.case 25 divisions.	£2.90
Item 326	1K pots. 25W ceramic wire wound, 40mm dia.	60p
Item 327	8R pots as above,64mm dia.	60p
Item 328	15R pots,w.w. linear, 36mm dia.	20p
Item 329	Pots, 33R,w.w.,linear, 36mm dia.	20p
Item 330	as above,50R,40mm dia.	20p
Item 331	" " ,100R, 36mm dia.	20p
Item 332	Ultrasonic transceiver pair	£1.00
Item 333	Insert microphones, 600R	40p
Items 336 - 343 (see Bull.140)	Resistors, $\frac{1}{3}$W, in range of standard values. in sequence: 270R; 100R; 1K0; 2K2; 4K7; 10K; 47K & 100K	1p
Item 372	12V d.c. geared motor heavy duty windscreen wiper motor, 60 rpm, 1.5A full load, 2½"x7", (as new) NOT the type with flexible drive suitable for wave power applications in Bull.137.	£5.50
Item 214	(Bulletin 133) 12V d.c. motor by Smiths, HP, spindle $\frac{1}{4}$" x $1\frac{1}{4}$" long, motor -ca.4" x 3" dia. single shaft.	£2.50
Item 215	(Bulletin 133) as 214 but double shafted	£2.50
Item 388	Planar gas discharge display 7 x 7 segment digits, each 1" high, 155V d.c.	20p

Photographic

Item 89	Ilford Ilfofix powder per box	30p
Item 205	Kodak DPC paper developer 5l for both RC & bromide papers	£1.00
Item 206	Ilfospeed paper developer 5l	£3.50
Item 236	Bromide paper,WSG3,100 sh. 16.5 x 21.6cm	£5.00
Item 237	FP4, cine film,35mm,b/w, 200' can, 125ASA.	£3.00
Item 243	Ilford Safety film, SP352 10.2 x 12.7cm.,25 sheets.	£1.00

Precision motor control

Item 352	Motor, precision d.c. Portescap obsolete stock with 3101:1 gearbox (see next two items for seperate motor and gearbox)	£6.50
Item 373	Portescap motor, 1524 E012 SG-131, suitable for servo mechanisms or for solar cell applications, operating current 1-3mA	£4-50
Item 374	Gearbox for above motor, 3101:1, rate - few degrees per second.	£2.30
Item 375	As above but 141:1, rate: 0.5rev per second	£3.00
Item 376	Portescap motor, 26SR1701B02C6 -suitable for servo speed control, operating current 10-100mA	£2.50

Item 377	Portescap motor, M11 208 21 gearbox & helipot in one unit (small stock only)	£3.00
Item 378	Encoder disk with 15 slots stainless steel, precision manufacture. Ext. dia.30mm shaft diameter 4.5mm.	50p

N.B. We also have a varied stock of precision multiturn pots suitable for use in control applications. These were donated by Beckman via a Fife school. Please write in for a detailed stock list.

MCC 'Switch Applications'

The following section consists of items grouped because of their likely usefulness in S1/S2 for schools seeking to pursue suggestions made in the recent published Microelectronic, Computing and the Curriculum project publication (see "Physics Notes").

Item 389	Motors, model BM6,27mm dia. 35mm long, plain spindle, without trailing leads, rating: 180mA @6V unloaded.	40p
Item 351	Motors,model BM1,20x18x7mm, worm gear output, open case useful to demonstrate construction. rating: 80mA @ 6V unloaded.	25p
Item 313	Thermostat, skeleton type with open construction for demonstrating bimetallic switching. Rated 10A, 250V.	60p
Item 380	Thermostat with 20" capillary (can be activated by heat of human hand). Rated 10A, 250V.	£1.25
Item 165	Bimetallic strip, 30cm.	40p
Item 353	Reed switch, s.p.s.t., length 80mm, large size aids demonstration of principle of operation.	15p
Item 354	Reed switch, s.p.s.t., length 46mm.	10p
Item 316	Miniature relays, 12V, 700 , d.p.d.t.	75p
Item 381	Switch, single pole, (s.p.s.t.).	20p
Item 382	Switch,6 pole,8 way wafer.	65p
Item 383	Switch, single pole, changeover,(s.p.d.t.).	20p
Item 348	Submersible pump, 12V d.c. nylon, corrosion free with strong pumping action.	£5.60
Item 384	Bilge pump, 12V d.c., with strong pumping action.	£5.50
Item 349	Dual action, water valve, 12V d.c., nylon, corrosion free.	£7.90
Item 385	Water level switch, operated by pressures of approx. 6-12"(sic.) rated 15A,250V. Size: 3" dia. x 2".	65p
Item 344	Fans, 12V, d.c., possibly ex heater fans from motors very quiet with speed controlled by voltage	£4.00
Item 386	Light dependent resistors resistance limits: dark - 1K to 4K, light 10R to 50R.	55p

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ELECTRONICS NOTES

Precision motors

In Bulletin 139 we advertised the availability of notes on servo mechanisms. This work we saw as relevant to the 'H' grade Physics option on analogue electronics as well as to 'H' grade Engineering Science. A special purchase of precision d.c. motors with large reduction gearboxes had also been made by us for resale to schools. These motors are suitable for servo control applications. For further detail of such sale offers see "Surplus Equipment Offers" in this issue.

Our work on motor control has continued since Bulletin 139 and we are now able to offer additional sets of notes on different aspects of servo mechanisms. We have also, of late, been working with stepper motors. Our notes on this work have still to be produced, but please order them if interested as the pressure of demand would ensure that they get finished! The basic charges made are nominal and are to cover copying costs.

1. Servo mechanisms, angular position control 15p

   -(new edition of earlier notes, expanded and re-written)

   Based on 741 op amp wired as a high gain amplifier. Suitable for 'H' grade courses.

2. Servo mechanisms, speed control 40p

   - two tachometer systems outlined (555 timer and 2917 ic) with servo control achieved by 741 op amp. Suitable for 'H' grade courses.

3. Servo motor control using ic ZN409 40p

   - gives details of a servo controlled angular position system using the BBC model B microcomputer. Includes full software listing.

4. Stepper motor control 40p

   - will deal with hard-wired control and software control by microcomputer of stepper motors.

Please add 25p to any payment for these notes to cover postage costs. Orders for under £2 in total should be accompanied by payment in SSSERC's favour. It is not economic for us to issue invoices for very small amounts.

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TRADE NEWS

Electronic stopwatches

We are often asked for sources of inexpensive models of these and until now have been unaware of anything on the conventional laboratory supplies market below about £15. However we have recently come across a supply which, if bought in quantity, even breaks the £10 barrier.

Hogg Laboratory Supplies are currently advertising an "Electronic Stopwatch" at £10.40 each or £9.36 for ten or more. In the stopwatch mode the display goes up to 12 hours by divisions of 0.01 seconds. The device also has lap and split timing facilities as well as a normal watch mode with alarm.

There are other less conventional routes to similar, possibly even cheaper, electronic timing. For some time a number of schools have been d-i-y mounting cheap electronic watch movements (a contradiction in terms?). One source of these are innumerable special offers on garage forecourts etc. The latest manifestation to us of this activity was at an exhibition of work to mark the 20th anniversary of the Fife Technician Service. Viewforth High was showing the use of the cheapest Casio stopwatch model with the "mode" button removed. The watch was then mounted on a block of wood or the inevitable section of plastic drainpipe.

Pulse monitor

We ran a "Foundation Science Notes" article on pulse monitors as far back as Bulletin 132. Since then large,coin in the slot, models seem to have sprouted like electronic weeds in swimming pool and sports hall foyers. This reflects the interest taken in such matters these days. One is given to hope that we are not about to face a general epidemic of hypochondria!

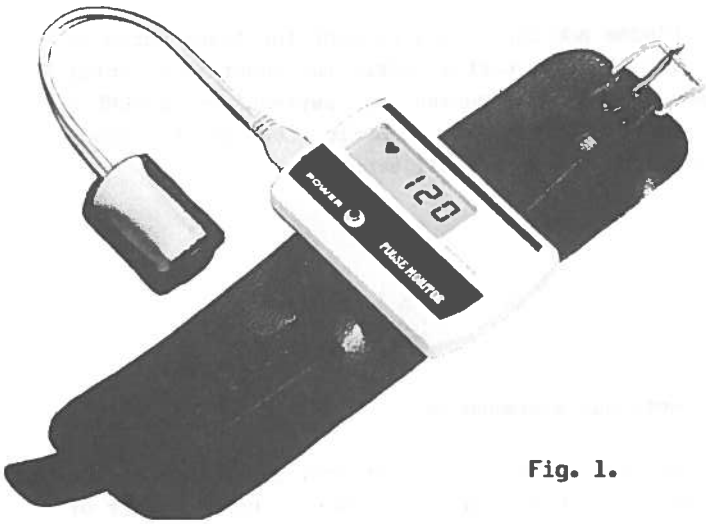

Fig. 1.

There have been a number of developments in more portable monitors over the two years since our short review. More micro-processor based, digital models have begun to appear. At the same time models are appearing with fewer external controls or functions. This is to meet a demand from exercisers who wanted simple models without lots of buttons (which ensured the fulfillment of Murphy's Law - that they always pressed the wrong one).

Fewer controls does not necessarily mean a lower price. Hence the single on-off control, PU-11 digital model from Andrew Stephens replaces the more complex "Actimeter", which we had been exhibiting, but at £45 actually costs slightly more. The PU-11 is shown in Fig.1. It utilises the usual opto-electronic sensor on the fingertip but contains an LSI (large scale integrated circuit) which measures the interval between several pulse beats and computes and displays a continually updated average of the pulse rate over the previous eight beats.

Disposable pipettes

Some years ago we began advocating the use of disposable, plastic transfer pipettes in place of glass types. This we did on grounds of both safety and economy. Tips do not easily break off and the polythene types will withstand many fills with corrosive liquids and most solvents. One of the cheapest sources of these items known to us is Atom Medical . This firm will supply the three different kinds of transfer pipette tabulated below, all at £9-45 per 1000 for the non-sterile forms. (Carriage is payable on orders for less than 10,000 pieces).

Type/ Volume (cm)	Graduated	Cat.No.
1.0	x 0.25	A-100
3.0	x 0.5	A-110
'microtip'		A-105

A new larger size of pipette has also appeared on the market. The "Maxi-pastette 204" will hold up to 6cm and sells at £9 per 400 for the non-sterile form. It is available from Alpha Laboratories as catalogue item LW 4204.

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SCET Microelectronics Project

Individualised Learning Materials

The Scottish Council for Educational Technology (SCET) has recently completed an investigation into the possible role of a microcomputer in an individualised learning course in digital electronics. The investigation was undertaken by Mr R.A. Sparkes, now at Stirling University.
Although not central to the project, an individualised learning course for the 'H' Grade Physics Option R has been developed and tested. It consists of individualised learning texts which guide students through the course enabling them to work if necessary with minimum supervision and tuition.

It is intended that two versions of the course will be available. It may be possible to incorporate these in one set of learning materials. The written texts will be available through colleagues on the distribution list for national examplar materials (REFER System). No arrangements are being made for the central ordering of equipment, but full details will be included in the teachers' notes accompanying the written text.

Version I.Spectrum 48K plus Tutorkit

This version requires access to the following equipment:-

1. Limrose Tutorkit LT2 (£21 app. unassembled)
(£28 app. assembled)

2. Griffin I Pack for Spectrum (Cat. No. CRA-776-F, £35 app.).

3. Logic Board

(a) A list of components plus circuit diagram will be made available. A set 2mm connecting leads will be required. Total price £5 - £7, **or:**
(b) Griffin programmable logic board at £10 to £12 including leads.

4. Computer programs on cassette.

Version II BBC Model B plus Tutorkit

Requires:
1. Limrose Tutorkit LT2 (£21 approx. unassembled).

2. Logic Board (as described in 3a above), plus Griffin I Pack for the Beeb (Interbeeb, Cat.No. CRA-950-010N at approx £60.)**or:**

3. An alternative, but more expensive version of the logic board can be constructed from the list of components and circuit diagrams. In this case a separate interface will not be needed.

4. Computer programs on 40 track disc.(It is possible to then copy these programs onto cassette tape).

Further information on the materials can be obtained by directing individual questions in writing to:

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GLASGOW G12 9JN

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