SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

Bulletin No. 108. October, 1978.

Contents

Introduction

We are well into the compilation of a revised equipment list for the Integrated Science Course, taking into account the modifications made by the National Working Party on mixed ability science in S1 and S2, and which are embodied in the New Science Worksheets published by Heinemann last year. Before finalising the list we would appeal to teachers who may have found difficulty with any piece of apparatus, or misprints in the text such as the one we noted in Bulletin 107, to get in touch with us. This will not only make the equipment list more effective, but will enable us to investigate the troubles teachers are experiencing and hopefully to find solutions which can be publicised in the bulletin.

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We would remind teachers that, with the exceptions noted below, the Centre is open on Saturday mornings until 1 p.m., although only one member of staff is present. The Centre will be closed from 23 - 26 December, and from 30 December - 3 January, 1979, all dates inclusive.

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Many teachers may know that the Health and Safety Executive have carried out a pilot study of the situation in schools and F.E. establishments in the Manchester area. Their report, which is called Pilot Study, Health and Safety in Schools and Further Education Establishments is now available and costs £3. The survey was carried out by a senior Factory Inspector assisted by a number of colleagues, and the executive stress that the report is therefore a personal assessment by inspectors of conditions found in the establishments visited, and is not in any sense a scientifically based sample survey.

The foreword mentions that a number of visits to schools and F.E. colleges were paid by the Factory Inspectorate in Scotland. The visits followed consultation with the S.E.D. and schools inspectors and were intended to take account of any differences in the organisation of education services in Scotland. Presumably none of any significance were found as Scotland is not thereafter mentioned in the report.

Running as it does to 104 pages, it is impossible to give more than a few snippets which we hope will convey the flavour of the whole.

"Non-teaching staff appear to bear the brunt of the serious accidents and on our limited information appear to account for some 86% of the total to employees. The study was hampered by the lack of accident statistics and as a result we found it necessary to examine in detail more establishments than were first thought necessary in order that a reasonably detailed account could be given of the type of hazard to be found in Education. A polytechnic and seven other further education establishments were inspected. Nine schools of different type from an urban primary to a residential public were seen."

Examination of the list of accidents shows that most are the type of thing which could just as easily happen at home: people tripping and falling, slipping on icy playgrounds etc. One or two teachers lost fingers in the circular saw. Out of over 2,000 cases of serious or minor injury, three occurred in science laboratories. There were two cases of acid burns following the addition of sulphuric acid to potassium permanganate, and one of a damaged ear drum after a hydrogen peroxide explosion.

"Local education authorities do not appear to be fully cognisant of their responsibilities under the Act and tend to leave to the teaching staff the duty of providing adequate supervision, instruction and training in safe methods of work. Safety seems to depend on the approach of the person in charge of each establishment and generally there is little safety expertise apparent within establishments and little guidance from local education authorities.

Nevertheless, education appears to be a safe activity. The apparent hazards increase the higher the form of education and the hazards found are very ordinary, with occasional examples of major risks. There is very little indeed to cause serious concern in junior schools and even in higher forms of education there is little risk to either teaching staff or students.

Ancillary workers suffer over 80% of known accidents and yet they do not appear to receive adequate attention so far as safety organisation, safety rules and advisory literature is concerned. Nevertheless ancillary activities are no more hazardous than similar activities in other industries. Most of the apparent hazards, particularly to ancillary staff, are of a sort which are already found in premises subject to the Factories Act 1961 or the Offices, Shops and Railway Premises Act 1963.

Where activities are undertaken which occur in other premises subject to the Factories Act conditions are generally poorer within educational establishments. However, the hazards arising from the poor conditions are usually greatly reduced by the educational environment. For example, machinery is generally poorly guarded, but few accidents occur because of under-use, stricter discipline, lack of production pressure and the natural caution of the inexperienced operator." (paras. 210-214).

"180. Some parties in the (educational) structure appear to have no obligation, duties or rights under the Act. DES, for instance, is not an employer (apart from its own civil servants and a few directly run establishments) of persons working in education. It does not control premises used by persons who are not their employees, nor does it design or supply articles or substances for use in the education world.

181. Schools inspectors are similarly placed. They do not have duties under the HSW Act under any of the categories mentioned above, but while at work they have general duties laid upon every employee by section 7(a) of the Act, to take reasonable care for the health and safety of himself and other persons.

182. Section 7(a) makes, de facto, very similar claims on schools inspectors as it does upon teachers whose position is considered below. The position is unusual however in that the duty under section 7(a) holds, despite the fact that the inspectors'

employer, i.e. DES, has no duty itself under the HSW Act and, in consequence schools inspectors have no duty under section 7(b), that is to co-operate to enable his employer to comply with his duties under the Act.

183. The duty comes nearer home if during his work in college a schools inspector might be specifically responsible for advising on safety, and fails to mention a particular matter, say, the guarding of a dangerous part of a machine. It seems there then might be, prima facie, a breach of duty under section 7(a).

184. The teacher has a similar duty, but this extends to section 7(b) because since his employer (the LEA or a board of governors) has duties and obligations imposed by the relevant statutory provisions, he, the teacher, has to co-operate so far as is necessary to enable that duty, or requirement, to be performed, or complied with.

185. There has been considerable misunderstanding about the extent of the teacher's duty under section 7(a) and there has been a tendency to assign to teachers duties which they do not have. The argument has been that the HSW Act requires local education authorities to provide safe conditions, including safe apparatus, fittings and laboratory space etc. This having been done, the teacher, it is said, is responsible if unsafe procedures or inadequate apparatus are used.

186. This widely held view is misleading in two respects. First because it lays upon teachers duties far beyond those set out in the Act, and second because it changes the thrust of the Act and directs it towards the protection of students and pupils, whereas it is, in fact, the teacher as an employee who is equally entitled to this protection. Only by due process of delegation could an LEA shift the substantial part of its responsibility to teachers. Delegation is an individual overt act, precisely defined in the authorities.

187. A teacher is paid to exercise control, but the principal responsibility for carrying out the provisions of the HSW Act lies with LEAs because they are the employers. Their main duty is towards their employees, the teachers, lecturers, technicians and multifarious non-teaching staff. These duties extend beyond the provision of safe conditions (apparatus, premises), to include safe systems of work and the maintenance of such systems and such apparatus and premises, and the like. The teacher is often the instrument whereby these duties are carried out, but does not himself thereby necessarily assume the LEA's responsibility.

188. The LEA has these general duties which are assigned to all employers. It has in addition to the duties in connection with plant and systems of work mentioned in the previous paragraph, the obligation to maintain them."

Sections 7(a) and (b) of the HSW Act, referred to above, state:

"It shall be the duty of every employee at work to -

a) to take reasonable care for the health and safety of himself and of other persons who may be affected by his acts or omissions at work: and

b) as regards any duty or requirement imposed on his employer or any other person by or under any of the relevant statutory provisions, to co-operate with him so far as is necessary to enable that duty or requirement to be performed or complied with".

The final sentences of paras. 186 and 187 would seem to be crucial to an understanding of the teacher's position. The second of these is vague enough to be tested only through the courts with the result depending on the circumstances of each individual case. But what is meant by 'Delegation is an individual overt act, precisely defined in (sic) the authorities"? Are all the delegators aware of the precise definition, so that they know, and the recipients know, when they have properly delegated? They may include science advisers delegating to principal teachers of science, and principal teachers delegating to technicians. Where technicians are appointed by the LEA's personnel department to serve the whole needs of the school, under the supervision of an assistant headmaster, the chain of command, and possibly the process of delegation, side-steps both science adviser and subject teacher.

In a section on the role of the school inspector in health and safety, the pilot study report comments (para. 37) "D.E.S. is quite clear that the role stops short of direction and the schools inspectors' advice must remain just that. This apart, schools inspectors and H.S.E. inspectors have very similar objectives". This has always been the attitude of the Scottish Education Department, that while they will advise on safety matters, the responsibility for action must lie with the education authority.

In the past the S.E.D. had a responsibility to examine plans for any new school, and this might have been expected to carry some responsibility for safety, particularly if the inspector concerned failed to point out some aspect, e.g. the omission of flammables storage provision, which constituted a potential hazard. Perhaps fortunately for the S.E.D., this responsibility ceased with regionalisation and the department does not now oversee plans or exercise any control other than financial, over new building by a regional authority. It would therefore seem to be in the interests of the authority that its architects have an early consultation with H.S.E. inspectors on safety aspects in order to avoid expensive mistakes later on. Flammables storage is only one aspect of the matter, although one to which we shall return in a later bulletin; one school visited by an inspector has been criticised for having a row of gas cookers sited along a window wall where sunlight made the flame almost invisible and draughts could blow out the pilot lights.

Biology Notes

At recent exhibitions we have held considerable interest has been shown in a pulse rate meter we have built. Most such designs, and we have made one or two ourselves and tried some sent to us by teachers and technicians, use a microphone or similar pressure transducer to detect the pulse beat of the carotid artery. Apart from the difficulty of finding it, the subject must then remain silent and preferably without breathing if the rhythm is not to be masked by the pick-up produced by these activities.

The alternative of using an optical method had been suggested to us some time ago and for a time we experimented with a lamp and photo-electric cell placed on either side of the subject's earlobe. For several reasons this was unsatisfactory and we were very interested to find a design published by the National Centre for School Technology which used the blood flow in the forefinger. The design is called Construction Guide No. 1, Pulse Rate Meter, and costs 50p plus 15p postage.

In principle this uses a small lamp bulb and ORP12 photoresistor inside a small lightproof can. When the subject's forefinger is in position light is reflected off the bone or the fingernail onto the ORP12. Dilation of the blood vessels during the pulse reduces the amount of light reaching the detector, producing a variation in the electrical signal, which is then amplified so that it operates a light which flashes in time with the pulse. There is also a 0-100 current meter which gives the pulse rate directly in beats per minute, and a x2 range switch.

We have made one or two slight modifications to the NCST circuit, omitting the earphone which gave an audible bleep when the light flashed and adding a pair of output terminals so that the beat could be shown on an oscilloscope, or made to operate a chart recorder. These changes in turn meant some modification of the internal circuitry, but the basic design is still that of NCST. Hence we decided not to publish it in full here, but we will send our own design and constructional details to any of our readers enclosing a stamped self-addressed envelope (227 x 100mm size). The cost of the circuit components is about £8, excluding the ammeter, batteries and a box to house everything.

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In the 'Teachers' Guide to the "New Science Worksheets" for S1 and S2, it is suggested (Section 6.1, page 113) that microfilm can be used as a test object to check that pupils can properly manipulate and focus a microscope. A number of teachers have mentioned to us their difficulty in obtaining suitable pieces of microfilm. Craigmount High School, Edinburgh suggested alternative test objects which appealed to us because they had the virtue of being relevant to other parts of the course. The suggestion was to use a 35mm negative showing the names of animals rather than use any odd pieces of microfilm obtained regardless of their content. Such test objects are easily prepared by photographing a 'master' sheet at a suitable distance. The lettering on this sheet requires to be of such a size that in the final format of the 35mm negative it cannot be read without magnification. However this final letter size should not too closely approach the film grain size which would make for difficulty in deciphering the image. Through a series of trials at the centre and by trying out the slides in a school, we have arrived at a basic recipe for

LION

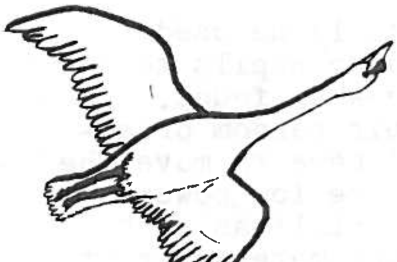
HEDGEHOG

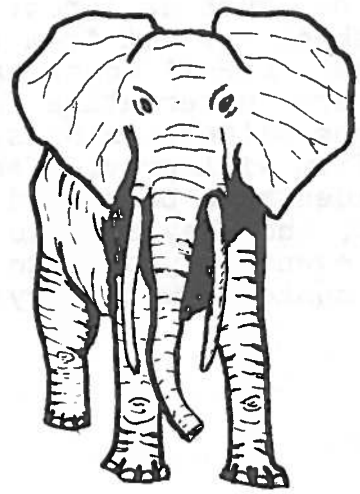
ELEPHANT

KANGAROO

SPARROW

THRUSH





producing suitable test slides. We have by no means exhausted the possibilities and offer the following account merely as a starting point.

We wanted a photographic negative which could be used directly with the microscope, which would require pupils to search but which would be readily recognisable when found. Hence the different sizes of the image and their random orientation. We also wanted that the pupils would have to move the slide around to find all the objects, even on the low power objective. It occurred to us that if the material was to be used by mixed ability classes, we should prepare material that did not depend on reading ability, hence the non-verbal sheet. We copied the drawings from the picture cards for Section 2 - supplied as 'sheets for reproduction' in Teachers' Guide, Sections 1-8.

These conditions will be obtained if the bulletin page is removed and photographed against a dark background at a distance of 2 metres. We used a 35mm SLR camera, fitted with a 50mm lens, and Ilford FP4 125 ASA film. Tripod and cable release were used to eliminate camera shake. Lighting was by means of three 500W photoflood lamps and under these conditions 1/30s at f8 was a satisfactory exposure. The negatives were developed using a fine grain developer such as 'Promicrol' or 'Acufine'. The image of the master sheet was cut from the film and mounted on a microscope slide under 'DePex' mounting medium and a coverslip. A quicker and cheaper alternative is to sandwich the negative between two microscope slides, using selotape to bind them together. One roll of film will provide enough slides for a class set. The test slides have been used with pupils of average and below-average ability, and they seem to fulfil their purpose in that most pupils were eventually able to use the microscope in order to identify the contents with varying degrees of difficulty.

Chemistry Notes

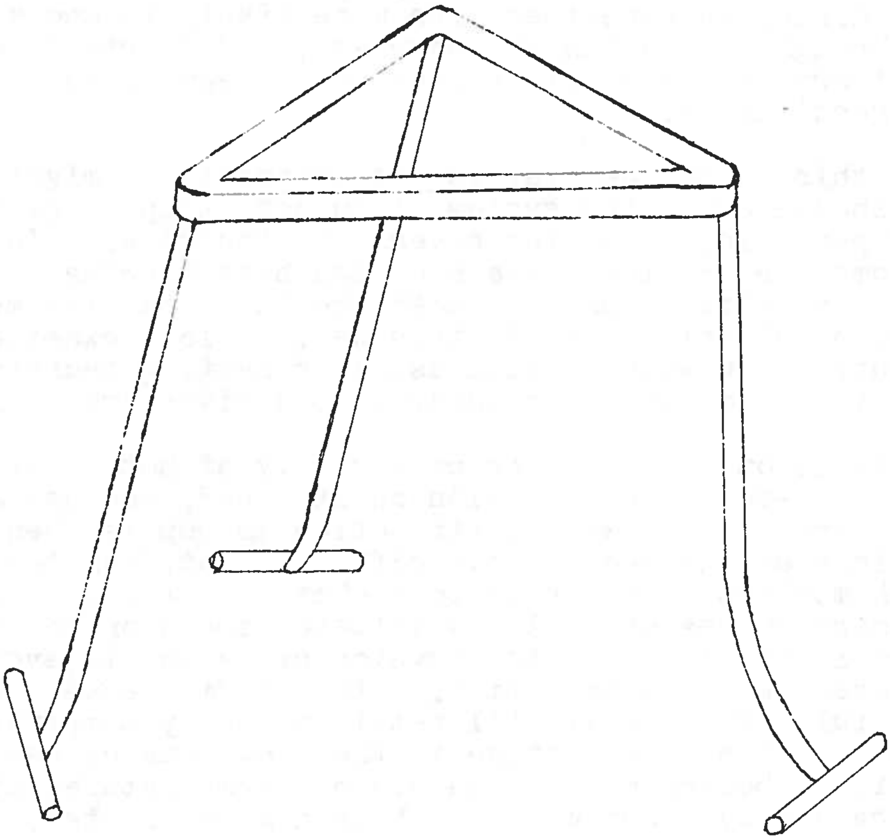
Heating a liquid in a beaker set on a gauze-topped tripod is such a common procedure in school laboratories that many teachers do not stop to consider how hazardous it can be, or whether a safer alternative is possible. Beakers can break, showering their contents on the bench or on incautiously placed hands and arms. It is also worth remembering that when some of our younger pupils are seated watching the liquid bubbling their faces may be at or below beaker level and hence be at risk. Wire gauze which does not have folded edges (and even some which do) can catch on clothing or on dusters used to lift off the hot beaker. The naked flame can ignite such cloth or singe long hair. Doubtless one should insist on the use of proper tongs to lift off beakers, but as long as these are expensive they are unlikely to be provided in sufficient quantity. Books dragged on the bench can pull Bunsen burners out of place via the tubing, can snag on the tripod and topple it. Children who are justifiably apprehensive about adjusting a burner during an experiment are more likely to knock over the tripod through an involuntary movement. Hot tripods which have to be put away after an experiment are a regular source of burns to childrens' hands.

All this - and the list is not exhaustive - might suggest that we should avoid the system of burner, tripod, gauze, beaker wherever possible. Yet the reverse is the case. In how many prep. rooms are the technicians or teachers brewing tea in this manner! The fire which initiated the investigation mentioned in Bulletin 107 originated in this way. Close examination of the situations in which pupils use this heating technique will surely reveal some in which safer alternatives are possible.

If it is only a question of a supply of hot water, can you turn the back-room tea situation on its head, and use a domestic kettle to provide it, with distribution to pupils when needed by an auxiliary or the teacher himself? If not, can the children supply themselves from a plastic bucket of water heated by a mains immersion heater? A low voltage immersion heater, the type used in Section K of the physics syllabus, is even safer and moreover is self-regulating. In a 500ml beaker three-quarters full of water it will remain a steady temperature of about 70°C. Its disadvantage is the slow rate of heat production, so that it is better used to maintain a temperature which has been quickly raised by other means such as a mains heater.

When steam baths are needed for evaporation or other purposes, metal cans (syrup tins) are a better alternative than beakers. Besides being unbreakable themselves, they allow one to dispense with that other source of hazard, the wire gauze. Wherever possible, vessels on tripods should be allowed to cool naturally until they can be safely lifted with the hands, rather than use any lifting tool. The inherent risk in the beaker/tripod system is its low stability. A 500ml beaker 2/3 full of water weighs about 450g, the tripod and gauze less than 400g, and most of this is concentrated at the top. Hence the centre of gravity of the system must lie a good way up from the base of the beaker. This means that a slight sideways blow may be enough to cause the system to topple.

The stability of the tripod could be considerably increased by shortening its legs and using a low form of burner. Ideally this should have its air control outside the base so that it is not necessary either to place a hand underneath the tripod or to withdraw the burner for adjustment. It seems unlikely that manufacturers will produce such a burner at a reasonable price. A practical way of increasing the stability of the tripod is shown below. 5cm lengths of 5mm dia. iron wire are brazed on to each tripod foot at right angles to the leg. The modified tripod required to be tilted through 26° before it would fall over, compared with 18° for a standard model. In turn this means that the displacing force needed to make it fall would be half as much again. Such modified tripods can still be stacked inside one another.



Trade News

The Chemistry department of Moray House College of Education have the following back numbers of School Science Review for sale at 20p per copy: 143, 153-5, 163-4, 167, 171-6, 178, 180, 183, 186-9. Intending purchasers please contact the chemistry department direct.

Philip Harris have informed us that they cannot now offer the plutonium 239 radio-active source (P66380/9) as the Radiochemical Centre have stopped production of the foils. The Americian 241 is not such a good alternative source of alpha particles as some 2% of the transmutations produce gamma radiation. Unfortunately it seems that this will be the only α source available in future.

Parisian Optical are offering at approximately half price, two microscopes which we have had in the Centre for display and evaluation. They are (i) Carton model KW microscope stand with coarse and fine focussing, fixed condenser lens and substage disc diaphragm, x10 widefield eyepiece with pointer, x4/0.15 and x10/0.25 objectives on a triple rotating nosepiece. There is no third objective (which would normally be a x40). Price £36. (ii) Carton model KWH microscope as above but with a scroll focussing; Abbe condenser, x10/0.25, x40/0.65 and x100 oil immersion objectives. Price £48.60. In both cases the cheque or official order should be sent to SSSERC but anyone intending to purchase either instrument should telephone us first to see if it is still available.

We can again offer bi-metallic strip, 6 x 0.4mm at 15p for 10cm lengths and 20p for 15cm lengths.

Bulletin Supplement

Summary of microscope tests. The instruments listed below were tested according to our published procedures for 'H' grade microscopes. 'Phase contrast' refers to the relevant specifications in Bulletin 46. Individual, detailed reports can be borrowed for one month by writing to the Director. The classifications used are: A - most suitable: B - satisfactory for school use; C - unsatisfactory.

Model	452*	462*	HSM Student
Manufacturer	Prior	Prior	Bausch and Lomb
Supplier	Prior	Prior	Bausch and Lomb
Price	£86	£112	ca. £100-150 depending on specification.
Eyepiece	x10, widefield	x10, widefield	x10, with pointer choice of widefield or Huygenian.
Objectives	x4/0.12; x10/0.18 or x10/0.25; x40/0.65(S)	x4/0.12; x10/0.18 or x10/0.25; x40/0.65(S)	x4/0.10: x10/0.25; x40/0.65;
Optical Head	Upright	Upright	Upright or Inclined
Condenser	Simple, 0.65 N.A.	Abbe, 1.2 N.A. or	1) Simple, 0.65 N.A. 2) Abbe, 1.25 N.A.
Condenser focussing	None (fixed lens)	Rack and pinion	1) None (fixed lens); 2) Spiral mount
Phase contrast	Available, becomes model 454 at £111.60	Available, becomes model 464 at £169	Not available
Illumination	Mains and 12V lamps available	Mains and 12V lamps available	Mains lamp
Assessment	B**	B**	B

* New 'Lightweight' models.

** Only when fitted with the optional x10/0.25 objective at extra cost of £2.50. With the x10/0.18 objective - C because of an unsatisfactory optical performance.

(S) Spring loaded objectives.

S.S.S.E.R.C., 103 Broughton Street, Edinburgh, EH1 3RZ
Tel. No. 031 556 2184.

Bausch and Lomb Optical Co Ltd, Lenten House, Lenten Street, Alton, Hampshire, GU34 1JD.

Philip Harris Ltd, 34-36 Strathmore House, Town Centre, East Kilbride G74 1LQ.

Health and Safety Executive, Baynards House, Chepstow Place, London W2 4TF.

Moray House College of Education, Holyrood Road, Edinburgh,
Tel. No. 031 556 8455, Ext. 251.

National Centre for School Technology, Trent Polytechnic, Burton Street, Nottingham, NG1 4BU.

Parisian Optical, 24/25 Princes Street, Hanover Square, London W1R 7RG.