SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No. 133 November, 1982

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CO_2 is also taken by Distillers from sources available at the following locations. (N.B. these are **not** order points. You must order through one of the addresses listed above): Cameronbridge, Fife; Carsebridge, Clacks; Haymarket, Edinburgh.

Gerrard Biological Centre, Gerrard House, Worthing Road, East Preston, West Sussex BN16 1AS (Tel. 09062 72071)

Griffin and George Ltd., Ledson Road, Wythenshawe, Manchester, M23 6NP. (Tel. 041 248 5680)

Philip Harris Limited, 34-36 Strathmore House, Town Centre, East Kilbride. (Tel. 03552 34983/4)

Philip Harris Biological Ltd., Oldmixon, Weston-super-Mare, Avon, BS24 9BJ. (Tel. 0934 413063)

Prior Scientific, London Road, Bishop's Stortford, Herts CM23 5NB (Tel. 0279 506 414)

RS Components Ltd., P.O. Box 427, 13-17 Epworth Street, London EC2P 2HA. (Tel. 01 253 1222 - Order dept. 01 253 3040 or 01 251 1676).

Science Studio (Oxford) Ltd., 7 Little Clarendon Street, Oxford, OX1 2HP. (Tel. 0865 54022)

Technical and Optical Equipment (London) Ltd., Zenith House, The Hyde, Edgeware Road, London, NW9 6EE. (Tel. 01 200 6505)

WPA, (Walden Precision Apparatus) Ltd., Shire Hill, Saffron Walden, Essex, CB11 3BD. (Tel. 0799 23028 and 27104).

Introduction

Surplus Equipment

This bulletin contains a list of equipment offered for sale subject to the conditions set out in Bulletin 116. We would ask prospective buyers to read carefully those conditions in order that unnecessary telephone calls and paperwork may be avoided.

Festive Season Closure

Readers should note that the Centre will be closed from 24th December 1982, through to the 3rd of January, 1983 inclusive. Until last year we used to remain open on the few days between Christmas and Hogmanay but folk rarely came (all together - aah, shame!). We closed last year because, with a small staff, it is difficult to keep on asking for volunteers to be on duty. No thwarted visitors complained, so we all intend to have the same Merry Christmas and Happy New Year we wish to all of you.

Saturday mornings

Readers are reminded that Saturday morning opening is still restricted to the first two Saturdays of the month.

Planning Committee

Under the terms of the committee's constitution half of the teacher membership of the SSSERC Planning Committee resigned after the Summer meeting and the new members attended their first meeting in September. One of the roles of a planning committee member is to act as one channel of communication between science teachers and Centre staff. In order that teachers can identify a SSSERC Planning Committee member when they see one, we give below the composition of the Committee. This, of course, is not the sole route for criticism, comment on SSSERC's work or, dare we hope - praise. However it may be useful for teachers to know that in some areas at least, such a route exists. We should perhaps point out that some attempt is made to achieve geographical balance by long term rotation of membership around the Regions.

SSSERC Planning Committee

Chairman	Mr. I. Young, Science Adviser (Renfrew and Argyll)
SED Assessor	Mr. H.M. McLaren HMI
Central Committee representative	Mr. A.H. Sloss (SCDS, Dundee Centre)
Technician member	Mr. S. King, Chief Science Technician, Woodlands Teachers' Centre, Glasgow.

Teacher members:

Mr. S. Robertson (Secretary)	P.T. Physics, St. Augustine's High School, Edinburgh. (Lothian)
Mr. D. Carnie	P.T. Physics, Dingwall Academy (Highland)
Miss C. Mathieson	P.T. Biology, Dumfries Academy (Dumfries and Galloway)
Mr. J.C. Pattison	P.T. Biology, Eastwood High, Newton Mearns, Glasgow. (Renfrew, Strathclyde)
Mr. A. Mackenzie	P.T. Chemistry, Peterhead Academy (Grampian)
Mr. G. Young	P.T. Chemistry, Bo'ness Academy (Central)

Co-opted: Mr. D. Tawney, Director, CLEAPSE

Officials: Mr. J. Richardson, Director, SSSERC.

Obituary Mr. J.N. Emery

It is with deep regret that we inform our readership of the recent death of John Nicholas Emery, M.A. of Glenalmond. John Emery, who was very well known amongst Scottish physics teachers, will be sorely missed by all who were fortunate to meet him. John taught physics at Trinity College, Glenalmond and was among the smallish band of enthusiasts who did so much pioneering work in bringing in the new physics syllabuses in the sixties.

An accomplished practical engineer as well as an excellent physicist, John was exceptionally skilled with his hands. I once heard it said of him that he was that rare kind of man who "given a couple of hours could knock you out a new watch on a lathe". These skills were put to very good effect in producing his best known invention - the 'Venner' stopclock. However this was only one of the many pieces of science teaching equipment which he designed or developed during his long and fruitful career. His considerable contributions were recognised by the ASE of which he was made an Honorary Member. Science education in the UK was the richer for his involvement. He will be sorely missed.

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CLEAPSE Guides

We have recently received the following new or revised guides from our sister organisation furth of the border. Copies of these guides may be borrowed for up to one month by writing to the Director of SSSERC.

L24b ''Microscopes and Magnifiers for Middle Schools''

L122s ''Electric Circuit Work for Secondary Schools: Worcester Circuit Boards and Circuit Kits''. In two parts, Part A discusses the relative merits of board and boardless systems; maintenance and choice of lamps and power supplies (rechargeable or disposable cells etc); d-i-y systems (N.B. see WOR below). Part B compares various commercial boards and kits.

L139 ''Amplifiers for Biology Teaching''. Discusses amplifiers for ECG and animal nerve activity experiments. With advice on safety and on the problems of getting experiments to work.

L157p ''Thermometers for Primary Schools''

L164a ''Heating in Primary Science''

WOR ''Worcester Circuit Boards'' - a maintenance guide.

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Safety Notes

Air-guns again

Following the publication of a note of the hazards of using air-rifles in the lab. we have been sent an idea on

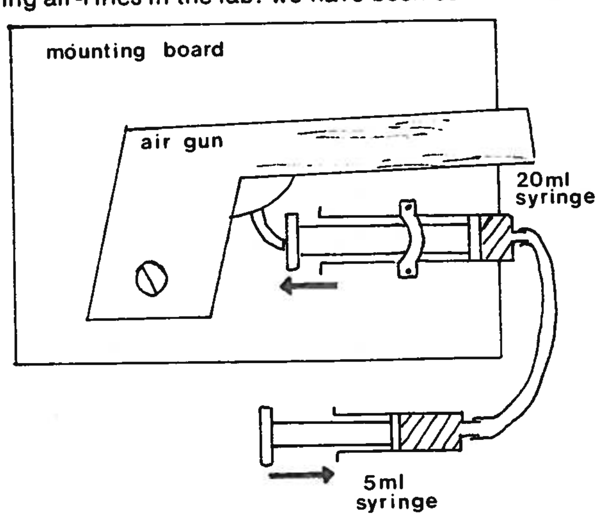

Fig. 1.

remote firing which, it is suggested, might further reduce the hazards. The design, by Mr. J. Rogerson, one-time technician at Selkirk High School, was not originally developed for safety reasons. It was intended to allow the measurement of recoil velocity with an air-pistol mounted on a trolley. This particular measurement proved difficult since the recoil velocity proved to be very small. However, the simple firing mechanism shown in Fig. 1 proved very reliable.

This idea may be worth adapting to air-guns bolted or clamped to baseboards. One obvious need is to add a small adaptor to allow the mechanism to be used with the majority of modern guns which have a trigger guard. This guard would interfere with the operation of the simple arrangement shown in Fig. 1. The main advantage, obviously, of such a remote firing mechanism is that it would allow the person operating it to retire behind a safety screen. We are grateful to Mr. Roxburgh of Selkirk High for sending in this idea.

''It makes you deaf, you know''.

''Who said that?'' - The principal teacher of physics who sent us a note following an incident involving a pupil using earphones with a signal generator. This teacher asked us to remind others that when anyone is using earphones they, alone, should be responsible for controlling the volume of the sound output.

Even when this common sense precaution is taken it is dangerous to make a discrete change in the frequency range if the source is a signal generator, since the result may be a large increase in perceived volume. A pupil in this particular teacher's school, made such a frequency change when using a headset and suffered nervous shock, headaches and temporarily impaired hearing. The output control should always be turned to its minimal setting before switching frequencies.

Murphy's Law

A recent correspondent reporting yet another 'near-miss' suggested that this law is universally applicable to school science experiments. This teacher wrote to us about an explosion in a zinc/acid type hydrogen generator. The apparatus was being used to generate test tube quantities of the gas. The pupils were to collect the hydrogen in a test-tube by the downward displacement of water. All permitted sources of ignition were remote, at the pupil's benches to which they were expressly instructed to return **before** investigating the flammability of the gas using the usual lit taper. Coincidence and human (ie. pupil) perversity combined to invoke Murphy:

a) The end of the delivery tube had come above the water. ...

b) A pupil then, despite clear instructions to the contrary, approached the generater with a lighted taper in his hand.

c) The reaction had not cleared all the air from the dead space in the flask.

Result - entirely predictable - an ear-aching explosion with broken glass scattered hither and yon. Fortunately the only casualty was a pupil who sustained minor cuts to one arm.

Even before this incident was reported to us, the SSSERC Planning Committee had asked for some investigation into safer ways of handling and burning flammable gases. What is fascinating is that incidents like this keep occurring, even though the hazards must be amongst the best publicised in science education. Our work will include investigations into some of the suggestions for improved safety made by this latest correspondent viz. the use of flame traps and plastic apparatus. What we can do about the other factor in such a Murphorial equation - pupil perversity - we really cannot say. We recall however, a particular "Not-the-Nine O'Clock News" sketch which made one, rather drastic, suggestion.

More cautionary tales

Full reports on the following incidents originally appeared in "Science News" a termly bulletin compiled and produced by the staff of the ILEA Science Centres and Science Inspectorate. The reports on the incidents are instructive, and we quote parts of them, with permission, below:

1) "As part of the 'Science at Work' course, a class experiment in casting was to be carried out, with a mixture of sulphur and carbon. This should have been melted in tin lids on sand trays, but the teacher was not aware that some pupils had put it direct on to the hot sand. The resulting combustion of sulphur filled the laboratory with sulphur dioxide. (We suspect some carbon disulphide may also have been formed, SSSERC Ed).

2) The revised Nuffield O-level Chemistry Teachers' book gives details of a teacher demonstration of the combination of a mixture of zinc powder and sulphur, stressing that only very small quantities must be used. A teacher was in the habit, instead, of heating several grammes of the mixture in a boiling tube. On the last such occasion there was an explosion, but, fortunately, the teacher escaped unhurt and the safety screen protected the class. (It should be noted, that as far as we are aware, this boiling tube scale method was a private, 'patent' one and has never been recommended in the usual texts etc. SSSERC Ed.)

3) A biology teacher was trying out some spectacular demonstrations for a forthcoming meeting of the school science club. He used all the obvious safety precautions, but was taking details for experiments from 'The Young Chemist', published in 1934, by the well-known historian and populariser of science, Sherwood Taylor. He intended to ignite a flash powder made from magnesium powder and potassium manganate (VII). Incredibly, the directions in this book call for the use of about 100g of mixture and give no warning of its very dangerous nature. It inflamed violently while preparations were being made to ignite it with touch paper, and the teacher was taken to hospital with extremely severe burns to the hands and wrists."

'Blazing Goggles' - again

Readers should note that the clips for holding back spare ends of goggle straps (Bulletin 132) are now available from Griffin and George. Details of these clips are given in the 'Trade News' section of this present bulletin.

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Foundation Science Notes

SSSERC 'Standard Hammer'

Experiments to investigate the properties of materials form part of the suggested activities in the proposed Core Topic 'Introduction to Materials' (Subtopic - "Properties and Uses"). The materials suggested include concretes and cements. Many of the piloting schools tried out one method for strength testing small cubes of these materials. This method was based on the use of a G-clamp with the number of turns of the screw to failure being used as an indicator of 'strength'. Unfortunately, judging by the feedback from the schools, this proved instead to be an excellent way of strength-testing G-clamps. It yielded only the comparative information that concretes and mortars may be more load resistant than metals. In short, the clamps broke before the concrete cubes did.

In response to requests for a more reliable method we developed the simple apparatus shown below (Fig. 1). Constructional details are set out in the "Workshop" section of this bulletin. The mode of operation of this standard hammer strength tester is fairly evident from the diagram.

The hammer is pivoted on the pin A, the other steel pin B acts as an adjustable stop. This allows for a range of standard blows according to the position of this stop. Once set, the stop should obviously remain in the same position for the complete set of tests on any particular batches of blocks of varying composition. The relatively deep sample holder tube is intended to serve two functions. Firstly it contains fragments of the block as it shatters or crumbles. Secondly it may discourage certain pupils from using the hammer to strength test

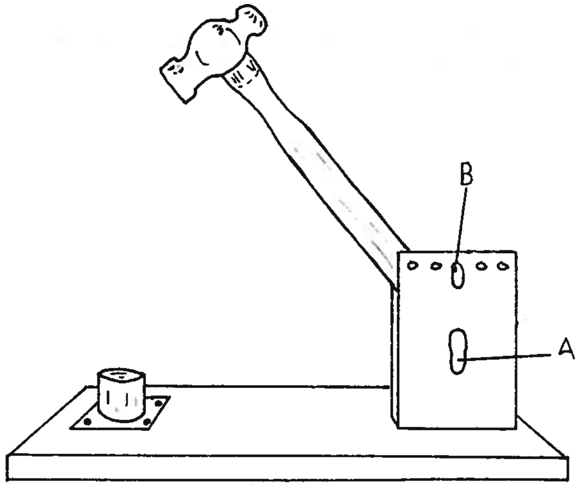


Fig 1

the fingers of their peers, which a planar test plate would more easily allow.

Operation of the tester is straightforward. A block is placed in the sample holder. The hammer is raised fully to the stop and then allowed to fall under its own weight on to the block. The number of such standard blows to failure of that block are then counted. Eye protection should be worn.

In our own tests we used roughly rectangular blocks of Portland cement mortar. These were cast by pouring mortar mixes into plastic ice cube trays producing blocks approximately 38x30x23mm. (Alternatively larger moulds, allowing the casting of more blocks, made of wood can be used. We found blocks were much easier to release cleanly from plastic moulds). The mixes used and the test results are given in Table 1 below.

Composition		No. of blows to failure (stop pin set halfway)
Sand :	Cement (V/V) (Portland)	
1 part	1 part	No breakage at 35 blows
3 parts	1 part	25 blows - crumbled
7 parts	1 part	2 blows - crumbled

TABLE 1

Strength is affected by the amount of water used and this variable should be controlled. Engineering experience on a larger scale has shown that the amount of water used in a mix has an important effect on the final strength of a batch of mortar or concrete. The other factor affecting the fairness of the tests is the curing time.

Full strength of concrete or mortar is only reached after a very long time as the chemical reactions involved in 'curing', which are rapid initially but then slow progressively, go to completion. The materials thus reach something like two-thirds of their final strength in a matter of days with full strength being reached many months later. Engineers use a test based on a standard number of days of curing. It is obvious from our test results that this is not strictly necessary here. However, for a fair test a standard curing time, actual number of days not critical, should be allowed for all blocks of varying composition for any one set of tests. Advance preparation, by teacher or technician, or by pupils mixing and casting in one lesson with testing in another is one way of organising this.

Thermocouple thermometer

In the Core Topic 'Energy' body and environmental temperature measurements are required. Some of the original pilot material also included various methods of heat detection in addition to the use of liquid filled thermometers. Some may still wish to use some of these techniques in optional material. One such exercise was designed to show one means of measuring relatively high temperatures such as those of flames etc. using a simple calibrated thermocouple.

A number of pilot schools requested assistance with these techniques because they experienced problems with calibration, lack of durability of 'thin' thermocouples especially when used in flames, scale problems with more than one meter being required etc. We give below details of a simple thermocouple which will allow a wide range of temperatures (from say that of the surface of a light bulb to a yellow bunsen/flame) to be measured with acceptable accuracy.

The thermocouple eventually selected, after much testing, uses 20 s.w.g. DCC copper and constantan wires. These relatively thick wires are somewhat more expensive than the thinner iron and contra wires we found in use in the schools. However they are more robust. They also produce a larger effective junction and therefore develop a bigger e.m.f. so that the 0-10mA meters found in most schools, rather than dearer more delicate microammeters, can be used.

The thermocouples are made by scraping or otherwise abrading clean the ends of ca. 40 cm lengths of the two types of wire. These are then twisted tightly around each other for approximately 10mm of their length and then hammered together to ensure good contact. This hammering stage is important and should not be omitted. 4mm plugs are then fitted at the free ends of the pair of wires being careful to ensure good contact.

The thermocouple so formed is used in a very simple way by being connected directly to the meter terminals which thus effectively form the cold junction. This cold junction is therefore at ambient, or room, temperature which of course may fluctuate. However, given the very large range of temperature to be measured, errors from this source will be insignificant. (It is because the cold junction is taken to be at room temperature that the calibration graph shown below does not pass through zero i.e. 0°C or 273K).

We made several of these thermocouples and calibrated them against the melting points of a number of metals. The melting points of these metals were obtained from data books but were also checked, in the experimental conditions used, against a commercial thermocouple thermometer. Slight differences attributed to variations in the degree of contact obtained by hammering junctions etc., were found. As with the cold junction errors, these variations were judged unimportant bearing in mind the range of temperature covered and the intended application. A typical calibration table is shown below (Table 2) and a graph is given in Fig. 2.

Thermocouple current (mA)	Temperature (Melting metal or other) °C	Metal used
0.	20 (room temp)	
1.10	232	Tin
2.0	328	Lead
2.8	420	Zinc
4.8	659	Aluminium

TABLE 2

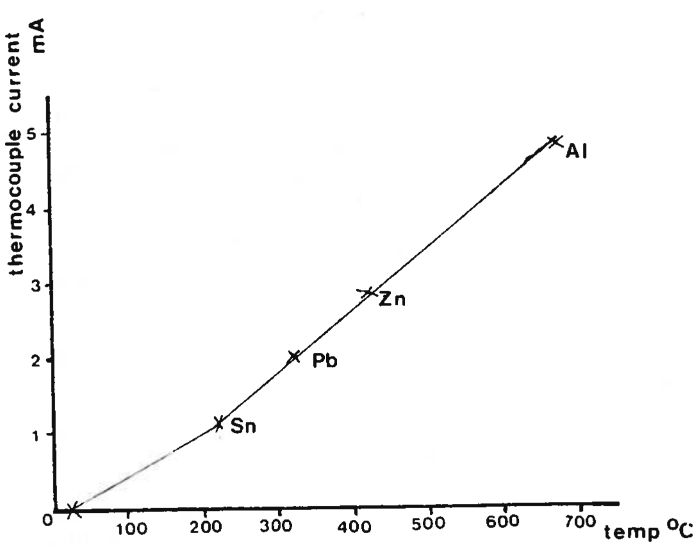


Fig 2

Thermocouples made to this specification were also used to estimate the temperatures of light bulb surfaces and various flames. Typical readings and temperature estimates from the calibration graph are shown in Table 3 below.

Source	Typical thermocouple current(mA)	Estimated temperature from calibration graph °C	Temperature as measured with commercial thermocouple thermometer °C
60W light bulb	0.6	135	160
Candle flame	4.4	610	ca.700
yellow bunsen flame	4.5	620	720
roaring bunsen flame	7	915 (by extrapolation)	(≥1000)

TABLE 3

The overall inaccuracy is significant but not important in the context of the intended application. The important point of the exercise is an attempt to measure relatively high temperatures with an instrument other than the familiar liquid filled laboratory thermometer; accuracy can reasonably be sacrificed here.

* * * *

Biology Notes

Marine aquaria

Over the years we have received many enquiries on setting up and maintaining marine aquaria. Therefore some bulletin notes on the basic principles to adhere to, and the pitfalls to avoid, might not go amiss. The main points outlined here are applicable to marine aquaria in general and not merely to the tidal aquarium described later in these "Biology Notes".

Marina aquaria have two basically different types of use in a school. The first is short term maintenance of a number of organisms after a field trip or of bought-in or collected single species to be used in behavioural or physiological studies. The second application is more ambitious and therefore more difficult to carry out successfully. This is the longer term maintenance of a range of organisms in what is meant to serve as an example of a habitat or ecosystem. The problems encountered in both types of application are discussed here.

(i) Tanks

As a general rule the larger the tank the better. This statement has to be tempered with cost and other considerations. The larger the tank the less are the limitations on stocking, the problems of overheating and pollution etc. On the other hand a greater weight of water has to be contained, supported and aerated. It is possible to avoid many of the problems of smaller tanks and they can be very acceptable for short term use. In small sizes, plastic tanks are relatively cheap but they are also fairly easy to crack or scratch if handled carelessly. Old fashioned tanks with panels of glass set into putty in painted steel angle frames are to be avoided. Corrosion can be a problem even with fresh-water in these tanks. With sea water it may be a nightmare.

For larger tanks the modern glass-to-glass silicone jointed types can be excellent. In many cases these days, apparently framed tanks are of this construction the plastic or plastic coated framing merely serving to cover the sharp glass corners. Many keen aquarists now make their own tanks this way. Such d-i-y tanks are quite quickly and cheaply constructed in the 20 to 50 litre sizes. All that is needed is some masking tape and clamps or a simple wooden d-i-y jig to hold the panes of glass square to each other, and a modern, proprietary, silicone aquarium sealer. Double strength glass (⅛" or ca. 3mm) should be used. For example a '10 gallon' size in ⅛" glass would require:

1 base 20x10"; 2 ends 10x12" and 2 sides 20x12"
(forgive please the imperial units of this original design but conversion for the sake of conversion seems such a nonsense).

The modern aquarium sealers give off a fair amount of ethanoic acid fume. They should be used in a well ventilated workspace. Allow adequate time for the sealant to cure fully before filling and stocking the aquarium. Finally a word to the real tiro - remember to move such an aquarium to its intended location before filling it. When full a typical larger aquarium will weigh well over 50kgf.

(ii) **Sea water**

This can be the real thing, or, probably for inland schools, a substitute. All else being equal, the former is preferable. However care must be exercised in collecting some real rather than 'instant' ocean. When filling containers stay away from rock pools higher up the shore. Rainfall or an influx of fresh water as a spring from cliffs or a streamlet may dilute the seawater here. Conversely evaporation from pools at low tide may increase the concentration of salts in water lying in small rock pools. Streams flowing into the sea itself can also create problems in collecting. The less dense fresh water floats on the sea water and the stream may influence the composition of the sea water not merely at its entry point.

Artificial sea water may be made up from aged tap or distilled water and various proprietary mixtures of salts. These are sold as 'Instant Ocean' etc. by aquarium shops and major laboratory suppliers. D-i-y sea water recipes abound. An example is given in (1). This may or may not work out cheaper than the commercial stuff but it may also not be quite as good. Many of the modern commercial formulae are claimed to include buffering ingredients and other useful compounds.

Aquaria should be fitted with loose-fitting glass or plastic covers to prevent excess evaporation and should be regularly topped up with distilled water. When marine tanks are maintained for any length of time it may become necessary to control the chemical changes which then take place in the seawater. Various test kits are available from aquarists' suppliers. A description of these and their use is outwith the scope of an article such as this.

(iii) **Overheating**

British marine organisms are often very sensitive to overheating and to the harmful effects of bright sun-light. As a rule the optimum temperature is about 10°C with the low and high extremes at 5°. and 14°C respectively. In practice a steady 10°C is unattainable unless special cooling arrangements are made. However a number of simple ploys can be used to avoid the most likely problems i.e. those caused by exceeding 14°C:

- if possible locate the tank in a room lacking any space heating and not subject to great solar gain
- use as large a tank as practicable
- keep the tank in shade by painting some of the windows of the room and/or painting the back and sides of the tank with greenhouse shading compound
- make a narrower choice of organisms if you know overheating is likely. Choose those which can tolerate wider temperature variations such as species usually found in the upper and middle shore rock pools
- avoid sensitive organisms like sea urchins and fish species usually associated with deeper water conditions.

Sensible use of the tactics listed will allow you to avoid overheating effects for most of the time when only short term maintenance of specimens is required. Longer term projects will need more effort. Two different basic approaches are possible.

Firstly one can avoid this particular problem by keeping a 'tropical' marine aquarium and deliberately heating the tank. This brings other problems of its own. Now you run the risk of the tank getting too cold in winter! In addition warm water marine specimens are expensive (British specimens can be obtained for free). They can also be finicky, prone to disease and to floating, dead, at the tops of tanks. Because of the higher temperatures, if the balance of the tank is upset through 'pollution' chemical changes etc, it all happens very quickly and may be difficult to correct in time to save the specimens. Some teachers and many hobbyists obviously think all the effort worthwhile. Certainly a well kept tropical, marine tank can be aesthetically stunning and biologically fascinating.

The other approach is to arrange artificial cooling of the cold water aquarium. A number of schools we know have managed this and have maintained such tanks for long periods of time. One such school had a cooled tank long enough to have 'trained' fish and other specimens to feed from the hand. The favourite cooling method has been to circulate the tank water through an old beer cooler. These have been begged or borrowed but not (as far as we know) stolen from a local brewery or publican. With pumped sea water, great care has to be taken to ensure that any tubing in the cooler or elsewhere in the system is of plastic or stainless steel (preferably the former). Any pumps should be magnetically driven with a plastic head and impeller. The system must include thermostatic control otherwise specimens will be over cooled rather than overheated.

(iv) Maintaining a balance and the choice of organisms

Sea water aquaria can rarely be truly self-regulating, balanced ecosystems. Both seaweeds and decomposers are generally unsuitable organisms to keep in relatively small aquaria. Therefore the balance must be maintained by you. Aeration by means of pumps with airlines and diffusers, is essential to provide an adequate oxygen supply in an artificial ecosystem containing so few plants. Because the sea water should be cold, circulation by convection may be poor. Mechanical aeration improves this water circulation and allows avoidance of localised concentrations of carbon dioxide and waste materials. A complicated filtering system may not be required if care is taken to avoid over feeding and to regularly siphon off waste accumulations from the aquarium floor.

Even the inclusion of sand and/or gravel in the aquarium may not be essential. In any case, uneaten food or other waste may infiltrate sand or gravel which then becomes a source of hidden problems. An assortment of rocks of various sizes and covered in encrusting algae or **small** green or red seaweeds bring few such associated problems. They also have the advantage of being a source both of food and of a variety of niches in the habitat.

The choice of organisms has several aspects; which are suitable to be kept in an aquarium at all and of these which are sufficiently compatible that they may be kept in the same aquarium? Choices on types and numbers of organisms are dependent on the many factors already outlined above, such as sizes and numbers of tanks, availability of seawater and suitable foods, control of temperature etc.

Definite undesirables to be avoided at all costs (at least by the beginner) are:

> brown seaweeds; the larger green and red seaweeds, jellyfish, large sea urchins, large crabs (anything bigger than a 2p piece) and most worms except the smaller 'Nereids' and tubeworms.

Of the organisms that will survive in an aquarium, crabs and lobsters can cause serious problems. They should be inter- and intra-specifically separated into different aquaria. A largish shore crab, becoming the top carnivore in a tank, may devastate the habitat in a matter of days and then die within a week in the polluted environment inevitably so created.

The following listed organisms can be successfully kept together by the beginner. In this context the adjective ''small'' means just that, stocking with specimens that are just too large for the tank is a common mistake.

Small molluscs such as periwinkles and mussels; sea anemones, small sea cucumbers (and possibly depending on temperature control small sea urchins); small starfish and brittle stars; sponges; blennies; pipe fish; bullheads and marine species of stickleback, tubeworms and barnacles on pieces of rock.

As confidence builds, the choice may be widened. A useful aid here is a small separate trial or 'quarantine' tank in which survival under the available aquaria conditions can be tested. The final breadth of choice depends very much on the availability of real seawater and natural food organisms. For example the mussels, sponges and barnacles included above are essentially plankton feeders. For these, real sea water is virtually essential. One mussel of reasonable size can filter many litres of seawater in a day. This can be a great advantage since it keeps a tank clean. However it clearly also limits the number of mussels that may be kept. Small additions of sea water are needed almost daily if several filter feeders are kept. Even the addition of an odd litre may result in fresh feeding activity like siphoning.

Decisions on numbers of organisms to stock are also not easy. Some rules of thumb are available, giving an approximate guide to stocking densities eg. ca. $20cm^2$ of water surface to every cm. length of fish, and not more than one sea anemone or similar organism to every $38cm^2$ ($6in^2$) of floor space. Over-populating tanks will exhaust nutrient supplies and organisms may die. These dead organisms if not removed, nor eaten by others such as starfish, dog whelks or hermit crabs, may cause serious pollution. The net result may be for you to have to start all over again.

A major problem with bivalves is that they may be dead without you knowing it. Care should always be taken when stocking with something like a clump of mussels. Some of them may be dead on arrival at the tank. Some or all may die of starvation later if fresh supplies of seawater are not added from time to time. If the dead specimens are not spotted and removed within a reasonable interval serious problems may result. It cannot be overstressed that the major consideration for marine aquarium care is the removal of dead or uneaten material within a few hours. It is better to under, rather than overfeed. Most littoral marine organisms are adapted to periods of starvation. Any uneaten food should be removed within two hours of feeding.

Many of the organisms which are not planktonic or filter feeders will be algal browsers or carnivores. The needs of the browsers will be automatically met in a well established tank. The carnivores can be fed small pieces of meat either of marine or terrestial origin. It should not be necessary to feed these more than once or twice a week.

Acknowledgement

Much of the above material is based on personal (sometimes bitter) experience. Some points also found useful in practice arise from a set of in-service course notes provided by a one-time tutor at the then North Riding Field Centre. Unfortunately that course was attended more years ago than I care to admit. I have forgotten the tutor's name. However - whoever and wherever he is - thanks!

Reference

1. Creedy, J., "A Laboratory Manual for Schools and Colleges', p.116, (Heinemann Educational Books, 1977).

Tidal aquarium

Our original design for a tidal aquarium appeared in Bulletin 6 and now just about qualifies as archival material. The original constructional details were for glass tanks and used siphon bottles etc. Since then we have refined and changed the design several times. Whenever we exhibit this current version it arouses a lot of interest, so much so that we have decided to publish.

Fig. 1 shows the basic arrangement. The tubing dimensions given are for standard small plastic aquaria of approximate dimensions 330 x 230 x 200mm. Obviously some of these tubing sizes will have to be changed if you use larger tanks and only trial and error can assist you there. We went for small tanks because of the need to mount one above the other. Only the bare bones of the design are shown in the diagrams. Our own exhibition model is mounted on a two-tier 'Dexion' framework with the tubing held by being passed through one or two holes in this framing. The underside of a top platform can carry a lamp to illuminate the bottom tank (see safety points below). The pump is mounted on top of the same platform in a space behind the tank so that it is hidden from view. In the small version described here a small, diaphragm pump of the 'Petcraft' type will suffice. Again if the design is scaled up, a larger pump such as a 'Hyflo' may be needed.

The principle of operation of the tidal mechanism is straightforward, relying on 'air-lift' pumping and siphoning to fill and empty the tanks. The cycle of operation will be described starting with the bottom tank full (high tide) and the top one empty (low tide). Hopefully all will now be revealed.

When the bottom tank is full, water will siphon over through tube A, the one way valve and three way tap assembly B, and into the 'Y' piece C. Here it meets a stream of air from the pump. A column of air and water (ie. bubbles) is then pushed up tube D to enter the top tank, slowly filling it with aerated water. The one way valve at B (see Fig. 2 for details) is there merely to prevent blow-back of air into tube A which would break that siphon. This one-way valve can be dispensed with if A is made much longer and formed into a loop hanging well below the base of the bottom tank. This would provide a head giving extra pressure preventing blow back into the siphon. This arrangement however is less tidy than the valve, which is easily constructed.

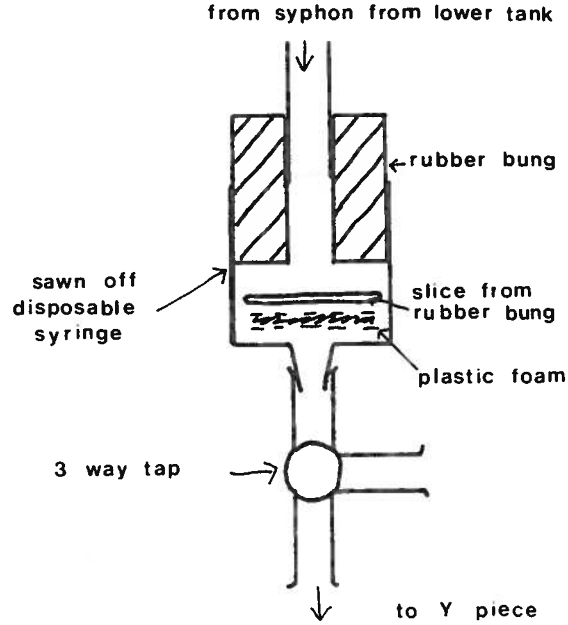
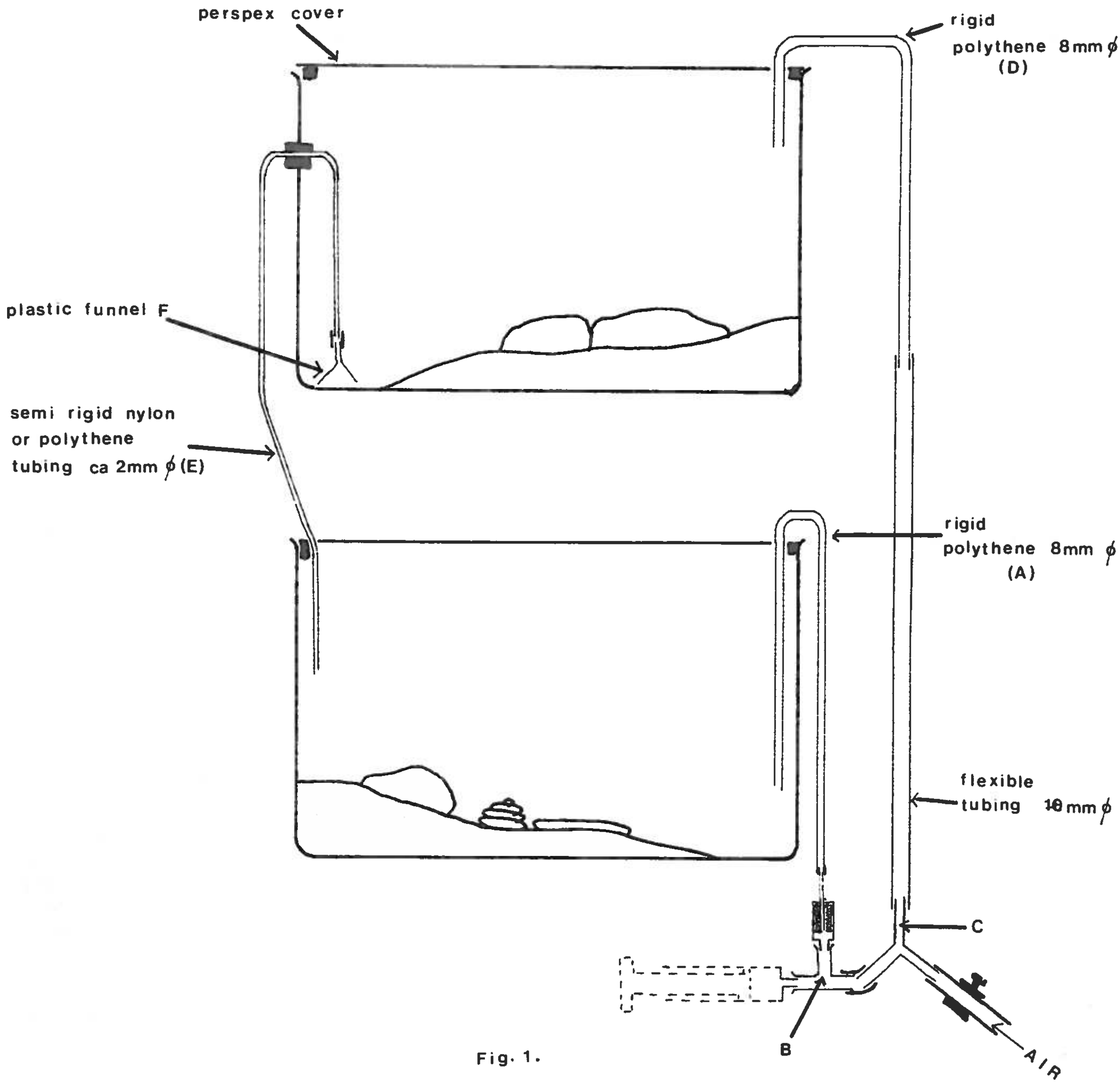


Fig. 2.

The three way tap at B is an optional extra allowing the fitting of a large plastic syringe. This can be used, in conjunction with the tap, to pull water into tube A when starting the tidal cycle from scratch.



perspex cover
rigid
polythene 8mm ϕ
(D)
plastic funnel F
semi rigid nylon
or polythene
tubing ca 2mm ϕ (E)
rigid
polythene 8mm ϕ
(A)
flexible
tubing 10mm ϕ
C
B
AIR

Fig. 1.

Eventually the top tank will fill above the exit point of the thin tube E. It will now be 'high tide' in the top tank and 'low tide' in the bottom one. Water will start siphoning slowly into the bottom tank (ie. 'ebb tide' in the top 'flood tide' in the bottom). Once the level in the top tank falls below the mouth of the small funnel (F) the siphon in the thin tube (E) will break. The function of funnel F is to ensure a clean break in the siphon. Without it, the outflow from the top tank may be continuous. Once the water level comes well up the bottom tank, the siphon in tube A will be re-established and the whole cycle repeated.

The arrangement as described is not accurate as to the timing of the tidal cycle. This present version is better than the original in this respect but in some ways it is also slightly more complicated. More accurate, that is approximately six hours low to high or high to low, tidal cycles may be a possibility using similar sizes of tubing with larger tanks - the present cycles being too short. It may then be that aeration from the air-lift alone may be insufficient. Supplementary aeration from a second pump may be required.

Despite that last paragraph we do not think an accurate tidal cycle is of great importance. What is possibly more important for the survival of any tank inhabitants is (i) the movement of water, and (ii) adequate aeration.

Electrical safety and aquaria

Care is needed when installing any electrical equipment to be used with aquaria. A single mains power cable with distribution through fused circuits from a properly designed and constructed control box gives the neatest and safest arrangement. Some major laboratory suppliers now offer aquarium wiring kits or packages. (See also CLEAPSE/SSSERC 'Hazcard' - "Aquaria").

* * * *

Interfacing Notes

You can expect to receive fairly soon a copy of "6502 Interfacing" which has been written by SSSERC staff and is being published by the Microelectronics and Computing in the Curriculum Project. There are certain advantages in publishing a large one-off specialist document, one being that if all the material were put in the Bulletin the latter would become completely unbalanced. We do intend however to follow up the publication of "6502 Interfacing" with technical articles in this column of the Bulletin.

We have had many requests from teachers for information on interfacing. Few of these requests have been for specific technical advice. Rather, they have been of the "I would like to get into interfacing but I don't know where to start" sort. We hope our "6502 Interfacing" will help you make a start.

Experimental errors - The measurement of g

We indicated the principal features of computer controlled experiments in Bulletin 132. We have picked out one of these for further discussion here, this feature being the analysis of experimental errors. This topic is discussed in the context of performing a routine experiment, the measurement of g.

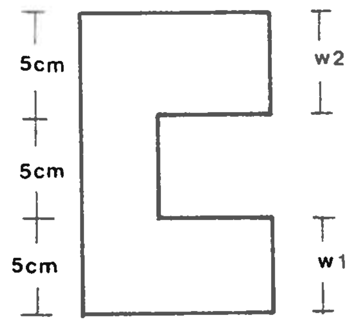


Fig. 1. freefall mask

Procedure

The procedure in the experiment involves dropping a mask (Fig. 1) through a light beam. The microcomputer is interfaced to the light sensor and programmed to measure three time intervals

T1 = first time interval, duration of first interruption of light beam

T2 = second time interval, duration of re-establishment of light beam

T3 = third time interval, duration of second interruption of light beam

One of the 6522 timers in the computer, Timer 1, is used to measure time. This technique is explained in "6502 Interfacing". For the purpose of this article you have to be aware firstly that time is measured to a resolution of 256µs and secondly that time measurements depend on the computer clock whose frequency is only nominally known.

T1 and T3 are used to calculate initial and final speeds.

$= W_1/T1$ $\qquad$ $v = W_1/T3$

and acceleration is computed from

$$a = \frac{v - u}{t}$$

where $t = \frac{1}{2}T1 + T2 + \frac{1}{2}T3$

The mask is symmetrical in that $W_1 = W_2$. It is made from sheet steel and is painted black to lessen the chance of reflected light triggering the light detector. The edges of the mask are smooth since this reduces the incidence of switch bounce, the switching on and off of the light beam during the passage of an edge, caused by specular reflection and/or diffraction. From previous experience with an aluminium mask we found that when its edges became ragged with use, switch bounce was common.

The light sensor is a light-activated switch (RS 305 434). This sensor has been used in another context in the optical transmission of ultrasound and is therefore believed to have a response time well below the resolution of the timer. The sensor was mounted inside an old 35mm film can(Fig. 2). The experiments were conducted in daylight.

The experimental procedure was simply to grip the mask at a point above its centre of gravity to that its long axis seemed vertical, and drop it through the light beam. Some of the experimental errors seem to stem from this procedure in that the long edge of the mask could be off vertical on some occasions and that on others the mask might be projected with a rotation.

A set of 40 readings of acceleration were taken and analysed. The computer was programmed to

1. measure three time intervals T1, T2 and T3,
2. calculate acceleration,
3. reject accelerations less than $8.0ms^{-2}$ or greater than $12.0ms^{-2}$,
4. calculate the average of 40 readings,
5. construct a histogram using 40 readings.

The set of 40 readings was repeated three more times on each occasion altering one of the variables. So four sets of readings in all were obtained. They were made under the following conditions

1. bottom edge of mask just above light beam before release (set A),
2. as above and mask weighted with plasticine (set B),
3. bottom edge of mask 10cm above light beam before release (set C),
4. bottom edge of mask 20cm above light beam before release (set D).

The readings and histograms are shown in Fig. 3.

Discussion

By common repute if its dead its Biology, if it smells its Chemistry and if it doesn't work its Physics. One of the contributing factors to the tradition of not working is that when quantitative experiments are repeated the experimental results are not all precisely the same. It is necessary to repeat an experiment many times over to appreciate why this effect occurs and this may readily be done with computer control.

Suppose, by way of example, we decide to measure g five times only. Our set of readings might typically look like the first five made in our readings here (Fig. 3, Set A)

10.082 9.928 9.934 9.278 $9.961ms^{-2}$

This poses the question of how to treat these readings and how to explain the fourth one. Do we take an average of all five? Do we reject the fourth reading and average the remaining four?

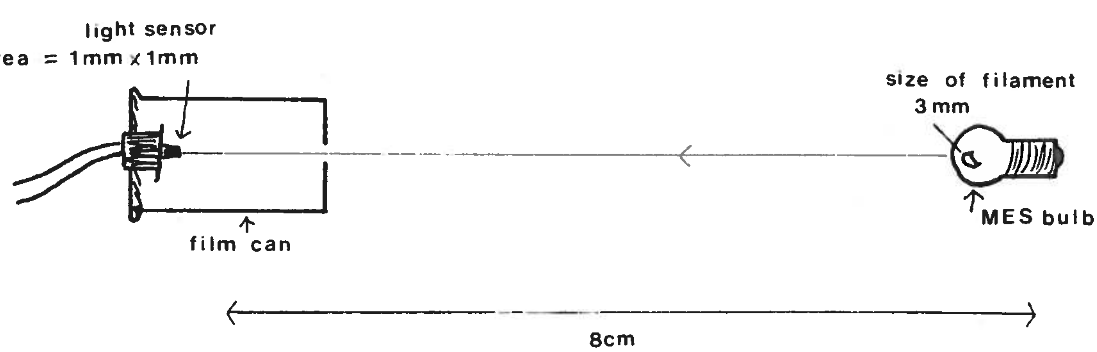
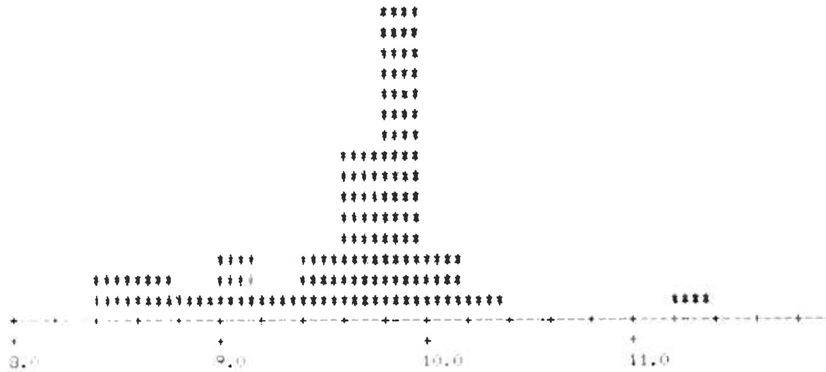


Fig. 2. light source and sensor

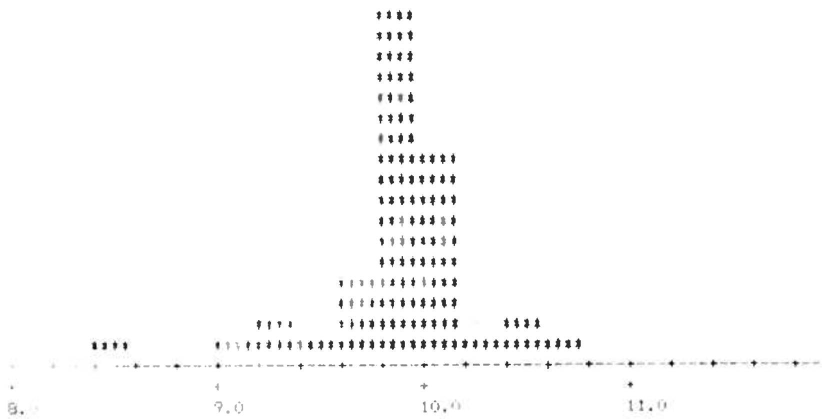
AVERAGE ACCELERATION IS 9.659 ms^{-2}
(a) Set A - bottom edge of mask just above light before release.

10.082	9.928	9.934	9.278	9.961
9.885	11.256	9.928	9.951	9.857
9.863	8.911	10.255	9.759	9.818
9.919	9.767	9.432	10.025	8.616
9.877	8.576	9.911	9.752	10.001
9.658	9.112	8.423	9.835	9.892
9.767	9.166	9.711	9.612	8.712
9.988	9.581	9.180	9.561	9.625



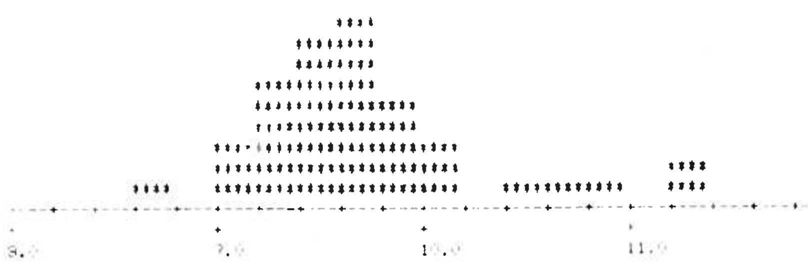
AVERAGE ACCELERATION IS 9.886 ms^{-2}
(b) Set B as above but mask weighted with plasticene (112g.)

10.515	9.25	10.191	10.106	10.033
9.061	9.851	10.649	10.201	10.432
8.423	9.865	10.062	9.880	10.019
10.100	10.076	9.984	9.998	9.821
9.892	9.919	9.881	10.109	9.865
9.726	9.834	9.783	9.752	10.098
9.946	9.319	9.957	9.934	9.911
9.456	9.838	9.890	9.799	10.031



AVERAGE ACCELERATION IS 9.743 ms^{-2}
(c) Set C bottom edge of mask 10 cm above the light beam before release.

9.383	9.286	9.554	9.662	10.089
9.361	9.458	10.498	10.644	9.550
9.286	9.72	9.739	10.87	9.992
9.631	9.383	9.706	9.429	9.327
9.843	9.163	11.371	9.046	9.099
9.408	9.408	10.100	9.647	11.371
9.921	9.458	8.795	9.830	9.513
9.773	9.703	10.089	9.994	9.631



AVERAGE ACCELERATION IS 9.644 ms^{-2}
(d) Set D bottom edge of mark 20 cm above the light beam before release.

9.645	8.864	9.911	9.752	10.336
9.146	9.911	9.347	8.707	9.146
9.472	8.252	10.076	10.077	8.720
9.911	9.690	9.911	10.063	9.982
11.034	8.782	9.699	9.733	11.131
9.911	8.409	9.815	11.127	9.146
9.246	9.146	9.571	9.472	9.472
9.982	9.911	9.571	9.726	9.982

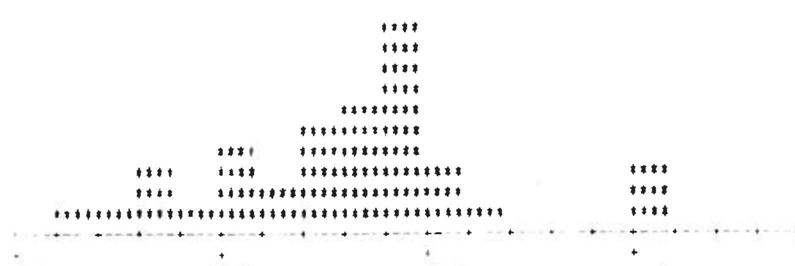


Fig. 3

Suppose we move on to remeasuring g making the comment on the way, that the scatter is due to "experimental error". Each time we remeasure we will alter one of the variables, weight, or height dropped. Typical readings would be the first from each set

set B greater weight 10.515

set C dropped from 10cm 9.383

set D dropped from 20cm 9.645

Any attempt to assess the significance of differences in these readings requires much data from many repetitions of each event. It also involves a careful examination of the procedure. To dismiss the differences as experimental error is to invite the obloquy sometimes justifiably heaped on our subject.

The direct benefit of collecting a lot of data and drawing up frequency distributions is that it becomes obvious that a scatter of readings is inherent in the measuring process. It would, we suggest, be satisfactory to leave the explanation at that. A lot can be gained however from delving into the nature of the frequency distributions.

On examination of the experimental procedure we have identified a number of sources of error. They are listed in Table 1.

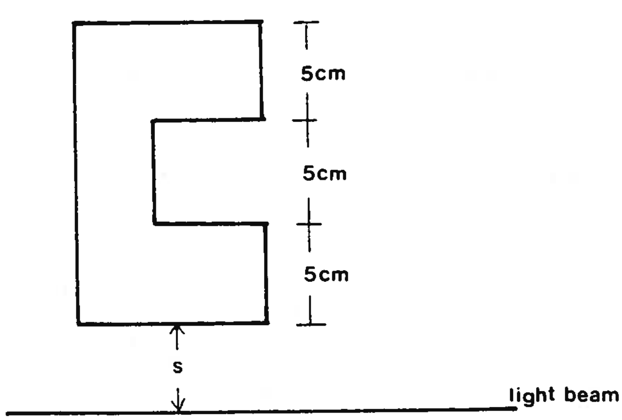
source of error	effect on measurement
1. resolution of clock	random effect
2. clock frequency	systematic effect
3. diffraction	systematic raising effect
4. switch bounce	random effect producing outrageously high and low accelerations and decelerations
5. tilt of mask in vertical plane	random effect
6. rotation of mask in vertical plane	random effect
7. tilt of mask out of vertical plane	random raising effect
8. rotation of mask out of vertical plane	random effect
9. width of light beam	systematic effect
10. assymmetry of mask	random effect

TABLE 1

Two of these errors are examined, as examples, in more detail below.

Error 1 Resolution of clock

We calculate firstly the approximate time intervals, T1, T2 and T3 from $S = \frac{1}{2}at^2$ taking care not to get into a circular argument. Height fallen is tabulated in 5cm increments because of the dimensions of the mask (Fig. 4) and the heights dropped in sets C and D.



s (cm)	t (ms)
0	0
5	100
10	142
15	173
20	200
25	224
30	245
35	265

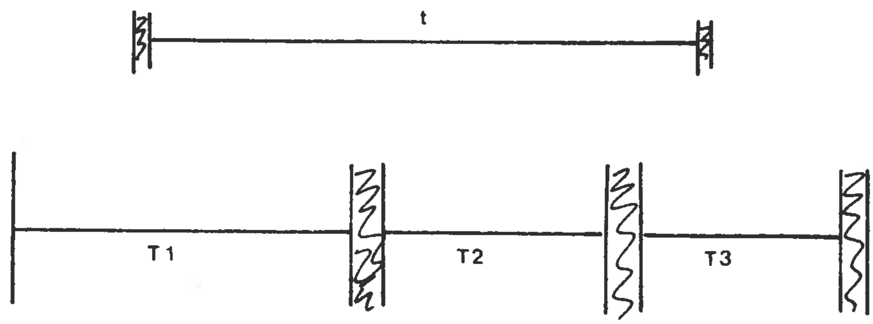
s = distance fallen by mask

t = time taken

resolution of clock = 0·256ms

Fig. 4.

The uncertainty in the measured time intervals is shown in Fig. 5.



256 μs uncertainty

time interval	absolute uncertainty
T1	+256μs
T2	±256μs
T3	±256μs
t	±256μs

Fig 5

The uncertainty in acceleration is due primarily to the percentage errors in T3 and t

	sets A and B		Set C		Set D	
	time	error	time	error	time	error
T3	31	0.8%	24	1.1%	20	1.3%
t	107	0.25%	54	0.5%	43	0.6%
a		1.05%		1.6%		1.9%

TABLE 2

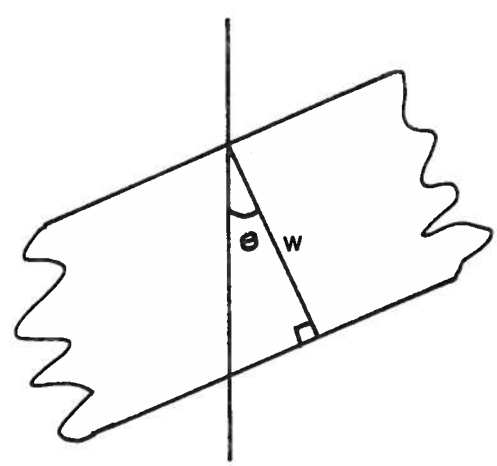


Fig. 6

Looking at the four frequency distributions we find that distributions C and D are broader than distributions A and B.

Error 5 Tilt of mask in vertical plane

If the angle between the long axis of the mask and vertical is θ, the effective width of the mask increases from W to $W/\cos\theta$ (Fig. 6).

Its effect on acceleration is

$$a = \frac{v-u}{t}$$

$$a = \frac{W/T3 - W/T1}{t}$$

$$a = W.k$$

$\Rightarrow$ % error in W = % error in a

Typical values are shown below (TABLE 3)

θ	cos θ	%error in 1
10°	0.985	1.5%
20°	0.940	6%
30°	0.866	16%

TABLE 3

This error has the effect of bringing the measured value of g below the true value. It explains why the breadth of the frequency spectrum is greater than indicated by our analysis of error 1, it explains why some measurements are several percent below the frequency peak, but it does not explain why there are some measurements out by 10% or more.

Summary

1. It should be recognised that it is less than satisfactory to repeat a measurement only a few times. The errors inherent in the measuring process can only be seen to be procedural errors when a large data sample is taken.

2. A computer measuring system enables you to take such a large data sample and perform the necessary data analysis with little effort.

3. An appreciation of the nature of experimental error could well be engendered by the experience of just one such analysis in 'O' grade and one in Higher grade.

* * * *

Physics Notes

Constant current supply

A paradox can be a most useful teaching device. After causing momentary confusion it should show the basic principles in operation thereby making them clearer, and revealing misconceptions. It also adds that bit of sparkle that turns a dull day into, well, a not so dull day.

We usually expect power supplies to be constant voltage devices, ignoring the effect of internal resistance in this discussion. Thus when presented with problems 1 or 2 we base our answer on this premise.

Problem 1

The ammeter reads 2A when a bulb is connected across the supply.

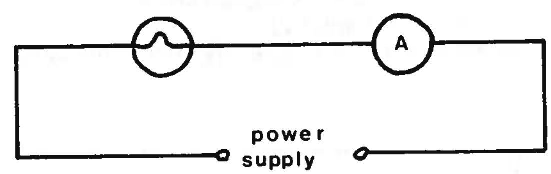


Fig 1

a) What does the ammeter read on connecting

i) two such bulbs in series across the supply?
ii) two such bulbs in parallel across the supply?

b) In which of the three circuits are the bulbs at their brightest?

Problem 2

An alternative way of presenting essentially the same paradoxical problem.

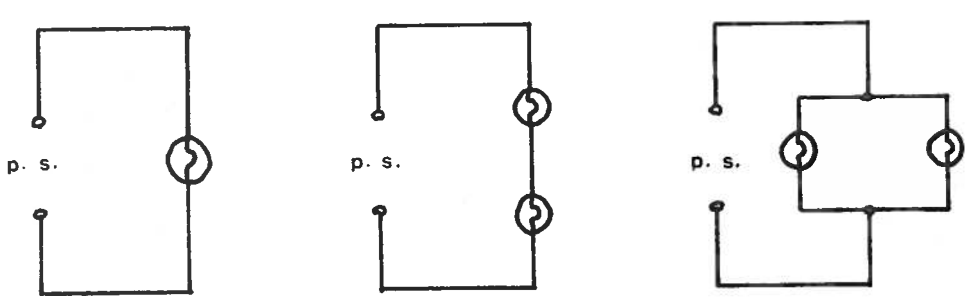


Fig 2

A pupil has a power supply and two similar bulbs. He wires up his equipment in the three ways shown above. Which of these arrangements gives the greatest intensity of light?

The paradox can be set up using a constant current supply.

The circuit (Fig. 3.) uses a 741 op amp and two PNP transistors wired in the darlington driver arrangement. Therefore in addition to having a use in O grade Physics it has a use as an extension to the Analogue Electronics course in Higher grade.

The principle of operation of the op amp is that its output potential on pin 6 moves to whatever value is necessary to ensure that the feedback signal maintains the inverting input (pin 2) at the same potential as the non-inverting input (pin 3).

i.e. potential at pin 2 = potential at pin 3
⇒ potential at point Y = potential at point X
but potential at point X is fixed and equals
+10V (set by R1 and R2)
⇒ potential at point Y = +10V and is constant.

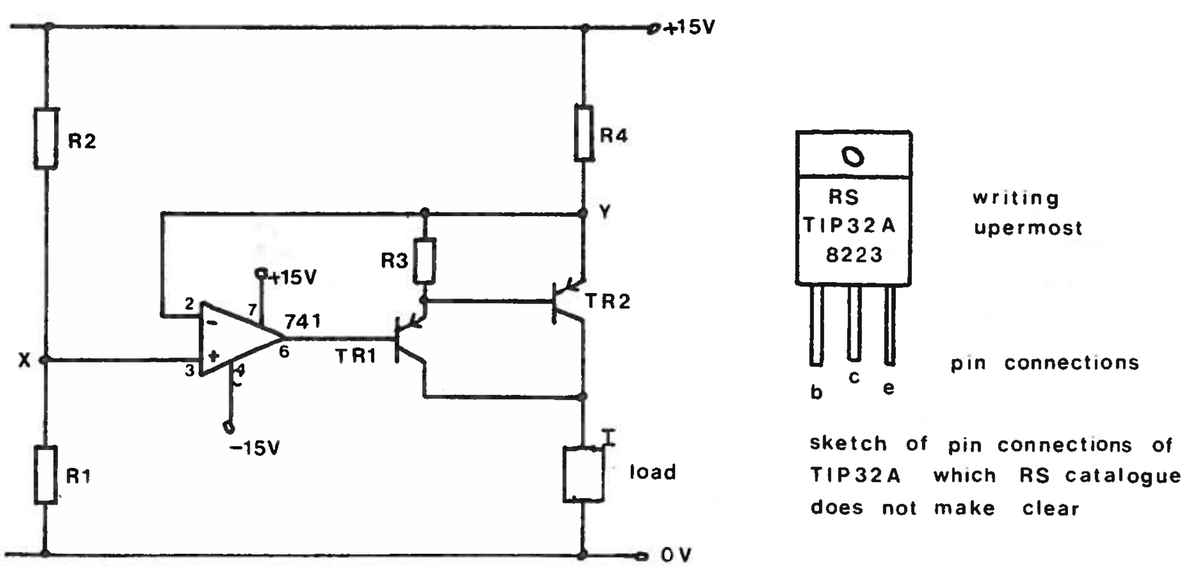
The current(I) through the load, TR2 and R4 is determined by two factors

1. resistance R4

2. p.d. across R4 (=5V)
   ⇒ I = 5/R4

For a constant current supply of 200mA, R4 should be 25R,2W. The nearest preferred value is 27R,2W. This value will give you an actual output current of 180mA. In practice a 2W resistor gets fairly hot. While this does not affect the long term stability we would prefer to use a 7W value. The maximum power which can be developed in transistor TR2 will occur when the load is short circuited. In this instance V_{CE} = 10V and P = IV = 0.200 x 10 = 2W. We have selected a medium power transistor for this role, TIP32A, which is rated at 40W, 3A. It should be mounted on a heatsink. An aluminium billet, 75 x 50 x 6mm with 6mm legs will do.

The particular value chosen will enable you to operate a load of three MES 2.5V, 0.2A bulbs in series to illustrate the paradox mentioned in the introductory



R1 = 10k
R2 = 4k7
R3 = 1k0
R4 controls current I
(see text)
741 (RS 305 311)

TR1 general purpose PNP
e g ZTX500 (RS294463)

TR2 medium power PNP
e.g. TIP32A (RS294211)
(use heatsink)

Fig. 3. constant current supply

part of these notes. You will find that the bulbs do not light when two are in parallel. This can be overcome by stepping up the current output from its actual value of 180mA to 260mA by changing the value of R4 from 27R to 18R. These bulbs shine very brightly at 260mA and dimly at 130mA. Do not run them for long at 260mA. Their filaments burn out.

You can conveniently alter the output current by use of a potentiometer to control the potential of point X. If you wish to set the lower and upper limits of the output current at 0 and 180mA respectively, replace R2 with a 5k pot and connect the non-inverting input (point X) to the centre tap. Watch the power ratings of R4 and TR2 for higher output currents. TR2 should be mounted on a larger heatsink if exceeding 300mA for long.

The other factor to watch is the resistance of the load. Going back to the original components in the circuit, the maximum p.d. which can be developed across the load is 10V. If the output current is 180mA the maximum resistance your load can be is 56R. As we said at the beginning we are dealing with a paradox. We normally quote the minimum resistance which a load can have.

* * * *

Surplus Equipment Offer

The following items of equipment are offered for sale, subject to the conditions laid out in Bulletin 116. Items with numbers less than 209 have already appeared in previous bulletin issues and details of these can be found in the relevant issue (number given in list). These items are **not** now subject to the ballot procedure and orders may be placed on a first-come, first-served basis. In addition to those listed we still have stocks of switches, capacitors and other small components. Let us know your requirements and we will try to meet them.

Items with numbers greater than 208 are those included in this present ballot. As with the last ballot in Bulletin 132, we will allow for delays in bulletin distribution. The ballot will not be held until three weeks after we judge that bulletins have reached the schools.

Item 84	Bulletin 125	Photographic Fixer, 30p.
Item 89	Bulletin 125	Dry cells, 1½V, 2 for 15p, 4 for £1.50, gross £8.00.
Item 165	Bulletin 129	Bimetallic strip 30cm,40p.
Item 173	Bulletin 132	Moving coil microphones (new in boxes) 50p.
Item 183	Bulletin 132	35mm b/w film, 1000′ cans £5.00.
Item 195(a)	Bulletin 132	Signal generator Advance £20.00.
Item 195(b)	Bulletin 132	As above, case in need of repaint. £15.00.
Item 200	Bulletin 132	Right angled torch £1.00.
Item 202	Bulletin 132	Stereo headset £2.00.
Item 203	Bulletin 132	Headset with amplifier £2.00.
Item 206	Bulletin 132	Developer 5l. £3.50.
Item 207	Bulletin 132	Fixer 5l. £2.50.

The equipment included in the ballot, numbers 209 onward, is listed below. Since the last ballot in Bulletin 132 we have been fortunate to make some bulk purchases of surplus stocks from two firms. With the exception of a few items in the group of numbers 226 to 239 (which is all ex-MOD stock), most of the items offered are new and unused, not secondhand items or ex-equipment components.

The following equipment is included in the ballot:

Item 209	Milliammeter, 1mA f.s.d., centre zero, scaled 120-0-120, ca. 75mm dia.	£3.50
Item 210	Microammeter, 500µA f.s.d., centre zero, scaled 10-0-10, ca. 75mm dia.	£3.50
Item 211	Milliammeter, 500mA f.s.d., scaled as such, 75mm dia.	£3.50
Item 212	Potentiometer, large wirewound, 25W, 8R	80p
Item 213	Potentiometer, wirewound 25W, 1k	60p
Item 214	12V motor by Smiths, ca. 100mm long 75mm dia. single ¼″ spindle.	£2.00
Item 215	As above but double ended with 2, ¼″ spindles	£2.50
Item 216	'J24' 12V power supply by 'Mini-models Ltd.', 240V to 12V transformer/rectifier in double insulated plastic casing, 600mA/7.2VA.	£3.50
Item 217	Ceramic magnets by 'Mullard' ca. 26x10x8mm	20p
Item 218	Mini-magnets ca. 18x6x2mm with central, 2mm hole, per pack of 10	£1.50
Item 219	S.B.C. 'pendant' lampholders in bakelite	20p
Item 220	Phototransistor ORP type	10p
Item 221	Silicon transistor, BC107 **or** BC 108 specify which	5p
Item 222	Speaker/microphone insert with balanced armature, 35mm dia. max.	30p
Item 223	Time clock and set switch by 'Smiths', 230V a.c. switch rating 25A, external set time, set to start and set to stop controls	£3.50
Item 224	Potentiometers, wirewound linear, 50R, 33R and 15R. Please specify resistance value when ordering	30p
Item 225	Mains dimmer switch, 1250W (needs casing)	£2.50
Item 226	Photographic paper, 'Kodak' bromide, WSG.2, 16.5x21.6cm(6½x8½″) box of 100 sheets	£5.00
Item 227	As above but WSG.1 and 30.5x40.6cm (12x16″) box of 100 sheets.	£6.00
Item 228	As above but WSG.2, size as last item, box of 100 sheets	£8.00

Item 229 Photographic paper, 'Bromesko', WFL 3D, 40.6x50.8cm(16x20") pack of 25 sheets £5.00

Item 230 Photographic paper 'Veribrom', F1, 30.5x40.6cm (12x16"), box of 100 sheets £12.00

Item 231 35mm Colour slide film, daylight or blue flash Kodak 'Ektachrome' 135-36, 200ASA, per roll 60p
per pack of 10 £5.00

Item 232 Dark room thermometers by Kodak, dual scale, 10°-45°C/50°-110°F £1.00

Item 233 Film clips by Paterson 50p

Item 234 'Polaroid' film 'land' type 107C, black and white (8.3x10.8cm) per film pack of 8 sheets £1.50

Item 235 6V lantern battery with **spring** terminals, type 996 70p

Item 236 6V battery of three rechargeable cells, Varley VPT 2.7/10, 10Ah, neat unit 100x80mm, £2.50

Item 237 Signal generator by Marconi, type TF2000AF, mains/battery operation, v.g.c. £20.00

Item 238 Attenuator (useable with above item) by Marconi type TF338C AF. £5.00

Item 239 Microburettes, self filling type with reservoir and 3-way tap, 5x0.05ml unused in boxes £2.50

Item 240 Balance, spring 'Salter 12' 500x5g £3.00

Item 241 Beaker, plastic, graduated 100x10ml 5p

Item 242 Beaker, plastic, graduated 400x20ml 10p

Item 243 Bottle, aspirator with tap, polythene 9l. £1.00

Item 244 Bottle, glass, wide mouth, bakelite cap, 60ml specify clear or amber 5p

Item 245 As above but 125ml in amber only 5p

Item 246 As above, but extra wide mouth, 125ml specify clear or amber 5p

Item 247 Bottle, glass, reagent, narrow mouth, polypropylene stopper, in amber or clear, 125 or 250ml please specify type and size 20p

Item 248 Buchner funnel, polythene, separating into two halves for cleaning, for papers of 4.25cm dia. £2.00

Item 249 Buchner funnel, porcelain, for papers of 5.5cm dia. £2.50

Item 250 Crucible, porcelain, 15ml 30p

Item 251 Crucible, porcelain, 50ml 30p

Item 252 Dessicator, glass £3.00

Item 253 Filter funnel, polythene, 63mm dia 10p

Item 254 Flask, Buchner, polypropylene, 500ml 60p

Item 255 Flask, Buchner, 'Pyrex', 100ml. 50p

Item 256 Flask, flat bottom, 'Pyrex', 100ml. 50p

Item 257 Flask, round bottom, 'Pyrex', 100ml. 40p

Item 258 Flask, volumetric, polypropylene 100ml with stopper. £1.00

Item 259 As above but 500ml £1.50

Item 260 Measuring cylinder, polypropylene, 1000x10ml £1.50

Item 261 Rubber teats, large (3ml) per 10 15p

Item 262 Rubber teats, eye dropper type (1ml) per 10 10p

Item 263 Spotting tile, white polypropylene, 12x1ml cavities 20p

Item 264 Scalpel blades, disposable, 'Swann Morton' No. 11, pack of 5 blades. 10p

Item 265 Syringes, disposable in 'sterile' pack 1ml, per 10 30p

Item 266 As above but 2ml, per 10 30p

Item 267 Syringes, plastic 30ml, each 10p

Item 268 Thermometer, glass, mercury filled, -10 to 110°C length 300mm, white back 60p

Item 269 Thermometer, photographic, blue spirit filled, ranges 56-86°F/13°-30°C, length 230mm 50p

Carrels Offer

Dundee College of Education has a number of individual study carrels, including some with tape/slide presentation equipment, which are surplus to its requirements. Anyone who is interested in purchasing these carrels should contact the college staff member responsible **directly**. This contact point is given below, please do not come through SSSERC.

Mr. W. Fyfe, Co-ordinator of Learning Resources, Dundee College of Education, Gardyne Road, Broughty Ferry, Dundee, DD5 1NY or telephone 0382-453433 Ext. 356.

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In the Workshop

SSSERC 'Standard Hammer'

Figures 1 and 2 below are largely self-explanatory. The base is of 20mm thick blockboard. The hammer is a 'standard 1lb' ball-pein type.

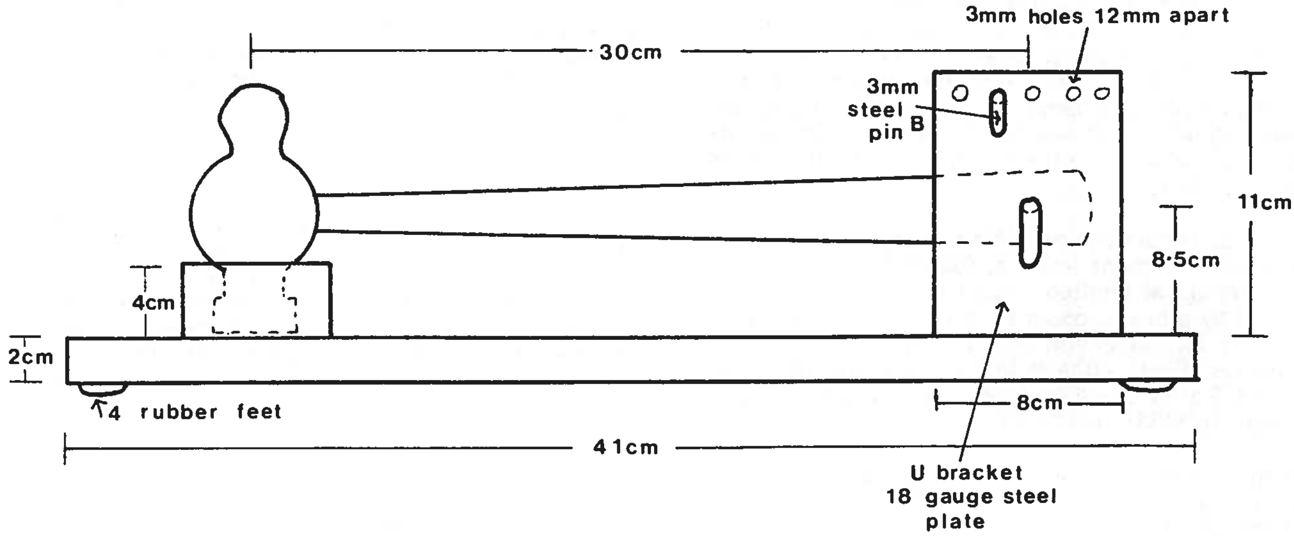

Fig. 1.

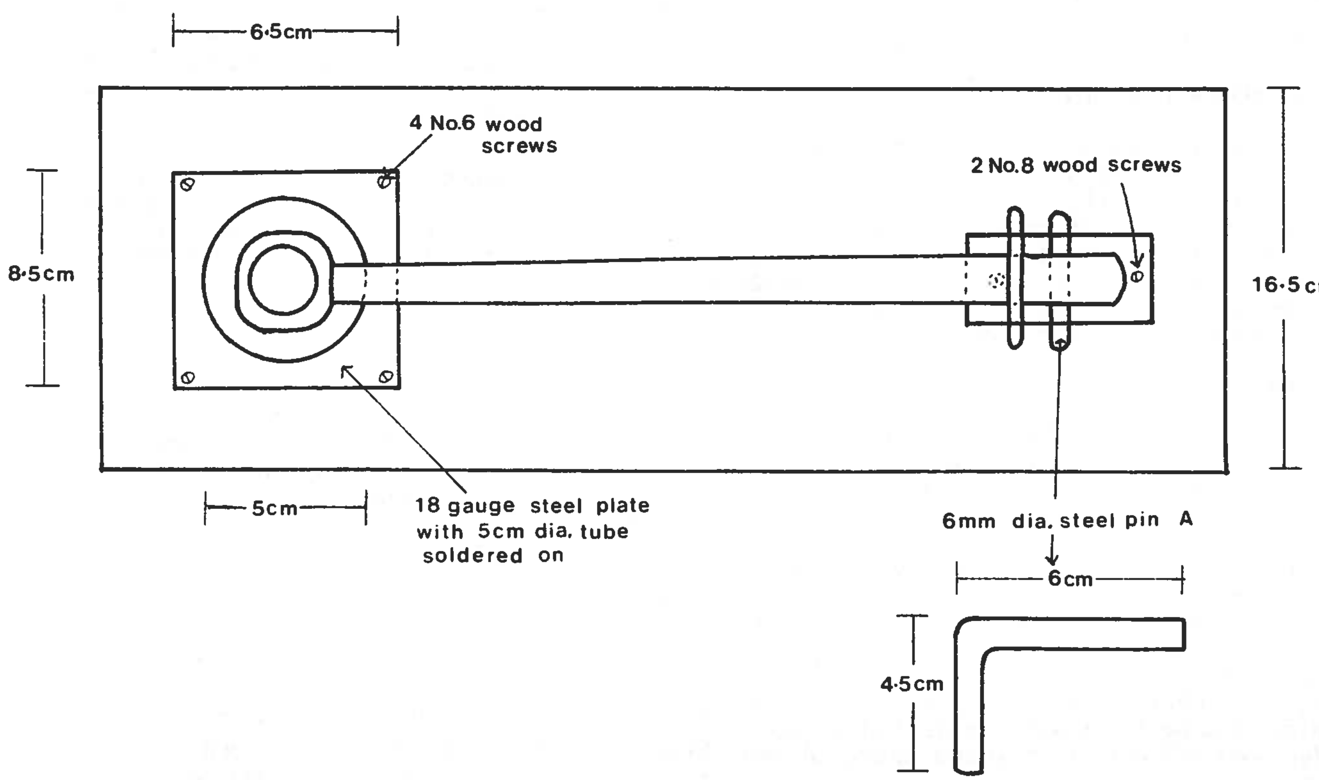

Fig. 2.

Trade News

'Methanal free' specimens

Griffin's **Gerrard Biological Centre** have recently told us of a new range of 'Formafree' preserved specimens. These are prepared using a new technique which, it is claimed, "makes them free from the unpleasant effects of formaldehyde (methanal)". The range includes rat, mouse, dogfish, sheep heart and ox eye, with discounts for quantity reflected in the prices for packs of 10 or 25 of rat or dogfish.

A similar announcement, this time for Harris 'JEM' embalmed specimens has just reached us from **Philip Harris Biological Limited**. Again these specimens are prepared by a new process so that, it is claimed, they contain no formaldehyde and are virtually odourless. The Harris 'JEM' range so far contains embalmed rats (M58444/3 at £2.50 each) mice (M58421/2 £1.10 each) and dogfish (M58114/4 £1.45 each).

Further information on both of these new ranges of specimens is available from the relevant addresses on the inside cover of this bulletin.

Microscope discounts

Prior Scientific have advised us that because of increased efficiency of production methods, extended discounts of 30% will be offered on all models in their British-made, 'Prior 400' range of student microscopes.

New 'S' range of instruments

Philip Harris have launched a new range of instrumentation with nearly everything from pH meters to power supplies being fitted into a new design of case. The new range features unified case design with particular attention also being given to "reliability, ease of servicing and user safety......... ease of storage and rapid identification". A 10 page booklet on this new range is available from Harris.

New range of disinfectants

No one disinfectant is suitable for all applications in biological laboratories. In recognition of this fact Philip Harris Biological have announced the launching of a range of three disinfectants selected for their suitability for biology. This new range, it is claimed, together with that old favourite Harris 'BAS' cleaner provides a disinfectant "to deal with all common situations". Harris 'Lab Disinfectant' is a clear, soluble phenolic (not to be confused with Lysol etc, see for example the 'Howie' Report). 'Dry-Chlor' is a chlorine releasing detergent powder and 'Lab-Spills' powder is a biocidal absorbent powder to contain and disinfect spillages. Further details from Philip Harris Biological (see address list).

Carbon dioxide

From time to time we receive enquiries for a source of supply of this compound either in cylinder or as the solid. **The Distillers Company (Carbon Dioxide) Ltd.** has recently published a leaflet summarising information on their carbon dioxide supply service for bulk CO_2, CO_2in cylinders and solid CO_2. Copies of this leaflet are available from the northern area sales office in Edinburgh. The relevant Scottish addresses however, are listed on the inside front cover of this bulletin.

WPA 'Guarantee Programme'

WPA have announced that with effect from 1st July this year all orders from their range of instrumentation are covered by a full two year guarantee. (This guarantee does not extend to electrodes, bulbs, or galvanometers). They have also announced a new, updated flat bed version of their well known CQ chart recorder. The new model is known as the CQ95 and cost £330.

Pressure sensor

New from **Griffin and George** is an electronic pressure sensor not utilising any mercury and converting changes in pressure into voltage changes. The output from the new sensor may be displayed on any suitable voltmeter, chart recorder, CRO, or via an ADC-interface to a computer. The pressure range claimed for the sensor is 0 to 2 atmospheres (ie 1 atmosphere below or above standard atmospheric pressure). At standard atmospheric pressure the output voltage is OV, at 1 atmosphere below SAP it is - 1V and at 1 atmosphere above, 1V.

The sensor is claimed to be very sensitive, detecting down to changes of the order of a few mm of water with an overall accuracy of ±2.5% and a linear response. The catalogue number of the sensor is XCR-500K and the price £57.90.

New Mettler balances

Also announced by Griffin are two new models of Mettler balance in a slim-line style. Both models have a variable integration facility, a hook for under balance (ie. suspended) weighing and are claimed to have been specially designed to interface to computers and printers. An accessory kit consisting of circuit board and connecting lead is available with instructions for hooking up to RS232, V24 or CL systems.

Catalogue No.	BFG-200-H	BFG-200-Q
Mettler No.	PE200	PE 2000
Readability	0.01g	0.1g
Mass of balance	3.7kg	3.8kg
Price	£589.00	£589.00

Microscope bulbs

Accompanying the demise of so many local agents for the 'Russian' (now 'Zenith') microscopes, has been an increase in enquiries on sources of spares for the MBR series of instruments held by many Scottish schools. In particular we keep being asked about spare bulbs for the sub-stage illuminator of the MBR-1. We are happy to report that **Technical and Optical Equipment (TOE) Ltd** had good stocks of these bulbs when we enquired recently. TOE's address is on the inside front cover. The order code for the bulbs, which are 15W, 240V, SBC is SB-3. They are available in either a frosted or pearl finish (the latter is preferable) and cost 95p each.

Science Studio (Oxford) Ltd - This is a source new to us of magnifiers, pocket measuring microscopes etc. With the trademark 'Microtec Oxford' Science Studio operates out of the address on the inside front cover.

Safety goggle clips

The clips for controlling free ends of goggle straps, mentioned in the 'Safety Notes' sections of this bulletin and in issue 132 are now available from Griffin and George. A pack of 50 clips, catalogue number SAP-422-750F, complete with fitting instructions costs £1.93. It should also be noted that the goggles referred to (SAP-420X) now come with clips fitted. They have been given a different catalogue number - SAP-424N and cost £2.24 each.

ZX81s - 'Griffin' repair service

The following information applies only to those units which were originally purchased from Griffin and George. Customers must send details of the delivery note number against which the unit was supplied.

The procedure for repair by 'Griffin' is as follows:-

(i) If the instrument fails within the guarantee period of one year from the date of receipt, the customer should return the faulty unit to the nearest Griffin branch (for Scottish customers this means the Manchester address). A free of charge replacement should then be sent within 7-10 days. This, Griffin tells us, "is provided the case has not been defaced or the unit has not been treated in such a way (as) to invalidate the guarantee".

(ii) If the instrument fails outside the guarantee period the customer should again return the unit to the nearest Griffin branch but this time accompanied by an order for repair. There is a standard charge of £20 for the repair and a refurbished unit (not the customer's original) will be sent to him, again within 7-10 days of receipt. A further 12 months guarantee is given with the refurbished unit.

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S.S.S.E.R.C.

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