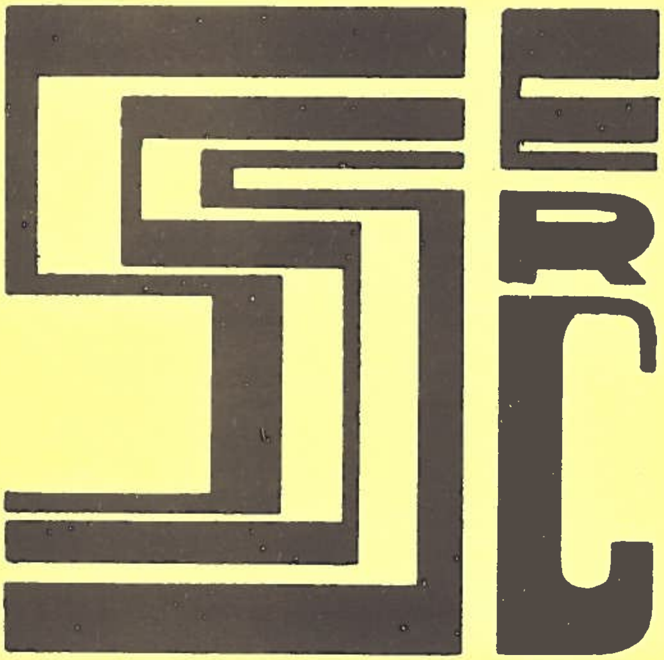
SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE



Bulletin No. 130 March, 1982

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Introduction

New Assistant Director

Following the appointment of John Richardson as Director of SSSERC a vacancy, at Assistant Director level, for a Physics/Micro-electronics specialist was duly advertised. This post has now been filled. We are pleased to welcome Mr. J.H. Jamieson, B.Sc. to the staff of the Centre. Jim Jamieson was educated at Rutherglen Academy and Glasgow University. He then spent some time as a physicist with the British Antarctic Survey before training to be a teacher. Jim (presently at Portobello High, Edinburgh,) has taught physics and electronics at all levels for over eight years. His knowledge of physics, micro-electronics and computing will bring some sorely missed expertise back into the Centre. He will join the Centre staff as from April, 1982.

Easter Holidays

Readers are requested to note that the Centre will be closed from Friday 9th to Monday 12th April, 1982, inclusive. This also means that there will be no Saturday morning opening on 10th April.

ASE Scottish Region Annual Meeting

This is to be held at Aberdeen College of Education on 14th-16th April 1982. SSSERC will be there, with the by now almost traditional exhibition of d-i-y apparatus.

'Hazcards'

We still have a few sets of CLEAPSE/SSSERC 'Hazcards' left at £3 per set including post and packing. Please refer to Bulletin 129 for details of the conditions of sale before ordering any sets.

Equipment Guides, Repair and Maintenance Notes.

The Planning Committee of SSSERC are currently reviewing our equipment testing programme. Also under review is the format of publications on commercially produced items. At the moment the Centre has standing remits for the testing of a number of types of equipment with other items being evaluated on a more ad-hoc basis. This system now requires rationalisation to take account of changes in the pattern of purchasing (or non-purchasing?). The committee is anxious that the right balance is struck between providing advice for purchasers of equipment and giving help to those in a less fortunate position who are struggling to keep functioning the equipment they already hold.

It would help us immensely if Principal Teachers could take the time to complete and return the loose-leaf insert to this bulletin. The replies we receive will help us judge the relative priorities for common types of capital equipment.

Eclipse

On the 20th of July this year there will be a partial eclipse of the sun. This event will be more readily observed in Scotland than in the rest of the U.K. We realise that most, if not all, Scottish schools will be on holiday at this time. We still thought that a reminder on methods of observation would not come amiss. It is worth pointing out to pupils that they should not look directly at the sun. Indirect observation by projection onto a screen is by far the safest course. Obviously care should be taken to avoid igniting the screen material. Being burnt is hardly a fair trade-off for retaining ones eyesight!

* * * *

CLEAPSE Guides

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

L.4a	Electronic top pan balances, published December 1979 amended January 1982.
P 29	Devices to extend the Functions of Basic Scaler-Timers: Pulse Time Control Module and Frequency Meter Module.
P 30	Projection Meters (Note: P29 and P30 are d-i-y guides).
MIC81/c	Illuminators for Griffin-Beck Student Microscopes (a d-i-y repair note)
L 92a	Scaler-timers and Related Equipment, January 1982
L 149	Chemical Spills, Revised September 1981

* * * *

Safety Notes

The material making up the first section of these notes was originally published in 'Education in Science' January 1982. The article is part of the 'Safety in Science' series prepared by the ASE-convened working group of which SSSERC staff are members.

Organising School Science for Safety

1. Introduction

The achievement of an acceptable standard of safety is only one of the aims of efficient laboratory organisation: others are effective teaching and economy. A recent survey showed that laboratory accidents are rare (affecting around 0.05% of secondary school pupils per year) and very seldom serious. However, active steps should be taken to reduce laboratory accidents and precautions can be used as part of a safety education of value beyond school science.

How a science department is organised for safety will depend on:
the size of the department,
the experience of the staff,
the arrangement of science rooms
and other factors, including the management style in the department. (For advice on science department organisation, see Hull R. & Adams H. **Decisions in the Science Department** ASE/Schools Council, 1981, ISBN 0 902786 741). This article merely suggests ideas which should be borne in mind when the organisation of a science department is considered.

In all cases, school staff are legally required to adopt safety policies and regulations prescribed by their employers. In their turn, employers are legally required to provide adequate safety training. They should also ensure that science staff, particularly heads of departments, have adequate time to organise for safety.

2. Policy

It is important that all science staff accept certain practices and procedures. These may include:

how safety information is circulated,
which chemicals should be stocked and who can use them,
what class practical work is carried out at different levels,
signing out and signing in procedures for radio-active sources,
what to do if equipment or services are thought unsafe,
what to do in case of accidents—summoning help and completing report forms,
checking a laboratory before leaving it,
technicians duties and timetables,
what technicians can do when alone in the department,
what to do with disruptive pupils who may cause hazards.

There are many others. Before an item of policy is established there should be discussion but, ultimately, decisions must be made by the appropriate head of department. It is important that procedures and practices adopted are recorded not only in a laboratory safety file, or some other flexible reference system which information can be added to or removed from, but also where it may be seen at the right time. The need for precautions can be indicated in schemes of work and on bottles, the boxes containing apparatus etc.

3. Information

An important part of organisation for safety is the circulation of information. Of the information reaching a department from the outside, education authority circulars have a mandatory status. In addition, a head of department may wish to circulate Government Administrative Memoranda, **Education in Science** articles, items in the bulletins of CLEAPSE or SSSERC etc. An effective procedure is to ask staff to initial an item after they have read it and, when all have read it, to put it in a safety file, with appropriate references in schemes of work, on apparatus etc. It is sensible to put a note in the file that the circulation of an item has begun, to avoid it being lost without trace.

It is as important to resist unreliable information as it is to spread reliable information; newspaper reports and conference hearsay have been largely responsible for an over reaction to certain substances and practices, e.g. mercury. In addition, there is a need to circulate and record internal policy decisions; see Section 1.

There should be opportunity within a science department for informal discussion of safety problems. This could lead to enquiries to bodies such as the ASE, CLEAPSE or SSSERC or representations to education authority advisers.

4. Training and Testing

It is not enough in some cases to provide information: the inexperienced need to be trained and informally tested. This category includes probationary and student teachers, newly-appointed technicians and teachers teaching outside their specialisms. Employers should provide training for major topics, e.g., microbiology, First Aid. However, there are certain skills most conveniently taught, or at least revised, in the department. For example:

certain experiments, e.g. using a steam engine; the thermit reaction;
preparing certain chemicals, e.g. diluting sulphuric acid;
assembling certain apparatus, e.g. any using glass tubing;
certain First Aid skills, e.g. washing eyes.

It is easy to see how failure of communication could cause an accident to occur; e.g. a physicist teaching an isolated chemistry class could ask an inexperienced technician to prepare chemicals, each unaware of the hazards and the others' ignorance. There is a need to list these skills and for it to be made clear that they are not to be attempted before instruction by someone experienced has been given. Teachers can be alerted to these skills through indications on schemes of work. Technicians could be given a list.

Pupils need planned safety training, with items interspersed where appropriate throughout their science syllabuses. There may be a place for a list of laboratory rules on the laboratory wall or in front of notebooks but it is not enough. Demonstrations, practical work, discussions, revision and informal testing are used in other areas of science education and should be used for safety education; exhortation and posters on the wall are not sufficient.

5. Supervision and Delegation

Heads of department, whether of a particular science or all science, have a duty to see that work in their department is safe. While some supervision duties may be delegated, it is necessary, nevertheless, to check from time to time that they are being carried out satisfactorily.

It is important that all staff understand the structure of responsibility within a department. A chart is one method of making this clear; see below.

Teachers or technicians who believe that defective equipment or poor conditions are causing hazards should report the matter and seek advice on what should be done before it is remedied. However, if they consider the risk unacceptably high, they should abandon the proposed work and try to achieve the desired objectives by a different method. See **Safeguards in the School Laboratory** (ASE, 1981, ISBN 0 902786 65 2), page 3.

6. Reminding and Checking

Hazards are caused by omissions and carelessness so that it is important that there are procedures for checking and reminding.

Check lists are a useful aid, particularly for ensuring that technicians' duties are carried out. Below is reproduced a check list for the inspection of a chemistry laboratory before it is left in the evening. Similar lists could cover points to be checked weekly, each holiday and annually.

A member of staff co-ordinating a group of teachers teaching an integrated science course might be given the duty of reminding the group of hazards in the course **as they arise;** again copies of schemes of work could have the danger points indicated.

Finally, it is salutary from time to time for a group of teachers to inspect the laboratories in which they work or the laboratories of a neighbouring school and produce a safety audit.

Most schools have fire drills to remind staff and pupils what to do in case of fire. Science staff might consider similar drills to cover other accidents, for example: chemicals in the eye, clothing on fire, spills of hazardous chemicals, electric shock producing loss of consciousness.

Chemistry Laboratory: evening check

Are any of the following left open?
  Doors
  Windows
  Cupboards

Are any of the following left on?
  Gas taps
  Water taps
  Fume cupboards
  Ovens, stirrers, water baths etc.

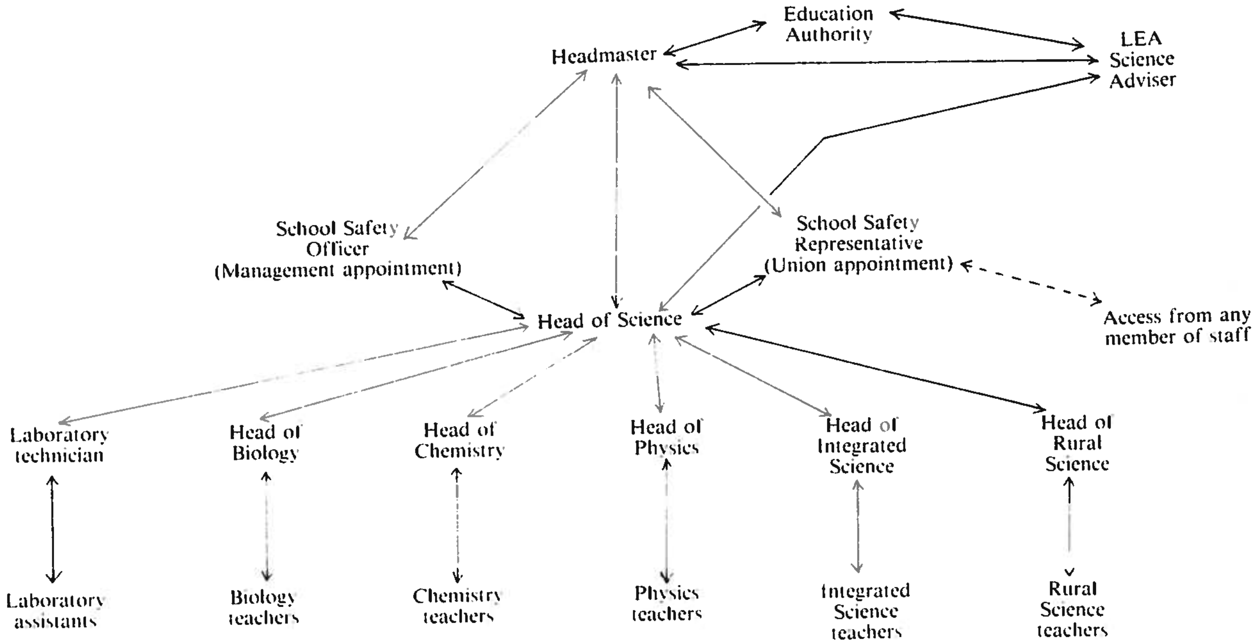
Are any of the following in the wrong place or missing?
  Bench reagents
  Toxic or corrosive chemicals
  Flammable liquids
  Cylinders
  Expensive or easily stolen apparatus
  Fire fighting equipment
  Contaminated apparatus

Are there any spills on the benches or floor?

Are any sinks full of water?

Are there any chemicals or pieces of broken glass not properly disposed of?

A POSSIBLE STRUCTURE OF SAFETY ACTION/ADVICE WITHIN THE SCIENCE DEPARTMENT



Note: This structure will require adaptation to suit the particular restraints of the school in question.

METHANAL (FORMALDEHYDE)

Following the publication in 1980 of a number of reports, notes and 'alerts' (1-3) arising out of research in progress at the Chemical Industry Institute of Toxicology (CIIT) in the USA, SSSERC has been trying to monitor the literature on methanal. Some results of the CIIT studies were published in late 1980 (4,5). The work involved a chronic (life-time) inhalation study in rats and produced evidence that methanal is carcinogenic in this species, producing an increase in the incidence of nasal tumours.

Since that time a number of reviews and 'overviews' have appeared (6,7,8). However in each case there has not been cited any convincing epidemiological or other evidence that methanal is a carcinogen in man. The additional consideration that nasal cancer is a rare disease in humans has led us to be cautious in making any pronouncement on methanal. We are still more or less in the position we were in two years ago. We await the results of one or two long term, epidemiological studies which are underway at the moment. In the meantime, we have an open mind on the subject. Methanal is a useful substance, with no known convenient and safe substitutes for some purposes. It is also a potent irritant and very toxic. It should be handled with the respect its toxicity demands, irrespective of any carcinogenic activity it may or may not have.

Other organisations and individuals may have been less cautious in their approach to this particular problem. This is understandable given the tone of some of the early reporting. Against this background of rumour and blossoming folklore on methanal, we felt it was time we made some statement on the substance and the evidence for its carcinogenicity. Fortunately, the Health and Safety Executive had already recognised that there was a problem. **HSE** has very recently published its 'Toxicity Review Number 2 - Formaldehyde' (9). The toxicity reviews are a welcome addition to the safety literature. Their purpose is clearly set out in a frontispiece which, with permission, we quote below.

> "These Toxicity Reviews set out the available scientific evidence on the biological impact of substances suspected of being hazardous to man. The papers have been prepared primarily for the Health and Safety Commission's Advisory Committee on Toxic Substances in order to assist its members in analysing the risks involved in working with such chemicals and in determining what controls of exposure may be appropriate. The Toxicity Reviews are critical summaries of the literature and, consequently, the opinions expressed in them are not necessarily those of the Health and Safety Executive. The Health and Safety Executive is publishing these papers in order to contribute information to scientific and

> public debate on the level of risk involved in exposure to such substances, on the acceptability of such risk and on the control measures that need to be adopted."

Rather than quoting isolated sections of the evidence discussed in the review, it seems more sensible to give in full the 'Summary' which states the main conclusions reached by the authors:

> **"Summary**
>
> Formaldehyde is a colourless, highly reactive gas with a pungent odour. It is very soluble in water, and inhaled vapour is absorbed mainly in the upper respiratory passages, before reaching the lungs. The absorbed material is rapidly converted to formate both in the liver and the blood.
>
> **Toxicity to animals**
>
> Formaldehyde has high acute toxicity to animals, deaths being reported in several species after exposure to 15 ppm for ten minutes. This concentration produced severe irritant effects on the eyes, nose and respiratory tract. Continuous (24 hours) exposure to about 4ppm of formaldehyde for 90 days produced no signs of toxicity during the exposure period, but some lung damage was noted at autopsy.
>
> Dilute aqueous solutions of formaldehyde (about 2%) have been shown to be potent skin sensitisers in the guinea pig.
>
> Formaldehyde has, under certain conditions produced mutations in bacteria, yeasts and Drosophila. A recent, chronic (life-time) inhalation study in rats has shown formaldhyde to be carcinogenic in this species, producing a high incidence of nasal tumours in animals exposed to 15 ppm of gas. Some increase in nasal tumours was also noted at 6 ppm; these tumours normally occur only very rarely in the strain of rat used, and none were observed in the control animals.
>
> No evidence for any teratogenic effect was noted in inhalation studies in pregnant mice. More limited studies in other species have also given no indication that formaldehyde has any teratogenic properties.
>
> **Toxicity to man**
>
> Formaldehyde is a severe irritant to the eyes and upper respiratory tract. The threshold for mild eye irritation may be as low as 0.01 ppm in some individuals: 4 ppm and above usually produces lachrymation, although continued exposure may result in some acclimatisation to the irritant effects on the eyes. Mild effects on the throat have been noted at 0.5 ppm, and marked irritant effects on the nose and throat at 10 ppm. Formaldehyde vapour and dilute aqueous solutions containing about 2.5% or more of the compound are irritant to the skin.
>
> Although it is recognised that formaldehyde produces acute irritant effects on the respiratory tract, little information is available to enable an assessment to be made of the effects of prolonged exposure on lung function. The studies that have been carried out are complicated by the simultaneous exposure of the workers to other irritants besides formaldehyde. However, the available evidence suggests that no chronic impairment of lung function has occurred in workers occupationally exposed to formaldehyde.
>
> Formaldehyde can produce skin sensitisation and cases of allergic contact dermatitis have been reported both in persons occupationally and non-occupationally exposed to formaldehyde. In addition there are a few reports of asthma-like symptoms occurring in persons occupationally exposed to formaldehyde, although the details given were insufficient to establish whether the response was due to a respiratory sensitisation reaction to formaldehyde. However, recently such a reaction was confirmed in two nurses, by measuring the response to formaldehyde under controlled conditions. In view of the small number of reports of such respiratory distress, despite the very widespread exposure to formaldehyde, the compound can be regarded as a weak respiratory sensitiser.
>
> There is at present no evidence suggesting that exposure to formaldehyde has produced cancer in humans, nor is there acceptable evidence for any adverse effects on the reproductive system."*

The toxicity review also mentions the possibility of the reaction of methanal with hydrogen chloride or inorganic chlorides to produce bis-CME (bis-chloromethyl ether) a potent carcinogen. We first reported on this in any detail in our own Bulletin 85. That report was based on a note in the Institute of Biology journal 'Biologist' (10) and, to us at least, suggested that appreciable quantities of bis-CME could be formed from relatively low concentrations (a few ppm) of methanal and hydrochloric acid vapour.

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*Footnote Sections of the review are quoted by kind permission of the Controller, HMSO.

This is not the interpretation taken from original literature (11, 12) by the authors of the 'Toxicity Review'. According to this present review "the reaction has been demonstrated only at high concentrations of formaldehyde (500ppm and above). It has been reported that there is no evidence of any BCME formation in air at concentrations around the level expected in an industrial environment, when using analytical techniques capable of detecting BCME at parts per trillion".

It looks therefore as though this particular potential hazard may have been a little exaggerated. However, it is only sensible to continue to follow advice regarding separate storage of methanal and hydrochloric acid, and to avoid the use of hydrochloric acid as a catalyst in organic preparations involving methanal (eg. 'formaldehyde'/urea plastics). In some of these experiments dilute sulphuric acid is an effective substitute.

Conclusion

Despite announcements from some sources to the contrary the carcinogenicity of methanal in humans is yet to be convincingly demonstrated. Until, what may be crucial, epidemiological studies are complete our verdict must be 'not proven'. In these circumstances it is only sensible to handle methanal carefully and to minimise exposure to the vapour (current TLV 2ppm), **something its toxicity alone always warrants.** We undertake to continue reviewing the situation regarding methanal and will report further on any important developments.

References:

1. "Hazard Alert: Formaldehyde" A.S.T.M.S. 'Health and Safety Monitor', February 1980.
2. Chemistry and Engineering News Oct 22, 1979
3. "Progress Report on CIIT Formaldehyde Studies" CIIT Statement, January 1980.
4. "Formaldehyde". Reported at the third CIIT Conference on Toxicology, Raleigh, North Carolina, November, 1980.
5. Swenberg J.A., Kerns, W.D., Mitchell R.I., Gralla E.J., Pavkov K.I., 'Induction of squamous cell carcinomas of the rat nasal cavity by inhalation exposure to Formaldehyde vapour. Cancer Res. 1980; 40: 3398-402.
6. 'Overview of Studies to Evaluate the Carcinogenic Potential of Formaldehyde'. Report of the Chemical Industries Association 'Formaldehyde Health Impact Study Group' January 1981.
7. 'Technical Report No. 1 - Assessment of Data on the Effects of Formaldehyde on Humans' European Chemical Industry Ecology and Toxicology Centre (ECETOC), May, 1981.
8. 'Technical Report No. 2 - The Mutagenic and Carcinogenic Potential of Formaldehyde', ECETOC, May, 1981.
9. 'Toxicity Review 2 - Formaldehyde', HSE (HMSO London) 1981. (Reviews 1 and 3 deal with styrene and carbon disulphide respectively).
10. 'Biologist', 22 No. 3 August 1975
11. Kallos G.J., Solomon R.A., 'Investigations of the formation of bis(chloromethyl) ether in simulated hydrogen chloride - formaldehyde atmospheric environments'. Am Ind Hyg Assoc J 1973; 34:469-73
12. Tou, J.C., Kallos G.J., 'Possible formation of bis(chloromethyl) ether from the reactions of formaldehyde and chloride ion. Anal Chem 1976; 48: 958-63

Accident Report

We have received, via. HSE, a report on an accident involving the escape of bromine from a demonstration diffusion apparatus. This is a 'standard' demonstration in which a tube with a side arm, fitted with a short length of rubber tubing which receives a phial of liquid bromine, is used (see Fig. 1). A phial of bromine is fitted into the rubber tubing and the tap opened. The phial is then crushed, through the rubber, using a pair of pliers, The diffusion of bromine vapour into the air is then observed.

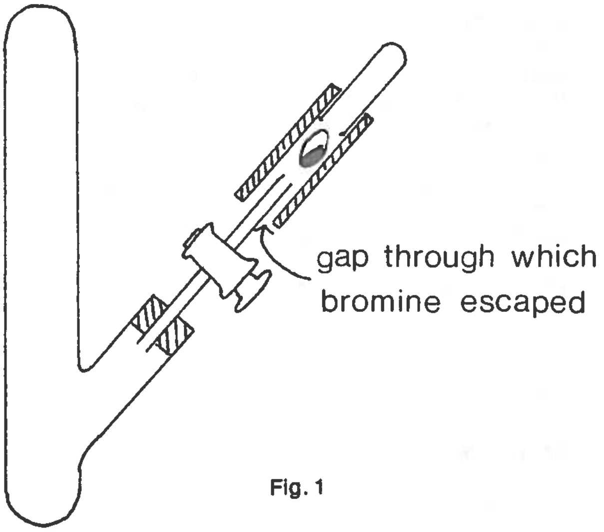


Fig. 1

On the occasion of the accident reported to us there was a leak of bromine into the laboratory because the rubber tubing was a poor fit on the glass, the vapour leaking out from around the joint. It transpires that **Griffin and George**, suppliers of this particular apparatus, used to make two different sizes of phials and rubber tubes for two slightly different versions.

It is part of good experimental technique to check joints in apparatus, for snugness of fit and potential sources of leaks before starting the experiment. This incident serves as a salutary reminder of this to us all.

Liquefied Petroleum Gases (LPG)

The attention of those readers, in schools and other educational institutions, using LPG is drawn to Guidance Note CS4 from the Health and Safety Executive. This particular 'Guidance Note' replaces and reprints, with minor amendments, the HSE red booklet: 'Code of Practice for the keeping of Liquefied Petroleum Gas in Cylinders and Similar Containers.

This present Guidance Note CS4 - 'The keeping of LPG in cylinders and similar containers' contains a number of points relevant to the conditions found in schools. It is available from HMSO at £1.50 per copy.

* * * *

Biology Notes

Vital Capacity Apparatus

Constructional details for a simple 'spirometer'/vital capacity apparatus are given in the workshop section of this bulletin. The advantage of this apparatus is that it resets very quickly, allowing a class of pupils to obtain vital capacity measurements in a relatively short time. This is not the case with the 'bell jar in the sink' with a pump, method more usually employed.

The apparatus shown on page 16 was designed a number of years ago. The design was never published because the plastic containers used could not be specified, the containers being those we happened to have to hand. However, the demand for such a device has been so great, especially from schools piloting 'Foundation Science' materials, that we have decided to publish the details of this SSSERC design. Schools will have to use the general principles shown and modify the design where necessary to suit the containers they can obtain.

The main purpose of the apparatus is the measurement of vital capacity. It can also be used for estimating tidal volumes but, because of the small total volume of air available and the lack of any carbon dioxide absorption, breathing in and out of the apparatus should be restricted to short periods of time - less than a minute. This is to avoid any possibility of fainting through anoxia or asphyxia. Because of the small diameter of the airways, it should not be used to monitor breathing after exercise. This again is to avoid fainting brought on by difficulty in breathing relatively large volumes of air through tubing of small diameter with the attendant resistance to air flow.

* * * *

Chemistry Notes

The Calorimetry of Fuels

We have been requested by a number of schools, some of them piloting Foundation level materials, for advice on methods for measuring heats of combustion ('calorific' value) of common fuels. Some of the d-i-y techniques for combustion calorimetry described in Bulletin 114 are relevant to the problems involved. For some fuels, eg. coal and smokeless fuels which are normally burned in combustion calorimeters using a stream of oxygen, alternatives which are both safer and cheaper were needed if these measurements are to be made by a class rather than by teacher demonstration.

It is not the intention in this article to specify experiments for any particular course or purpose. We merely seek to pass on our hard-won experience of certain techniques. This is in the hope that teachers wishing to pursue this topic will use the material presented as a technical resource.

Wood

Here it was found that pine, deal or other softwoods would give results in a demonstration using a commercial calorimeter or the SSSERC d-i-y version described on Page 6 of Bulletin 114. The use of oxygen meant great care had to be taken (see list of precautions in 'Safety Notes' Bulletin 113). With this method the mean of three determinations gave a figure of 13.3MJkg^{-1} (published data - 14.5MJkg^{-1}).

Two arrangements for a pupil scale experiment were also trialled. The apparatus used was a '2lb' syrup tin with a dented base, (see p.3. Bulletin 114) sitting on a rubber covered retort ring (Fig. 1).

The heat capacity of this tin with 300g of water was 1303JC^{-1}. In the first method, pieces of wood cut up as fingers were weighed and then lit in a Bunsen flame and placed under the dented tin. The initial and final water temperature were noted and the extinguished piece of wood reweighed. Using initial masses of wood varying between approximately 1 to 3g gave actual masses burned of between 0.7 and 1.4g. The two sets of figures were not directly correlated, small masses burning completely sometimes giving higher burned masses than large pieces incompletely burned.

The mean for six determinations using this method was 8.4MJkg^{-1} (see above for published figure). However the results were variable the range being from 6.7 to 10.5MJkg^{-1}.

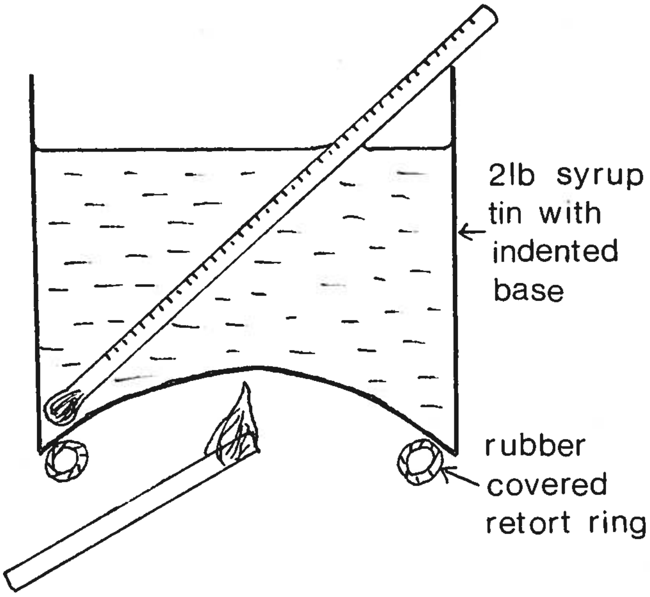


Fig.1.

A variation of the method was trialled using a bundle of wooden spills (laboratory tapers) fastened together with loops of nichrome wire. Five tapers were used in the bundle, but this is not crucial to the method! Here the mean of five determinations was 10.4MJkg^{-1} and the range was narrower (10.0 to 10.9MJkg^{-1}). These higher, more consistent figures were attributed to more complete combustion, possibly through a better supply of air to a bundle with its greater surface area to mass ratio. On the other hand, it just could be attributed to the wax or potassium nitrate treatment to which some commercial spills are subjected. Drying the spills in an oven at 150°C for three hours, lifted the figures yet closer to the published data. After drying, a mean of 11.7MJkg^{-1} was obtained (with a range 10.7 to 12.4MJkg^{-1}).

Thermometers used by pupils will usually only read to 1°C. Therefore a reasonable temperature change is required to reduce the significance of any error from this source. Too great a temperature rise however will result in significant heat losses. A balance is needed between the output of the heat source and the amount of water used in the calorimeter. The volumes of water given here, and used at SSSERC, seem effective in this respect.

With these simple methods and indeed for the others described below, a simple, practical approach is needed to matters like compensation for heat losses and the calculation of the results. This is especially so if the methods are adapted for use with pupils belows 'H' grade level. In order to allow for heat losses, use water as cold as can be obtained from the tap. If the final temperature is approximately as high above room temperature as the initial temperature was below it, then heat loss should be more or less compensated for by heat gain (a pragmatic, chemist's solution!). For practical purposes some pupils need not be told why they are to use water as cold as possible, just ask them so to do.

The calculation is not readily simplified beyond:

$$\text{HEAT EVOLVED kg}^{-1} = \left[\frac{\Delta T}{\Delta m} \times \text{heat capacity}\right] \text{kJ.}$$

The heat capacity of the calorimeter can be marked on it as a 'constant'. The aim is to give pupils a factor for any particular calorimeter/fuel combination so that multiplication of the temperature rise by this factor will yield an approximation of the heat of combustion. (Who knows, there may even be a use for a microcomputer here?) Those teachers tempted to grumble about magic numbers and 'black box' experiments should bear in mind the main objective of this exercise. The main interest lies in revealing the relative thermal yields from a range of common fuels. The aim is not to teach sophisticated calorimetry.

Candles

Another simple pupil experiment involves the use of the syrup tin calorimeter with a candle (paraffin wax as a fuel).

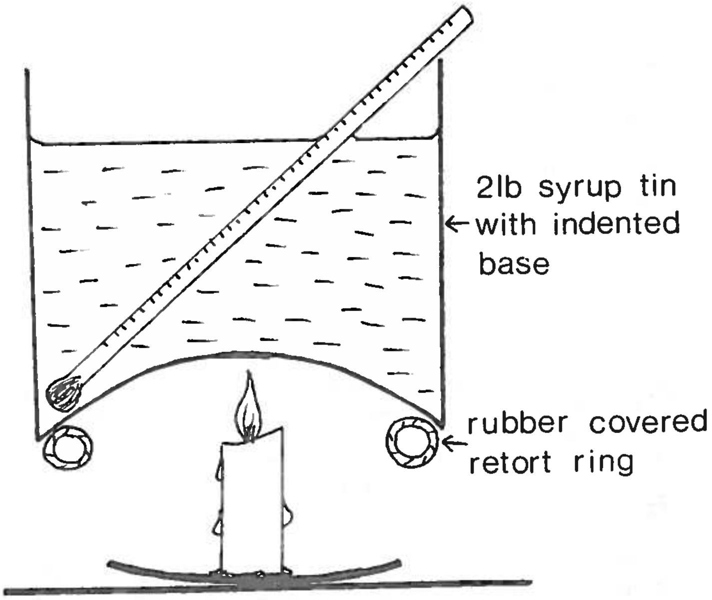


Fig. 2.

The method is very similar to that described for a pupil experiment with wood. The dented tin is placed so that the candle flame licks the underside. The flame can be extinguished at any time once a suitable temperature can be recorded (ie as far above room temperature as the initial reading was below it). In our trials the mean heat evolved per kg of candle wax was 41.6MJ (in a range 37.7 to 44.6MJkg^{-1}).

Coal

Domestic coal, it was found, could be burned in the SSSERC d-i-y combustion calorimeter, and in commercial versions, provided oxygen was used. Clearly these experiments would have to be demonstration only, with care being exercised. Results with a mean of the order of 18.3MJkg^{-1} were obtained with these methods. Published data suggest much higher figures ranging from 29.65MJ to 34.3MJkg^{-1} depending on the type of coal. Even with the use of oxygen in 'proper' combustion calorimeters, the coal very occasionally burned for a little while but then 'went out'. This was less likely when the oxygen was supplied from a cylinder (with a needle valve for close control) when a faster flow rate could be used.

Other simple d-i-y methods were tested, including variations of the gauze basket method for foods (described in Bulletin 63). However none of these were satisfactory as pupil scale experiments. There was one method however that was a good d-i-y demonstration/stations experiment. The essentials of the apparatus for this method are shown in Figs 3 and 4

The clay pipe with its air supply from an aquarium pump (eg. 'Petcraft' models) forms the equivalent of a forced draught furnace. A collar of 'Kaowool' or 'McKechnie' ceramic fibre strapped by wire onto the pipe bowl provides heat insulation. Ignition is electrical, an 8V heater being made from a coil of 28swg nichrome wire. The calorimeter is the SSSERC 'chamber' calorimeter shown on page 4 of Bulletin 114, minus the heat exchange coil (see Appendix for dimensions). The coil could be used and, for a while, would have the advantage that fumes would be removed and 'scrubbed' at the filter pump. Unfortunately, the coil would eventually be blocked by soot and condensates.

The method of use of the clay pipe furnace is as follows:

1) The pipe, insulation, coil and fuel are weighed as a single unit.

2) Connect up the pipe to the pump and switch on to start the air flow. The flow may need slight restriction to avoid blowing out any coal dust.

3) Energise the coil heater.

4) Once the fuel is well lit, as judged by flames coming from below rather than just gases and volatiles burning on the surface, switch off the current to the coil.

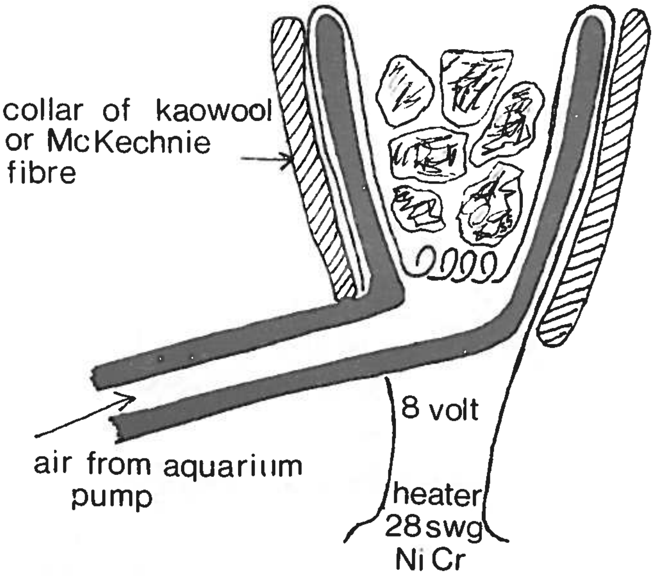


Fig. 3.

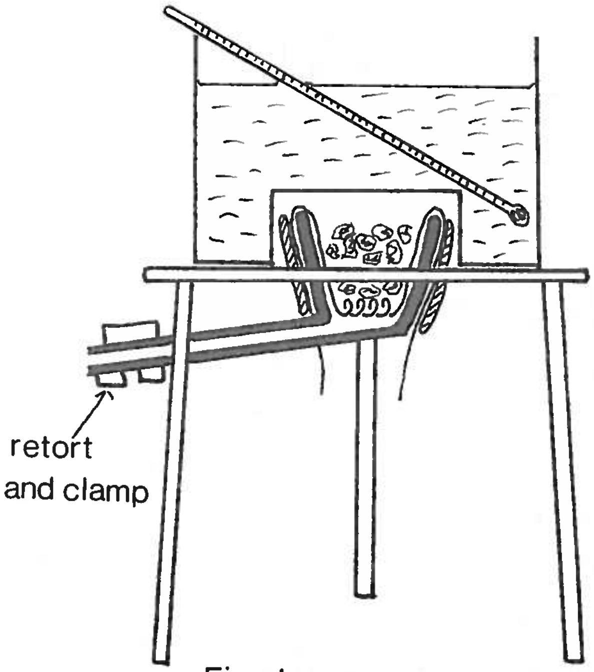


Fig. 4.

5) Place the chamber calorimeter, with a known volume of water, on the top of the clay pipe (see Fig. 2). (300 to 400g of water was found to give a good temperature rise - ca. 19°C).

6) Stir with the thermometer. When a sufficiently high temperature has been reached, switch off the pump. Continue stirring and reading the temperature (this could take a while) to ensure that complete transfer of heat to the calorimeter has occurred. In most of our experiments the temperature was observed to rise a further 2-3°C before steadying and beginning to fall.

7) Disconnect the air line and the crocodile clip connections to the coil. Lift off the calorimeter and remove the pipe and its contents carefully to be re-weighed.

8) The factor restricting this to a demonstration or stations technique - all of the operations 2-7 should be carried out using a fume cupboard or other efficient means of fume extraction!

Results for a calorimeter with 1000g, 300g and 400g of water are shown below. Note that using 1000g of water gives a higher figure for the heat of combustion but with 300 or 400g a greater and more easily recorded change in temperature is obtained.

RESULTS	MASS OF WATER		
	1000g	300g	400g
Mass of pipe and coal (g)	20.83	30.30	30.44
Mass of pipe and residue	19.25	28.51	28.07
Mass of coal burned	1.58	1.79	2.37
Initial temperature °C	10.05	10.04	10.02
Final temperature	16.02	29.04	29.06
Change	5.07	19.00	19.04
Heat evolved MJkg coal	15.08	13.93	14.16

TABLE 1

The clay pipe furnace was also used with the simpler, dented, syrup tin calorimeter containing 400g of water. This simple method gave a mean result of approximately 11.3MJkg^{-1}. Comparison of the figures obtained, for the two types of calorimeter, with the published data suggests a 43 per cent efficiency for the two chambered type and a 34 per cent efficiency for the simple syrup can. In the interests of simplicity this slightly lower efficiency may be acceptable.

'Smokeless' solid fuels

a) **'Phurnacite'** The only satisfactory method with this fuel proved to be a demonstration experiment using a combustion calorimeter with oxygen. 'Phurnacite' would sometimes burn in the clay pipe furnace but was difficult to ignite. On one occasion it failed to continue burning in oxygen in the combustion calorimeter!

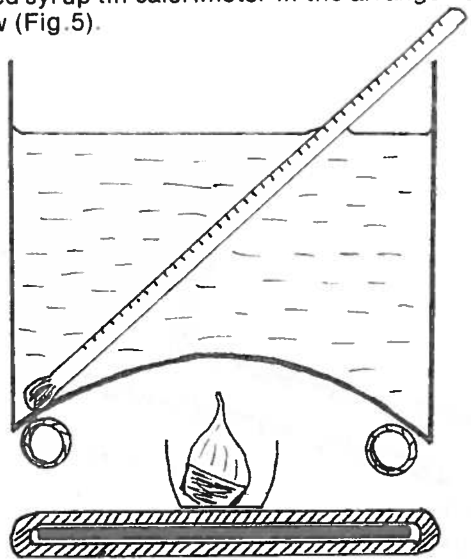
These combustion calorimeter measurements yielded figures ranging from 15.9 to 25.0MJkg^{-1} with a mean of approximately 19.4MJkg^{-1}. Commonly accepted figures for Phurnacite are 29 to 32MJkg^{-1}.

b) **Welsh Anthracite Cube** This burned in the clay pipe furnace but only remained alight when the bowl was well filled with pieces of varying sizes. With the d-i-y, chambered calorimeter (see above) figures of 14.9 to 16.8MJkg^{-1} were obtained for the clay pipe method.

With a combustion calorimeter proper and oxygen, lumps seemed to burn better than small pieces, with the fuel obviously having a higher efficiency than smoky coals. When burning lumps, figures of 25.6 and 25.5MJkg^{-1} were obtained with small pieces giving 20.3 to 23.9MJkg^{-1}. The latter results compare well with published figures of 29MJkg^{-1} or thereabouts.

Paraffin Oil

Paraffin (domestic oil heater fuel), soaked into 'Kaowool' ceramic fibre in a crucible, was used with the dented syrup tin calorimeter in the arrangement shown below (Fig.5).



clamped syrup tin lid covered in kaowool to reduce heat loss

Fig. 5.

300g of water were used which, allowing for the specific heat and mass of the can, gave a heat capacity of 1.304kJC^{-1}. Burning approximately 0.4g lots of paraffin produced temperature rises of 11.4 and 12.6°C. These results yield figures for heat evolved per kg of 37.2 to 39.1MJ. Most of the published figures for alkanes in the range C_{10} - C_{20} lie between 47.5 and 48.0MJkg^{-1}. This exercise would seem then to constitute a reasonable, if smelly, pupil experiment. There are safety considerations here, but the difficulties are not insurmountable. Paraffin, though flammable, will only burn if absorbed onto a material which will act as a wick and allow rapid vaporisation (it will also burn easily once in aerosol form). The obvious security measure is for there to be close teacher control of the dispensing of the paraffin, with the volume allowed per pupil pair being severely limited.

Natural Gas

Here the most satisfactory method involved the use of a microburner (**Flamefast**) with the chimney removed and fitted with a flame retention device in the shape of a nichrome wire coil. (Fig.6).

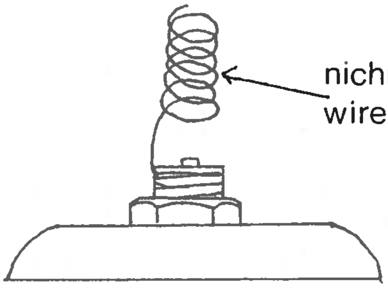


Fig. 6.

This was used with the dented syrup can calorimeter. With gas, weighing the fuel is not very practicable! It is therefore the usual practice to express results in terms of heat evolved per m^3 of gas burned. It is a relatively easy matter to measure the volume of gas delivered to a burner in unit time (see below) but because of safety considerations this should be carried out only by an experienced teacher or technician. For pupil experiments it is best if they merely run the burners for a standard time, being provided with the information that approximately x cm^3 are delivered in that time.

An important consideration is the avoidance of too high a temperature rise in the calorimeter. Once the temperature of the water approaches 40°C, heat losses to the environment will be considerable. Thus microburners are preferred for this work to avoid the need for large volumes of water. However, even a microburner with a medium size flame may require the use of a large calorimeter volume. There is a limit to how far the flame can be turned down because natural gas is easily extinguished once the pressure is reduced. Hence the use of a microburner base fitted with a nichrome coil as a flame retention device. Together with the flow rate governor described below, this flame retention coil allows the use of a low gas flow rate and therefore manageable volumes of water. When using such a burner ensure that the wire is glowing and the flame steady before placing it under a calorimeter can.

The flow rate governor consists of nothing more than a length of glass capillary tubing fitted in the gas line (Fig. 7). This restricts the volume of gas delivered but allows the use of the full (nominally 8" water (sic)) pressure at the gas tap.

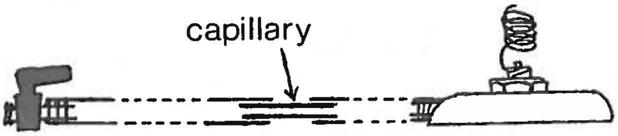


Fig. 7.

This simple expedient also provides a constant-flow device reducing flow differences when other gas taps on the same supply pipe are brought in and out of use. This is shown in the results given in Table 2.

Volume of gas (cm^3) delivered from the gas tap in two minutes				
Length of capillary (0.4mm i.d.)	(a) With no other taps in that line in use (2 determinations)		(b) With three other taps in use. (2 determinations)	
	1	2	1	2
54mm	255	252	258	250
94mm	140	145	145	143

TABLE 2

The results suggest that the flow rate to any one burner is unaffected by what is happening at the others. Within practical limits, any desired flow rate can be obtained by choosing suitable lengths of the 0.4mm diameter capillary.

When used by younger pupils to determine a 'calorific value' for the gas the calculation can be kept to a minimum by standardising the volume of water and the time for which the gas is burned ($\propto$ volume of gas), so that

$$\text{If Heat Evolved per unit volume} = \frac{\text{Heat Capacity of the calorimeter} \times \Delta T}{\text{Volume of Gas}}$$

Then since $\frac{\text{Heat capacity of colorimeter}}{\text{Volume of Gas}}$ will be a constant K

$$\text{Heat Evolved} = K \times \Delta T$$

There is no reason why this constant could not be the same for all the sets of apparatus. In addition the calorimeter heat capacity could be marked on the side of the can eg. "With 400g (cm^3) of water this can requires an input of 1700J for each 1°C rise in water temperature". The teacher can give the figure for the volume of gas burned in the unit time used by the pupils. At Foundation level even more help with the maths is probably needed, with the 'constant' being supplied. The students then having merely to multiply this figure by the recorded rise in temperature.

For the teacher to measure the volume of gas delivered in the unit time, he or she simply immerses a burner in water under a water filled inverted measuring cylinder. (Fig. 8).

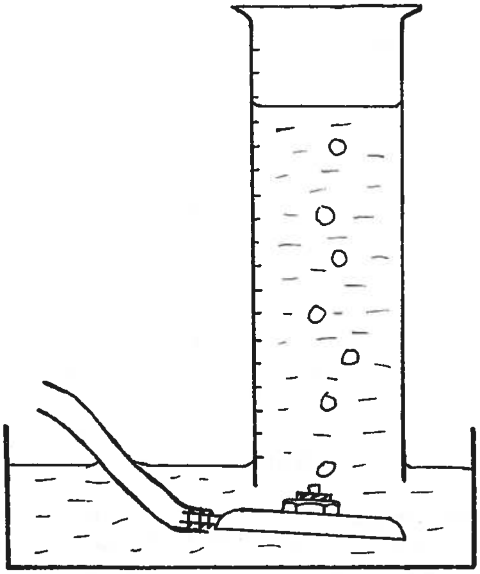


Fig. 8.

Measuring the volume delivered in say, two minutes, and multiplying up will give the volume per unit burning time. It is important to keep the burner orifice jet close to the main water surface or the flow rate will be significantly reduced. Dispose of this surplus gas with care, in a well ventilated area with all sources of ignition removed!

In our experiments, using a syrup tin calorimeter with 400g of water and a microburner with a flame retainer, the results shown in Table 3 were obtained. The heat capacity of the calorimeter was 1722 Joules per °C - using heat capacity contribution of the water as (400 x 4.18) Joules per °C and of the can as (113 x 0.44) Joules per °C (specific heat of iron = 0.44).

CONDITIONS AND RESULTS	REPLICATES			
	1	2	3	4
Initial temperature (°C)	10.0	11.0	11.2	11.3
Final temperature	31.6	33.0	32.6	32.1
Rise	21.6	22.1	21.4	20.8
Burning time (min)	10	10	10	10
Flow rate (cm^{3}min^{-1})	117.5	125	100	103
Vol. burnt (cm^3)	1175	1250	1000	1030
Heat evolved (J) (=1722x ΔT)	37,195	38,056	36,851	35,818
Heat evolved per m^3 of gas (MJ).	31.65	30.44	36.85	34.77

TABLE 3

The mean figure obtained for natural gas is thus 33.4MJm^3 . This compares with a figure given by Scottish Gas as 1017-1035BTUft^3 (sic) which translated, means 38.4MJkg^{-1}. Therefore, given the relative crudity of the method, the results shown in Table 3 are quite encouraging.

Summary

Of the determinations described in these 'Notes' the likely candidates for pupil work are those using a simple can calorimeter with:

(i) candle wax,
(ii) wood
(iii) liquid fuels, for example paraffin, absorbed on 'Kaowool' (and alcohols in spirit lamps - see Bulletin 114).

More advanced 'options' could involve the use of the clay pipe, forced draught furnace to burn domestic coal (and peat, but here the dust can be a problem, tending to be blown from the pipe). Determinations for gas probably also fall into this 'more advanced' or 'option' category. Experiments involving 'Phurnacite' and 'Welsh Anthracite Cubes' probably require the use of a combustion calorimeter with oxygen. Those with patience, taking care may obtain results for anthracite using the forced draught furnace. This method is for teacher demonstration only.

All calculations will involve multiplying the heat capacity of the calorimeter and water by a temperature rise, and dividing by a change in mass or a volume. The calculations can be simplified by fixing one or more of these variables. At first sight incorporating an 'inefficiency' coefficient into the heat capacity figure looks an attractive possibility. In this case the 'constant' in the equation is the product of a factor allowing for the inefficiency of the method, and the heat capacity of the calorimeter.

Put in 'pseudo-maths' (not recommended for the pupils!) this becomes:

$$\text{Heat evolved} = \frac{(K \times \Delta T)}{\Delta m}$$

where $K = fi \times k$ (fi = 'inefficiency' factor
k = heat capacity)

Such a ploy may create more problems than it solves. The efficiency of heat transfer is not constant, varying with the geometry of the apparatus (eg. how close the pupil puts the calorimeter to the fuel) and with the particular fuel in use, even though the apparatus is the same (eg. compare the efficiency of heat transfer for smoky coal and anthracite). Given these facts, it will be obvious that some pupils are bound to obtain results which are in excess of the 'theoretical' or published figures.

It is better on balance that pupils realise that their results are much lower than the 'official' values. The reasons for this are in themselves valuable teaching points.

Appendix - Equipment details

a) Clay pipes, believe it or not, can still be bought at specialist tobacconists. In cases of difficulty in obtaining local supplies try branches of **Findlay** (see yellow pages) who currently sell them at 30p each - cheaper than crucibles!

b) The micro-burners used were by **Rhodes Flamefast.**

c) Rubber covered rings to support a 2lb syrup tin are available from **Hays** - Cat.no. 261/0300/03. Alternatively retort rings from **Griffin** (STF-550-030F) or **Philip Harris** (C69880/8) can be covered with split rubber tubing.

d) The dimensions of the SSSERC 'chamber' calorimeter made from two cans are given in Fig. 9 below. These are not critical but are those of commonly available tin-plated cans.

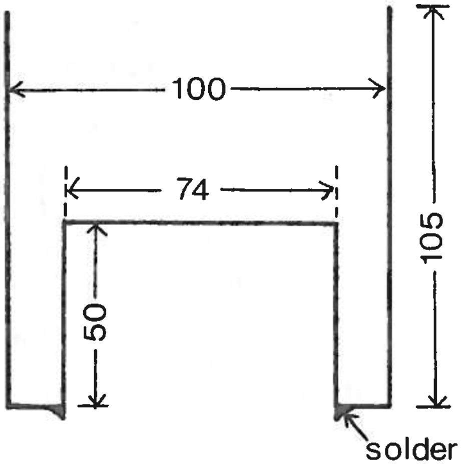


Fig. 9. ALL DIMENSIONS IN mm

Reference

Unless otherwise stated, the published and 'theoretical' figures given are based on those of:
Rose J.W. and Cooper J.R., "Technical Data on Fuels" published as part of a Conference Report of the British National Committee on World Energy, 1977.

* * * *

Microelectronics Notes

Science Interfacing Register [SIR]

This register, advertised in Bulletin 129, is now a reality, issue number 1 having been sent out to registrants in January. SIR has several aims or functions. Firstly it is an attempt to put those active in the field in touch with one another in order to reduce duplication of effort. Secondly it will eventually contribute to a clearing house programme allowing SSSERC to stand between the individual, hard-pressed teacher and the many others seeking information. Having your teaching time interrupted repeatedly for the same basic request can be wearing. It is more efficient, as well as kinder on the nerves, to tell the tale once to some central agency. The third function of SIR (and we hesitate to reveal this) is to help identify individuals who might be willing to assist in SSSERC's evaluation and testing programme. At present the register is small but growing. Hopefully it will eventually grow too large to handle manually and will have to be put on a data base/file handling system!

If anyone else active in this field wishes to be included on the register would they please send the information requested on page 3 of Bulletin 129 to SSSERC as soon as possible. Issue No. 2 of SIR is being compiled and will be sent out in the fairly near future.

SSSERC Microelectronic Technology [MET] Panel

The Centre has taken another initiative in an attempt to provide a national advisory service on MET hardware for school science. There is so much work to be done in this field, assistance from outside the Centre became imperative. A Microelectronics Technology (MET) Panel has been convened to help SSSERC with its evaluation and development programme. In the not too distant future publications containing the results of some of this panel's work should appear.

The members of the panel were selected with a balance between technical and curricular expertise very much in mind. The provision of a curricular framework for any published hardware details is of the utmost importance. This is in order to avoid the fragmented presentation of topics or, worse, the pursuit of a dubious objective merely because for it there exists a particular technological vehicle.

The main roles proposed for SSSERC in science based MET development are:

a) General evaluation of commercial interfacing circuitry along with the provision of constructional details for tested, purpose built d-i-y systems.

b) A study of the microcomputer as a single multipurpose laboratory instrument for measurement, storage, retrieval and manipulation of experimental data.

c) Use of a microcomputer for control applications in science experiments including elementary robotics.

d) An evaluative and comparative report on microcomputers providing information on their suitability for scientific laboratory applications in schools.

e) Development of experimental content for the microelectronic sections of physics courses similar to the SYS experimental guides already published.

The MET Panel will assist SSSERC staff to pursue a programme of work based on these identified roles. Consultation with other interested parties is clearly necessary.

Various considerations lead one to think in terms of three categories of hardware:

(i) microcomputers interfaced with transducers and instruments;

(ii) microprocessor tutor/demonstrators;

(iii) extended logic boards, modules and discrete components.

Each of these categories forms a part of an evaluation programme embarked upon by the MET Panel.

The main functions of the panel are, in consultation with SSSERC staff, to:

(i) supply evaluations and development work for publication through SSSERC;

(ii) referee articles submitted by others;

(iii) vet d-i-y circuitry and materials for technical veracity and detailing.

All of this work will be carried out in a well defined, science based context. Overlap and duplication of effort will be avoided as far as is practicable through liaison with other agencies such as MCC, MEDC and SMDP.

Some elements of a format for any SSSERC generated or edited articles arising out of these activities have been agreed by the panel: Every article will carry:

a) A clear statement of curricular aims and objectives fulfilled by the equipment and software package. (Here this is still in connection only with the three hardware categories delineated above. It is not intended for the panel to be involved directly in general science CAL or CML).

b) For any d-i-y circuitry, clear circuit diagrams with costed lists of components, giving alternatives where possible, together with all relevant constructional details.

c) For interfacing (data-logging and control) applications, printouts of associated software and exact details of machine requirements. In this connection the feasability of providing facilities for disc or cassette copies for a range of machines is being examined. Of the two alternative vehicles for the provision of software the latter is favoured by the MET Panel. In controlling software standards and format etc. and in disseminating software the panel will seek co-operation with SMDP.

MET Panel Membership

Chairman - Director of SSSERC or his nominee.
Mr. W. Barr, P.T. Physics, Carrick Academy, Ayrshire.
Mr. C. Crooks, Adviser in Science, Ayr Division.
Mr. D. Duncan, Lecturer in Computer Education, Dundee College of Education.
Mr. J. Jamieson, Physics Dept., Portobello High School, Edinburgh, (SSSERC from April 1982).
Mr. W. Jeffrey} Physics Dept. Jordanhill College
Mr. J. Muir } of Education.
Mr. R.A. Sparkes, Physics Dept. St. Andrew's College of Education.
MCC Assessors - Mr. J.A.R. Hughes, O.B.E. Co-ordinator MCC Project
Dr. A.D. Milne, Wolfson Institute, Edinburgh. (Project Steering Committee MCC)

SED Assessor - Dr. G. Gray HMI

* * * *

In the Workshop

The simple spirometer/vital capacity apparatus shown in Fig. 1 uses two polythene bottles. The design shown employs 2 gallon and 1½ gallon (nominal) polythene bottles but obviously the basic idea is adaptable, allowing other similar containers to be used. For this reason only major dimensions are given since most of the detailed dimensions will depend on the specific containers used. This is one of those rare occasions when we are not able to specify exact components, much will depend on exactly what is available in and around the school.

The larger container has a hole cut in it about 20mm above its base. The tube labelled A in Fig. 1 passes through this hole. A number of arrangements are possible for effecting a watertight seal at this entry point and various materials will serve for the tube. For example 12mm copper pipe bent into an 'L' shape can be sleeved with rubber tubing and inserted into a hole cut with a hot cork borer (No. 11, 16mm diameter). Alternatively, nylon tubing bent when warm or plastic domestic cold water supply pipe (with an 'elbow' and a 'tank connector') may be used.

The smaller bottle, inverted inside the larger is supported by a length of thin string or twine which runs over two pulleys and to which a counterweight is attached. In the SSSERC model a 250g brass, balance weight served as the counterweight. This proved to be very slightly heavier than the inner container in water. 'Fine' adjustment of the balance was effected by pressing pieces of plasticine onto the top of the inner bottle. Pulleys of a suitable type are available from the major suppliers (eg. Griffin and George XBD-720-Q or Philip Harris P13750/4) in a price range of £2.50-£3 each.

In order to have minimal resistance to the subject's breathing, the water level in the outer container should be as close as possible to the top of the inner cylinder when the latter is at its lowest possible position. This is in practice limited by the danger of water spilling into the breathing tube. In the model shown it was found that the water level can come to within 50mm of the top of the inner container when it is at its lowest setting.

There are at least three alternative ways of calibrating the device. The scale can be calibrated easily by calculation, if the inner container is a cylinder or some other simple shape of 'regular' dimensions. Another method is to mark the level on the outside of the inner container (the 'right' way up!) each time a litre of water is added to it. The distances between the marks can then be transferred to the scale (with each distance ≡ 1 litre). The third method involves coupling the breathing tube to a calibrated aspirator bottle which has a second tube from a laboratory tap.

The aspirator is calibrated simply by pouring water into it, a litre at a time from a measuring cylinder and making a mark each time. It is then emptied and coupled up to a tap and the spirometer. As water is run in a litre at a time (ie. to the marks) litre aliquots of air will be displaced into the spirometer. It is then a simple matter to mark off the scale where the bottom of the counterweight or a marker on the twine rests against it. In use the apparatus is reset by merely steadily pushing downwards on the inner container expelling the air until the zero position on the scale is reached. Clearly regular disinfection of the end of the breathing tube is necessary with the whole apparatus being cleaned and disinfected between classes, (See CLEAPSE/SSSERC Hazcards 'Spirometers' and 'Disinfectants').

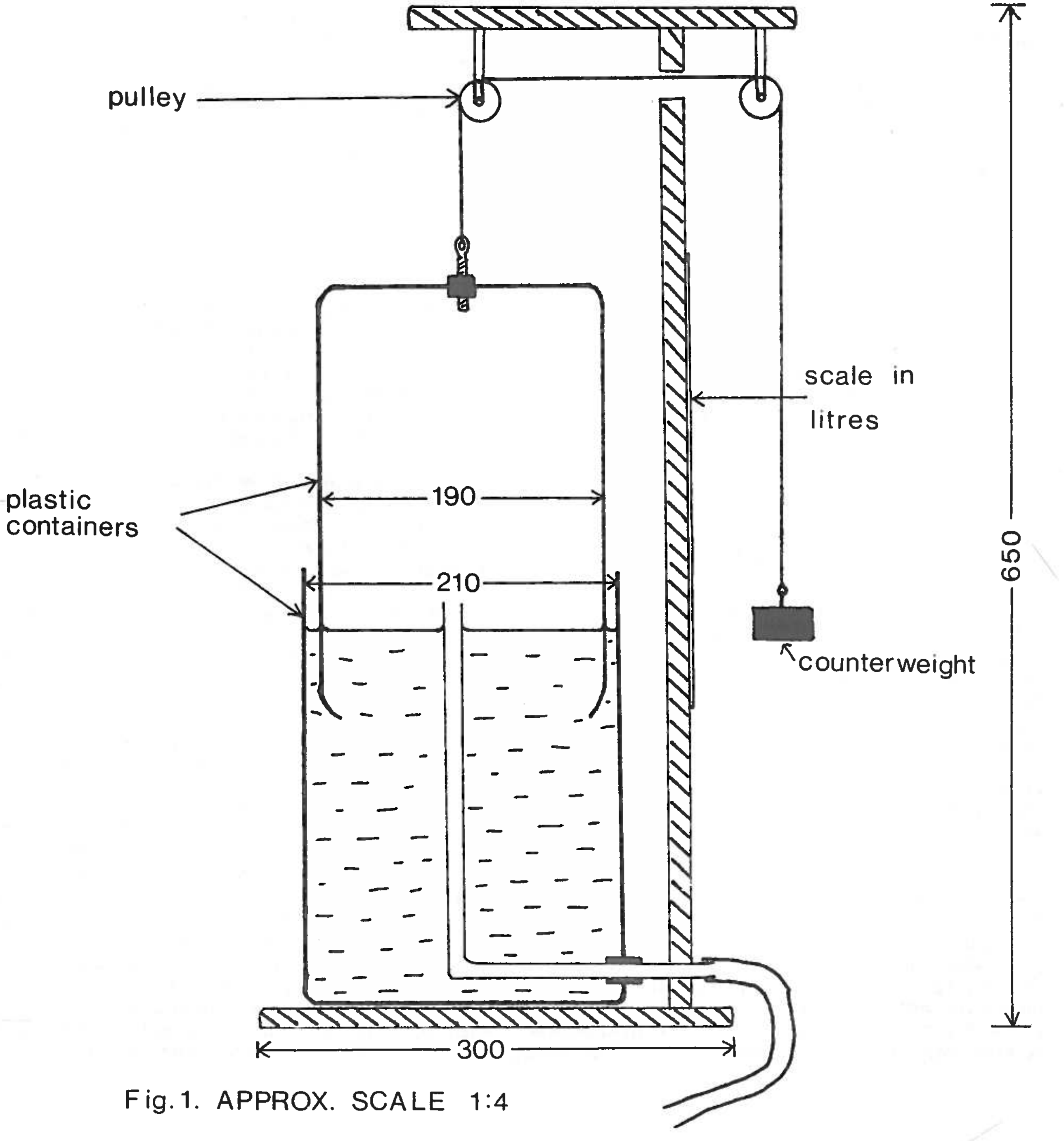


Fig. 1. APPROX. SCALE 1:4

DIMENSIONS IN mm

Trade News

Silver nitrate

The price of this chemical has increased markedly over the last few years. Two competitively priced sources are (i) the chemical manufacturer **Johnson Matthey** (our thanks to CLEAPSE for identifying this source), and (ii) **A. and J. Beveridge** in Edinburgh. Prices fluctuate with movements in the precious metals market. Any would-be purchaser is thus advised to first contact the firms before ordering.

Matthey's present prices are very attractive at £21 per 100g. Johnson Matthey make no handling charges nor minimum order stipulation and the price includes delivery. Discounts for quantity, eg. £140 per 10 x 100g bottles, may be sufficiently attractive for an Education Authority to consider bulk purchase. The specification is similar to that given for 'General Purpose Reagent' (GPR) grades. This, in our opinion, is quite suitable for all school purposes.

For the perfectionist, Beveridge offer Analar grade at £25.25 per 100g. These prices have to be compared with £58.50 (for GPR grade) and £63.80 (Analar) for 100g from one of the usual suppliers.

'Oxoid' Materials

In Bulletin 129 'Trade News' we quoted part of some correspondence from **Philip Harris Biological** on this subject. This may have given the impression of exclusivity. We would wish to correct any such mistaken impression. **Griffin and George [Gerrard Biological Centre**) have confirmed that they continue as a distributor of Oxoid products to schools and other educational establishments in the U.K. A number of smaller, local firms will no doubt also continue to obtain 'Oxoid' materials for schools.

New Products at ASE

At the ASE parent body Annual Meeting at Canterbury in January, a number of new products were launched. Lack of space precludes mentioning all of them here. Many of these products will be on show at the Scottish Region Annual Meeting at Easter. We can thus only provide a foretaste below for those who will attend the Scottish meeting, and a somewhat incomplete review for others.

Computer Interfaces

Not surprisingly these were in evidence on a number of stands. Griffin and George were showing their digital and analogue interface units (CRA-930-020B at £83 and CRA-930-040S at £116, respectively). These two units were designed for use with any microcomputer with an 8 bit parallel port eg. 380Z, PET, Apple and Sorcerer. They obviously are not 'universal'. The first versions available will be for Sorcerer, PET and Apple, other versions following closely after that. Griffin were also showing a proposed range of interfacing devices for the ZX81 including D →A and A →D devices. These should be launched at about the time this goes to print.

Irwin Desman were also showing, amongst a lot of other 'goodies', a ZX81 interface in their 'Pippa' range at just £49. **Unilab** showed a microcomputer interface designed for use with various versions of the PET, BBC A or B models, Acorn Atom and Vic 20. Still a prototype, this was tentatively forecast to be 'out in about six months'. Philip Harris also had a prototype interfacing device, an A →D →A unit, said to be "out very soon".

Lasers

Several firms were showing lasers of the 'new generation' with proper internal glass seals. Unlike the epoxy or silicone sealed tubes, the new type is said to be reliable having a long 'shelf-life' and not requiring regular running. **Artec**, Griffin, Harris, **I for E**, Unilab and **WPA** all had lasers on show with Griffin and I for E offering 'trade-in' deals. We noticed a wide range of prices with Unilab's £150 for a new laser (no part exchange offered to our knowledge) looking particularly attractive.

Timers

Here we must mention the new Unilab electronic stop clock (Cat. no. 513.051) at only £14.50. This features a mounted stop clock module, in a case small enough for any bench use but large enough to spot in a pupil's pocket. An optional timer module under development will convert the instrument into an inexpensive centisecond timer for mechanical, electrical or photoelectrical inputs. Also exhibited was a ticker timer of 'revolutionary' design which uses a patented mechanism and self-marking paper, doing away with the need for carbon paper. For those who have yet to 'take the pledge' on ticker timers this device, Cat. No. 061.001 may be of interest at £14 with 10, 450m reels of the special paper at £10. I for E were showing a novel 'powder timing' method for timing a trolley-like vehicle. Artec a new company started up by Bill Jarvis of Rannoch School and 'Questions in Physics' fame (and until recently with Unilab) were offering, among other things, a kit for the now famous, cardboard clock design from Wireless World. A separate company from I for E, Artec is meanwhile also carrying the I for E range in a joint trading arrangement.

Meters

Griffin exhibited a number of new meters including a digital multimeter at £75, a student multi-meter at £16 and a clampmeter/multimeter at £62. Also on show was a new diode protected demonstration meter EHB-850-Y, suitable for use with all the EHA-870-890 series shunts.

Unilab had another 'winner' with their l.c.d. 'Easy Read' meters. Requiring only one external attachment to give each range of up to 20VDC or 10ADC the meters are clearly very versatile. A resistance module and attachments for other ranges, including AC, will be available. 'Easy Read' meter, Cat. No. 523.001, £24.90, 20V DC attachment 523.002, £3.34, 10A DC attachment 523.003, £3.34.

Biology Apparatus

Griffin had a great many new items on show. We can only give a subjective sample of those that were of greatest interest to us: a pulse monitor, YTH-630-U at £29.13 which converts a finger pulse into an audible signal; an environmental multimeter, YRC-480-E at £269.30 measuring oxygen, pH and temperature, (pH measurement temperature compensated) and a breathing monitor YTK-, 20-X at £60.

A number of new microscopes were on show. Some of these, in our view, were little more than 'toys' (as in most years, some of those who should know better were excitedly waving these around at new biology equipment lectures). Notable exceptions were provided by the new **Prior** and Swift instruments (Swift shown by main agents **Pyser**) and most of the Griffin Gamma range.

Philip Harris Biological had a number of innovations on show. In microbiology these included novel culturing methods in the shape of 'Try-cult' slides and 'micro-ecology' tubes. They were also showing 'plastinated' specimens which had been resin impregnated, giving a very ingenious method of preserving whole or part specimens. For their part, the biological side of Griffin were showing a new range of resin encapsulated specimens called 'plastomounts'.

Chemistry Apparatus

The most noticeable event here was the appearance of a vast array of re-styled, or new, pH/mV and conductivity meters, colorimeters etc. many of them with digital read-outs. The more obvious displays of these were to be seen on the stands of Irwin-Desman, WPA and of the 'big-two'. Some interesting and competetively priced digital instrumentation was to be seen on the stand of a firm new to us - **Demco**. As usual we were also treated to a host of electronic balances too numerous to mention individually. Of great interest however, is a new generation of small, highly portable and relatively inexpensive balances based on strain-gauge technology. The front runner here is undoubtedly '**Ohaus**' with their 'Porto-o-gram' range. 'Ohaus' balances are sold by a number of the well known laboratory suppliers. We have already tested the latest models and were impressed by their performance at the price.

On the simpler side a number of cheaper items were of interest. For example, Griffin had a range of stainless steel tripods in three sizes and a delightfully simple, refillable aerosol sprayer. A number of companies, notably Harris, **Exelo** and **Horwell** were offering inexpensive items of glassware, the latter two having some interesting graduated borosilicate test tubes at competitive prices.

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