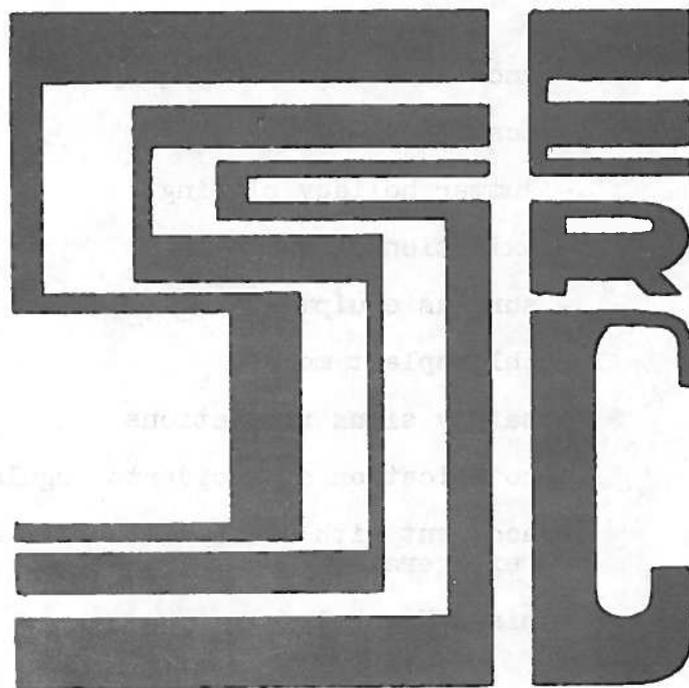


SCOTTISH SCHOOLS SCIENCE
EQUIPMENT RESEARCH CENTRE



For distribution to all teachers and technicians
in science and technical studies.

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Introduction

Elsewhere in this bulletin we have details of surplus equipment available for sale. Those who have read the article in Bulletin 116 which gives the conditions of sale will know that while we will post items if asked to do so, we deplore the waste of money in postages and prefer personal collection, however long it may be before items are uplifted. This has its negative side, and we suspect that some items in our packing bay have been there so long that their owners have forgotten they bought them. The list below gives those schools who still have items uncollected from previous ballots, and if this raises the hackles of some who are perfectly well aware that they still have to collect stuff but have not been able to do so, we are sorry. In no way is it intended as a spur to those who think they have been remiss, it is only a reminder to any who may have forgotten. Equally it is no problem if after this lapse of time the equipment is no longer needed; we simply put it back on the shelves.

Broughton High School, Edinburgh
Boroughmuir High School, Edinburgh
Leith Academy, Edinburgh
Napier College, Edinburgh
Moray House College, Edinburgh
Moray Middle School, Grangemouth
Linlithgow Academy
Preston Lodge High School, Prestonpans
McLaren High School, Callander
Auchmuty High School, Glenrothes
Queen Victoria School, Dunblane
Wallace Hall Academy, Dumfries
Dalry Secondary School, Castle Douglas
Aberdeen Technical College
Inverurie Academy
Stromness Academy
Oban High School.

* * * * *

Our cost index of consumable items of equipment which is sampled twice yearly in May and November, and for which the base line is 100 in May 1974, was 297 in May, 1981. This is an increase of 15.6% since May 1980, and 12% over the past six months.

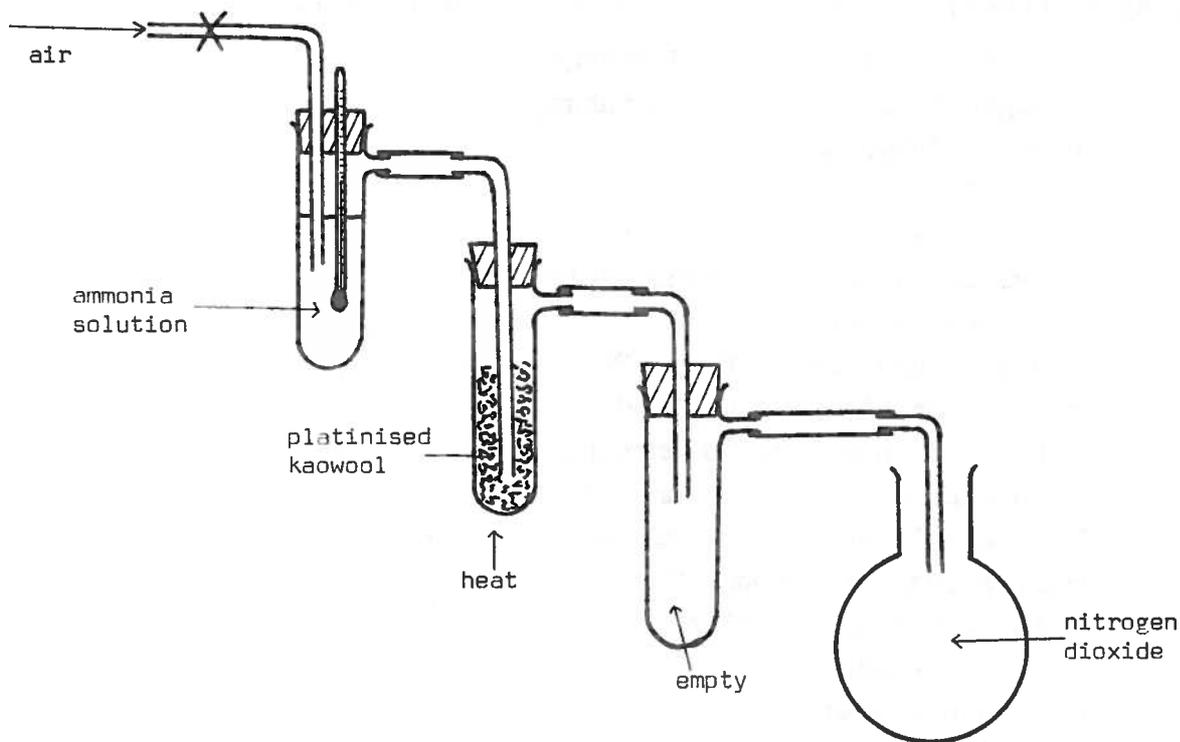
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Following our usual custom, the Centre will not open on Saturdays through the summer holiday, from 4th July to 15th August, both dates inclusive.

Chemistry Notes

The oxidation of ammonia as carried out in the model of the Ostwald process has been causing some problems. There have been reports of failures to demonstrate the formation of the product, and more alarmingly, of explosions. As a result many teachers are reluctant to carry out this worthwhile demonstration.

In the light of this we had another look at it and used a modified version of the small scale method first described by the Department of Education at Stirling University and later in Bulletin 67 and in Memorandum 15 of the Scottish Curriculum Development Centre. Our modified diagram is given below.



The stopper in the bubbler tube was replaced by a two holed one carrying a thermometer thus enabling measurement of temperature of the ammonia solution. The calcium chloride for absorbing excess ammonia was omitted from the third tube since the presence of white fumes is a warning that the mixture is too rich in ammonia and it seems foolish to mask such an indicator. A large R.B. flask (1 or 2 litre) was used in place of the last tube as a greater depth of nitrogen dioxide shows itself more easily. A small aquarium pump and screw clip were used to give a controlled airflow rate. Platinised Kaowool with 5% Pt as obtained from BDH Cat No. 33169 2G was used in place of platinised asbestos.

The reaction takes place with a current of air and oxygen should

not be used. Most teachers find that when the air/ammonia mixture is made by bubbling air through '880' ammonia solution the mixture passing over the catalyst contains quite a large excess of ammonia which reacts with the nitrogen dioxide to give white fumes of ammonium nitrate and nitrite. When such mixture has manifested its richness in ammonia there may be a temptation to balance it by substituting oxygen for air. A better alternative is to reduce the ammonia content by using a more dilute solution of ammonia. Oxygen ammonia mixtures undiluted by nitrogen are more likely to be explosive.

Another factor not often considered is the cooling of the solution as the stream of air causes evaporation. We found that the temperature of the ammonia solution could fall from room temperature to 4°C and this would clearly reduce the partial pressure of ammonia in the mixture and hence the rate of formation of the product. (Strangely this effect may be useful in reducing the excess of ammonia gas from an '880' solution down to the 'correct' proportions and this is presumably why the white fumes which appear initially become replaced by brown nitrogen dioxide). Gentle warming of the ammonia bubbler flask by a beaker of warm water is a useful means of control. With a diluted solution (1 vol NH₃:1 vol water) and an air flow of 1 litre/minute the following products were observed as the solution was warmed up.

Temp. of ammonia solution

8-12°C,	faint brown fumes,
30-40°C,	dense brown fumes,
60°C	white fumes, indicating excess of ammonia.

These white fumes were replaced by copious amounts of NO₂ once the temperature fell below 55°C. Using a fresh batch of the² same solution this 'changeover temperature' was found to be 45°C.

The flammable limits for ammonia are 15-28%. The H.S.E. points out that under stable conditions the concentration of ammonia above the surface of '880' ammonia solution at 15°C is approx. 83% v/v and that the industrial process is carried out at concentrations below the lower flammable limit. 5cm³ samples of the gaseous mixture above the surface of a bottle of '880' ammonia were slowly drawn into a syringe whose contents were discharged into water and titrated with 0.01M hydrochloric acid. The results for two samples at 16°C were 81% and 80% which are close to published data. To see what concentrations are reached in experimental rather than in stable ideal conditions, air was blown at different rates both over the surface and through solutions of different concentrations and 5cm³ samples of the gaseous mixture entering the catalyst vessel withdrawn. These were analysed as above. All the percentages are volume/volume and two determinations were used to give each figure.

When the air was being blown onto the surface the tip of the air delivery tube was 1-2mm above the surface and when bubbled through the depth of immersion was between 6 and 9mm. Obviously a larger volume of gas withdrawn should reduce the experimental error, but it would also produce some dilution in the sample being measured in that more air would be drawn in. For that reason a sample volume of 5cm³ was taken as a reasonable compromise.

concentration of solution ($\text{NH}_3/\text{H}_2\text{O}$)

air flow rate		'880'	(1 + 1)	(1 + 2)	(1 + 3)
30cm ³ /min	over	37%	13%	12%	6%
	through	59%	15%	13%	7%
200cm ³ /min	over	28%	12%	9%	3%
	through	62%	18%	15%	5%
1 litre/min	over	26%	6%	4%	3%
	through	48%	18%	13%	7%
2 litre/min	over	20%	7%	6%	3.5%
	through	43%	18%	11%	7%

In all cases except those in which the ammonia concentration is very low the experimental error should be less than 6%. Larger errors are probably due to sampling procedures and the cooling and evaporation effects mentioned above. It is most unlikely that teachers will be measuring the flow rate of the air, but these figures are useful in that a comparison is possible. The slowest speed is approx. 1-2 bubbles/second for a 6mm o.d. tube and the highest speed is the maximum obtainable from the Petcraft aquarium pump i.e. very vigorous agitation. All these rates of flow were tried in order to cover all possible situations even though many of them are unlikely to be used. Examination of the table shows that the two weakest solutions do not give explosive mixtures under any conditions. The (1 + 1) solution produces mixtures just on the edge of the explosion limit and an explosion of such a mixture even if it did occur would almost certainly be a very weak one. We have not had a report of an explosion using air and 880 ammonia.

The model Ostwald process was then tried out with these diluted solutions.

Solution

- '880' The catalyst glows very brightly and copious white fumes are produced. Later brown nitrogen dioxide is produced, presumably as the solutions cools and the vapour pressure of the ammonia falls.
- (1 + 1) The catalyst glows visibly only if the air flow is fast. The white fumes initially formed are soon replaced by brown nitrogen dioxide.
- (1 + 2) The glow on the catalyst is visible from close up but a good supply of brown fumes is produced from the beginning.
- (1 + 3) There is no visible glow from the catalyst and brown fumes are formed initially. However the reaction soon ceases and the catalyst needs to be reheated frequently.

We would make the following recommendations:-

- (a) The (1 + 2) solution is probably a good compromise giving both some catalyst glow and nitrogen dioxide over a variety of airflow speeds. The (1 + 1) solution does not appear to give a mixture

which could be counted as really being explosive and gives a more visible glow in the catalyst.

- (b) A good control of the proportions of ammonia and air can be achieved by varying either the airflow rate, the temperature of the solution or the depth of immersion of the bubbler tube. Shallow immersion of a few mm gives less violent agitation.
- (c) Oxygen must never be used.
If the above precautions are taken together with additional safeguards like the use of safety screens and eye protection then this experiment poses no greater risk to health than many of those currently undertaken.

Physics Notes

The following items of equipment are offered for sale, subject to the conditions laid out in Bulletin 116. We would earnestly ask balloteers to read these conditions, because it sometimes happens that obviously they haven't, which causes unnecessary paper or telephone work all round. Items with numbers less than 109 have already appeared in bulletins 116, 122 or 125 and are not subject to the ballot. Item numbers 109 and above are in the present ballot.

Because bulletins are now being distributed through the regions, there will be a further delay in transit between our posting them, and their being read by the teacher. The ballot will therefore take place later, although we have really no idea of how long it will take, on average, once the bulletin is in the school, to get into the hands of the teacher who wants to ballot for surplus equipment. It is almost as difficult for us to predict how long the bulletin will be in the printer's hands, and therefore when it will be sent out. But, as far as we can judge, this bulletin will be posted on or before 8th June, and the ballot will be held on Tuesday, 26th June. This allows three weeks for extra-mural percolation, and will be altered if we have complaints that it is not sufficient. We do not mind getting complaints on this or indeed on any other subject: at least it tells us that the bulletin is being read. Another idea which may help those interested in surplus equipment would be for us to give warning of surplus in the previous bulletin, and we will try to do this where we can, despite our unwillingness to pre-empt part of the bulletin space three months in advance.

Item 1.	Bulletin 116.	Photographic film, 35mm, 25p.
Item 3.	" "	As above, TXP120, 15p.
Item 20.	" "	Silicon grease, £1.
Item 21.	" "	Silica gel, 50p.
Item 32.	" "	Centre zero ammeter, £3.
Item 34.	" "	Ammeter, £2.
Item 35.	" "	Ammeter, £2.
Item 36.	" "	Heavy duty rheostats, £3.
Item 37.	" "	Heavy duty rheostats, £2.

- Item 38 Bulletin 116. Heavy duty rheostats, £1.
- Item 39. " " Helipots, £1.
- Item 44. " " Head and breast set, 75p.
- Item 48. " " High voltage capacitor, 10p.
- Item 49. " " Toggle switch, 5p.
- Item 50. " " Bottle brush, 3p.
- Item 63. Bulletin 122 Loudspeaker unit, 75p.
- Item 64. " " Display unit, £5.
- Items 65-70. " " Regulated power supplies, £6.
- Item 84. Bulletin 125 Photographic fixer, 30p.
- Item 88. " " Dry cell, 15p.
- Item 89. " " Dry cell, 15p, £1.50 or £8.
- Item 90. " " Dry cell, 15p.
- Item 91. " " Dry cell, 10p.
- Item 94. " " Signal generator, £20.
- Item 95. " " Battery charger, £3.
- Item 108. " " Perspex offcuts, £1.50 and £2.40.
- Item 109. Dual trace oscilloscope type 1049MkIV by Cossor, 10cm dia. screen. Time base 750ms/cm - 15 μ S/cm in 9 ranges. Y1 sensitivity 0.3 - 100V/cm in 8 ranges. Y2 sensitivity 100 - 1V/cm in 7 ranges. X and Y1 both have calibrated shift controls to allow calibration of horizontal and vertical deflections, £30.
- Item 110. Dual trace oscilloscope, type D56 by Telequipment, incorporating separate timebases and separate amplifiers on the two channels. Time base range 5s/cm - 0.5 μ s/cm, Y sensitivity 50V/cm - 100mV/cm with x10 switch giving 10mV/cm. Either trace may be controlled by either time base simultaneously, £30.
- Item 111. Oscilloscope type CD513 by Solartron. 10cm dia. screen. Y channel 60V/cm - 1mV/cm in 6 ranges. Time base 0.1 μ S/cm - 200ms/cm in 6 ranges, £20.
- Item 112. Valve voltmeter, type V200A by Furzehill. Range 1mV - 100V in six decade ranges on direct connection; a high voltage input probe gives 10:1 attenuation, so increasing the range to 1kV. A switch allows the meter to be bypassed, so that an amplified output can be obtained, £10.
- Item 113. D.C. millivoltmeter, by Pye. Range 1.8V x 1mV. Pairs of terminals for 2V power supply, galvo, standard cell and test cell, £7.50.
- Item 114. Standard moving iron voltmeter, by Sangamo Weston, for a.c. or d.c. Ranges 4-20, 10-50, and 20-100V. Mirror backed quadrant scale, 120mm radius. Enclosed in brown bakelite case with handle, £10.
- Item 115. Voltmeter as above, one range only, 1-15V a.c., £7.50.

- Item 116. Standard moving coil ammeter, by Sangamo Weston. Ranges 10A - 100 μ A in 6 decade ranges, 100 division mirror backed scale, 90mm radius, £10.
- Item 117. D.C. millivoltmeter as above, ranges 1000, 500, 200, 100 20, 5mV, £10.
- Item 118. Multimeter type 127A by Taylor Instruments, a.c. and d.c. 10, 25, 100, 250 and 1000V; 2.5V d.c. only; d.c. 50 μ A; 1, 10 and 100mA. Three resistance ranges direct, x100 and x10,000, £15.
- Item 119. Scaler timer type Panax 102ST; internal 1KHz oscillator for timing. Two decatron tubes and 4 digit mechanical relay. 250 - 500V supply for g.m. tube. With start and stop timing terminals, £20.
- Item 120. Timing Unit, type 1350A by Labgear. Timing from 20 min. to 0.01s on five decatrons. There are also external positions on the switches which should make it possible to start and stop the decatrons by external contacts or voltage levels, £5.
- Item 121. D.C. Power supply, ex-equipment, 240V mains input. Outputs +5V 5A, +12V 0.5A, -12V 1.5A, +24V 8A. This is an open chassis and will need some form of cover before being used, £5.
- Item 122. Mains heater, 300W. This is fitted in a massive finned seat sink for free standing use, but not on carpet, linoleum etc. We think it could have use with kilowatt hour meters, as an energy converter halfway between the lamp bulb and one bar fire, £3.
- Item 123. Four decade resistance box, by Jay Jay. Range 100K Ω x 10 Ω , £6.
- Item 124. Four function calculators, desk type, some with memory, £3.
- Item 125. Manual typewriters, various makes, £5.
- Item 126. Electric typewriters, including one golf ball type, £10.
N.B. items 124-126 will be sold only against an invoice on the school.
- Item 127. Ionisation chamber, Griffin and George L91-185 without dosimeter, 50p.
- Item 128. Photographic paper, Bromesko WFL2D, 16" x 20" 25 sheets, £5.
- Item 129. As above, Ilfospeed 4.1M glossy, 12" x 16" 100 sheets, £10.
- Item 130. As above, Kodak bromide WSG3S, 10" x 10" 100 sheets, £4.50.
- Item 131. As above, WSG2S, 8 $\frac{1}{2}$ " x 6 $\frac{1}{2}$ " 100 sheets, £3.50.
- Item 132. Photographic developer, Ilford ID57, 1 litre bottles, 30p.
- Item 133. Photographic timer, mechanical. Range 60 x 0.1s in two ranges. Connection for mains input and appliance. Manual over-ride, £3.
- Item 134. High voltage capacitor, 0.5 μ F 6.6kV, 50p.
- Item 135. Electrolytic capacitors. The range of these is too wide to be described separately. State your wants and we will see what we have. They range from 1000 μ F, 12V at 5p to 9000 μ F, 50V, 40p.

- Item 136. Mains interference suppressor, 2A, 25p.
- Item 137. Nixie tubes; these need a 150V supply at about 5 μ A, 50p.
- Item 138. 1" glass cartridge fuses, 1A, 2p.
- Item 139. Low power transistors, mostly pnp and ex-equipment but all with usable leads, 2 and 3p.
- Item 140. Lead acid battery, new and cut away to show the construction, 50p.
- Item 141. Pressure gauge mechanism. This shown how the coiled tube type can be made to operate a pointer. Most are too insensitive to respond to mouth pressure, and would require a hand pump or similar, 50p.
- Item 142. Silica gel desiccant, in 1, 2, 4, and 8oz packs; 1p per oz.
- Item 143. Rubber bungs, size 10, $\frac{1}{2}$ p.
- Item 144. Silver gauze 20 mesh, 15 x 5cm, 50p.

In The Workshop

The construction of the chloroplast model described below followed discussion with a teacher. He was sure that a simple model would aid pupils' understanding of chloroplast structure and function, but was unwilling to pay for a relatively expensive commercial model.

The base of our model was made from a piece of perspex 250 x 250 x 5cm. To represent the 'grana' a number of sections were cut from a close turn 12mm diameter steel spring. These sections were of varying lengths from ca. 10 down to 3mm. This to allow for the varying headroom under the 200mm diameter clock glass obtainable from watchmakers, used to represent the upper 'membrane'. The spring sections were plugged with pieces of 8mm dowelling. This was effected by 'screwing' the spring sections onto the end of a length of dowel and then cutting the dowel. The sections were then painted green and put aside to dry.

The next step was to drill the perspex base at each 'granum' location. We used 16 spring sections and so drilled a corresponding number of countersunk holes in the base plate to take 3/8" No. 4 wood screws. The 'grana' were then fixed in position by screwing up through the holes in the perspex base into the dowels plugging the centre of the spring sections. Because the clock glass is domed, the shorter sections are placed towards the outside with the taller 'grana' in the centre. The outer 30mm or so were left free of 'grana' because of the lack of headroom.

The 'stroma lamellae' were represented by lengths of thin nylon tubing inserted between the spring coils and run from granum to granum. We used nylon tubing of ca. 3.0mm external diameter (e.g. 'Portex' tubing from Baird and Tatlock). It proved easier to insert the tubing between the spring coils if the ends were first crimped with pliers. The ends of each piece of tubing do not have to be at the same level. A stroma lamella may begin at a high level on one

granum and end at a point low down on another. When the stroma lamellae have been completed the ends of the tubes can have spots of adhesive (see below) applied to them to hold the tubing in place.

The last step is to glue the clock glass cover in place. A silicone type adhesive can be used for this. This is the type used for glass to glass joints for aquaria or as a bath sealant. The clock glass is placed in position and a line drawn around it. A thin line of adhesive can then be applied on this marked circle and the cover pressed down onto it. The surplus can then be wiped off before finally positioning and fixing the cover. A more secure fixing can be arranged if a large enough trepanning tool is available. At the time of drilling the base one of the holes can be drilled in the centre to take the centre pin of the trepanning tool. A 200mm diameter groove can then be cut to about half the depth of the perspex base. At final assembly the adhesive can be applied to the groove and the edge of the clock glass cover seated in it.

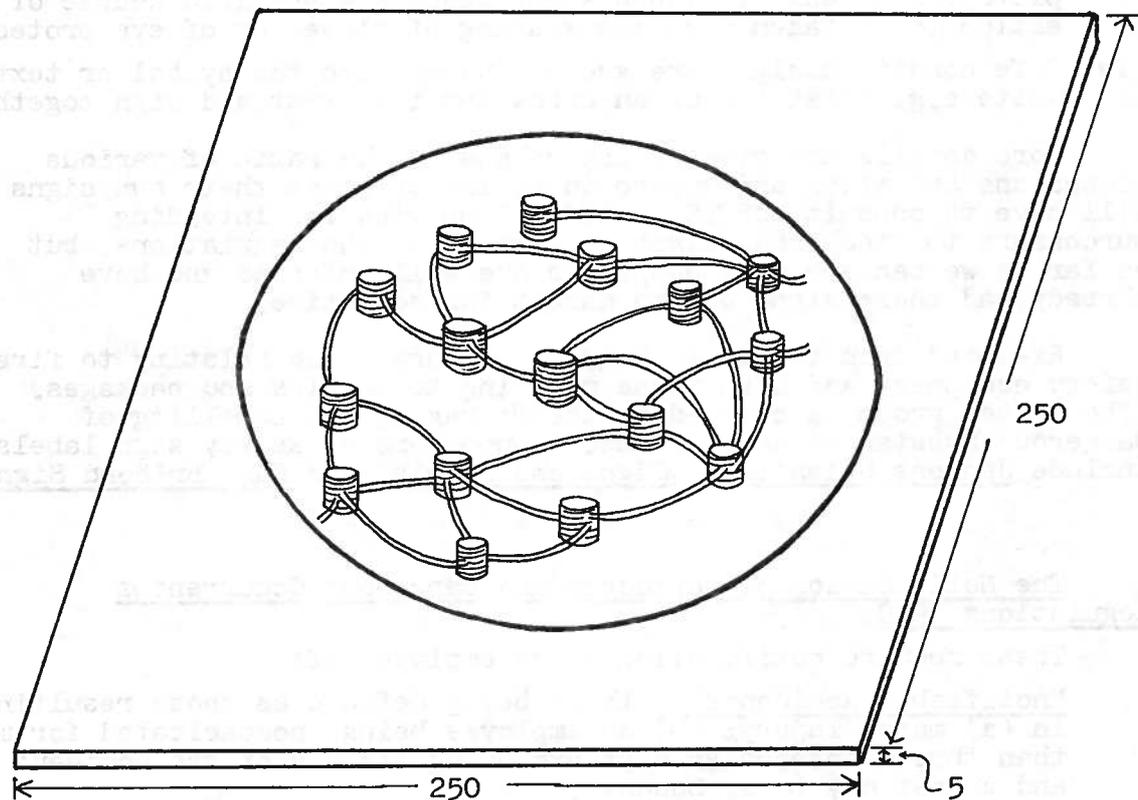


Diagram not to scale. Dimensions in mm.

Safety Matters

The Safety Signs Regulations 1980 which came into force on 1st January 1980, whilst they do not in fact require signs to be used in particular situations, do require that all new signs erected after that date conform to certain specifications relating to shape, colour, and design as laid down in British Standard 5378 Part 1. Older types of signs presently in use do not have to be replaced until 1st January 1986.

The following shapes are used for different situations:

- (i) Prohibition signs are white circles with a red ring round the circumference and a "S. East - N. West" red diagonal blocking out the prohibited activity e.g. use of open lights, use of mouth pipetting etc.
- (ii) Warning signs are yellow equilateral triangles with a black edging and the pictogram of the potential hazard in black. E.g. risk of radiation, fire, explosion, or toxic hazard.
- (iii) Mandatory signs are a light blue circle with a centrally placed pictogram in white. Such signs require a specific course of action to be taken e.g. the wearing of gloves or of eye protection.
- (iv) Safe condition signs are green squares with the symbol or text in white e.g. First Aid or an arrow and the first aid sign together.

More details are given which relate to the ratio of various dimensions and areas and anyone intending to paint their own signs will have to consult BS5378. It will be wise for intending purchasers to check that signs do conform to the regulations, but as far as we can see most suppliers are well informed and have already had these signs on the market for some time.

Exempted from the above Regulations are those relating to fire safety equipment and also those relating to bottles and packages. (The latter group is covered by the Packaging and Labelling of Dangerous Substances Regulations. Suppliers of safety sign labels include Jencons Scientific, Signs and Labels, and Bush Bribond Signs.

* * * * *

The Notification of Accidents and Dangerous Occurrences Regulations 1980.

These require notification by an employer of:

1. "notifiable accidents": these being defined as those resulting in (a) major injury; (b) an employee being incapacitated for more than three consecutive days excluding the day of the accident and a rest day (e.g. Sunday).

Major injuries are defined as those resulting in fracture of the spine, skull or pelvis, amputation of the hand or foot, loss of the sight of an eye, fracture of any bone other than either wrist or hand in the case of an arm injury and ankle or foot in the case of a leg injury.

2. "notifiable dangerous occurrences": the relevant ones are described in Schedule 1 Part 1 of the Regulations under

descriptions of fourteen types of incident. Most of these are general and are not peculiar to science. A few do however seem pertinent to science departments:

No. 8 - "The uncontrolled release or escape of any substance or agent in circumstances which, having regard to the nature of the substance or agent and the extent and location of the release or escape, might be liable to cause damage to the health of, or major injury to, any person". (The underlining is ours).

No. 9 - "Any incident in which any person is affected by the inhalation, ingestion or other absorption of any substance, or by lack of oxygen, to such an extent as to cause acute ill health requiring medical treatments".

No. 10 - "Any case of acute ill health where there is reason to believe that this resulted from occupational exposure to isolated pathogens or infected material".

3. death of an employee as a result of a notifiable accident or dangerous occurrence within the previous twelve months. The employer is also required to keep a written record of all notifiable accidents in connection with work under his control and of all enquiries from the DHSS concerning claims by employees. It further states that this record is to be kept at the place of work, presumably the rector's office. This accident book would appear to be quite separate in purpose from many of the accident books presently kept in science departments.

These regulations clearly concern the employer in all aspects of school activities but we felt it was important for teachers to be aware of the new situation.

* * * * *

We have a report of a fire resulting when a bottle of ethoxyethane (diethyl ether) in a refrigerator ignited. The fire was made worse because the fridge also contained ethanol. The most probable cause of the ignition was arcing at the thermostat, or at the interior light switch. The occurrence should serve as a warning that ether and other flammable solvents should be stored only in a modified fridge, i.e. one with the switchgear for these controls installed outside the cabinet.

* * * * *

An article in Education Chemistry, November 1979 described the preparation and testing of an anti-oxidant which could form the basis of a sixth year project. Unfortunately the preparation involved the use of hydrochloric acid and methanal and this would lead to formation of the potent carcinogen, bis-CME (chloromethoxy-chloromethane). We pointed this out to the editor and suggested the use of dilute sulphuric acid in its place. The authors have now confirmed that 30% sulphuric acid is a satisfactory substitute and an amended version of the preparation has been published in Education in Chemistry, March 1981.

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Tel. No. 031 556 2184.

B.D.H. Chemicals Ltd., Poole, Dorset BH12 4NN.

Baird and Tatlock Ltd., P.O. Box 1, Romford, Essex RM1 1HA.

Bush Bribond Signs Ltd., 184/6 Old Shoreham Road, Hove, Sussex.

Jencons Scientific Ltd., Mark Road, Hemel Hempstead, Herts.

Signs and Labels Ltd., Ralli Building, Stanley Street, Salford
M3 5EE.