SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No.73. August, 1974.

Contents

Introduction

With this bulletin we have to warn our readers that it may be some considerable time before we are able to mail them the next. This astonishing state of affairs arises because of an extreme shortage of envelopes. Normally we purchase a two year supply and then have them addressographed into sets. This mailing is the last of the present batch. We placed an order for a fresh batch in April, and a query in July brought forth the information that the main manufacturers of this type of envelope were on strike, but that before the strike they were quoting a nine month delivery. In common with every other commercial firm or organisation using a 9" x 4" envelope, we are searching for an alternative source for these, after which the addressographing may take up to four weeks. So if anyone can find 30,000 envelopes and an owner willing to sell, we may be interested.

Matters are further compounded by regionalisation. Normally, before having a batch of envelopes addressographed we circulate to each local authority the existing list of addressees insofar as it affects them, asking them to bring it up to date by deleting schools no longer in existence, schools which by demotion have ceased to teach science, and by adding new schools and amending those which have changed their title or address. But even one year hence these local authorities will have ceased to exist, and many schools, perhaps all, will have changed their postal address.

An enquiry to the Post Office produced the information that a decision whether or not to change postal addresses in Scotland has not yet been taken. If the decision is to change, then it will not come into effect before 1st July, 1975, and thereafter there will be an interim period of one year during which the old address will stil be acceptable to the postal authorities. Hence on this occasion we have not asked L.E.A.s to update their lists, and have decided to print only sufficient envelopes for one year. This, if we get the envelopes in time, should carry us forward to September, 1975, when we shall introduce any changes which the Post Office has seen fit to make, after consulting the new regional authorities.

* * * * * * *

Mr. Colin Weatherley has left SSSERC to take up a full-time appointment on the staff of the Royal Blind School, Edinburgh, with responsibility for developing a science course for blind children. This project grew from very small beginnings; a request from the S.C.E.E.B. that we investigate methods of reproducing the anatomical diagrams used in the Board's paper on Anatomy, Physiology and Health, so that they could be 'read' by blind candidates. When we had produced what we thought were suitable diagrams, in typical Weatherley fashion Colin arranged to test their effectiveness by teaching two evenings per week at the Royal Blind School. This developed into part-time teaching in SSSERC's time rather than his own, and since June, 1973, Colin has been on full-time secondment to the school. Now the finance has been found to continue his project for a further two years

and he has therefore resigned from SSSERC. We are not to lose contact with him entirely, as we shall continue to provide any technical assistance he may require in respect of special apparatus and currently we are hoping to interest a sixth year pupil in a local school in taking as his CSYS Physics project the problem of adapting the read-out of a top-pan balance to make it detectable by blind children. We should be interested to hear from anyone who has considered this or any other problems related to teaching science to the blind.

Meanwhile Colin goes to the Royal Blind School with our best wishes for his future and our thanks for what he has done for us, and for biology teaching in Scotland, in the past. His place at SSSERC has been filled by John Richardson, who was appointed a year ago to the post of temporary assistant director upon Colin's secondment to the Blind School.

* * * * * * *

Most of the larger Scottish L.E.A.s have appointed Science Advisers, and for some years they have met informally to discuss common problems. They have now formed themselves into a group, with a permanent secretary, whose address will be found in the address list to this bulletin. One of their members, Mr. John Pearson, Joint Science Adviser for Glasgow, has recently been appointed to the Development Committee of the Centre.

* * * * * * *

In Bulletin 67 we mentioned that rising costs had compelled the Governing Body to consider the annual subscription payable to SSSERC by direct grant and fee paying schools, and by manufacturers who receive our bulletins. In that bulletin we pointed out that since SSSERC began operating in 1965 the L.E.A. contribution had risen by over 50%, while the annual subscription had remained static. To bring the latter more into line with the L.E.A. contribution, the annual subscription is now being raised to £7, which will include VAT. Notices to this effect are being sent to all our subscribers, reminding them that the subscription for 1974/75 is now due.

Opinion

It has never been part of our policy to sing our own praises; yet we have sometimes thought that what is taking place in science teaching in Scotland, when recognised, would cause envious eyes to be cast on us from the rest of the world. We know that this is true in the case of the English peninsula; requests for information on Scottish Integrated Science reach us at the rate of two or three

a week. With our entry into the Common Market we felt we had something of value to the E.E.C. Hence for some time we had been active in exploring ways and means whereby we might exhibit at Didacta.

Didacta describes itself as an Educational Materials Exhibition originally held every four years, but from now on annually, in some European city. It lasts for a week, and this year in Brussels there were over 600 exhibitors from 25 countries, in five large exhibition halls. The Governing Body of SSSERC had given us permission to exhibit, but naturally enough would not allow any direct financial commitment for an exhibition which was of no benefit to Scottish teachers. Some hard talking with the Department of Trade and Industry resulted in their sponsorship, which meant that they paid our exhibitor's fee and supplied and erected the stand. A grant from the Scottish Education Department covered the travelling and subsistence of those taking part in the exhibition.

Our thanks are due to both these bodies for their financial help, without which it would have been impossible for us to go to Didacta. We did bring back over £18 in orders for back numbers of bulletins, and to that extent fulfilled the D.T.I.'s criterion that our exhibition should have some commercial value. More important, we established a great deal of goodwill. Teachers who saw our exhibits returned next day, bringing their colleagues, their wives, their cameras. We were photographed, filmed, video-taped, interviewed. So many times we heard expressions like prima, fantastique, wunderbar. By 5 p.m. on Friday, the final day of the exhibition, many of the exhibitors had started to knock down their stands; some of the more favoured each had a little group of people round a television set, watching the first of the World Cup football matches. At 6.15 p.m. Hugh Medine was still showing two people some of our exhibits; that was fifteen minutes after Didacta had officially closed.

I said at the start of this article that we are not given to blowing our own trumpet; nor am I doing so now. Our thanks, in a very real sense, are due to all those teachers and technicians, mainly but not wholly Scottish, who provided the material for our exhibition. We took thirty exhibits to Didacta. More than half owe their origin to people outside SSSERC, sometimes in the form of an idea, sometimes as a complete design. So that those who provided the ideas, and others, may know the extent of our indebtedness and gratitude to them we detail below the exhibits which have been published, and/or which have originated outside SSSERC.

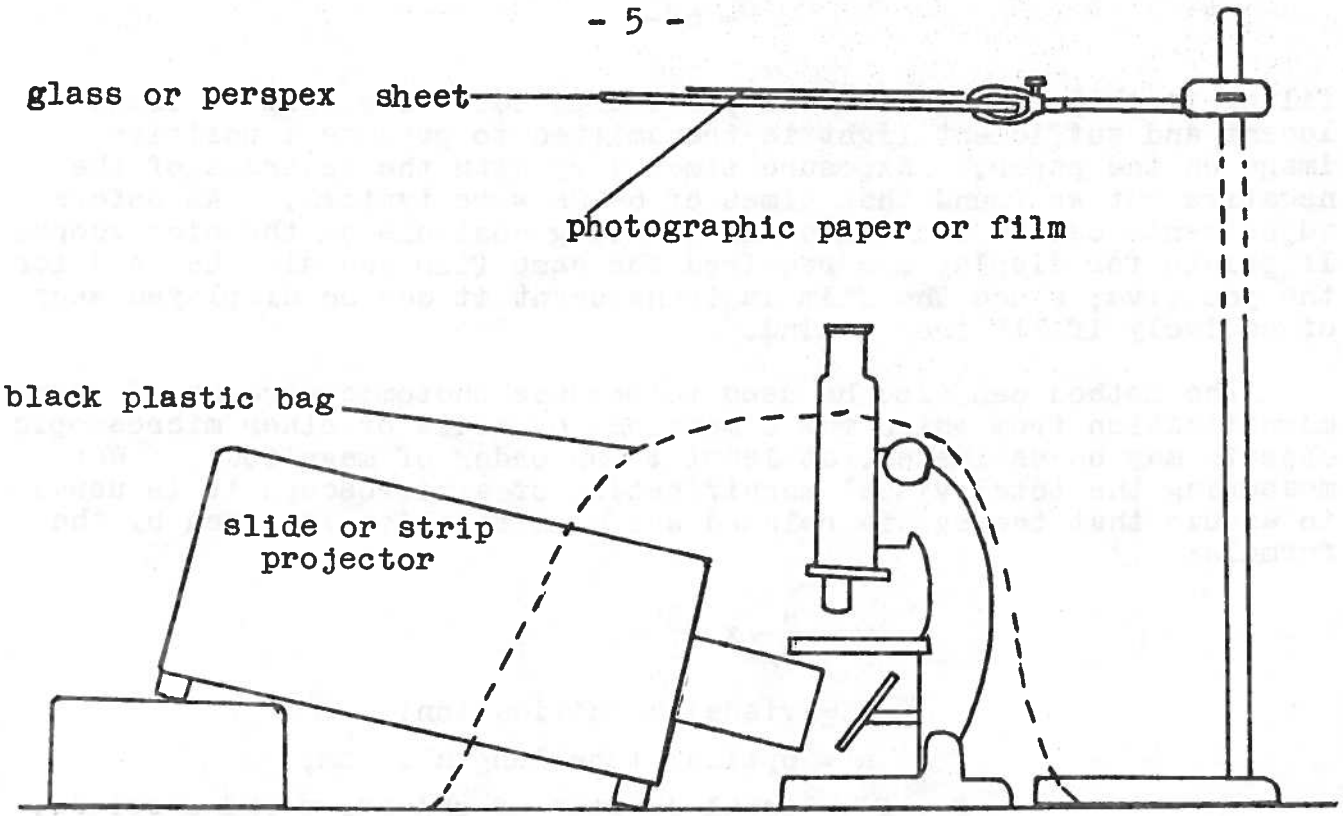
Smoke cell	- Bulletin 4.
Semi-circular canals	- Bulletin 13.
Binary adder	- Bulletin 16.
Fuel-oxygen explosion	- Bulletin 22.
Liquid dispenser	- Bulletin 29.
Direct current motor	- Bulletin 31.
Brownian motion	- Bulletin 33.
Atomic model template	- Bulletin 36.
Gas collector	- Bulletin 47.

Spark generator	- Bulletin 49.
Aquarium aerator	- Bulletin 49.
Gas analysis	- Bulletin 50.
Pinhole camera inversion	- Bulletin 52.
Blood flow model	- Bulletin 56.
Hot-air engine	- Bulletin 57.
Respiration module	- Bulletin 60.
Electronic thermometer	- Bulletin 62.
Energy content of foods	- Bulletin 63.
Pipette filler	- Bulletin 64.
Flower-pot viewing head	- Bulletin 67.
Chemical kinetics	- Bulletin 68.
Gas chromatograph	- Bulletin 69.
Resonant air tubes	- S.S.R. No. 157, p.700.
Car brakes	- S.S.R. No. 187, p.343.
Methane substitution model	- not yet published; designed in Stirling High School.

Biology Notes

Judging by correspondence and queries we have received at exhibitions there has been a revival of interest in photomicrography. Sophisticated special set-ups for photomicrography are very expensive and we doubt whether the amount of use they would receive, even in a Science Centre would justify their purchase. If facilities for colour work are required then 'mid-range' equipment would be adequate, i.e. single lens reflex camera and high intensity illumination but no image-splitter or other refinements incorporated. However if all that is required is a record, then there are simple methods for monochrome photography which do not require even a camera. The use of a film holder for 35mm film, which fits over the microscope eyepiece tube was described in "Photography for Secondary School Science Teachers" by Dr. Kellington of Notre Dame College of Education in 'Visual Education', February, 1972. We found that because of the relatively small format the production of prints by enlargement is not very satisfactory. Focussing of the image on the film has to be very critical since all the faults are magnified in the print. We have developed a method in which the microscope is used to produce an enlargement directly by projection.

The image produced in a compound microscope is a virtual one, in practice seen by an observer at the near point. However, the eyepiece can also form a real image, which allows the use of viewing heads, projection eyepieces and a camera body for photomicrography. This image can be projected directly onto bromide paper or orthochromatic film, using the arrangement shown below.



If negative prints will suffice, and these are adequate for many purposes, bromide paper is used. The apparatus shown is set up in the darkroom. The image to be photographed is focussed roughly onto a sheet of paper placed on the screen. The light source is switched off, a piece of orange or red 'Cinemoid' filter is placed over the microscope eyepiece, and the paper replaced by bromide paper. The light, now 'safe', is switched on again and the image focussed as accurately as possible. The bromide paper can then be exposed by removing the filter momentarily, and then developed, fixed and washed in the usual way. Exposure times can be controlled to some extent by adjusting the aperture of a sub-stage diaphragm or condenser, and by altering the distance between light source and mirror. Times, initially established by trial and error, range from 1-3s depending on the contrast etc. of the microscope slide. Stray light can be prevented from affecting the paper by using a black polythene bag over the lower part of the microscope and the front end of the projector. Care should be taken to see that the projector air intakes are not blocked, and that the heat from the lamp does not melt the bag! We obtained satisfactory results with Kodak bromide paper WSG4S (extra hard), Johnson's D19 type developer and Kodak liquid fixer. However, almost any type of paper could be used with other suitable developers.

If for some reason positive prints are required then ortho-chromatic sheet film can be used to obtain the negative. We used Kodak Professional projection print film, Estar thick base, type 4588 (Professional and Graphic Arts catalogue). This is relatively expensive at £4.30 per box of 25 8" x 10" sheets, but for routine use each sheet can be cut into four pieces which brings the price to less than 5p per exposure. The negative is produced exactly as described above. The positive is made by contact printing onto bromide paper. The slide is removed from the microscope stage, leaving a circle of light on the screen. This is made 'safe' using the filter on the eyepiece. The negative is positioned on the circle of light and the piece of bromide placed over it. The

filter is then removed and the print exposed. The film is translucent and sufficient light is transmitted to produce a positive image on the paper. Exposure times vary with the contrast of the negative but we found that times of 6-12s were typical. As before, adjustments can be made with the lighting controls on the microscope. If prints for display are required the same film can also be used for the positive; since the film is translucent it can be displayed very effectively if lit from behind.

The method can also be used to produce photomicrographs of known magnification from which the dimensions of cells or other microscopic objects may be estimated, at least to an order of magnitude. When measuring the total visual magnification of a microscope it is usual to assume that the eye is relaxed and magnification is given by the formula;

$$m = \frac{a}{f_o} \times \frac{250}{f_e},$$

m = visual magnification;

a = optical tube length in mm;

f_o, f_e = focal lengths of objective and eyepiece, in mm.

It can be shown (Introduction to Microscopy, G. W. White, Butterworths) that the magnification in microprojection and photomicrography is given by

$$m = \frac{a}{f_o} \times \frac{b}{f_e},$$

where b is the distance in mm from eyepiece to screen in microprojection, or eyepiece to film in photomicrography. It follows that if the eyepiece to screen separation is 250mm the magnification will be the same as that experienced at the eyepiece by a relaxed eye. If this distance is used when producing photomicrographs then they are of known magnification. Sizes of cells, cell organelles etc. can be estimated by measurement and calculation. An example is shown below.

Diameter and thickness of chloroplasts.

A slide of Prunus leaf was projected and the palisade layer and chloroplasts focussed carefully. A negative print was produced and several chloroplasts measured.

Chloroplast diameter on print = 1mm = 1,000µm;

Magnification = 200 (10x eyepiece, 20x objective);

Diameter of chloroplast = $\frac{1000}{200}$ = 5µm.

Chloroplast thickness on print = 0.5mm = 500µm;

Magnification = 200;

Thickness of chloroplast = $\frac{500}{200}$ = 2.5µm.

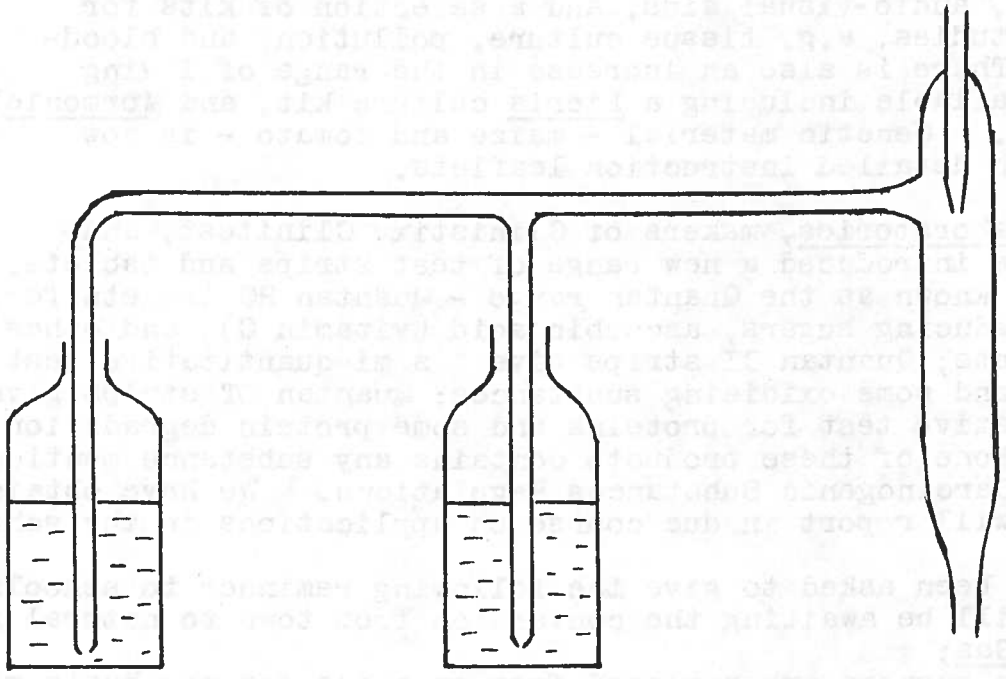
The published values for these dimensions are 5µm and 2-3µm respectively.

Obviously/

Obviously the measurements above do not require the production of a photograph and if a record is not required then measurements can be taken directly from ordinary paper placed on the screen.

Chemistry Notes

The apparatus sketched below shows a safe method of diluting solutions which are to be disposed of as waste and which require to be diluted before emptying into the drains. The method is also trouble-free in that it does not normally require the attention of a technician once it has been set up. As shown in the sketch, the method also takes care of those instances when the reagent requires to be neutralised before disposal; in other cases the T-piece and second bottle would simply be omitted. The rate of dilution and of neutralisation are controlled by the sizes of the orifices of the tubes in the bottles.



* * * * * * *

To recover silver from silver halide residues, add dilute hydrochloric acid to ensure that all the silver has been precipitated. Allow the precipitate to settle out, decant, filter and wash the precipitate thoroughly. Finally dry the precipitate, mix with sodium carbonate and heat strongly in a crucible. A small lump of solid silver will then be obtained. This can of course be used to prepare a further supply of silver nitrate.

Trade News

Ideas for Education have changed their address to that given in the address list for this bulletin.

Servicing of Oertling balances will be done for Scotland from their new regional office, the address of which will be found in the address list to this bulletin.

We have received the following reports from Cleapse;

L87a - Natural gas bunsen burners;

L114 - Small rechargeable cells;

L115a - Greenhouses - general advice and list of suppliers.

In common with all reports these may be borrowed by writing to the Director of SSSERC.

The new Philip Harris Biological catalogue has been available since May. This contains an increased range of materials, publications, audio-visual aids, and a selection of kits for particular studies, e.g. tissue culture, pollution, and blood-grouping. There is also an increase in the range of living materials available including a Pieris culture kit, and Mormoniella (Jewel wasp). Genetic material - maize and tomato - is now supplied with detailed instruction leaflets.

Miles Laboratories, makers of Clinistix, Clinitest, and Albustix have introduced a new range of test strips and tablets. The range is known as the Quantan range - Quantan RC tablets for estimating reducing sugars, ascorbic acid (vitamin C), and other reducing agents; Quantan CI strips give a semi-quantitative test for glucose and some oxidising substances; Quantan DT strips give a semi-quantitative test for proteins and some protein degradation products. None of these products contains any substance mentioned in the 1967 Carcinogenic Substances Regulations. We have obtained samples and will report in due course on applications in the schools.

We have been asked to give the following reminder to schools which may still be awaiting the conversion from town to natural gas by Scottish Gas;

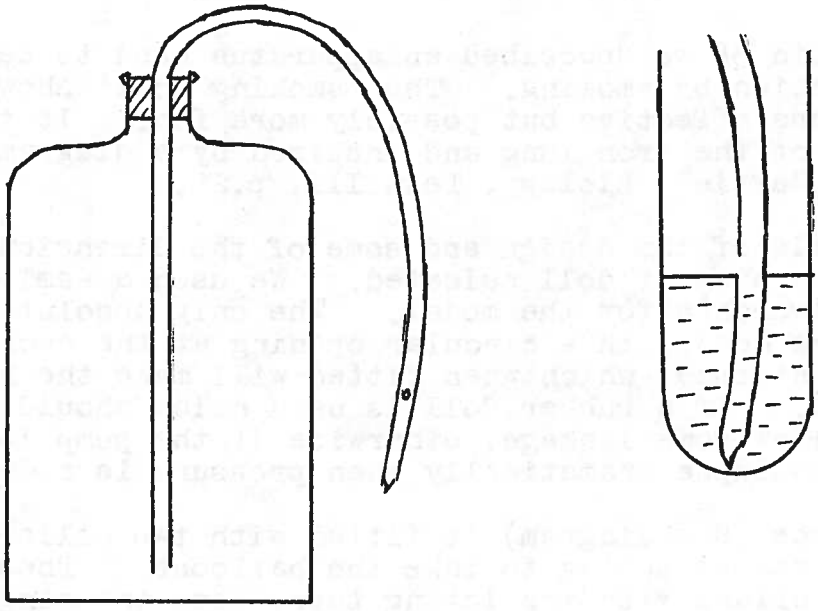
Town gas burners are replaced free on a one-for-one basis with natural gas burners by Scottish Gas at the time of conversion. About six months prior to conversion a letter is sent to schools and notices appear in local newspapers about conversion, and this is followed by the visit of a Surveyor to determine the equipment requiring conversion or replacement. To ensure that all burners are available for use as soon as possible after the introduction of natural gas, it is important to have a thorough check so that the Surveyor can be told the total number. If some lurking in corners of store cupboards are forgotten, there may be delay in getting them replaced.

The Meopta AZ-2 microscope which we consider suitable for 'O' grade use, is available from E. J. Arnold at £25.20.

A series of thirteen optical illusion cards, which have application in the Integrated Science Course on the limitation of the senses, is available from Irwin-Desman. The set, catalogue EA87, costs 70p.

In The Workshop

It sometimes arises, early in their science careers, that pupils are asked to put equal or nearly equal quantities of some liquid reagent into several test-tubes. Without good guidance those who decant too much from the reagent bottle - sometimes twice as much - will consider it natural to return the excess to the bottle, which is a bad habit to acquire at an early age. The dispenser to be described eliminates this, as it does the risk of spillage and contamination of stoppers placed on dirty benches.



A plastic detergent bottle is the container for the dispenser. It is fitted with a single-holed rubber stopper, or any other means of making it air-tight, which it must be. Semi-rigid polythene tubing, 3.5mm internal diameter fits the stopper and the length used must be sufficient to reach to the bottom of the test-tube being filled. A length of 50-60cm should be adequate. This diameter of tube is not in the catalogues of Philip Harris or Griffin and George, but can be obtained from Baird and Tatlock, 275/0256/02, 16p/m in their latest catalogue. The smallest bore of tubing in the Griffin catalogue is 5mm which will not pass through a standard stopper without modification. As will be seen from the action of the dispenser, it is essential to have the semi-rigid tubing.

The outside end of the tube is sealed by heating gently and clamping together with tongs or pliers. A hole 2-3mm diameter is then made in the side of the tube some way back from the sealed end, by melting it out with a hot steel knitting needle or similar. The distance from the sealed end to the hole will determine the amount of liquid which will be dispensed; the greater the distance the larger the volume obtained.

To use the dispenser, fill the bottle with the liquid, push the tubing into the test-tube until the end hits the bottom (hence the need for semi-rigid tubing) and squeeze. When the test-tube has filled past the hole in the tubing, release, and the relaxing bottle will draw the excess reagent back into it until the level reaches the hole, when air will be drawn in. Thus if the hole is always at the same height from the bottom of the test-tube the same volume of liquid will be delivered. This is achieved by having tubing which will not easily bend, and ensuring that the end of the tube is always at the bottom of the test-tube. Obviously test-tubes must be the same size when more than one is being used. No great accuracy is claimed for the method, but when a test with the 19mm dia. size of test-tube was done, the delivered volumes were usually equal within 1ml.

* * * * * * *

In Bulletin 38 we described an apparatus used to demonstrate lung contamination by smoking. The 'smoking doll' shown below is probably no more effective but possibly more fun. It is based on the principle of the iron lung and inspired by a diagram of an iron lung model in Nuffield Biology, Text III, p.21.

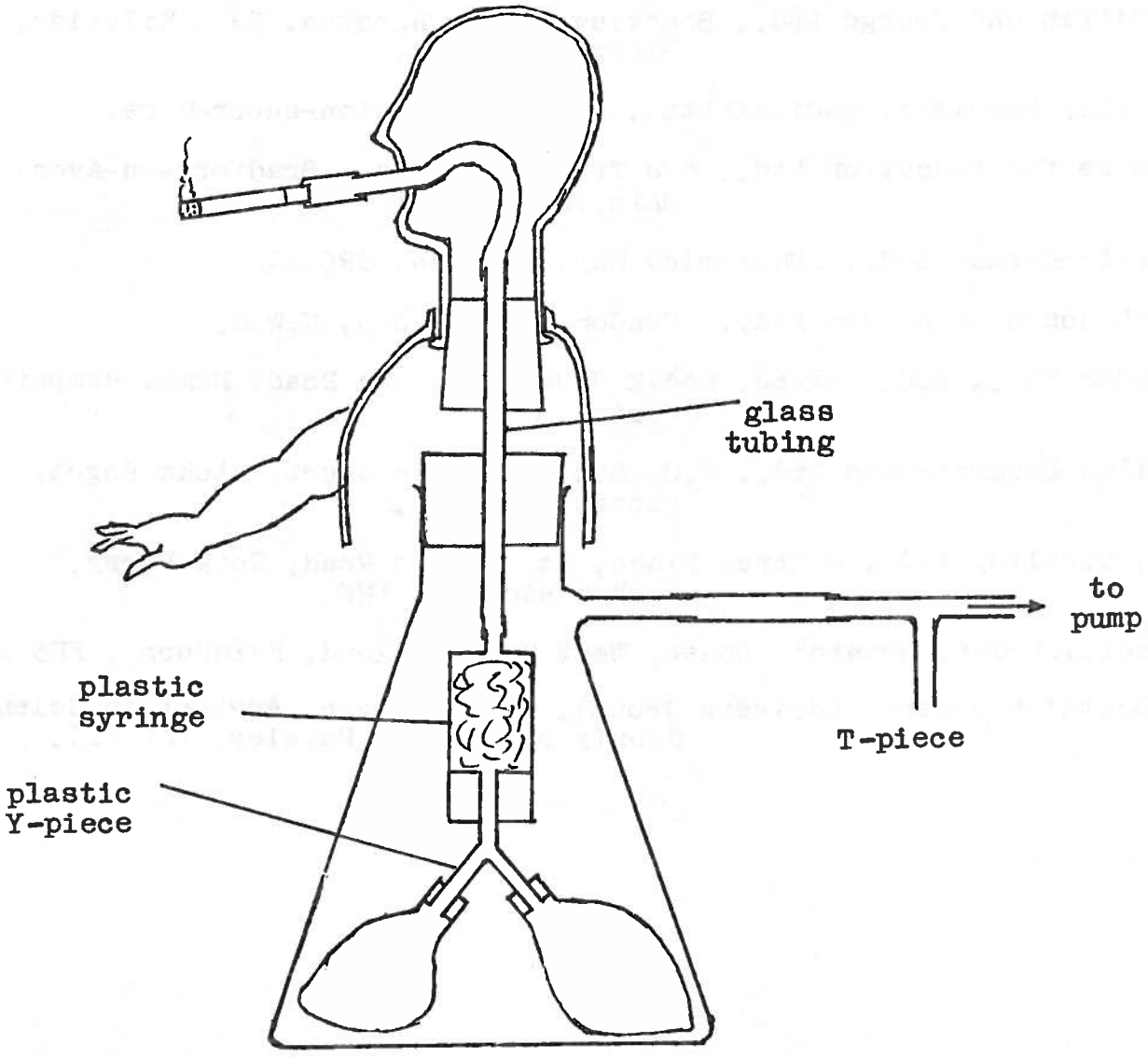
The details of the design and some of the dimensions will be governed by the size of doll selected. We used a semi-rigid plastic doll from Woolworth's for the model. The only absolute requirement is for a hollow head with a circular opening at the neck which will take a rubber stopper, which when fitted will make the head more or less air tight. If a rubber doll is used holes should be made in the head to allow some leakage, otherwise if the pump is efficient the head may collapse dramatically when pressure is reduced.

The Y-piece (see diagram) is fitted with two collars of 14mm dia. rubber pressure tubing to take the balloons. These should be taped to the collars with insulating tape, thus ensuring a tight seal. The third leg of the Y-piece fits into a No. 15 rubber stopper which in turn fits the sawn-off barrel of a 10ml plastic syringe. This contains tightly packed cotton wool to trap tars and other contaminants. A short length of glass tubing is fitted into two rubber stoppers placed back to back. The stoppers should be of a size to fit one into the doll's neck and the other to a 500ml Buchner flask. The lower end of the glass tube is fitted with a short length of rubber tube to join to the syringe nozzle.

Flexible polythene tubing, 8mm dia. is used to connect through the doll's mouth to the cigarette. A 15-20cm length is cut off and pushed through a hole in the mouth made slightly oversize with a drill bit or a punch. The glass tube is then fitted and the bung assembly pulled or pushed back up into the neck so that a tight fit results. The tubing protruding from the mouth is then trimmed back to the desired length and a cigarette holder of 10mm dia.

rubber tubing is fitted. Finally the bung assembly is fitted into the Buchner flask. All the stoppers should fit tightly as should the balloons on their collars; otherwise the model emits high-pitched, bronchitic whistles. This also applies when replacing the stopper in the syringe barrel after renewing the cotton wool.

The operation is straightforward. A filter pump or similar is used to withdraw air from the flask when the open limb of the connecting T-piece is closed by a finger. The pressure difference between flask and atmosphere causes air to be pushed in through the doll's mouth and inflate the balloon 'lungs'. When the finger is removed the pressures inside and outside the flask equalise and the 'lungs' deflate under their own elasticity. Apart from the actual cause of the pressure difference, this is what happens in human breathing. If a cigarette is placed in the holder and a match applied with the T-piece closed, it will light and can then be smoked in puffs by opening and closing the T-piece side-arm. After smoking the cotton wool can be removed for examination and renewal by partly dismantling the model. The model works well with a filter pump provided that the water pressure is adequate. Otherwise a suitable pump should be available in most physics departments. If the pump is too efficient the doll will not smoke realistically; this may be cured by fitting a length of capillary tubing in the air line, or by fitting it with a screw clip.



S.S.S.E.R.C., 103 Broughton Street, Edinburgh, EH1 3RZ.
Tel. 031 556 2184.

E. J. Arnold and Son, Ltd., Butterley Street, Leeds, 10.

Baird and Tatlock Ltd., Freshwater Road, Chadwell Heath, Essex.

Cleapse Development Group, Brunel University, Kingston Lane,
Uxbridge, Middlesex.

Griffin and George Ltd., Braeview Place, Nerston, East Kilbride,
Glasgow G74 3XJ.

Philip Harris Biological Ltd., Oldmixon, Weston-super-Mare.

Ideas for Education Ltd., 87a Trowbridge Road, Bradford-on-Avon,
BA15 1EE.

Irwin-Desman Ltd., 294 Purley Way, Croydon, CR9 4QL.

Johnson's of Hendon Ltd., Hendon Way, London, N.W.4.

Kodak Ltd., P.O. Box 66, Kodak House, Station Road, Hemel Hempstead,
Herts.

Miles Laboratories Ltd., P.O. Box 37, Stoke Court, Stoke Poges,
Slough, SL2 4LY.

L. Oertling Ltd., Oaktree Place, St. Paul's Road, Rock Ferry,
Birkenhead, L42 1NF.

Scottish Gas, Granton House, West Granton Road, Edinburgh, EH5 1YB.

(Scottish Science Advisers Group), Mr. J. Hogan, Adviser in Science,
County Buildings, Paisley, PA1 1LE.