SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

Bulletin No. 94. January, 1977.

Contents

Introduction

Several weeks ago schools will have received Memorandum No. 23 on Project Work in Chemistry for C.S.Y.S., issued by the Scottish Centre for Mathematics, Science and Technical Education. The memorandum makes no mention of help which can be obtained from outside organisations, deliberately so, because the author felt that it would be impossible to include them all, and to mention some and not others would be invidious. However, we feel ourselves to be in a special category in this respect, that whereas help provided by further education institutions, research organisations or industry is voluntary and incidental to their main purpose, what advice we can and do give has already been bought and paid for by the regional authority, and it is moreover one of the purposes for which we were established.

Among the areas in which we can provide help is safety; a project may bring the teacher as well as the pupil in touch with an unfamiliar chemical or reaction and we keep Sax and other standard references on chemical hazards. We are members of Interlab Scotland, the object of which is 'to bring into friendly contact laboratory staffs in different fields of science and technology, including agriculture and medicine, so that they can help each other with problems which fall outside the immediate scope of individual teams'. This means that we can probably identify individuals with an expert knowledge in a particular field and the student or teacher can be given a name to be contacted. We ourselves can and do accept queries from teachers or pupils regarding individual projects, and provided we have been informed by the teacher in advance, a pupil can visit us to discuss what help we may be able to give. Very occasionally, usually when a project takes an unexpected turn, we have lent out equipment for a limited period to enable a project to be completed. These facilities and any others we may be able to provide, are available on demand by teachers in any regional authority school or in any school in the private sector which subscribes to SSSERC.

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Concurrent with this bulletin we have sent out part I of a biology equipment list for C.S.Y.S. In an effort to cut costs we have sought to identify all the schools which might attempt S.Y.S. biology and sent the list to those schools only, but if any school has been omitted we will send a copy free of charge upon request. Part I lists the hardware for the course: Part II which we hope to issue later will give details of expendible items - organisms, specimens, chemicals etc.

Opinion

Shortly after our Bulletin 93, which contained some observations on the D.E.S. ruling on the wearing of safety goggles in schools, went to print, we received our copy of the A.S.E. bulletin, Education in Science. It appears that others had been sufficiently concerned regarding the ruling to write to D.E.S., because

the bulletin contains an explanatory note from Mr. Norman Booth, Staff H.M.I. for Science.

It is a curious statement which does nothing to clarify the position in law of the teacher, and we must be thankful that - at the time of writing, at least - no similar pronouncement has been made for Scotland. It begins by misquoting the D.E.S. pamphlet, using 'should' in place of the italicised 'must' in the original, and throughout the statement Mr. Booth talks about 'advice', which to me is a misinterpretation of the imperative verb used. It asks the questions I asked in Bulletin 93 - "Is it not absurd to say 'whenever chemicals are used?' Is not everything chemical, does it not include for example, water, or stirring sugar in a cup of tea?" - but does not supply the answers.

It says "We could have said 'Insist on the wearing of goggles (or suitable eye protection) whenever in your opinion there is a possibility of injurious substances getting into the eye'", and this would have been close to the Protection of Eyes Regulations, which refers to a 'reasonably foreseeable risk', and on which any legal interpretation must surely be based. But the statement then goes on to imply that they wished to 'harden the advice' beyond the legal requirement quoted above, as 'there were cogent arguments for getting the pupils so accustomed to wearing goggles that they did so as a matter of course. There are parallels with motor cycle crash helmets and car seat belts.' Unfortunately there are no legal parallels - the law regarding crash helmets has been proven in the courts, and legislation on car seat belts is still on its way through Parliament. The statement in Education in Science is not a retraction on the D.E.S. pamphlet, which still insists that goggles must be worn whenever any operation with chemicals is performed. The teacher is still left in the dark concerning the interpretation which may be put on the statement by the Health and Safety Executive, or by the law court should the teacher be unfortunate enough to have to defend a civil action.

I would be in favour of any advice which made the wearing of goggles or other eye protection by chemistry pupils habitual, while still leaving the final decision with the teacher. However I think it a mistake to attempt to make such wearing compulsory, as it appears to give the action a force of law where none exists, and leaves the teacher more confused than ever regarding his legal responsibility. Meanwhile in the Chemistry Notes section of the bulletin, we discuss another problem which arises with the use, however infrequent, of eye protectors, that of their cleaning and disinfection routine.

Biology Notes

In microscopy there are many objects which, because of their transparency, cannot be seen easily by transmitted light. In such cases an increase in contrast can be more helpful than sheer resolution. This problem was discussed in Bulletin 85 where an inexpensive polarising facility was described. Inspired by a recent Royal Microscopical Society meeting on microscopy in the classroom, we have been looking again at a number of simple

techniques involving special methods of illumination. Two of these which we have found especially useful are described in a number of texts on microscopy - the use of a 'patch stop' to provide dark-ground illumination and 'Rheinberg discs' which give differential colour illumination or 'optical staining'. These techniques are useful when unstained living material is to be observed and also give interesting effects when crystals, mineral sections and textiles are examined. For a number of reasons, they give the best results with the lower power objectives (x10; x20) used on a microscope with a focussing condenser. However it is possible to use them to some extent on the simpler '0' grade type instrument.

Usually when discussing the use of the focussing condenser the importance of obtaining maximum light into the objective is stressed. For dark-ground illumination the opposite situation is aimed at, i.e. prevention of any direct light from the condenser entering the objective. If all the central rays entering the condenser are stopped by an opaque disc - the 'patch stop', fitted into the filter carrier below the condenser mount, a hollow cone of light can be focussed on to the object without any direct rays entering the objective. If the object at the point of focus reflects or scatters any light some of this will enter the objective. A bright image of the object will be seen against a dark background. This is dark-ground or dark-field illumination (Fig.1).

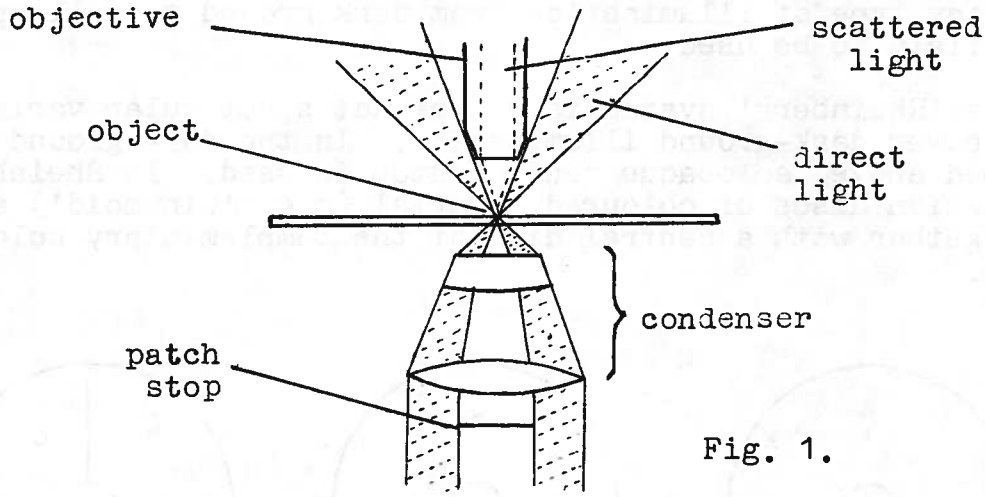


Fig. 1.

It will be obvious from the diagram, that the size of patch stop used will vary with the power of the objective. The stop diameter is easily determined. The microscope is set up and focussed on a fairly transparent object. The eyepiece is removed and the back lens of the objective observed as the substage iris is opened carefully until it just fills the objective aperture. The iris aperture is then measured with dividers and this is the diameter of stop which is required for use with that particular objective. This is the method used whenever a central stop is required for this article.

Opaque stops can be cut from insulating tape or other suitable material and stuck on to clear transparent or coloured glass or celluloid. 'Cinemoid' filter is a suitable coloured material. Care should be taken to ensure that the stop is fairly accurately centred. Fig. 2 shows a number of filters which will give various types of dark-ground illumination.

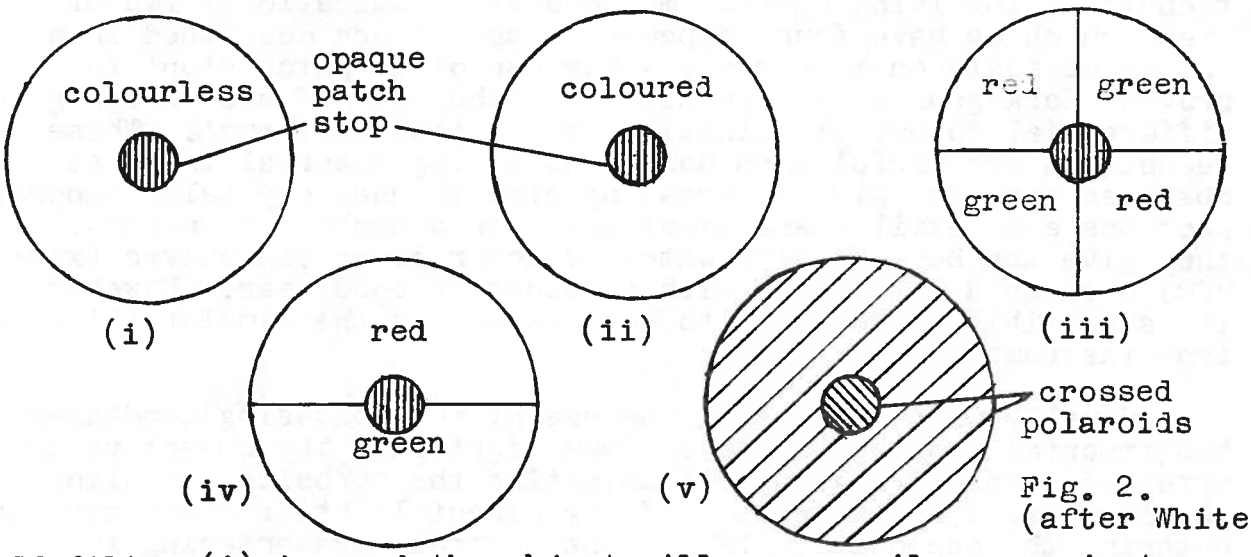


Fig. 2. (after White).

If filter (i) is used the object will appear silvery against a dark background. However if the outer ring is coloured as in (ii) the object will appear in that colour on a dark background. If the outer annulus is split into two colours either as quadrants (iii) or semi-circles (iv), two colour effects on a dark background can be obtained. These two colour systems are affected by specimen orientation. The filter shown as (v) together with a polaroid in the eyepiece gives variable dark-ground illumination. This is known as the 'Mullinger' system. Rotating the eyepiece allows any type of illumination from dark ground to full aperture bright field to be used.

The 'Rheinberg' system is a somewhat spectacular variant of low power dark-ground illumination. In the dark ground systems described above, an opaque central stop is used. In Rheinberg illumination discs of coloured material (e.g. 'Cinemoid') are used together with a central disc of the complementary colour (Fig.3).

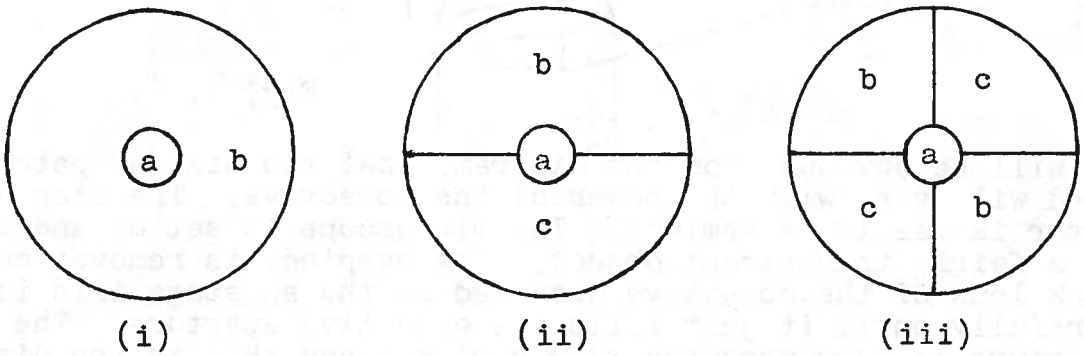


Fig. 3. (after White).

In the simple filter (i) the colour of the central disc determines the background colour, whilst the outer ring provides illumination in a contrasting colour which picks out the object. Colour pairs we have found useful have been: (central colour first) red on yellow, blue on orange, dark blue on cyan. It is best if the central disc is somewhat darker than the outer annulus to allow the fainter outside colour to show. In the more complicated three colour arrangements 3(ii) and (iii), two colour effects on a coloured background are obtained. As with quadrant and semi-circular colour filters for dark-ground illumination, the orien-

tation of the specimen will have an effect on the appearance of the image.

Whilst the Rheinberg effects are very attractive aesthetically, they often do not provide any more information than conventional dark ground illumination. However the colour contrast, in some cases, can remove some of the glare that accompanies a white object on a black background. The three colour, quadrant arrangement can prove extremely useful in the examination of regularly arranged objects such as textiles and crystals. Certainly for open days and exhibitions it can prove a major attraction.

References.

Bradbury, S. (1976) 'The Optical Microscope in Biology' Institute of Biology 'Studies in Biology No. 59' Edward Arnold (Publishers) Ltd., London.
Bradbury, S. 'Additional Notes on the use of the Microscope' Royal Microscopical Society, Oxford.
Mullinger, L.W. (1950) 'A Useful Illumination System' J. Quekett Micr. Club, 3, 125.
Pugh, F. (1937) 'Differential Illumination' The Microscope 1, 109.
White, G.W. (1966) 'Introduction to Microscopy' Butterworths, London.

Chemistry Notes

Whatever views one may hold regarding the use of eye protectors by pupils in chemistry lessons and elsewhere, few teachers would dispute the fact that eye protectors have arrived in schools. It is the employer's duty under the Health and Safety at Work Act to provide the teacher with a written statement on safety, and in schools where safety spectacles or similar protection have not been provided, it is in the teacher's own interest that he seek a statement of policy from his employer regarding their use.

Assuming, however, that safety spectacles are in the science department, and side-stepping the question of how often they are to be used, how does the teacher keep them clean? We have discussed this with many and varied sources, and all medical advice is that the risk of infection from wearing safety spectacles is small, smaller for example than by direct contact between pupils in classrooms, playgrounds, gymnasia etc. However the situation is slightly different in that pupils are being compelled to wear spectacles which have previously been worn by others, and they, and their parents have a right to feel that the spectacles are clean. Indeed the subject should be discussed with parents through school councils or parent teacher associations, as some parents may wish to provide children with their own. In such cases the school should consider making provision for this, as safety spectacles do not come into the category of items picked up from the shelves of a supermarket.

No doubt this is the ideal solution, and as such it should be encouraged, that each pupil has his or her own eye protectors, and is responsible for their cleanliness. For situations falling short of the ideal, the most important thing is not the method used to clean the spectacles, but the fact that it is a routine. It

should be established by consultation between teachers and technicians that cleaning is done regularly irrespective of the amount of use of the spectacles, a slot for the process found in the technician's timetable, and the details entered in the technician's manual, with provision for an alternative if the person concerned is absent for any reason.

At first sight, irradiating with ultra violet light seems a promising way of killing off the germs. It is effective, dry, and takes up the least amount of technician time. However, it is not the whole answer; spectacles still need to be cleaned of dirt, not only to keep them usable but because dirt is impermeable to u.v. radiation. Moreover all the people we talked to, apart from those with u.v. cabinets to sell, were against its use. The hazards to the technician from the u.v. and from the ozone it produces are far greater than those to the pupil wearing the spectacles, and eliminating them is expensive. The germicidal effects are confined to one wavelength of 254 nm, and u.v. lamps may appear to be operating satisfactorily when the intensity of emission of this line has greatly decreased. One estimate is that the intensity can drop by 30% in the first 100 hours of life of the lamp. Hence one must monitor the effectiveness of the lamp, and filters for this purpose cost over £100. An alternative is to culture agar plates inside and outside the cabinet and then to rely on a subjective judgement of when the lamp should be replaced. Many sterilising cabinets used by hairdressers are ineffective for this reason and in the opinion of one research worker make more impression on the customers than on the germs.

Turning to chemical means of sterilisation, we seemed unable to get any unbiassed advice. Phonotas appeared to think we wanted to set up in opposition and refused to give any details of their material. The G.P.O. was equally unhelpful: no one was able to find the people who disinfect the phone box telephones and we were unable to catch them at it. We found the same difficulty when we inquired regarding the phones in the multi-storey government departments which proliferate in Edinburgh. The Medical Advisory Service of the Health and Safety Executive pointed out that old-fashioned soap and water was quite a powerful bacteriocidal agent which had the advantage over many more sophisticated germicides that it would avoid the build-up of surface adsorbed reagents which could lead to dermatitis. Their medical officer advised

(i) that teachers be aware of the small degree of risk;

(ii) that pupils' heads be monitored and any obvious case of infection be isolated and the pupil supplied with a special pair of spectacles of his or her own:

(iii) that spectacles be wiped with clean tissue paper at the end of a class;

(iv) that they be cleaned once a week with soap and water and left to dry.

Anyone wishing to add to this routine with proprietary sterilisers should realise that cationic biocides will be inactivated by anionic detergent residues, so that rinsing is necessary. The choice amongst the proprietary brands is wide. The British Standards recommendation for the cleaning of safety spectacles used

by welders etc is: 'Equipment is disinfected by immersion in a 1% solution of dodecyl di(aminoethyl) glycine hydrochloride for a period of ten minutes. Other than for the removal of gross accumulations no preliminary washing is necessary nor is subsequent rinsing required'. This recommendation was made in 1960 and there may well have been improvements since then. We understand that dodecyl di(aminoethyl) glycine hydrochloride is one of the ingredients of Tego MHG, available from Goldschmidt, to be used at 1% concentration for 10 minutes. Ciba-Geigy recommend Bradophen, used at 0.5 g per litre for 15 minutes. The spectacles should be rinsed afterwards as the biocide may build up on the surface. Boots the Chemists suggest their baby bottle sterilising tablets, used as recommended but rinsed with water afterwards. Savilles Hydrological Corporation suggest Sursan 219, which is used for sterilising surgical instruments at 0.25% concentration for 15 minutes. The comparative costs of 4 litres of working solution of these biocides are:
Tego MHG 1.0p: Bradophen 2.0p: Boots tablets 2.3p: Sursan 219 1.2p.

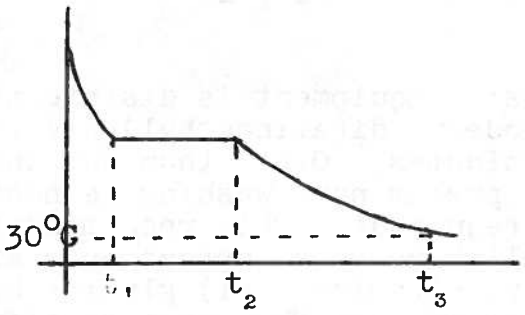
Physics Notes

At the request of a group of teachers preparing an exemplary module on heat for teaching to S3 and S4, we investigated possible alternatives to naphthalene as a substance to be used in a melting point determination. Objections to naphthalene are its noxious odour, that it may catch fire (although this risk can be lessened by heating in a water bath), and that after being used several times it becomes discoloured by carbon particles. We dislike salol and hypo as alternatives, on the pedagogic ground that it is always unwise to teach what is wrong and which may have to be unlearned at a later date. What is wrong is that both substances dissolve in their own water of crystallisation, rather than melt.

The substances listed below were all tested by putting in a 125 x 19 mm test-tube which was immersed in boiling water. On reaching the required temperature the test-tube was taken out, wiped dry on the outside and placed in a rack to cool. Stirring was carried out with the thermometer until the material had solidified. The first temperature recorded was usually about 90°C. We would consider any of the substances satisfactory for melting point determination, although we have not repeatedly heated and cooled them to see if there is any deterioration with repeated use.

Substance	Amount	Melting Point	Time t_1	t_2	t_3
Cetyl alcohol	7 g	53°C	7	12	34
Hexadecan-1-ol	4 g	49°C	6	18	35
Octadecan-1-ol	3.5 g	57°C	4	15	31
Palmitic acid	8 g	59°C	3	8	21
Stearic acid	3 g	67°C	4	11	23

Times in min.



Comparative costs of the various substances, taken from B.D.H. catalogue and available from Macfarlane Robson are:

Substance	Cat.No.	Qty.	Price
Cetyl alcohol	26048	500g	£2.50
Hexadecan-1-ol	28480	250g	4.32
Octadecan-1-ol	29404	500g	2.64
Palmitic acid	29433	500g	2.70
Stearic acid	30267	100g	1.60

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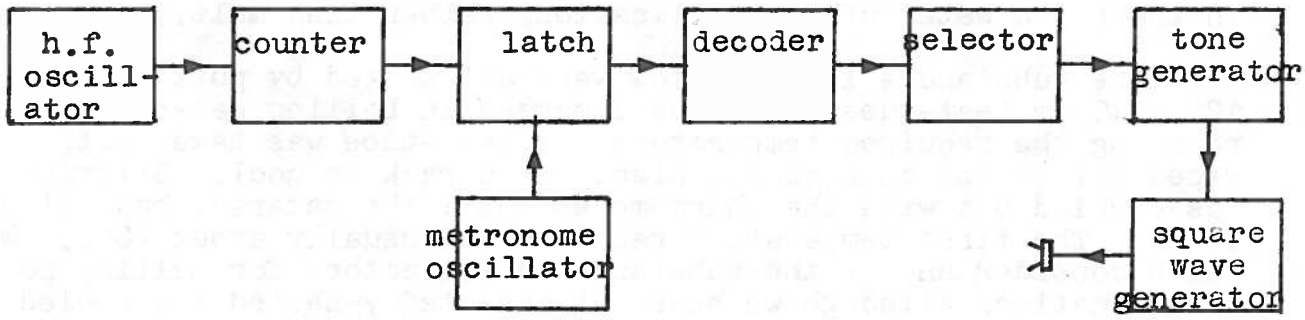
This is an ear-catching device for open or parents' day. The idea was suggested by a similar generator exhibited by a pupil at a B.A. Science Fair. His had developed an intermittent fault so that it produced the same effect. The sequence of notes and its length are both random, so that the device is a musical equivalent of six monkeys typing Shakespearean sonnets, and takes much the same time to play a Beethoven symphony.



The principle is as follows. A h.f. oscillator (100 kHz) has its output counted continuously in a cycle of 0 - 9 (SN7490). The counter output passes to a SN7475 latch, and thence to a SN7442 decoder. The latch has an 'enable' input which, when high, allows the counter output to pass directly to the decoder. In this state the decoder output signal would cycle continuously through the 0 - 9 count. If the enable input goes low, the latch outputs are 'frozen' at the last counter state, so that the decoder output is held on one pin until the latch enable again goes high.

The enable pulse, obtained from the metronome oscillator, is short (ca. 50 μs) with a repetition frequency about 3 Hz. The decoder output therefore changes to a different pin at random, but is held there for 1/3 second. The 0 - 9 outputs of the decoder pass to different pre-set resistors in the selector; each of these resistors determines a particular frequency of oscillation for

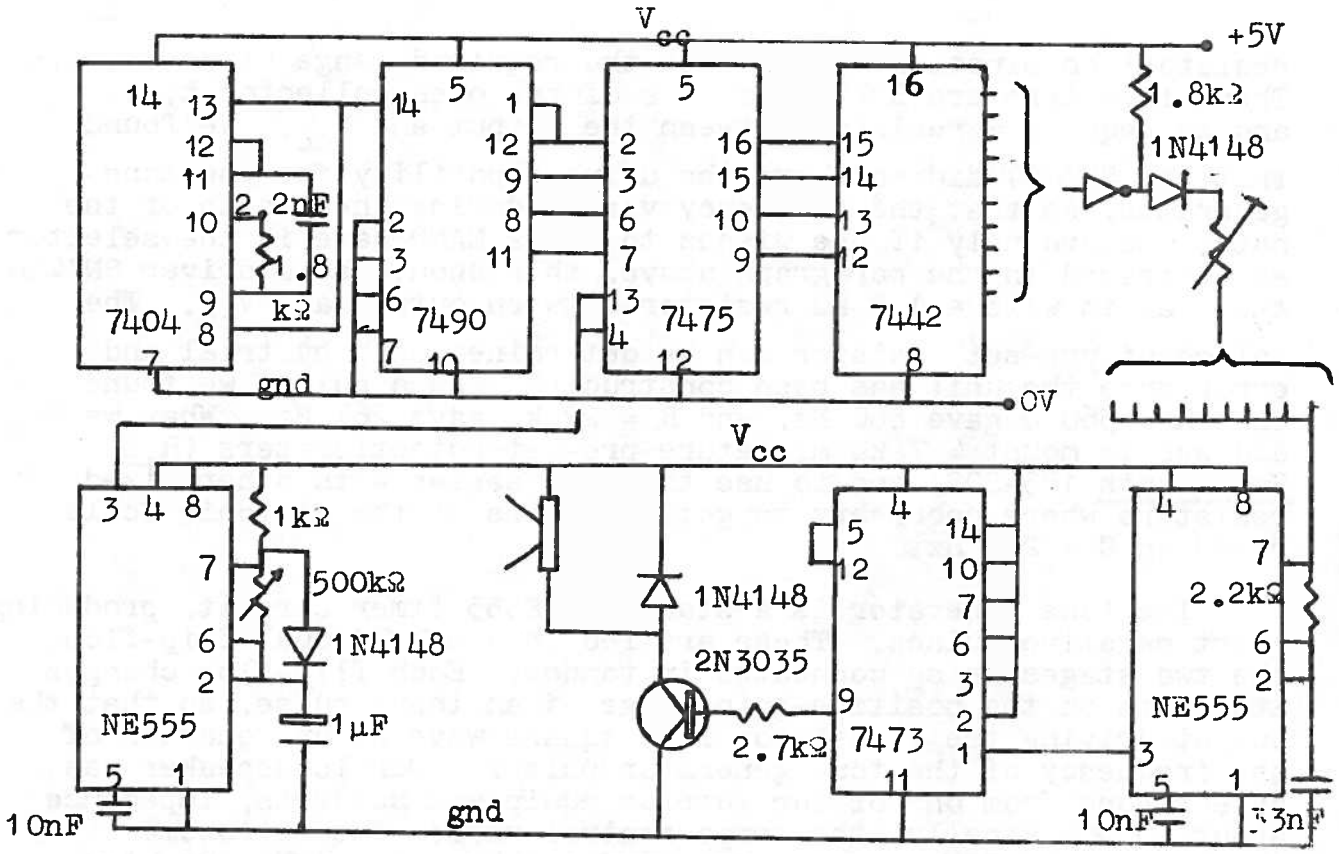
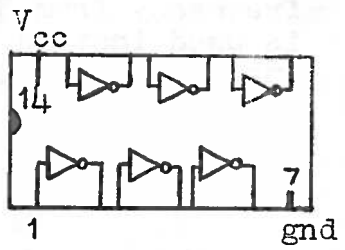


Fig. 2. All pin connections when viewed on top are numbered anti-clockwise from the locating spot - see SN7406 at right. Pins 1 - 7 and 9 - 11 of SN7442 are all decoder outputs, and connect in any order to SN7406 inverter gates.



SN7406 connections, viewed on top.

the tone generator. The generator output is also in the form of short pulses, and these are used to drive a flip-flop in the 'toggle' mode, so that the loudspeaker or earphone receives square waves no matter what the frequency is.

Several refinements on this basic pattern are possible. With a 0 through 9 count, ten different tones can be obtained. The effects are more interesting, however, if one output is left unconnected. This creates a break of one note length in the sequence. If the SN7490 and SN7442 are replaced by SN7493 and SN74154 respectively, the range of outputs is increased to 16, so that if two of these are left unconnected, one can have a range of 14 tones with a break on average once every 8 notes. The chance of occurrence of a particular tone can be doubled, at the expense of reducing the range by one tone, by feeding two decoder outputs to the same pre-set resistor through a NAND gate. The tempo at which the sequence is played can be varied from adagio to presto by varying the frequency of the metronome oscillator.

Fig. 2 shows the circuit diagram as we assembled the generator. The bracketed section after the SN7442 is what we have called the selector and comprises 9 or 10, similar 'inverter-diode-preset

resistor' combinations to produce the required range of notes. These inverters are SN7406 drivers of the open collector type and so require a resistor between the output and V_{cc}. We found that the SN7404 did not have the drive capability for the tone generator, so that the frequency varied during the length of the note. Accordingly if one wishes to use a NAND gate in the selector as described in the paragraph above, this should be a driver SN7426 type, again with a 1.8 kΩ resistor between output and V_{cc}. The values of pre-set resistor can be determined only by trial and error once the unit has been constructed. As a guide, we found that R = 560 Ω gave 660 Hz, and R = 22 kΩ gave 264 Hz. What we did was to mount 4.7 kΩ miniature pre-set potentiometers (R.S. Components 185-202) and to use these in series with other fixed resistors where necessary to get the notes of the diatonic scale based on C = 264 Hz.

The tone generator is a standard NE555 timer circuit, producing short negative pulses. These are fed to a SN7473 dual flip-flop, the two stages being connected in tandem. Each flip-flop changes its state on the positive-going edge of an input pulse, so that the output driving the transistor is a square wave at one quarter of the frequency of the tone generator pulses. Our loudspeaker was an earphone from one of our surplus equipment headsets, impedance about 80 Ω. Finally, the tempo control varies the metronome frequency from 3 Hz down to just under 2 Hz; if a 1 MΩ rheostat is used instead of 500 kΩ this will reduce the 'tune' to a stately one beat per second.

Trade News

An inexpensive galvanic oxygen electrode is available from Uniprobe who will also supply full details of a measuring circuit using a microammeter or chart recorder, and a circuit for an oxygen meter based on the 741 operational amplifier. The Uniprobe D100 electrode is £11.20 including circuit details, notes and an electrode maintenance kit. Further information on the use of this electrode will be given in a future bulletin.

In Bulletin 89 we mentioned the new designs of aquarium heaters and thermostats made necessary by new consumer legislation. These are now available. The recommended price for the Uno heater/thermostat is £4.25 which includes 12½% VAT. This is an earthed unit with impact resistant tubes containing the heater and thermostat components. Griffin and George also sell this unit as APN-750. A recent Griffin circular gave its price as £5.42 but we are informed that this was an error and that the correct price is £4.74. Interpet Super Maxamatic Mark II heaters rely on double insulation rather than earthing: the 50, 75, 100 and 125 W ratings should cost £4.75, and the 150 and 200 W £5.04 from pet shops. In quantitites of 100 or more, which may interest regional authorities, these prices reduce to £2.20 and £2.34 respectively, obtainable direct from Interpet. Philip Harris stock the 100 W unit: it is B4999X (B56441/9 in the 1977 catalogue), and costs £5.04. While it is now illegal to sell the single insulation type of heater, their use is still permitted and it is unnecessary to rush out buying replacements.

We have recently received the following CLEAPSE reports. These may be borrowed by writing to the Director of the Centre.

L60 Stereomicroscopes (revised)

L86z Electrical Safety and the Users of School Laboratories

L107 Newton meters - spring balalnces

L115b Greenhouses - Advice on automatic greenhouse watering systems

L129 Middle school science kits

L132 Solar panels - flat collector plates for water heating.

A new, plastic, hand-operated pump would seem to us to be ideal for those 'stations' experiments in section 4 of Integrated Science where the rotary pump is too fearsome to be placed before little children. Even if the handgrip is intended for adults, children could operate the pump with two hands and blow up balloons in bell jars etc. The pump, catalogue no. 6131-0010, costs £9.65 from Techmate. The nozzles will fit 5 mm diameter rubber tubing, and the manufacturers claim a vacuum of up to 25 in Hg (sic) after a few squeezes, or it will give 7 lb/in^2 positive pressure through the exhaust nozzle.

We have the following information on asbestos substitutes from Philip Harris and Griffin and George:
Wire gauze; either plain stainless steel gauze, 150 mm square, Harris C42680/8, 50p; Griffin GMX-340-030A, £2.85 for 5, or iron wire gauze with a ceramic fibre centre, Harris C42500/8, 33p; Griffin GMX-310-030V, £3.05 for 10. In the Philip Harris case, a ceramic centre must be specified: otherwise a gauze with asbestos centre will be supplied against this catalogue number. We must say that we have had a sample of this ceramic centred gauze in the Centre, and that thumping it flat on the bench a few times causes the ceramic to fall out of the spaces between the mesh. Both Philip Harris and Griffin and George claim that this will not happen once the gauze has been heated, but by then our sample had been in the Centre one week and had been subjected to numerous tests of heating with chemicals spilt on it.
Bench mat; Harris, hardboard heat resistant mat, 250 x 250 x 3 mm, C46800/1, 22p. Griffin, calcium silicate matrix 225 x 225 x 6 mm, HCR-400-030R, £2.55 for 10.
Platinised asbestos; Griffin supply kaowool, 5% platinised, 161-035-300J, £1.05 for 1 g.
Asbestos paper; Griffin supply ceramic fibre paper sheets, 500 x 1000 x 1 mm, HCR-350W, £2.25 per sheet.

Macfarlane Robson also supply kaowool, 5% platinised, under catalogue number 331692G at £3.72 for 5 g.

A range of 15 species of amphibian is offered in the new catalogue of Xenopus. As well as supplying living animals they offer foodstuffs, chemicals and amphibian husbandry equipment.

Torbal balances are now being manufactured in the U.K. by Scientific and Educational Aids. The FP400 costs £290, and the FP1200 £315. Macfarlane Robson are Scottish agents for S.E.A.

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

Ciba-Geigy Ltd., Agro-chemicals Division, Whittlesford, Cambridge, CB2 4QT.

Cleapse Development Group, Brunel University, Kingston Lane, Uxbridge, Middlesex, UB8 3PH.

Goldschmidt Ltd., York House, 353a Station Road, Harrow, Middlesex, HA1 1LH.

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

Philip Harris Ltd., 30 Carron Place. Kelvin Industrial Estate, East Kilbride, Glasgow, G75 0TL.

Interpet, Curtis Road, Dorking, Surrey, RH4 1EJ.

Macfarlane Robson Ltd., Burnfield Avenue, Thornliebank, Glasgow, G4 0BA.

Medical Advisory Service, Health and Safety Executive, Meadowbank House, London Road, Edinburgh.

R.S. Components Ltd., P.O. Box 427, 13-17 Epworth Street, London, EC2P 2HA.

Savilles Hydrological Corporation, Deerpark Road, London, SW19 3UQ.

Scientific and Educational Aids Ltd., Vale Road, Windsor, SL4 5JL.

Scottish Centre for Mathematics, Science and Technical Education, College of Education, Gardyne Road, Broughty Ferry, Dundee, DD5 1NY.

Techmate Ltd., 173 Lower Luton Road, Wheathampstead, Herts.

Uniprobe Instruments Ltd., Clive Road, Cardiff, CF5 1HG.

Uno Aquatic Products Ltd., Uno House, Arnold Street, Nantwich, Cheshire, CW5 5RB.

Xenopus Ltd., 151 Frenches Road, Redhill, Surrey, RH1 2HZ.