SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

Bulletin No. 54 March 1972.

Contents

Introduction

A weekend meeting of the Scottish Branch of the A.S.E. will be held from Friday, 7th April to Sunday, 9th April, in Inverness Technical College. Our exhibition of apparatus will be from 9.00 - 17.00 on Saturday, 8th April. A lecture demonstration on new equipment produced by manufacturers for science teaching will be given by members of our staff. The lecture is scheduled for 14.30 - 15.30 on Saturday, 8th April. We are always searching for new ideas in science equipment, consequently we look forward to seeing a large number of items at the Members' Exhibition which is always of great interest to all members.

We have been requested by the School Science Audio-Visual Materials Development Group, Jordanhill College of Education, 76 Southbrae Drive, Glasgow, W.3, to pass on the following information. Members of the Biology, Chemistry and Physics Departments have combined their efforts to form the Group. The Group plan to supply information on visual aids materials, organise courses, arrange exhibitions, etc. for science teachers. They are however, not involved in the assessment of Visual Aids hardware. Interested teachers are asked to contact one of the following group members - Mr. J. Aitken (Biology), Mr. M. L. Crowe (Chemistry), Mr. V. A. Seath (Physics).

Biology Notes

P.T.C. Tasting. A recent article in Nature New Biology, (Vol. 235, January 19th, 1972) on the subject of Phenylthiocarbamide has pointed out the possible hazards in the use of this compound in schools. Briefly, the article describes work with rats, where it was found that a dose of 3mg per kg body weight was lethal for 50% of the animals. The method of testing recommended in the Nuffield 'O' level Biology Year V Text and Guide (Chapter 10) is to prepare strips of filter paper, dipped in 0.13% P.T.C. solution, and there appears to be no possibility of pupils receiving anything remotely near a hazardous dose if this procedure is followed. However, the article points out that other methods are sometimes used, particularly one where subjects are asked to taste a range of solutions, to determine their taste threshold. Under certain, admittedly improbable, circumstances, subjects may receive doses up to 2mg per kg body weight from this type of test. Most importantly, however, non-taster pupils may be tempted to take actual crystals in acts of bravado - indeed the writer has witnessed a colleague allowing pupils to do just this. Needless to say this is a highly irresponsible act, and one to be avoided at all costs.

After/

After consultation with Science Advisers, H.M.I.'s and College of Education staff, therefore, the following recommended course of action has been agreed on. Since P.T.C. tasting is not essential for teaching the new biology syllabus, it is probably best if schools abandon its use altogether. If, however, individual teachers feel very strongly that they wish to continue its use they should make quite certain that it is only used according to the directions given in the Nuffield Year V text and Guide, i.e. on filter paper strips as described earlier. Of course, individual Authorities may decide, notwithstanding, to ban the use of P.T.C. whatever their teachers' views.

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Albustix and Clinistix. The use of these papers to test for protein and glucose is already widely known. They are obtainable from most chemist shops, at 34p per 50 for Albustix and 28p per 50 for Clinistix. We have tested a range of foodstuffs with them, and come to the following conclusions.

Albustix react positively with a wide range of protein foods, e.g. egg albumen; minced meat (shaken up in cold water); milk; cheese. Unlike Millon's Reagent they are non-poisonous; they are also much easier to use, especially since no heating is required. 100cm^3 of Millon's costs about the same as 250 Albustix (£1.60); therefore, if pupils are likely to use more than 0.4cm^3 of Millon's per test, Albustix will be cheaper.

Clinistix react positively with glucose whenever it is encountered, but they are much more expensive than Benedict's Solution. However, their convenience does make them very useful in digestion/diffusion experiments where they will not be used in such large numbers as they will in food testing.

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Respiratory Quotient. The classical way of measuring this is by use of the Ganong respirometer (cf. 'Biology by Inquiry', Book 3, page 66). The procedure is time-consuming and involves using 40 per cent caustic potash solution. An alternative method, using a compensated respirometer, is suggested in the Nuffield 'A' level Biological Science course. We have simplified the latter procedure, using the compensated respirometer described in Bulletin 48. The procedure is as follows.

Set up the respirometer with the same mass of material - e.g. peas or mung beans - in each chamber, but with soda-lime in only one chamber. Leave the apparatus with the manometer sealed off for some minutes, to allow equilibration. Then connect only the 'soda-lime chamber' to the manometer, turning the other tap handle to expose the other end of the manometer to the atmosphere. Record the/

the time taken for the manometer fluid to move 10 divisions up the scale. Let this be t.

Allow both chambers to re-equilibrate, i.e. with their contents exposed to the atmosphere for several minutes, and then turn the taps so that both the chambers are connected to the manometer. Record the number of divisions moved in the time interval t. This gives a direct measure of the respiratory quotient, e.g. for a R.Q. of 0.8 the latter reading will be 8 divisions.

The reasoning behind this is as follows. In both chambers the equivalent of 10 divisions of oxygen is absorbed in time t. In the 'soda-lime chamber' no gas is given out to replace this, but in the other chamber the equivalent of 8 divisions of carbon dioxide is released, if the R.Q. is 0.8. Therefore the manometer fluid is moved 8 divisions towards the 'soda-lime chamber' in time t.

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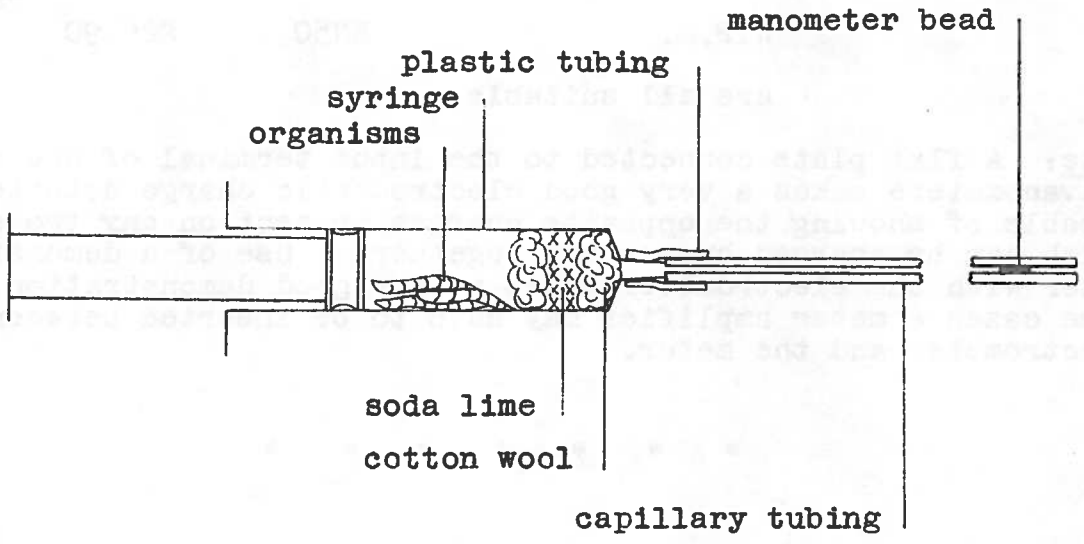
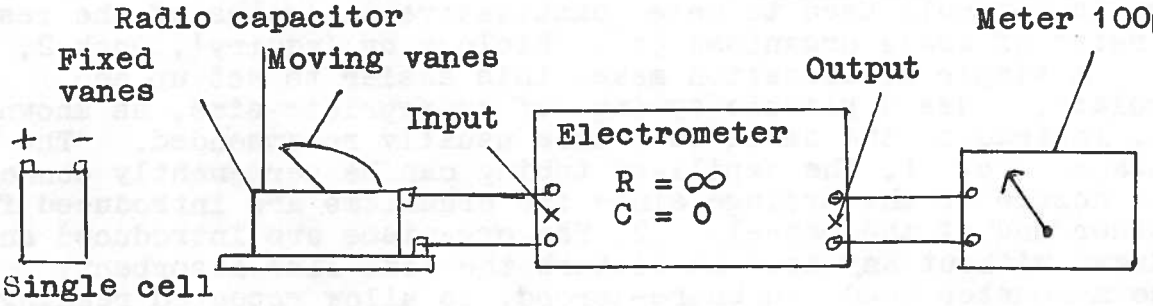
A simple respirometer. A respirometer based on the Macfadyen design is commonly used to make quantitative estimates of the respiratory rates of small organisms (cf. 'Biology by Inquiry', Book 2, page 141). A simple modification makes this easier to set up and manipulate. Use a plastic syringe of appropriate size, as shown below, instead of the small test tube usually recommended. The advantages are: 1. The capillary tubing can be permanently connected to the nozzle of the syringe since the organisms are introduced from the other end of the barrel. 2. The organisms are introduced and withdrawn without any need to disturb the soda-lime absorbent. 3. The manometer bead can be re-zeroed, to allow repeated readings to be taken, by gently depressing the syringe plunger.



Physics Notes

Variation of P.D. with capacitance at constant charge. The availability of very high input resistance ($10^{12}\Omega$) electrometers makes it comparatively simple to demonstrate that the P.D. across a charged capacitor varies with the capacitance. $C = Q/V$. A normal radio tuning capacitor can be used in place of the Aepinus Air condenser. The capacitor is connected across the input terminals of the electrometer (moving plates to earth), the capacitor is set to minimum capacitance, then charged to approximately 1 volt by momentary connection to a single cell. If desired, the gain of the electrometer can be reduced to give F.S.D. for the charging potential, 1.3V for nife cell or 1.5V for dry cell, rather than for the normal 1 volt input. Variation of the capacitance appears as an immediate variation of output current. Leakage on the electrometers is so small that the demonstration can continue for some time. The inbuilt resistance and capacitance within the electrometer should not be used.



Electrometers from	Griffin and George	491-400	£32.00
	Unilab	003.811	£16.00 (without resistors)
	W.P.A.	EN50	£26.90

are all suitable.

Note: A flat plate connected to the input terminal of one of these galvanometers makes a very good electrostatic charge detector, capable of showing the opposite charges present on any two substances which can be charged by rubbing together. Use of a demonstration meter with the electrometer makes a very good demonstration, but in some cases a meter amplifier may have to be inserted between the electrometer and the meter.

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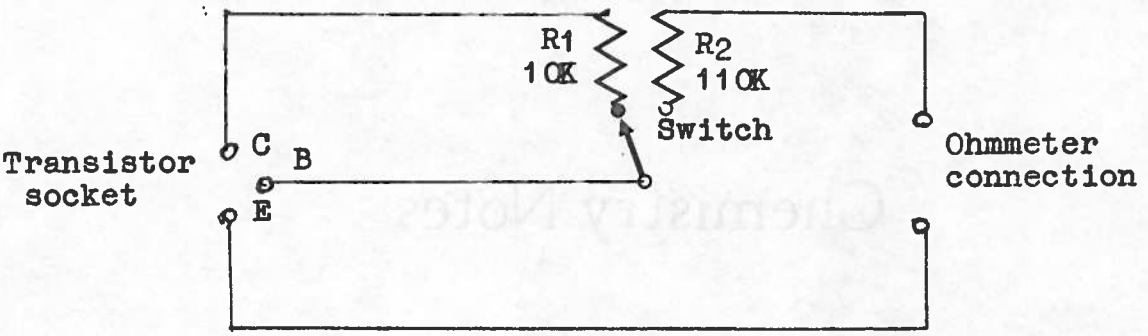
A Simple Transistor Tester. This unit, costing only a few pence, is designed to allow, in conjunction with an ohmmeter, a quick test on any transistor. The device gives a rough check on the transistor's current gain, h_{FE}, or β, and this allows a rapid classification of a batch of transistors into at least 3 categories/

categories - "dud", medium gain", "good gain".

The idea and a prototype model was submitted by the Physics Department of Grammar School, Dunoon, who first sighted it in "Radio Communication" the R.S.G.B. publication.

The circuit is simple and is shown here.



The resistance between collector and emitter is measured at two different values of base resistor R_1 and R_2, and an approximate value of the D.C. is given by

$$\frac{\Delta R_B}{\Delta R_C} = \frac{R_2 - R_1}{R_{CE2} - R_{CE1}} = \frac{100{,}000}{\text{Difference in ohmmeter readings}}$$

With practice, one seldom needs to do the calculation as the transistor's status is readily shown by the ohmmeter readings.

It is important that the correct polarity from the ohmmeter is applied to the transistor, e.g. for a PNP transistor the collector is connected to the negative, i.e. the red lead of the ohmmeter. Care must also be taken not to exceed the transistor's voltage rating - this could occur if the high ohms range on some ohmmeters is used. The Ω x 1 range on an Avo meter is quite safe, but any ohmmeter could be used, even a simple 1.5V cell, 1.5kΩ resistor and 1mA meter, if the unit is to be made self sufficient.

The transistor holder can be one of the commercially available units or simply three crocodile clips. The single-pole two position switch can be replaced by a 4mm wander plug and two 4mm sockets. The mounting board can be approximately 10cm x 6cm, and a short piece of U section Marley Tile is satisfactory.

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Polaroid are no longer producing a camera with a shutter having a 'brief' setting which is required for multiflash photography as was discussed under "Opinion" in Bulletin 43. Loudoun Academy, Galston, have informed us that the Polaroid cameras with electric eye for automatic exposure tuning can be used for stroboscopic photography. It is only necessary to cover the electric eye at the front of the instrument/

instrument by means of black insulating tape and this causes the shutter to remain open. When the shutter release button is kept pressed down the shutter is then closed by releasing the shutter release button. The above operation is possible because the electric eye in darkness is determining prolonged exposure. The Polaroid 300 series varying in price from £39 to £89 are satisfactory.

Chemistry Notes

Gas Chromatography. A Natural Gas Conversion Kit is now available from Griffin and George for their Gas Chromatograph, reference No. S17-801. Fine jetted natural gas connectors replace the connectors at the right hand side of the back plate. An additional valve is supplied for fitting in the plastic tube leading from the gas connector to the stationary phase tube. Finally, a flame retaining wire helix is placed over each jet. We carried out the conversion on a chromatograph which had been purchased more than a year ago. Tests had first been carried out with town gas and performance was satisfactory. Tests were now carried out on the converted apparatus and it was found that the gas flow was so small that it was impossible to obtain a steady flame. Gas flow was increased by breaking off about 7mm at the tip of each glass jet. The hole in each jet had diameter equal to 24 gauge wire. Now with the helix on each jet a good flow of gas was obtained which could be ignited easily. A fairly large flow of gas is required before the gas will ignite. The valves are then closed gradually until the flame at each jet is a minimum steady one to ensure a reasonable sensitivity of the thermocouple detector. Using a Scalamp galvanometer with sensitivity setting at 0.05 tests were carried out on the apparatus. 1cm^3 of air injected produced a deflection of 5cm; the separation of cigarette lighter gas fuel was unsatisfactory; good deflections were obtained when ether and air were used. The sensitivity with natural gas is not as good as when using town gas because of the higher heat of combustion of natural gas. With the method of detection used, viz. thermocouple, the sample gas is detected because of the difference between its heat of combustion and that of the sample, and this explains why detection of the components of lighter gas fuel is not as good with natural gas. The Conversion Kit costs £2.25 but for schools converted to natural gas already or in the future, the kit will be supplied by the Gas Board. A new model which is suitable for natural gas and town gas is now available, reference No. S17-802 and it costs £14.50.

Griffin and George have commented on the conversion described above, stating that they have modified the tolerances applied to the base of the jet to eliminate the smaller sizes such as were fitted to the Gas Chromatograph we used.

Trade News

British Drug Houses now have a catalogue of chemicals used in polymer chemistry.

Flamefast Manufacturing Co. Ltd. have added to their range of natural gas burners, a brazing torch which is constructed of aluminium and weighs ten ounces. Price is £9.90 for the standard model.

Educational Service Department, Mullard Limited. Please note their new address in the address list.

Reynolds and Branson have taken over the microscope business of Eastern Scientific which has gone into liquidation.

Gallenkamp and Co. Ltd. have informed us that their Olympus range of microscopes with the exception of the MIC are now supplied with a slit in the top of the body tube to grip the eyepiece. The HSC is now supplied in a fibre glass "attache-type" case.

Texas Instruments Ltd. and R.C.A. will sell cheap resistors direct.

Philip Harris Ltd. are now producing a viewing head B4539/20 intended for use with their Universal Illuminating Base (B4539). The head which has a screen size of 140 x 140mm, fits any microscope with an upright body tube; the combination of base and head provides a sufficiently well illuminated image for viewing under a 40x/0.65 objective without blackout - particularly with a low power eyepiece, e.g. 5x. The illumination, from a quartz iodine 12V 100W bulb, is also sufficient to enable living material to be demonstrated under a 40x phase contrast objective in partial blackout conditions. Cost of the base, including a mirror attachment for projection, is £75.00. Cost of the head is £17.50.

Harris Biological Supplies will supply 0.01% Giberellic acid in lanolin paste at 90p per 100g.

P.K. Dutt and Co. Ltd. have announced their new name: Griffin Biological Laboratories Limited. The address is unchanged. They now offer the complete range of living and prepared biology materials.

Farnell Electronic Components Ltd. are a useful supplier of small electronic items such as transistors, integrated circuits and photo electric devices, as well as normal electronic hardware. They issue a very comprehensive catalogue, and carry stock from most manufacturers including Mullard. Teachers should note that packing, postage and handling charges are made for orders under £5.00 in value.

In The Workshop

S.H.M. Circle of Reference Demonstrator. The apparatus to be described is meant to assist in the teaching of simple harmonic motion, by showing that when a particle travels at constant speed in a circle, its projection onto a straight line travels with a variable velocity and acceleration (S.H.M.).

A series of light bulbs is arranged around the circumference of a circle, and made to flash in turn by means of a rotary switch. Another series of bulbs is arranged along a horizontal line below the circle, each bulb being positioned vertically beneath the corresponding bulb (or bulbs) in the circle above and wired in series with it (or them). As current is supplied to each bulb around the circle from the rotary switch, light is seen to travel around the "circle of reference" at constant angular velocity while its projection appears to move back and forth in S.H.M. along the base line.

Dimensions of the board are not critical. We used a circle of 330mm diameter, and chose twelve positions around the circle, giving 30° intervals, with seven projected positions on the base line. A ply board, 12mm thick, 600mm high and 450mm wide was used, and 11mm diameter holes were drilled through the board to suit the size of the glass bulbs used, which were 3.5V, 0.15A types, mounted on MES battenholders. The battenholder sockets were screwed to the baseboard from behind, using screws long enough to keep the top of the holder tight against the board while the bulb protruded slightly through the front of the board. The top of the circle was 40mm from the top of the board while the straight line was drawn 80mm below the bottom of the circle. The board is held in a vertical position by a pair of wooden feet, slotted to accept the board as a tight fit. The general layout is shown in Figure 1.

The twelve position rotary switch was constructed on a piece of ply board 125mm by 125mm by 5mm. Twelve 4 BA brass machine screws were inserted at 30° intervals around a circle of 100mm diameter, and the heads of the screws were filed or turned down to give a flat thin top surface above the board. 20mm lengths of strip brass, 5mm wide, were then soldered to the tops of the screws so as to give a fairly long "make" time for the wiper arm. The length of these strips is determined by the width of the wiper contact and is arranged to give a definite "break" between each "make" while still ensuring as long a "make" as possible. The wiper arm was a tapering 60mm strip of springy brass taken from an old rotary rheostat. It was soldered to a $\frac{1}{4}$ inch shaft which passed through a bearing in the centre of the board, its locking nut rubbing on a brass sheet below the board to give electrical contact. A simple handle, made from a drawer knob, a strip of aluminium and a radio instrument knob was attached to the top of the $\frac{1}{4}$ inch shaft. Solder lugs were inserted between the locking nuts on the 4 BA screws to facilitate soldering the connecting cable to the switch contacts. The switch was connected to the S.H.M. board by means of a 1.5m length of thirteen core cable (home constructed or from a disposals source), care being taken in wiring to ensure that clockwise rotation of the switch produced clockwise/

clockwise flashing of the bulbs. The switch was mounted above a baseboard by four supporting pillars, and two 4mm sockets were mounted on this baseboard for connection to a suitable 7V source, A.C. or D.C.; one of these sockets is connected to the rotor arm of the switch, the other socket goes to the common lead behind the S.H.M. board via wire 13 of the connecting cable.

A wiring diagram is shown in fig. 2. Each bulb on the circle is wired in series with the bulb on the base line vertically below it. It may be found necessary to match up the bulbs to equal brilliance for each member of a series pair.

Note 1. If a pulley is mounted on the shaft of the rotary switch, a low frequency A.C. generator can be belt-driven in unison with the S.H.M. disc to give an in-phase alternating current swing on a demonstration meter placed beside the S.H.M. board.

Note 2. If a pendulum is hung in front of the S.H.M. board it can be set swinging with the same amplitude and frequency to help in teaching the pendulum as an example of S.H.M.

Note 3. If desired, a low r.p.m. motor can be coupled to the shaft of the rotary switch to give continuous action without tiring the teacher's arm. It would be necessary to be able to disconnect the gear box from the shaft to allow slow motion manual demonstrations during teaching. We built up a second switch, motor driven, and wired it in parallel with the manual switch to obviate the need for decoupling the shaft.

S.H.M. Demonstration Board

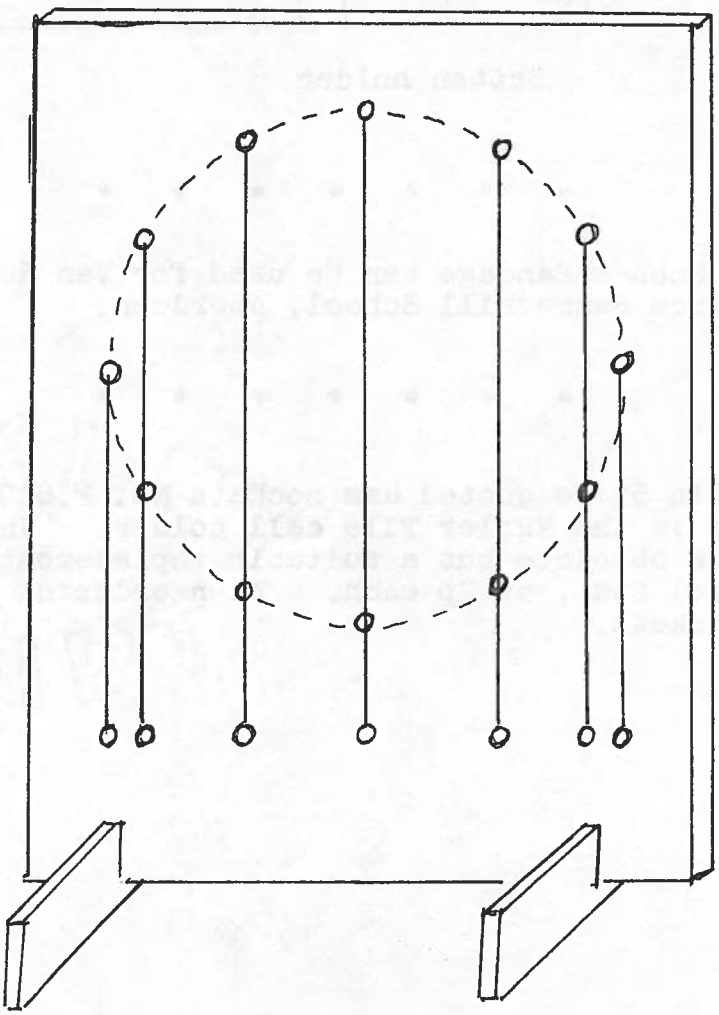
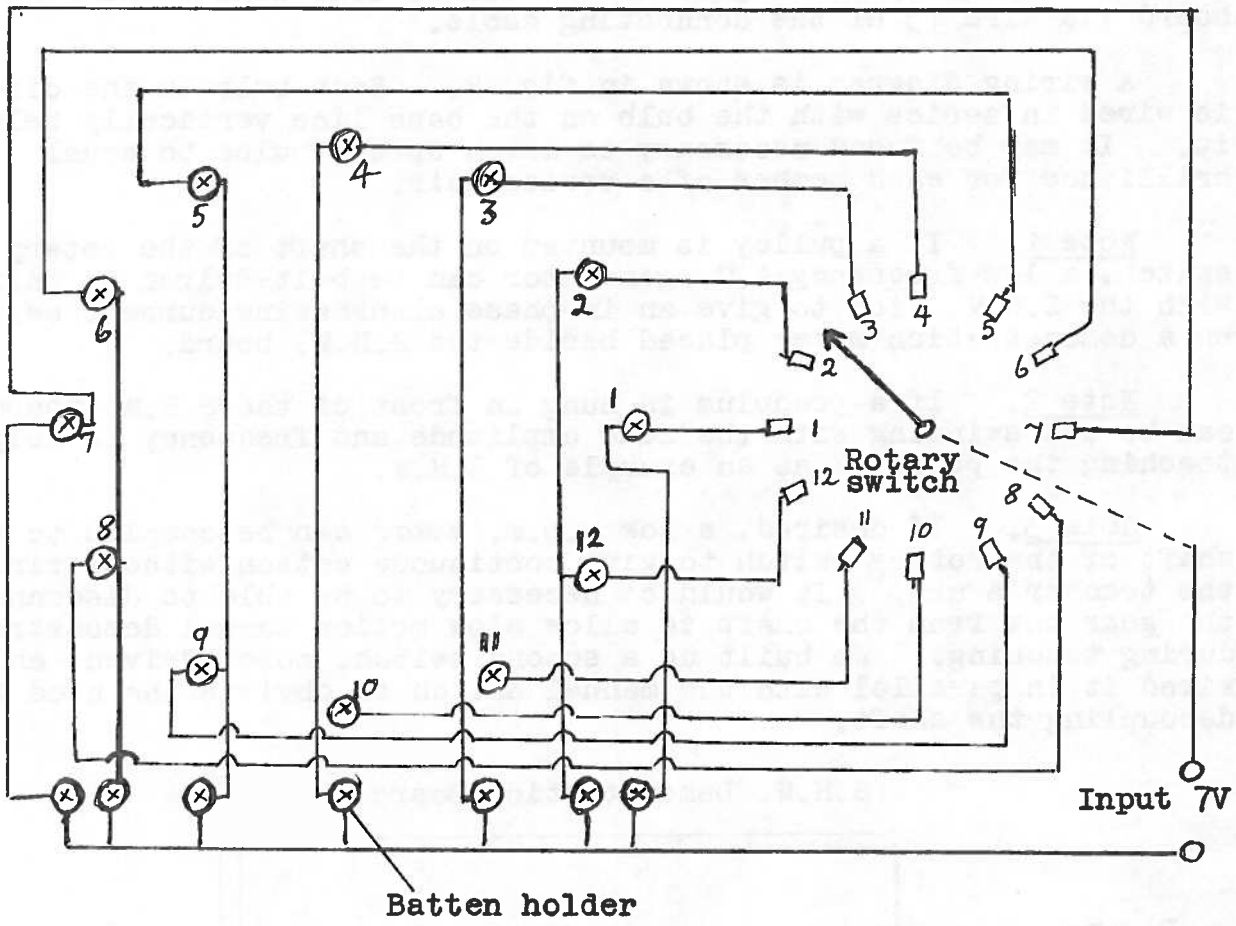


Figure 1.
Front view

Figure 2. S.H.M. wiring diagram



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Surgical Rubber Bandage can be used for Van de Graaf belts. This idea is from Summerhill School, Aberdeen.

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In Bulletin 51 we quoted 4mm sockets No. F.6400 from Wood and Cairns for use in the Marley Tile cell holder. Unfortunately these sockets are now obsolete but a suitable replacement is available from Fortronic (Fife) Ltd., at 2p each. When ordering please quote 4mm uninsulated sockets.

Bulletin Supplement

Summary of Microscope tests. The instruments listed on this page were tested on the '0' grade procedure published in Bulletin 48. Individual reports on the instruments can be borrowed for one month by writing to the Director. The classifications used are: A - most suitable for school use; B - satisfactory for school use; C - unsatisfactory.

'0' Grade Models

Model	M240	AZ-2	MD-2
Manufacturer	Swift	Meopta	Didactic
Supplier	Pyser Britex	Reynolds and Branson	Universal Optics
Price	£29.50 duty paid £24.80 duty free	£21.60 duty paid	£23.50 duty paid
Eyepiece	10x Widefield; pointer; fixed	10x Widefield	10x Huygenian
Objectives	4x/0.10; 10x/0.25; 20x/0.40	3.3x; 6.7x; 20x (non-standard)	6x/0.10; 10x/0.30; 20x/0.40
Optical head	Inclined	Upright	Inclined
Condenser	0.65 N.A.	None	None
Aperture control	Rotating disc	None	Rotating disc
Smoke cell	Yes	Yes	Yes
Illumination	Mains available	Low voltage available	Mirror only
Assessment	B	A	C*

* Mechanically and optically unsatisfactory.

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

British Drug Houses Ltd., Poole, Dorset, BH12 4NN.

Educational Services Dept., Mullard Ltd., New Road, Mitcham, Surrey.

Farnell Electronic Components Ltd., Canal Road, Leeds, LS12 2TU.

Flamefast Engineering Ltd., Pendlebury Industrial Estate,
Bridge Street, Swinton, Manchester, M27 1FJ.

Fortronic (Fife) Ltd., 13 Knowehead Road, Crossford, Fife.

Gallenkamp Ltd., Portrack Lane, Stockton-on-Tees.

Griffin Biological Laboratories Ltd., 113 Lavender Hill,
Tonbridge, Kent.

Griffin and George, Braeview Place, Nerston, East Kilbride.

Harris Biological Supplies, Oldmixon, Weston-super-Mare, Somerset.

Philip Harris Ltd., Highgate Square, Moseley Road, Birmingham B12 ODR.

Polaroid (U.K.) Ltd., Rosanne House, Welwyn Garden City,
Hertfordshire.

Pyser Britex Ltd., Fircroft Way, Edenbridge, Kent.

R.C.A. (Gt. Britain) Ltd., Lincoln Way, Sunbury-on-Thames, Middlesex.

Reynolds and Branson Ltd., Head Office, P.O.Box H.P.1., North West
Road, Leeds, LS6 2UX.

Texas Instruments Ltd., Manton Lane, Bedford.

Unilab Science Teaching Equipment, Clarendon Road, Blackburn,
England.

Universal Optics Ltd., Dominion's House, St. Augustine's Parade,
Bristol, BS1 4UF.

Walden Precision Apparatus, Shire Hill, Saffron Walden, Essex.