SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

Bulletin No. 68. January, 1974.

Contents

Introduction

The annual meeting of the Scottish Branch A.S.E. will be held in the College of Education, Aberdeen, from 8th - 11th April. On the evening of Monday 8th we shall give our usual review of new equipment for science teaching, and we shall stage an exhibition of SSSERC built apparatus for the whole of the meeting. Other public appearances by SSSERC in the forthcoming months will include the following:

January 23rd	Lecture on Pen Recorders	Central Scotland Science Centre, Stirling
January 30th	Lecture on Pen Recorders	Dundas Vale Science Centre, Glasgow
February 4th	Lecture on CSYS Chemistry	College of Education, Dundee
February 20th	Exhibition on RoSLA science	College of Education, Aberdeen

Opinion

"There is a certain relief in change, even though it be from bad to worse; as I found when travelling in a stagecoach, that it is often a comfort to shift one's position and be bruised in a new place."

Irving - "Tales of a traveller".

Is curriculum change necessarily curriculum development? Development implies progress and improvement, a farewell to the bad old days of teacher-centred courses and the evils of set text-books. Has the evil of repetition and exaggeration of errors that went with text-books been eradicated by the new semi-heuristic, pupil-centred, teacher-powered, practical-based courses that many of us have clutched to our bosoms?

In our experience, there is evidence of a new source of self-perpetuating errors. Pressure on those involved on working parties, sheer lack of time, money and manpower, mean that material may be borrowed, in all good faith, from other very reputable courses - the development of which suffered from the same pressures. The result may be that practicals may appear again and again, and the people responsible for writing the material may never have done the experiments. Our evidence for such a general thesis is perhaps flimsy and merely circumstantial but as Thoreau put it -

> "Some circumstantial evidence is very strong, as when you find a trout in the milk".

For example; we have had occasion of late to investigate an experimental method for part of the C.S.Y.S. Biology course. This involved the use of a potentially very dangerous chemical which can explode on contact with organic material such as human hair, skin etc. ! The experiment was borrowed from a well-known brand of modern biology course. We made contact with members of working parties involved on this original course. The first two contacts we admit did not actually write the material, but were involved with various school trials. The first had not done the experiment but believed it had been done in trial schools. He did not do the experiment not because it was dangerous (?) but because "it has only a 40% success rate" and he believed models were better for showing this particular hydrolysis. The second contact had not done the experiment either, although involved in trials and in writing other units. He was very helpful however, and passed us on to the actual author. Success, you might think; but no, the author hadn't carried out the experiment and thought that one of the alternative chemicals given in the instructions might also be dangerous. We quote: "I believe the experiment was done in some trial schools and I seem to remember there was some success with it. I can't see why A-level students need to do such an experiment, are your eighteen year-olds different from ours?". One was tempted to ask, although of course was far too polite to do so; "Why then is it in the well-known, much-loved, trendy 'A-level' book?"

It turns out that the experiment was suggested by an HMI, now retired. We have no doubt that he can follow the procedure safely and successfully, but can most biology teachers, never mind their pupils? Indeed, more to the point do they really need to do the thing at all? Perhaps if teachers and others had more time to devote to curriculum development work instead of doing it on top of everything else, these questions would have been asked before rushing into print. As it is those who get involved are usually the energetic ones who are already fully committed in terms of time and energy to their work in school or college. It would be unfair to expect them to try out every technique and double-check on every chemical. They are forced to become plagiarists and take a lot on trust. Unfortunately the people they borrow from have done the same under the same sorts of pressure. An astute colleague when he detected a certain naiveté in one's attitude to the printed word, was wont to say:

> "Oh, I see, read it in a book did you? Hm, in that case it must be true".

Physics Notes

In Bulletin 47 we gave details of an apparatus for measuring the beat frequency of two pendulums of unequal length, by having their ends dipping into a conduction solution in which a source of DC had set up a potential gradient. We have now modified the apparatus so that it does not require a purpose built trough, but more importantly we have extended its application to that of a very low frequency sine wave generator which can be used to show the phenomena associated with rectification and smoothing.

We now use a standard plastic tray, 30 x 20 x 10cm. Two electrodes made from sheet brass to the shape shown in Fig. 1 are placed one at each end of the tray, and supplied with direct current either from a battery or a smoothed DC supply. The two pendulums are suspended one behind the other from the same tall stand so that they dip into the solution in a line mid-way between the electrodes. If the top ends of the pendulums are connected as in Bulletin 47 to a centre-zero milliameter, or to an oscilloscope with a long persistence screen, then the typical beat frequency envelope will be seen when the pendulums are set swinging. We have omitted to give orders of magnitude for this experiment because none of these is critical. The voltage of the DC supply, the amplitude of pendulum swing, the concentration of the solution, and, if one uses the instrument, the gain control on the oscilloscope can all be varied to give a convenient response.

If a demonstration meter is used this will limit the shortness of the pendulum, since the latter will need to have a longer period than that of the meter pointer, if the meter is to follow the swings.

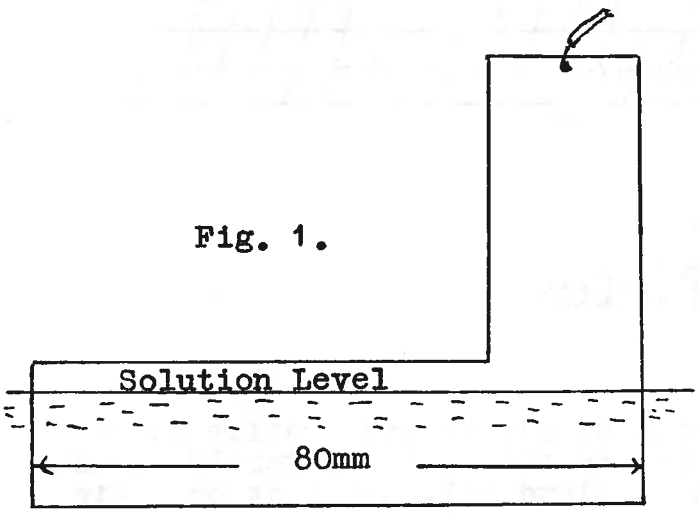


Fig. 1.

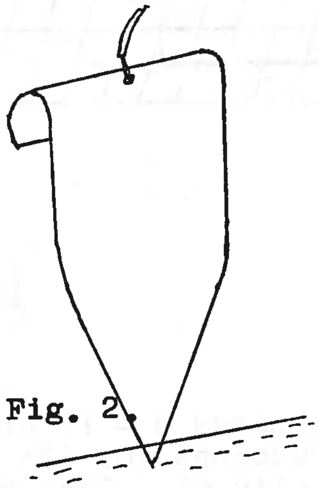
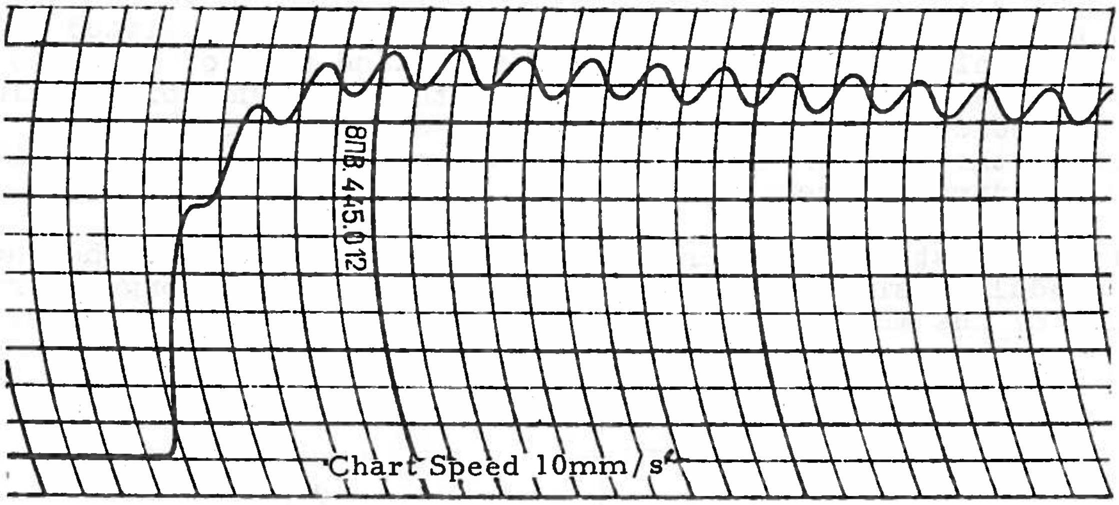


Fig. 2.

The modification needed to convert the apparatus to a V.L.F. generator is to replace one of the pendulums by a fixed point electrode dipping into the solution at the mid-point of a longer side, i.e. opposite the pendulum tip, so that with the pendulum at rest the two pick-up points are at the same potential. The shape of this point electrode is shown in Fig. 2. Like the others it is made from brass sheet and has its top bent over to provide a firm attachment to the top of the tray. Setting the zero, i.e. setting the pick-up points at equipotential, is probably best done by moving the tray on the bench relative to the stand supporting the pendulum which must of course be stationary.

We use copper sulphate solution and the electrolytic effects on a brass anode are messy but we have so far found it easier to throw out the electrolyte and scour the anode clean again when dry, than to find an electroplating solution (no pun intended) to the problem.

Once the generator has been constructed it may be used in conjunction with an oscilloscope, preferably long-persistence, or a chart recorder to show rectification and smoothing. A diode such as OA10 in series with the detector will show half wave rectification, and a bridge rectifier such as REC 60 from R S Components will give full wave rectification. Capacitor storage and resistive load circuits can be added, and the trace below is a pen recording with the Russian H-320/1 recorder of the initial charging of a 7000µF capacitor working into a 5KΩ load, using a REC 60 bridge rectifier. To get the graph the recorder was connected in series with the 5KΩ load; a long persistence oscilloscope connected across the capacitor would show the same effect.

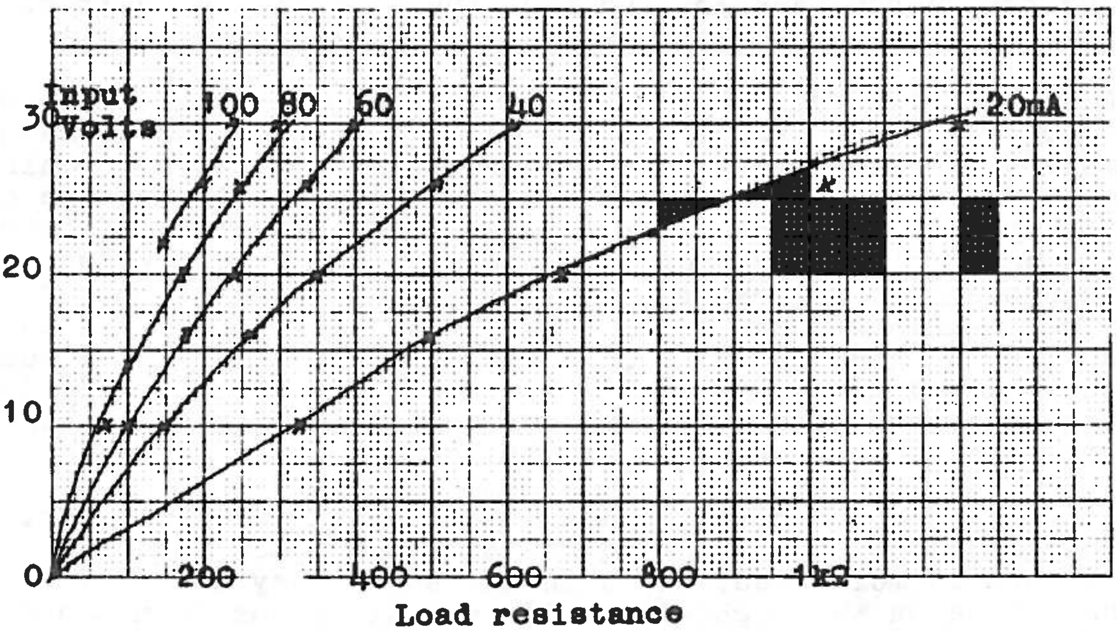


Biology Notes

On pages 9 - 11 of this bulletin we give a comparative survey of microscopes for 'O' grade, similar to that printed for 'H' grade in Bulletin 66. Customers outwith Scotland will see that on their copy, sheet 9/10 has been omitted and page 11 left blank, and the reasons for so doing have been given in Bulletin 66. With reference to the summary, prices are as up-to-date as we can possibly make them but they change so quickly it is imperative that they be checked before ordering. The price of the Olympus STN, with 4x and 20x objectives is given as £30, which is what it will probably cost in April 1974. Instruments with 4x and 20x will not be available until then since the entire production of 20x objectives has been cornered by a South American Government to equip its schools. Teachers seem to like the assessment into categories of A, B, and C but we would point out that these are becoming less meaningful since they are based partly on price differences. In these inflationary times more attention should be paid to the general comments.

Chemistry Notes

There would seem to be an increasing requirement for a constant current power supply for use in coulometric titrations, to judge from the requests we have had from teachers. In Bulletin 31 we published one such design which supplied a maximum current of 15mA into a 900Ω load. Another design of what is basically the same circuit, but which would supply up to 100mA, was published in the October issue of Practical Wireless, No 800, P 558. We have constructed and tested this design, and found that in order to get good control of the current selector, it was necessary to reduce the values of the twin-ganged 10KΩ potentiometer to 250Ω on each gang. For copyright reasons we cannot reproduce the Practical Wireless circuit here, and the editor recommends those seeking a back number to apply at their local public library. The circuit is driven from a low voltage power supply, such as a battery of Nife cells - if a mains derived power supply is used, it must be smoothed - and for the benefit of those who may have constructed the unit we give below a graph showing what input voltage will be required to drive a given current through a given resistive load. The resistive load values are the maximum permissible for the circuit.



However, if the requirement is only for a 'nearly constant' current supply, this can be readily met from apparatus already in the school. The resistance of a conduction cell is of the order of hundreds of ohms and may vary typically by about 100Ω throughout a titration. If current is supplied by a high voltage source through a series resistor, the variation in cell resistance has negligible effect on the current, by comparison with the much larger series resistance. Thus, the Radford labpack has a 300V, 100mA supply, and many schools have these units. If a 10KΩ, 10W resistor, available from R S Components is used in series with the cell, it will give a maximum of 30mA current, will dissipate 9W, and a variation of 100Ω during titration will cause a 1% variation in the 'constant' current, which may be small enough to be ignored. Two such resistors in parallel would allow the current to be increased to 60mA, but at the expense of a 2% variation during titration.

* * * * * * *

It was some years ago that we noted in the members' exhibition of an A.S.E. annual meeting, a wind machine which showed how the rate of reaction of substances could be affected by such things as temperature, activation energy, the exothermic or endothermic nature of the reaction etc. Air was blown up from below a wire mesh compartment, divided in two by the activation energy barrier. Initially a quantity of table tennis balls is placed in the left-hand compartment, the air raises these into the space above where, due to collisions with the compartment walls or with each other they may cross the middle barrier and occupy the right-hand side. They are then assumed to have changed from reactants into products. After a given time the air is switched off, and a count of the numbers of balls in the right-hand side indicates the tendency of the reaction to proceed from left to right. Provision was made for raising or lowering the energy barrier, and also the floor in one half of the compartment to simulate exothermic or endothermic reactions.

We have shown our own version of this apparatus at various exhibitions where it aroused considerable interest, but we have not been able to publish the design in a bulletin because it required an extremely powerful fan which was not generally available. We are therefore pleased to announce that the Workshop section of this bulletin carries a design for the same apparatus which requires little more than standard apparatus. The basic principle has been to give up trying to maintain the balls airborne by wind force, and to use instead the 'diluted' gravity of a slope. The scale of the model is then reduced and the effects are observed by overhead projection. With these modifications the driving force can be supplied by a signal generator and electro-mechanical vibrator.

Like all analogies, this one should not be taken too far. There is a danger that pupils watching the dancing shadows on a screen will imagine them as molecules, which in one sense they are, but will not see that those on the right-hand side are different from those on the left; they do not show that they have undergone a structural change. Another limitation of the system lies in the method of energising the balls which is by collision with the base of the box. In terms of the analogy, the half compartment which has fewer balls will be at a higher temperature than the other half. The energy supplied to each half is the same, but in the crowded half this has to be partitioned amongst a large number of balls, and much of it is dissipated by collisions. In the half with few balls, these have a greater mean free path, fewer collisions, and hence an average speed which is greater. These considerations mean that the driving amplitude of the vibrator has to be carefully controlled, as the model may otherwise show spurious effects.

In The Workshop

The chemical kinetics model mentioned in Chemistry Notes and now to be described is based on a perspex tray 20mm deep. The lower end of the tray is cut from 7mm thick perspex, 105 x 20mm as shown in Fig. 1. The circular hole takes the central shaft of the vibrator and should be cut to suit. The slot beneath it will allow the activation energy barrier to be slid in and out. The remaining three sides of the tray are made from a 20mm wide strip of 3mm perspex, bent into two right angles with the bender described in Bulletin 61, or any other means of heating and softening perspex. Before this is done however it will be convenient to cut out a slot 75mm x 3mm on the centre line of the strip, starting 17mm from one end. This slot is referred to in Fig. 3 where it will be seen that it allows the compartment floor on the left-hand side to be raised or lowered to vary the initial energy level. Similarly a bolt hole to fix the compartment floor on the right-hand side should be drilled in the appropriate position. When this has been done, the strip can be cemented to the lower edge, using perspex cement, and a piece of 3mm perspex measuring 110 x 160mm cemented on to form a base. The two compartment floors are both 50 x 20 x 7mm pieces of perspex. The left-hand one is drilled and tapped at one end to take a 6BA cheese head bolt, to which is soldered or brazed a small piece of brass to make it into a wing nut. The other is similarly drilled and tapped at both ends, one to take the fixing 6BA bolt which anchors it to the side of the tray, and the other to take a countersunk 6BA bolt which will hold the activation energy barrier.

This barrier is a 3mm perspex strip, cut as in Fig. 2. The 35mm slot is bevelled on one side, so that it will fit the sloping underface of the countersunk screw. This allows the screw to hold the strip in position while still permitting it to be slid up and down. The bevelling is done by clamping a countersinking bit in the power drill at the correct height and then pushing the perspex strip against it on the drill table.

To assemble the model the left-hand floor is bolted on first, with a washer between the bolt head and the side of the tray. Then the strip of Fig. 2 is bolted to the other floor with a washer between the two pieces of perspex. The strip is pushed into position in the slot in the lower end of the tray, and the thick perspex bolted firmly to the side of the tray.

The tray rests on the surface of the overhead projector, which is tilted to an angle of about 5° by means of a height block under one pair of feet. Its lower edge is bolted to the stem of a vibrator which must be supported in a wooden stand so that it is at the correct height and in line with the tray as it rests on the projector. We have not given details of the construction of the stand as this must depend on the type of projector used, but Figs. 4 and 5 show the general idea.

We found it desirable to tune the signal generator frequency so that the vibrator is in resonance - about 40Hz in our case - and then to turn down the output voltage control until the 'molecules', which are 3/16 inch steel ball bearings, do not have sufficient energy to strike the top of the tray. The type of vibrator used may limit the amount of movement possible for the central barrier strip, because of the length of its central stem and it may be necessary to change some of the dimensions in Fig. 3 to allow for this. We also found it necessary to clamp the vibrator stand to the bench with a G clamp as otherwise the conservation of momentum principle meant that the stand moved almost as much as the tray.

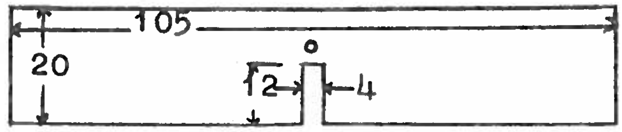


Fig. 1.

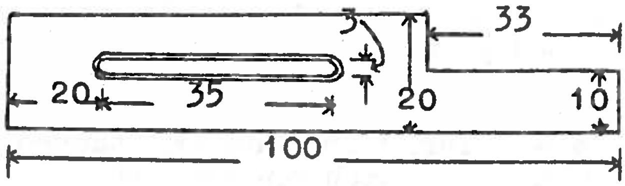


Fig. 2.

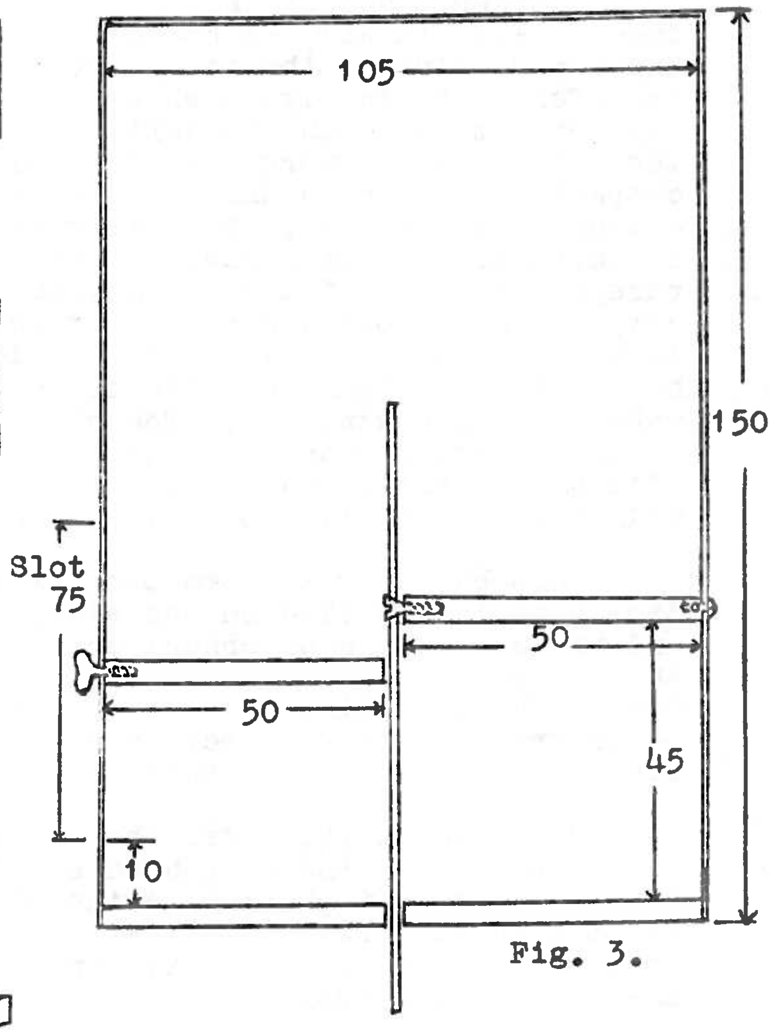


Fig. 3.

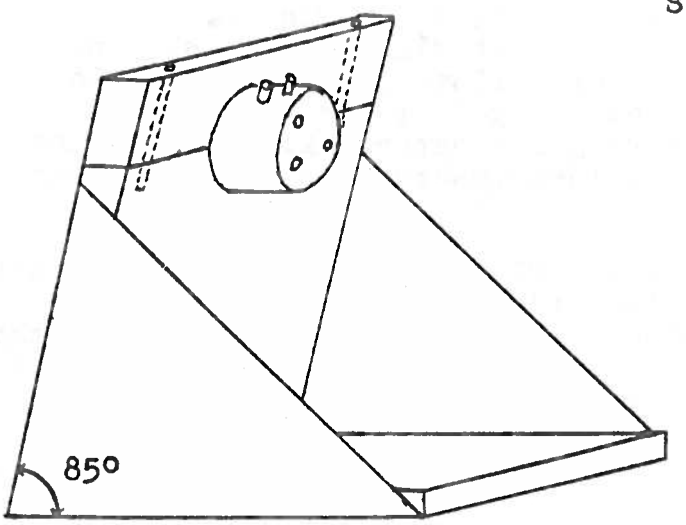
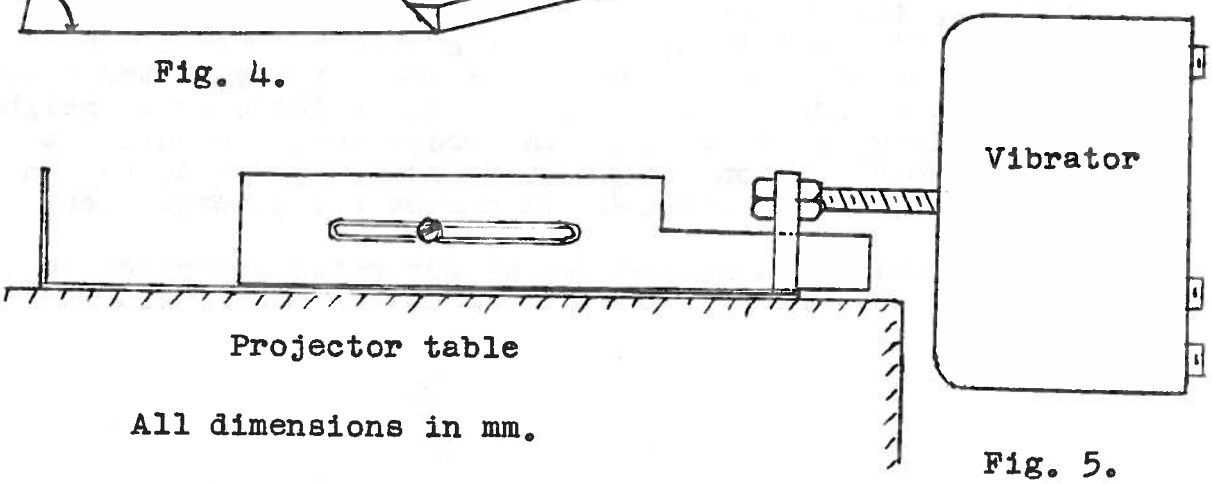


Fig. 4.



All dimensions in mm.

Fig. 5.

This summary should be read in conjunction with the Biology Notes in Bulletins 65 and 66, in which the terms used here are explained. Abbreviations used in the summary are as follows: (H) = Huygenian eyepiece; (P) = Pointer in eyepiece; (S) = Accepts Musselburgh smoke cell. Imported instruments are indicated thus: * Import duty may be reclaimable on these.

Model	Supplier and Price	Stand	Optics	Mechanics	Light Source	General Comments	Assess-ment
Olympus *MIC	Griffin and George £20	Angled head; solid base.	Magnifications 40x, 75x, 150x, 300x.(S)	Stage focussing. Adjustable safety stop. Eyepiece screws into body tube.	Built-in mains or mirror.	Very easy to use but optically limited.	C
Olympus *STN	Griffin and George £26.90 (4x,10x,) £30, (4x,20x.)	Upright head; open base.	Eyepiece 10x(H) Objectives 4x,20x.(S).	Body focussing. Adjustable safety stop. Eyepiece held but removeable.	Built-in mains or mirror.	Very satisfactory optically and mechanically. Safety stop too easily adjustable. Convenient to use. Wf eyepiece available. Standard model has 10x objective 20x must therefore be specified.	A
Opax *NES 200x	Opax £22.50	Upright head; open base.	Eyepiece 10x(H) Objectives 5x,10x, 20x(S)	Body focussing. Adjustable safety stop: Eyepiece not held.	Built-in mains or mirror.	Satisfactory optically. Some mechanical faults. Safety stop too easily adjustable. Convenient to use.	B
OU Mac-Arthur	Open University £15.50	Rectangular. 127 x 75 x 25mm	Eyepiece 10x(H) Objectives 8x,20x.	Fixed safety stop. Eye lens removeable.	Built-in battery or mirror.	Inadequate optical performance. Difficult to handle. Lacks versatility. Very light and compact.	C

Model	Supplier and Price	Stand	Optics	Mechanics	Light Source	General Comments	Assess -ment
*STZ 200	Bausch and Lomb £22.90	Upright head; open base.	Zoom magnif- ication change. 50x -200x	Stage focussing. Fixed safety stop. Eyepiece integral with body.	Mirror only.	Zoom system convenient to use, but optically limited. Some mechanical faults on the model tested.	C
Didactic *MD-2	Universal Optics £23.50	Angled head; solid base.	Eyepiece 10x(H) Objectives 6x,10x, 20x(S)	Stage focussing. Fixed safety stop. Eyepiece not held.	Mirror only.	Plane mirror only with no condenser lens gives inad- equate illumination for 20x objectives. Some mechanical faults.	C
Griffin -Beck Student	Griffin and George £21.80	Upright head; solid base.	Eyepiece 10x(Wf) (P) Objectives 3.5x,8x, 20x.(S)	Stage focussing. Fixed safety stop. Eyepiece screws into body tube.	Built-in 6V (exter- nal supply) or mirror	Satisfactory optically for Integrated Science. Mechanically robust. Glass condenser cover prone to cracking.	B
Meopta *AZ-2	Reynolds and Branson £22.90	Upright head; solid base.	Eyepiece 10x(Wf) Objectives 3.3x,6.7x, 20x(S)	Stage focussing. Fixed safety stop. Eyepiece not held.	Built-in low volt- age or mirror	Very large field of view makes it useful for Integrated Science. Some mechanical weaknesses. Very portable.	B

Model	Supplier and Price	Stand	Optics	Mechanics	Light Source	General Comments	Assess -ment
C.O.C. *Model C	Parisian Opera £30.00	Upright head; open base.	Eyepiece 10x(H) Objectives 5x,10x, 20x(S)	Body focussing. Fixed safety stop. Eyepiece fixed.	Mirror only	Satisfactory optically and mechanically though quality a little variable. Convenient to use.	A
Russian *SHM-1	T.O.E. £20.79	Upright head; open base.	Eyepieces 7x,10x, 15x(H) Objectives 8x,20x.(S)	Body focussing. Fixed safety stop. Eyepieces not held.	Built-in mains or mirror.	Single nosepiece requires objectives to be unscrewed for magnification change. Safety stop liable to damage.	C
Russian *MBU-4	T.O.E. £29.57	Upright head; open base.	Eyepieces 7x,10x, 15x(H) Objectives 8x,20x(S)	Body focussing coarse and fine. No safety stop. Eyepieces not held.	Built-in mains or mirror.	Single nosepiece, consequently same limitations as SHM-1. Fine focussing unnecessary. Optically satisfactory.	C
Swift *M240	Pyser-Britex £34.65	Angled head; solid base.	Eyepiece 10x(Wf) (P) Objectives 4x,10x,20x	Stage focussing. Adjustable safety stop. Eyepiece fixed.	Built-in mains or mirror.	Very satisfactory optically and mechanically. Convenient to use. Huygenian eyepiece available.	B

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

Bausch and Lomb Ltd., Aldwych House, Aldwych, London, W.C.2.

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

Opax Ltd., 6 Frant Road, Tunbridge Wells, Kent.

Open University, Walton Hall, Walton, Bletchley, Bucks.

Parisian Opera and Field Glass Co. Ltd., 24-25 Princes Street,
Hanover Square, London W1R TRG.

Pyser-Britex (Swift) Ltd., Fircroft Way, Edenbridge, Kent.

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

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