SCOTTISH SCHOOLS SCIENCE

EQUIPMENT RESEARCH

CENTRE

Bulletin No. 50. September, 1971.

Contents

Introduction

The Governing Body has approved the secondment for a year of the Director to work on a United Nations Development Programme for the Promotion of Teaching Science and Technology in Thailand. During Mr. Stewart's absence Mr. Medine, at present Assistant Director of Chemistry will serve as Acting Director. SSSERC has been extremely fortunate in securing the services of Dr. Vincent R. McKenna, O.B.E. as Assistant Director in charge of Physics for the period of the Director's secondment. Dr. McKenna has had a long and distinguished career in teaching, as primary and secondary teacher, University lecturer and headmaster. He was awarded his O.B.E. for services to science education in Australia; he is a past president of the Science Teachers Associations of Victoria and Western Australia and was awarded the Australian Industries Association Medal for outstanding contributions to science teaching. In 1969 he was awarded a Churchill Fellowship to study education in Europe and the U.S.A. He is a member of the Wireless Institute of Australia, which is the approximate equivalent of our Radio Society of Great Britain. It is hoped that Scottish physics teachers will make the most of Dr. McKenna's expert knowledge while he is here and that his period of service with SSSERC will be a successful and happy one.

Biology Notes

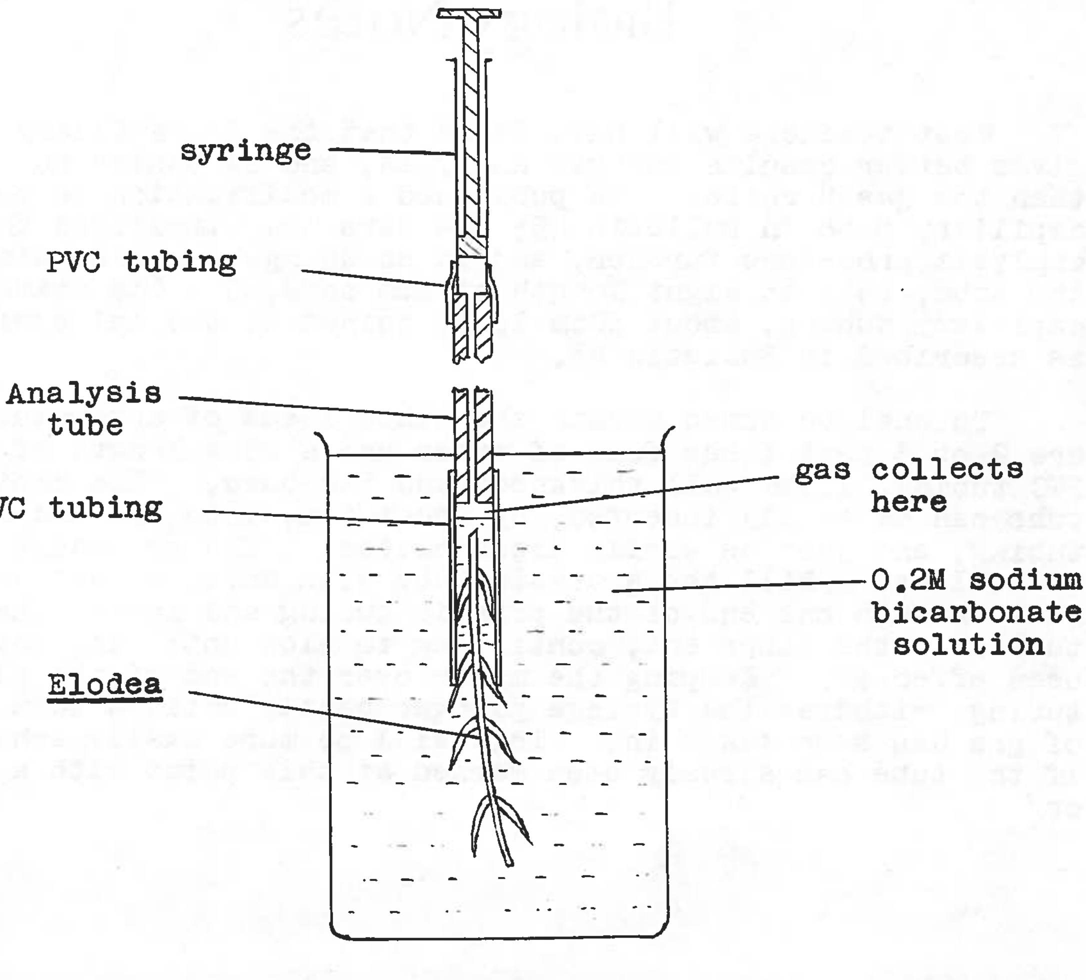
Most teachers will have found that the J- capillary tube gives better results for gas analysis, and is easier to use, than the gas burette. We published a modification to the capillary tube in Bulletin 45; we have now simplified the whole analysis procedure further, and in so doing have also simplified the tube, to a straight length of 1mm bore, 5 - 6mm diameter capillary tubing, about 30cm long, joined to the 1ml syringe as described in Bulletin 45.

To analyse human breath the other items of apparatus needed are 2 or 3 test tubes full of water and a 25cm length of clear PVC tubing, 1.5mm wall thickness and 5mm bore. The capillary tube can be easily inserted, by about 5mm, into the end of this tubing, and just as easily disconnected. The procedure is then as follows. Fill the analysis tube with water to act as a seal. Blow through one end of the plastic tubing and insert the analysis tube into the other end, continuing to blow until the join has been effected. Keeping the mouth over the end of the plastic tubing, withdraw the syringe plunger gently until a 10cm length of gas has been taken in. This will be more easily achieved if the tube has already been marked at this point with a file, or/

or chinagraph pencil. Disconnect the analysis tube and immediately dip into water to draw in a seal. Analyse with potassium hydroxide and pyrogallol as usual.

The analysis tube is rinsed out in a test tube of water between analyses. A water bath is not required; we have obtained satisfactory results (average of 3.7% carbon dioxide and 16.6% oxygen over 6 runs) by simply leaving the tube at room temperature for a few minutes before each reading. The tube should be more thoroughly rinsed out, in dilute acid followed by hot detergent at the end of each practical session. The syringe plunger should be rubbed, when necessary, with silicone grease.

To analyse the gas produced by Elodea, a short length of the same plastic tubing is slipped over the end of the analysis tube, and a sprig of Elodea introduced as shown. The capillary tube is held in position by a retort stand. The 1ml syringe plunger is partly withdrawn so as to fill the plastic tubing and capillary tube with liquid. Using a 60W pearl light bulb placed 5cm from the beaker, sufficient gas will have accumulated within 10 minutes. It may be necessary to tilt the shoot slightly to one side to prevent bubbles of gas passing directly up the capillary tube, where they will not coalesce. When about 1cm length of gas has collected at the top end of the plastic tube, a 10cm length is drawn into the capillary, the plastic tube is eased off the lower end, and a short length of the solution is drawn in to seal off the gas. The capillary tube is then removed from the solution and analysis carried out as usual. Given sufficient mains power points and electric light bulbs, the experiment can be done by pupils themselves, well within the normal time allocation.



As far as we are aware, there has until now been no reasonably simple way of demonstrating the evolution of oxygen by land leaves. As a result, the pupils' investigations of photosynthetic gas exchanges cover carbon dioxide absorption by both land and water plants, using bicarbonate indicator, but oxygen evolution in water plants only. This can give an incomplete, and perhaps a misleading impression of the process.

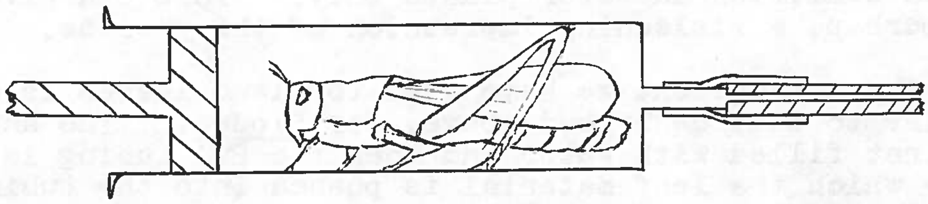
The arrangement we have used for land leaves is essentially similar to that described above, for Elodea. The analysis tube is first filled with water and then the PVC tubing is attached after which the leaf material is pushed into the tubing. The analysis tube is positioned in a beaker of 0.2M sodium bicarbonate solution as before, but this time the air trapped in the tubing is not drawn up. The solution supplies carbon dioxide continually to the leaf, which in turn enriches the enclosed bubble of air with oxygen. It is best to illuminate the material for about 1 hour with a 100W bulb, positioned 2-3cm from the edge of the beaker. The bulb must be uncovered; when in a bench lamp, for example, it will greatly overheat the water. One possibility we have not examined is the use of heat resisting glass between lamp and beaker. After illumination, a 10cm length of gas is drawn up, the tubing slipped off and water drawn in to seal, and the gas is then analysed as before. We have found grass and onion leaves to be suitable, in both shape and performance, though other monocot. material may be equally suitable.

Oxygen content averaged 43% over three trials with onion, and 32% over six trials with grass; in two controls, the average content was 21%. In all cases the solution maintained an equilibrium carbon dioxide level close to 2%.

At the moment in biology courses, pupils will investigate carbon dioxide production by small organisms such as insects, seeds, and small mammals, and themselves, using bicarbonate indicator. They will also make a more detailed analysis of their own breath, and find out that it not only contains more carbon dioxide but less oxygen than air. They will not, however, carry out this last investigation with the smaller organisms. The simplified analysis tube allows this to be done easily.

The analysis tube is filled with water; the organism is then placed in a suitable size of plastic disposable syringe with a short sleeve of thin rubber tubing over the nozzle, and the syringe nozzle is connected to the end of the analysis tube by a short length of the PVC tubing. The end of the analysis tube should be in contact with the syringe nozzle - see diagram below - to reduce the possibility that the air drawn in for analysis comes from the 'dead space' in the PVC tubing. The apparatus is left for 10 - 12 minutes, after which a 10cm length of gas is drawn into the analysis tube, the tube disconnected and quickly dipped into a test tube of water to seal. Analysis then proceeds as before. We have obtained compositions of 2.5% carbon dioxide and 17% oxygen with a locust 5th instar after 10 minutes; and of 2% carbon dioxide and 15% oxygen with germinating mung beans after 15 minutes. The tube may also be used to analyse the gas produced/

produced by yeast in sugar solution, by using the arrangement shown for Elodea. After several hours sufficient gas should accumulate for analysis. In our trial the gas was 98% carbon dioxide.



As well as being less liable to breakage than the J- shaped version, the straight analysis tube makes it easier to draw up potassium hydroxide and pyrogallol.

* * * * * * *

In Bulletin 48 in the article on the test procedure for O-grade microscopes one of the test slides used in determining optical performance was that of the diatom Gyrosigma attenuatum. We find that this test slide is referred to by biological suppliers as Pleurosigma attenuatum, and it is under this name that we shall refer to it in our reports.

* * * * * * *

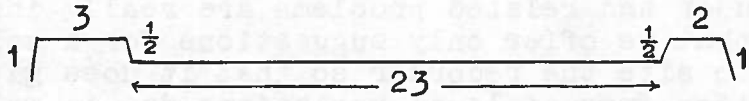
We have a suggestion from St. George's School, Edinburgh to use syringe needles in place of dissecting pins. They are easier to handle, more finely pointed, and do not rust.

* * * * * * *

The method recommended in Nuffield Year I Teacher's Guide, p. 67, for keeping adult Xenopus is to use a polythene stackable tray as a heated water bath with two plastic aquaria containing the animals inside it. Water loss by evaporation from the tray is quite rapid, and it can dry out over a week-end. For some months we have used a system which allows the outer tank to be covered to reduce evaporation. The outer tank is a 'Polybox' HX883, measuring 61 x 46 x 23cm from Kabi, cost £1.97½. The aquaria used are obtainable from most pet shops under the trade names of Hyware and Petcraft, and are manufactured by Thomas's Ltd. The size is 325 x 225 x 200mm, inside top dimensions, since they have sloping sides to make them stackable. These tanks will sit completely inside the Polybox.

16 SWG Twilweld, with 1 x ½in mesh, which can be obtained from ironmongers, or Weldmesh in the same size, was the material used for the top cover. Weldmesh can be bought from the manufacturer, B.R.C. Engineering, at £3.72 for a 25 x 3ft roll, but there is a minimum order charge of £5.00 so that one should buy/

buy two rolls. The use of the same material for making test-tube and bottle racks was described in Bulletin 48. A piece of mesh measuring 17½ x 31in is bent into the profile shown below, so that the humps at either end fit firmly over the Polybox ends. The 23in long central section is then covered top and bottom in a complete loop of clear 'Contact' adhesive film, obtainable from ironmongers or Woolworths, e.g. by using a 23in piece of 36in wide material. It is necessary to overlap both ends of the Contact to prevent moisture from attacking the adhesive.



Measurements in in.

* * * * * * *

In an earlier bulletin we asked chemistry teachers to notify us of any laboratory accidents of which they had personal knowledge. We now make a similar request in biology, that teachers notify us of any hazards which may or may not have had serious consequences and which are more probable in biology than in other laboratories. In the new biology courses there are two possible areas, and there may well be others, where pupils could be at risk; in microbiology and in the use of caustic chemicals for gas analysis. As in the case of chemical accidents, it is not necessary for us to know where any accident occurred or who was involved, but we must have a name and address so that we can refer back for further information if necessary.

In The Workshop

One of the topics in the second cycle of Integrated Science is Weather. A significant concept in this study is the association of predictable changes of weather which accompany the passage of a front across the country. One such change is the variation in wind direction, and since fronts do not occur conveniently during school hours, a wind direction recorder is called for. This is not an instrument which features in the daily recording stations set up by the Meteorological Office and run by amateurs, such as a school might seek to establish and although there is presumably a design for one somewhere we were unable to find it and had to start from scratch. This is an exercise which we recommend the teacher to pose to his pupils themselves/

themselves, i.e. to devise a gadget which will give a 24 hour record of the position of a wind vane. The thinking which goes into the design is probably the most valuable part of the exercise and it may be that the pupils will produce one which is superior to that which is now described.

The basic principle of the design is that the vane is attached to a circular shaft and thence to a large disc so that the whole rotates as the wind changes. A clock movement is then used to move a pen radially across the disc at a very low speed of about 5mm per hour from the centre to the periphery. Consideration will show that since it is the disc and chart paper attached to it which moves under the pen, the compass points on the paper will be in the reverse order but we think that this is a minor disadvantage.

Two major and related problems are really incidental to the design so that we offer only suggestions for a solution. These are where to site the recorder so that it does give the prevailing wind direction free of local variations due to walls, chimneypots, trees etc., and how to keep the chart paper dry. To these some might want to add a third, how to site it away from the attentions of vandals. All of these may be solved simultaneously is there is an isolated building through the roof of which the vertical shaft can be brought so that the disc and winding gear are under permanent cover. A portable recorder can be set on a flat roof (provided the vane rises above chimneypots) or placed on the sports field. The supporting stand needed for the vane must then be constructed with a view to providing wet weather protection for the chart. A hardboard cover is satisfactory, but requires to be designed so that the charts can be removed and replaced easily. Polythene taped over the stand will survive all except gale force winds. The base of the stand requires to have anchor points so that it can be pegged to the ground or weighted down with bricks to prevent its being blown over. These comments all arise from our own experience during a week's trial in equinoctial gales.

Fig. 1a shows the vane itself. Pupils who have designed their own version will start, as we did, with a single fin, and after a few records have been obtained will ask themselves, "how can we stop the vane swinging about so much in a high wind?" We think a split V vane is a decided dampener in this respect. Two fins in 22 SWG aluminium sheet are made to the same shape and braced 40mm apart at the open end to form a narrow V, using two U-brackets of the same material riveted one at the top, one at bottom of the vanes. The shaft is a 7mm dia. mild steel rod, slotted at each end to a depth of 30mm for the insertion of vanes and pointer, both of which are riveted to the shaft. The pointer is 16 SWG mild steel sheet. The brass bush (Fig. 1b) holds the vane shaft by means of an Allen screw, and has a side-entry 4 BA brass bolt for locking it to the vertical shaft. If the bush is fitted as close to the vanes as possible it will be nearly at the point of balance, and further slight adjustments can be made before finally clamping down the Allen screw. All except the fins require to be painted or varnished for protection, although our own version was polythene coated following the technique described in Bulletin 48.

The/

The vertical shaft holding vane and disc is also 7mm steel rod, length to suit the local conditions under which the recorder is being assembled. For a portable model 1m is sufficient. The rod is blunt pointed at the lower end, which will rest in a nylon bearing. A No. 15 single-holed rubber stopper fitted into the top of a plastic detergent bottle is positioned on the rod at a point just above its entry to the supporting frame; this prevents rain-water trickling down the shaft.

The chart paper is supported on a hardboard disc 36cm in diameter with formica cemented on top. A bush is turned from aluminium rod and fitted to the centre of the disc using three countersunk 4 BA bolts. A 4 BA butterfly bolt is used to lock the disc on the vertical shaft at a convenient height. Brown wrapping paper, provided it is not too thin will serve as chart paper, selotaped to the disc at points round the rim. To change a chart, the vane is lifted up from its bearing and the butterfly bolt unscrewed so that the disc can be removed. Locating the compass points on the chart is best done once the new chart has been locked in position on the shaft. The vane is turned to point N and the position of the pen marked with a short radial line near the centre of the disc. Two nylon bushes are made, one to carry the vertical shaft through the frame at the top, and one to act as a bearing at the base. Both of these are push-fitted into necessary holes in the frame and dimensions are not critical.

A clock movement, which comprises a clock less hands, face and case, may be bought from watchmakers for about £1.50. A pulley is turned from aluminium rod so that the winding circle is 20mm diameter. When the pulley is push-fitted to the hour shaft of the clock, this will give a linear movement of the pen of just over 5mm per hour.

Referring to Fig. 3, a wooden block supports two metal rails. The clock is supported behind the block at 60° to the vertical, this arrangement being necessary to allow one to rewind the clock without removing it from its frame. Two small holes are drilled in the flanges of the aluminium pulley to take thin cords, which are then knotted on the outside. The cords pass through holes in the block, round a nylon pulley at the far end to opposite sides of a nylon block carrying the pen, which is therefore pulled along the rails by the clock. A spring inserted in the cord at a convenient point will maintain tension; we used the type which held down old-fashioned electronic valves into their sockets. 6 BA bolts threaded into the pen-holding block were used as anchor points for the cord ends. The nylon pulley is similarly bolted at the appropriate angle to an extended part of one of the steel rails.

The pen can be set at the start of a run by turning the aluminium pulley, which will slip relative to the hour shaft, so that the pen is at the extreme end of its travel and is wound thereafter towards the clock. The whole winding gear should be placed on the base of the main frame so that the pen is near the centre of the chart and the line of travel of the pen is radial. This position is marked and then three strips of wood are nailed on the baseboard so that the winding gear can be pushed into position relative to the chart.

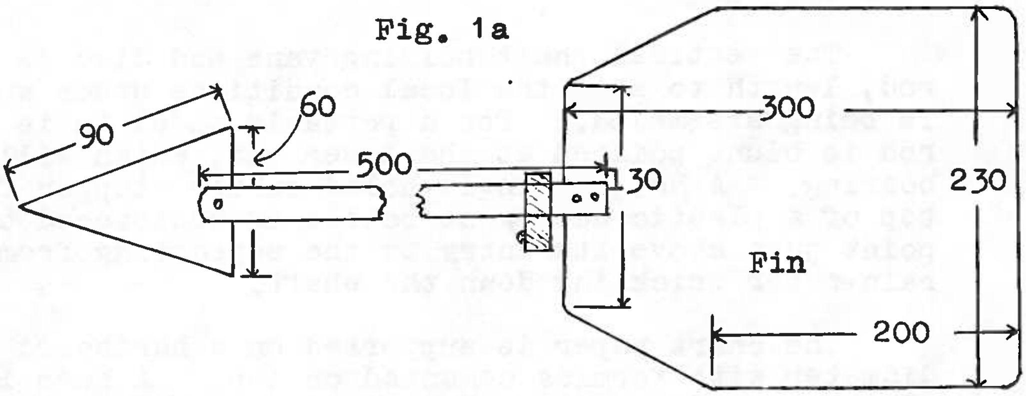


Fig. 1a

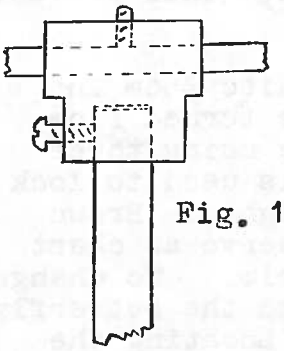
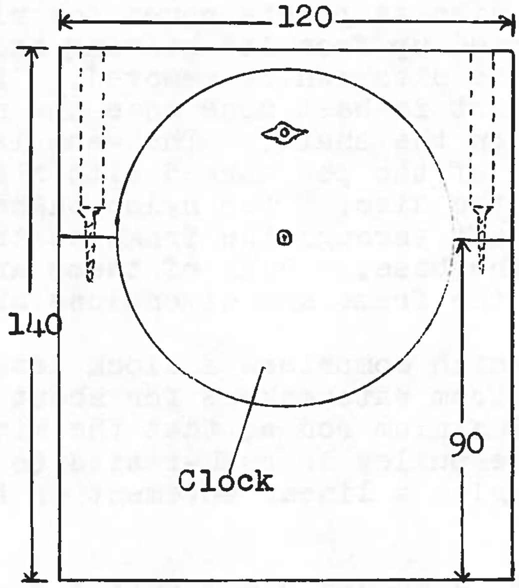


Fig. 1b



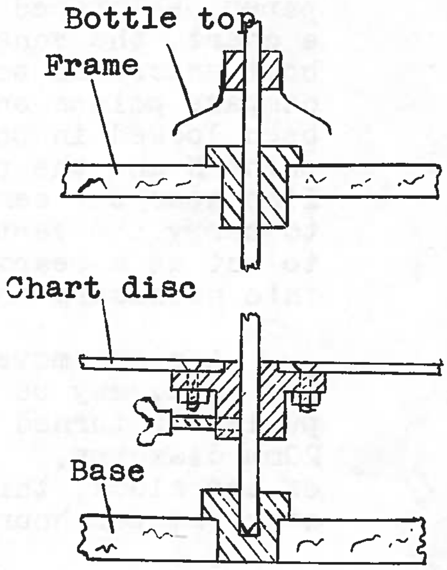


Fig. 2

Dimensions in mm.

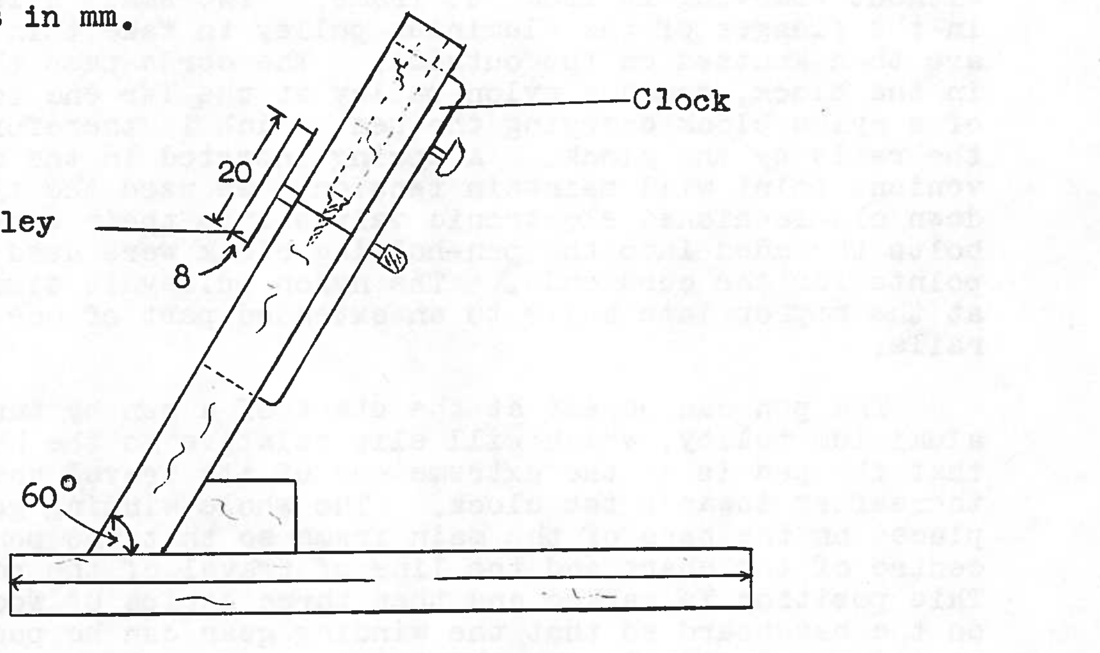


Fig. 4. Clock mounting.

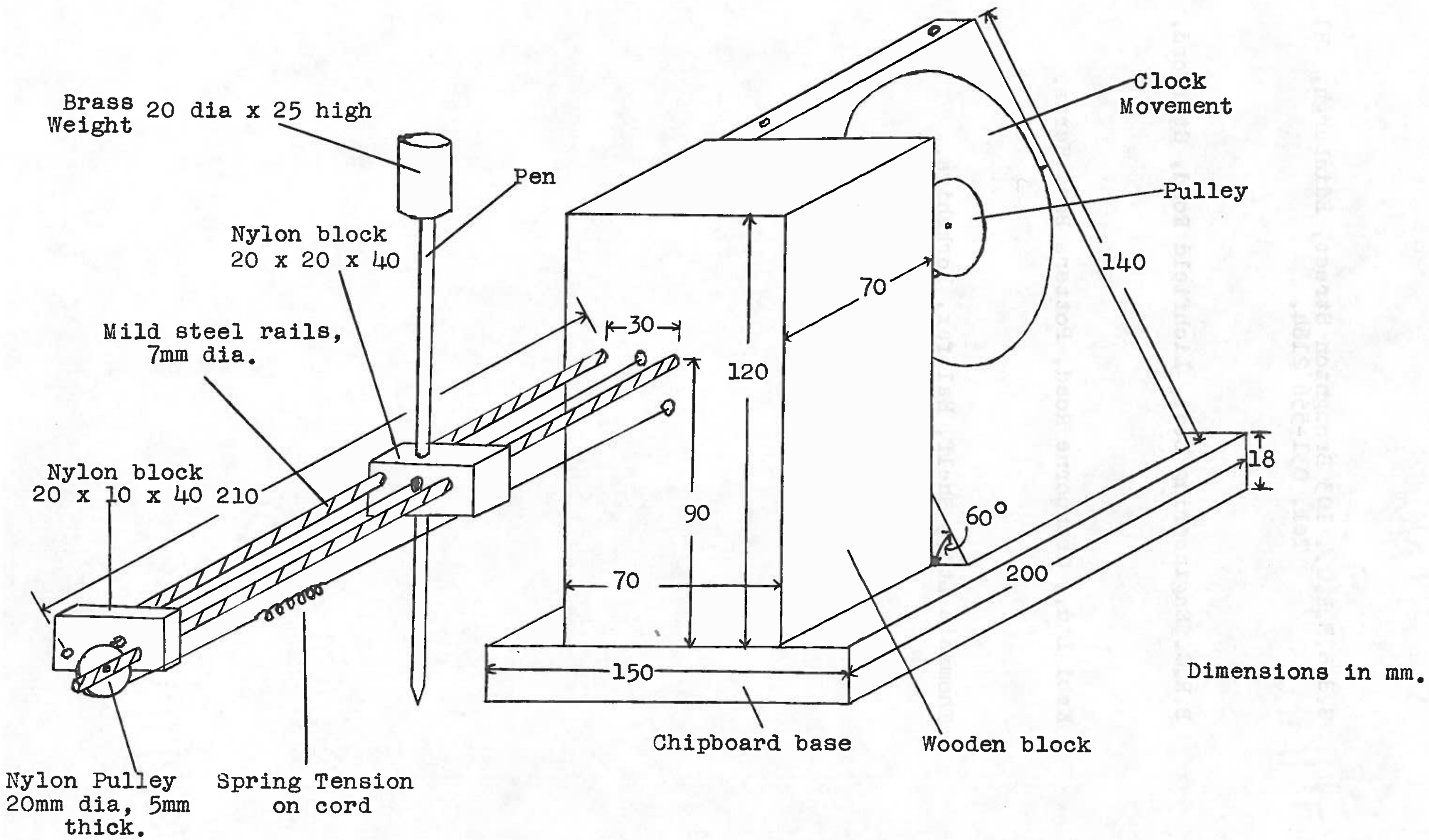


Fig. 3. Pen moving mechanism. Not to scale.

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

B.R.C. Engineering Ltd., Lichfield Road, Stafford.

Kabi Ltd., Cranborne Road, Potters Bar, Herts.

Thomas's Ltd., Shelf, Halifax, Yorkshire.

Bulletin Index, Nos. 40-49.