Section 7

Water

Introduction

Water is the second of the great biological environments and it holds rich and engrossing possibilities for children's scientific investigations. Undoubtedly many of these investigations will have their starting point in the study of animals which live in water. However, the biological aspects of this work are very adequately dealt with in several books, which will be well known to teachers. Therefore, in the pages that follow, the emphasis has been placed upon aspects other than the biological. It is a subject frequently studied by schools, not only because of its inherent significance, but also because water is available, for it is such a common and important factor in our surroundings.

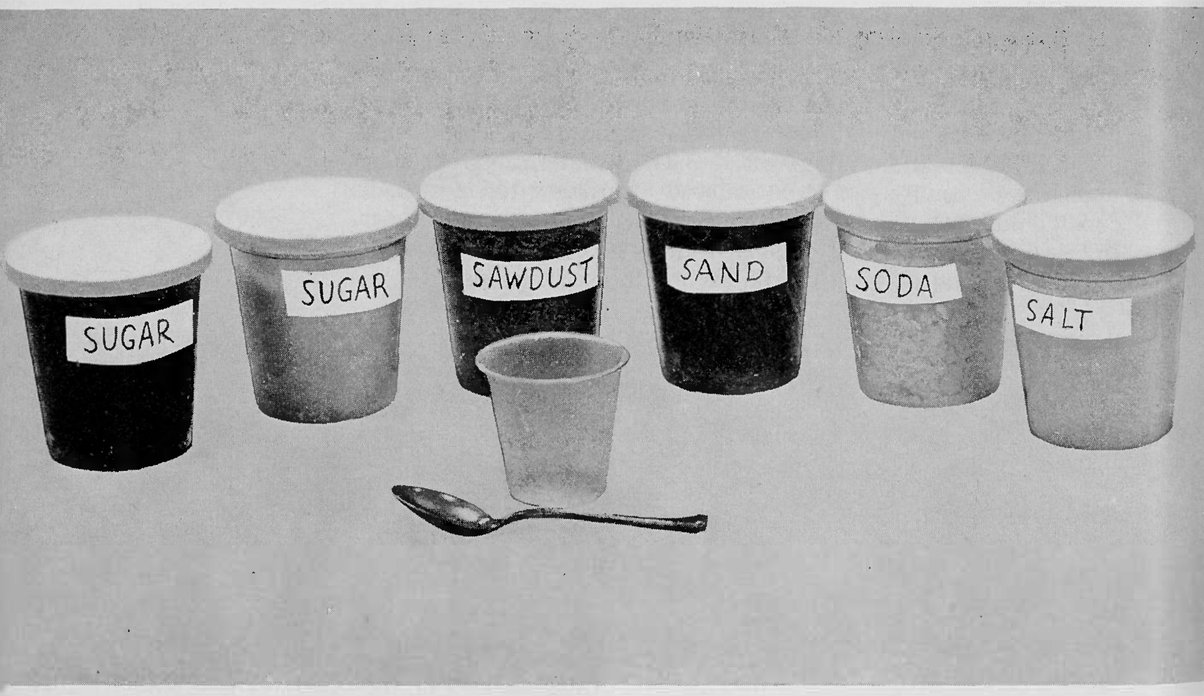
1. Evaporation and change of state

It is not easy for children in the junior stages of education to build up an appreciation of the three states of matter, solids, liquids, and gases, and certainly not without thinking about the problem in practical terms. The position becomes even more complicated when changes of state are dealt with. The photograph below on the left shows a safe and simple means for children to observe changes in state of water, that is, from the liquid to the gas, water vapour, and back to the liquid again. The lower container has hot water in it, and the flask has a quantity of very cold water. If ice cubes are available it will be helpful to cool the water with these before pouring it into the flask. When the flask is held above the hot water, the water vapour will condense on the cold flask and produce droplets again.

When children have become acquainted with the facts of the water cycle and the new vocabulary related to it, a new range of investigations soon opens up around the whole topic of evaporation, drying, and drying conditions. The photograph below on the right shows some simple means of conducting experiments in this field. Squares of blotting paper or linen of the same size make units of measurement, and the dropper-bottle will make it possible to put the same size, as well as number, of drops on each. These can be placed in different situations in order to measure the rate of evaporation or discover the conditions bringing it about. A variation and refinement upon the procedure can be introduced by using a liquid such as cobalt chloride, which turns colour on changing from humid to dry. In this type of experiment, it is particularly necessary to explore the results of several different conditions and to use strict controls.

2. Solubility A

Water as a solvent is a subject which children can investigate well beyond the elementary stage of sorting substances into those which are soluble in it and those which are insoluble. Even at this elementary stage, however, it is possible to stimulate the children to think, 'How much do I need?', and to encourage a quantitative approach at every stage. The substances for experiment will surely be drawn from those of everyday life—kitchen chemicals and vegetable and mineral materials should all be tested. To begin with, the level teaspoonful and the fluid ounce make convenient units of measurement. As work proceeds these may prove to be unsuitable, and so the need for greater precision and an appropriate choice of units of measurement enters the work. Older children will undoubtedly be able to enlarge and refine the scope of their work quite rapidly, not least in their methods of recording and illustrating results.

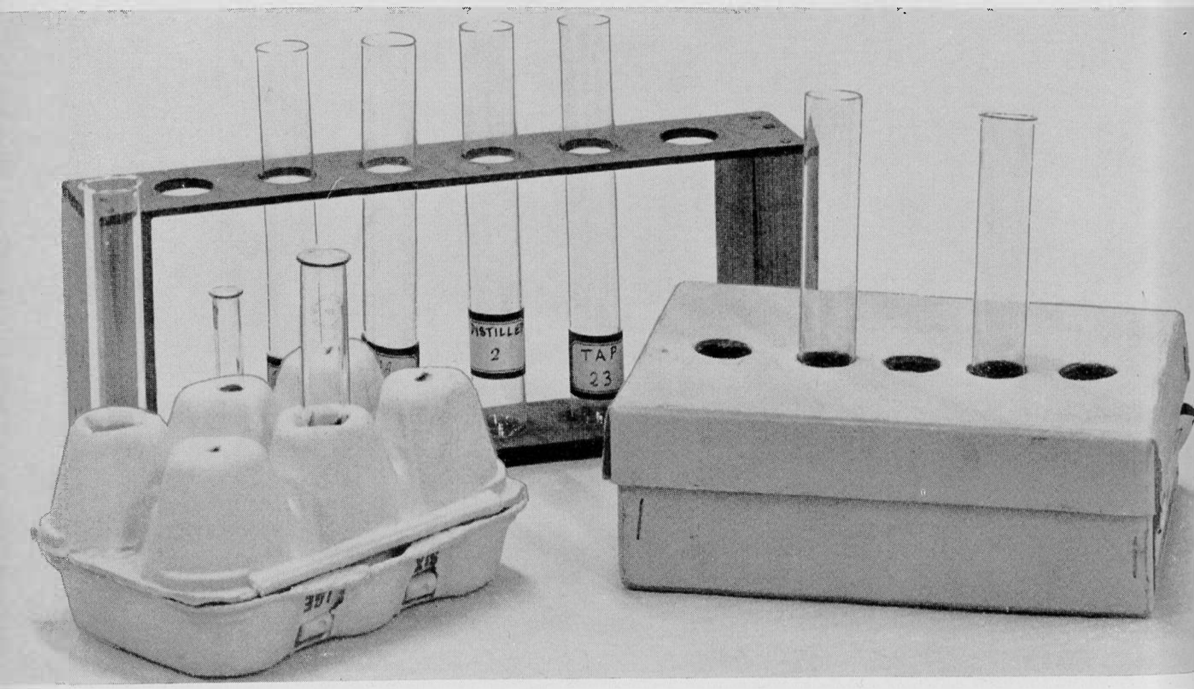


3. Solubility B

Factors affecting solubility can be investigated fairly easily. This illustration suggests a way. Standard size cubes of sugar placed in measured quantities of hot and cold water can be observed and the child can time how long it takes for them to dissolve completely. As a variation of the previous experiment, he can investigate the effect of agitation on solubility by stirring one jar and keeping the other still, and so on. Children will get the most out of a situation when they can range broadly rather than deeply.

4. Hardness of water

The qualities of different samples of water, particularly their relative hardnesses, can easily be investigated by using the soapflake method. It can be applied to an examination of equal quantities of different kinds of water, e.g., tap water, pond water, sea water, stream water, distilled water, water from vegetation, and so on. Equal quantities of the samples of water are put into test-tubes, a soapflake is added to each, and the tube is shaken for a given number of times, perhaps twenty. Then, another flake is added to any tube where there was no lather, and so on. The number of flakes needed to first form a lather will be an indication of the hardness or softness of the water. It is essential to use flakes of an even size, such as Lux soapflakes. For this experiment, a test-tube holder is useful. Three holders made by children are shown in the photograph. The easiest one to make is from an egg container, the next easiest from a pencil box. The example in the background is made from hardboard with two end-pieces of wooden battening.



5. Compound filter A

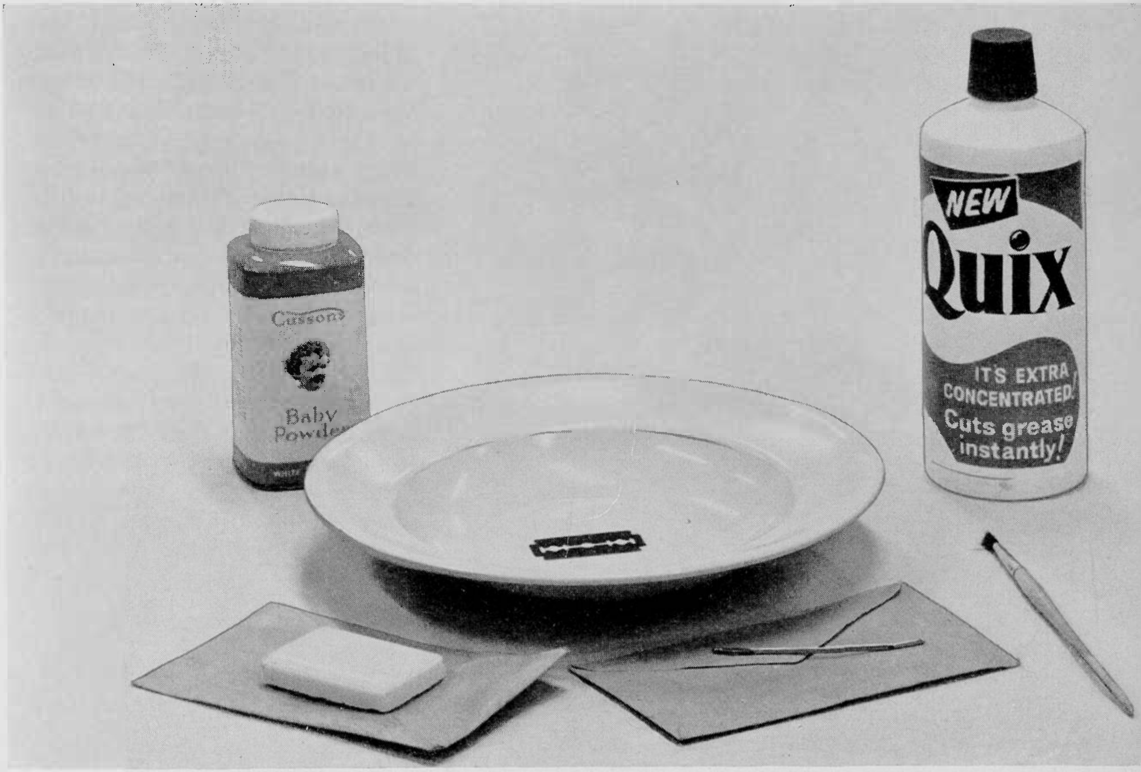
Problems of filtration will be met by children in many contexts in their work in science. Simple filters will easily be devised, using blotting paper or thin cloth. However, sooner or later, children may be faced with the problem of producing a fine filter. The illustration shows one arrangement which children have made which provided a successful answer. The material of the filter is contained in the larger flower pot, where layers of blotting paper, sand, charcoal, cottonwool, and fine gauze make up the improvised filter bed. The inverted flower pot at the top holds the funnel, through which a preliminary filtering takes place. The stages in the improvisation and in the inventive thinking can well be seen from this illustration.

6. Compound filter B

Empty detergent containers are excellent raw material for apparatus construction. They are particularly useful for making beakers and funnels of all sizes. On the left of the illustration is shown a compound filter made from three empty detergent bottles. The lowest container takes the clear liquid, the larger middle one, suitably pierced, holds the filtering medium, and above this the inverted top section of a container makes a funnel. These containers can be cut easily with a sharp pair of scissors. It is a good plan to have a stock of such plastic bottles ready as basic raw materials for the children's work.

7. Surface tension

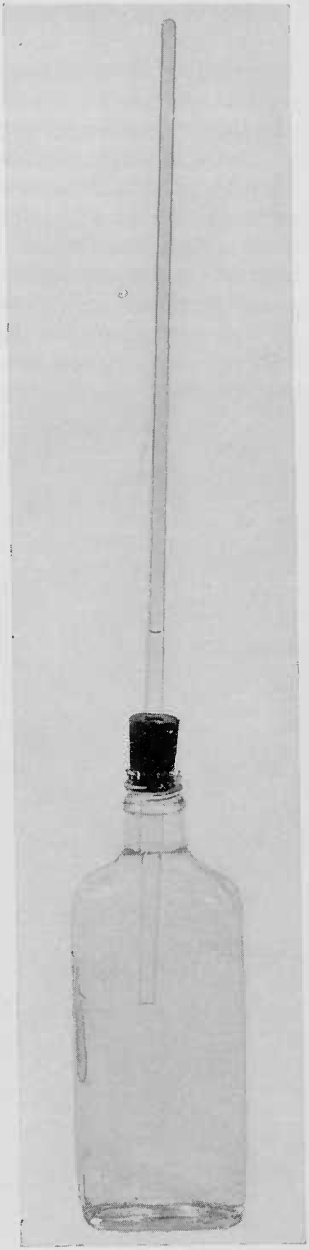
It will be unusual if children who have studied aquatic life do not raise questions about the phenomenon of surface tension. The illustration shows some basic raw materials which they may find helpful when they are trying to isolate some of the problems in such a study. Discarded plates from the school canteen provide useful containers for samples of water to be studied. Talcum powder sprinkled lightly on the surface of water will show up its movements better. A weaving needle, for use with raffia, can be used to pull up the surface of water. Soap and detergent both reduce surface tension and the results of this can easily be observed. It should be stressed, however, that scrupulous cleanliness is essential if experiments are to be rewarding. Traces of grease or soap or oil from the skin can all make for unsatisfactory results.



8. Hot and cold water

Convection currents and their causes are not easily understood by children, who find the relationship between hot water and cold water particularly difficult to grasp. An arrangement is shown here which may help their understanding of this matter, and above all, give openings for more questions which will take their thoughts a stage further. The large sweet jar contains water at a very low temperature. This is produced by putting several ice cubes into it. The coloured water in the small ink bottle is hot. The child should place his thumb over the top of the ink bottle to prevent the liquid from escaping too soon, then gently lower it to the bottom of the sweet bottle and remove his thumb. He should try not to disturb the water too much as he does this, or the experiment will be less satisfactory; then the ensuing mixing of the two liquids can be carefully watched. If the temperature differential between the hot and the cold water is as great as possible, the results will be all the more effective.

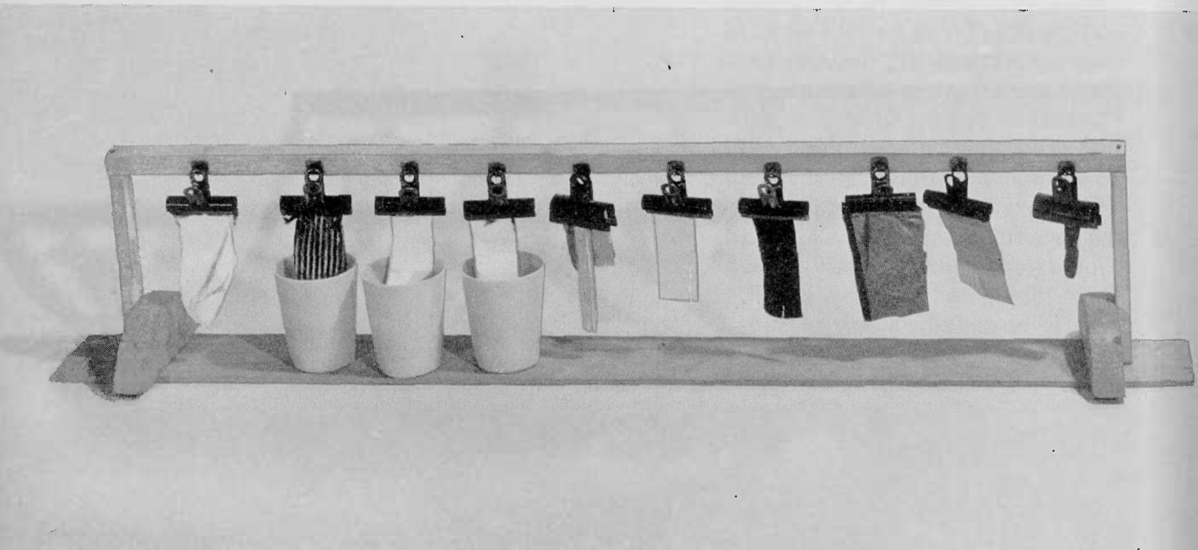
9. Water thermometer



During the course of their experiments with hot and cold water children may meet some of the problems of elementary thermometry. This, in turn, will give them an opportunity to make a thermometer for themselves, using water as the medium. A simple water thermometer is illustrated here. The glass tube is inserted through a rubber bung which fits the top of a medicine bottle tightly. A certain amount of adjustment will be necessary to obtain the right water level in the tube, but if the bung is inserted carefully it is possible to displace just the right amount of water to start the level reading at a suitable height in the tube. Care should also be taken when inserting glass tubing into rubber bungs. The safest method is to find the size of cork borer which will just take the glass tube, insert the borer through the rubber bung, and then insert the glass tubing into the cork borer. The cork borer can then be withdrawn from the bung, leaving the glass tubing in place. Children should not be allowed to try to use glass tubing in this way at all. This is essentially a job of preparation for the teacher to perform.

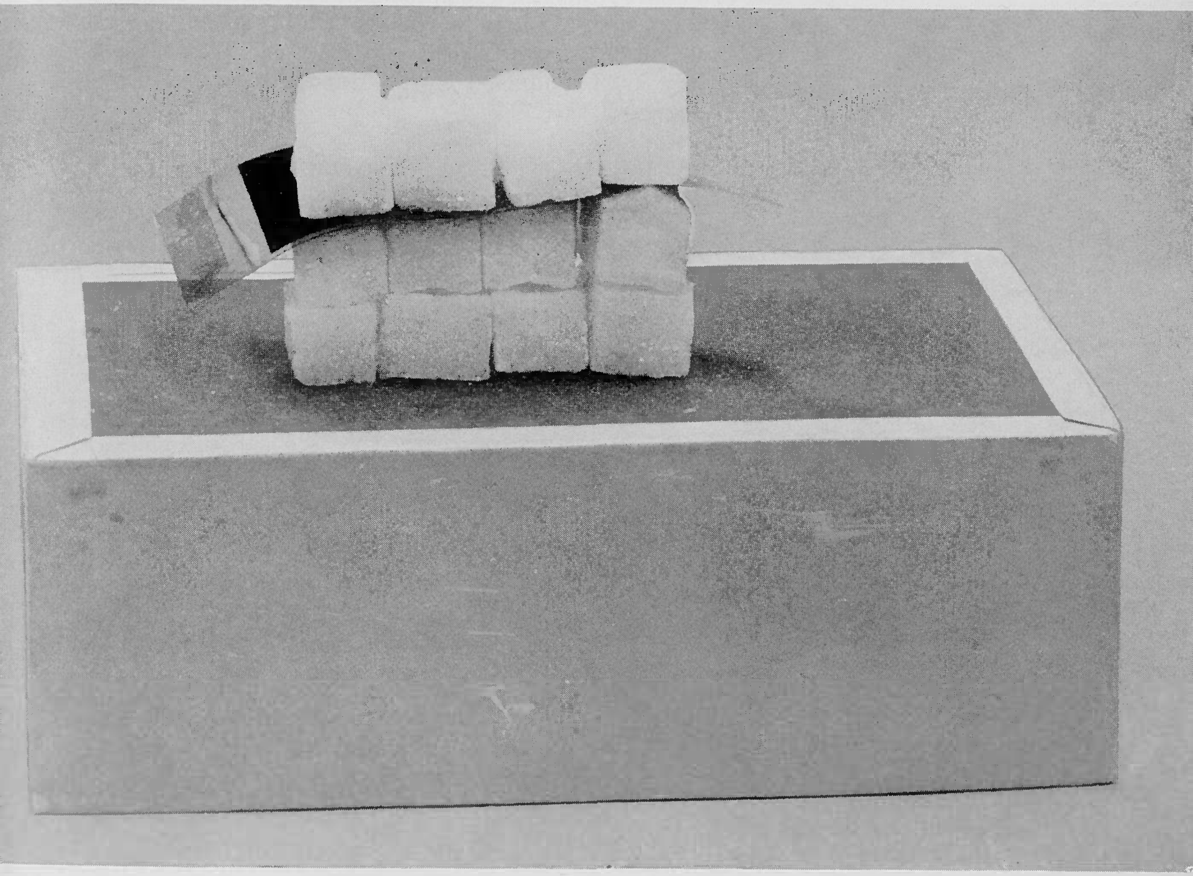
10. Water absorption

This illustration shows an attempt to set up a device to discover the reaction of various materials to immersion in water. Equal lengths of material are dipped into equal quantities of water placed in the beakers. An examination of the materials is carried out at regular intervals and the results noted. Results like this can be exploited in a great number of ways, and children will respond according to their own leanings and abilities. Younger children may be content with the facts of the absorbency of some materials and the apparently waterproof properties of others. Some children will be able to devise various ways of measuring these facts. It is essentially part of the teacher's contribution to see that they make all the use they can of their discoveries.



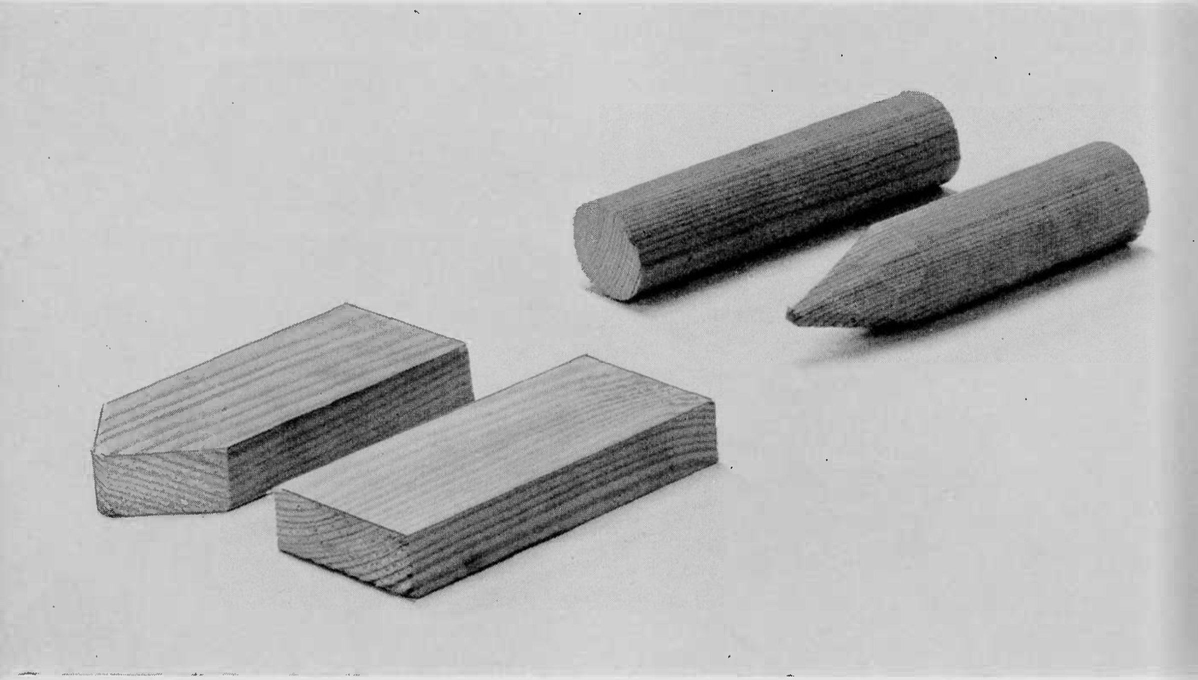
11. Damp courses

A visit to a building site made a number of children curious about the nature and function of the damp-proof course in a house. The photograph illustrates the means they adopted for exploring the question. The two lower courses of sugar lumps, which take the place of bricks, are put in a shallow tray of water. The damp course, in this case a piece of plastic material, is inserted, and the top course of bricks placed upon it. If coloured water is used the effect is all the more vivid. The damp course itself can be the subject of experiment, and a whole range of materials should be tested for their suitability.



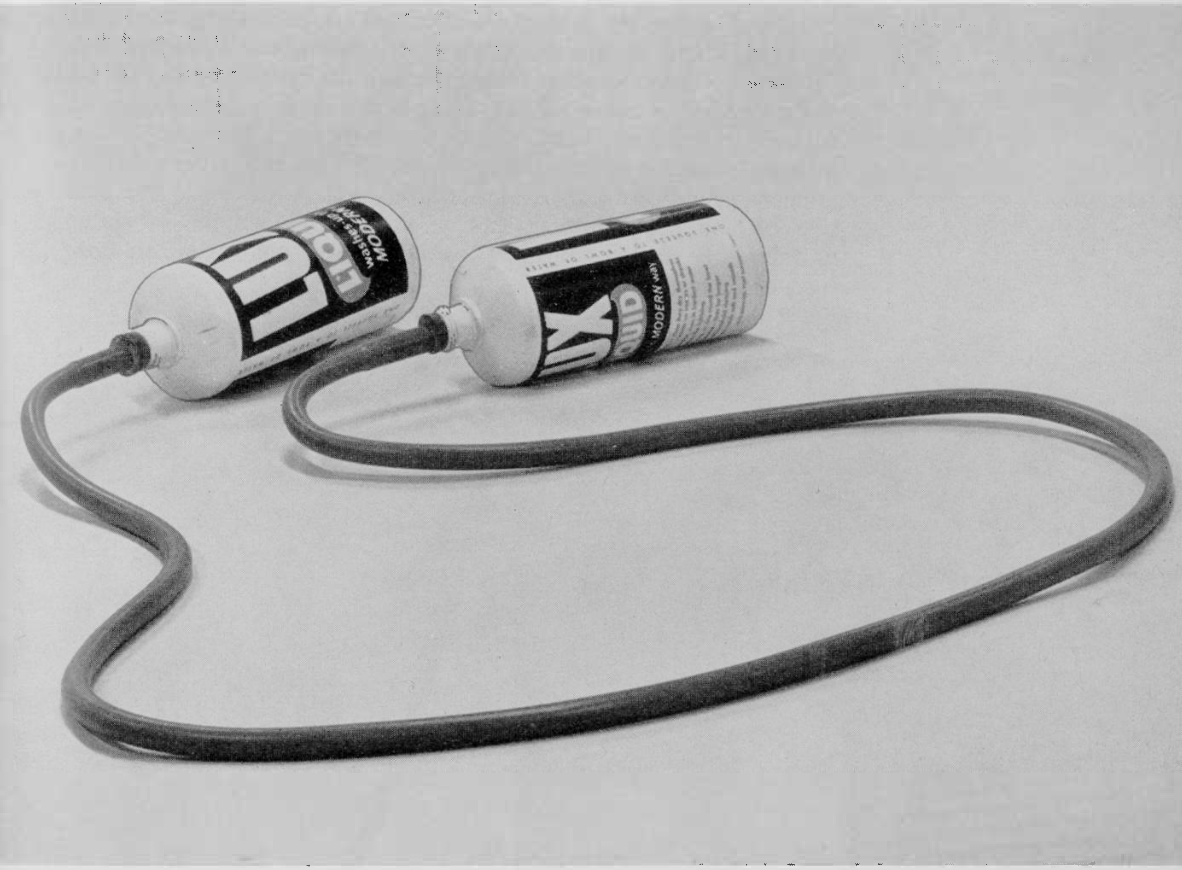
12. Boat shapes

Some children will be aware of the significance of streamlining the shapes of aircraft and motor cars. They can be helped to learn more about streamlining in general by making a simple study of the profiles and shapes of bodies that move through water. The photograph shows some of the ways of beginning this study. Comparative shapes can easily be made from soft wood. If a standard means of propelling the 'boats' through the water is adopted, comparisons can be made. An easy means of propulsion is a thread carrying a hook onto which small washers can be placed, the thread in turn being fastened to the front of the 'boat', and hanging over the end of the sink or bath in which the experimental boats are placed. Attention can be directed towards the nature and shape of the bow waves, as well as to the speeds through the water. This particular experiment is a most productive starting point for work of an unusual and exacting nature.



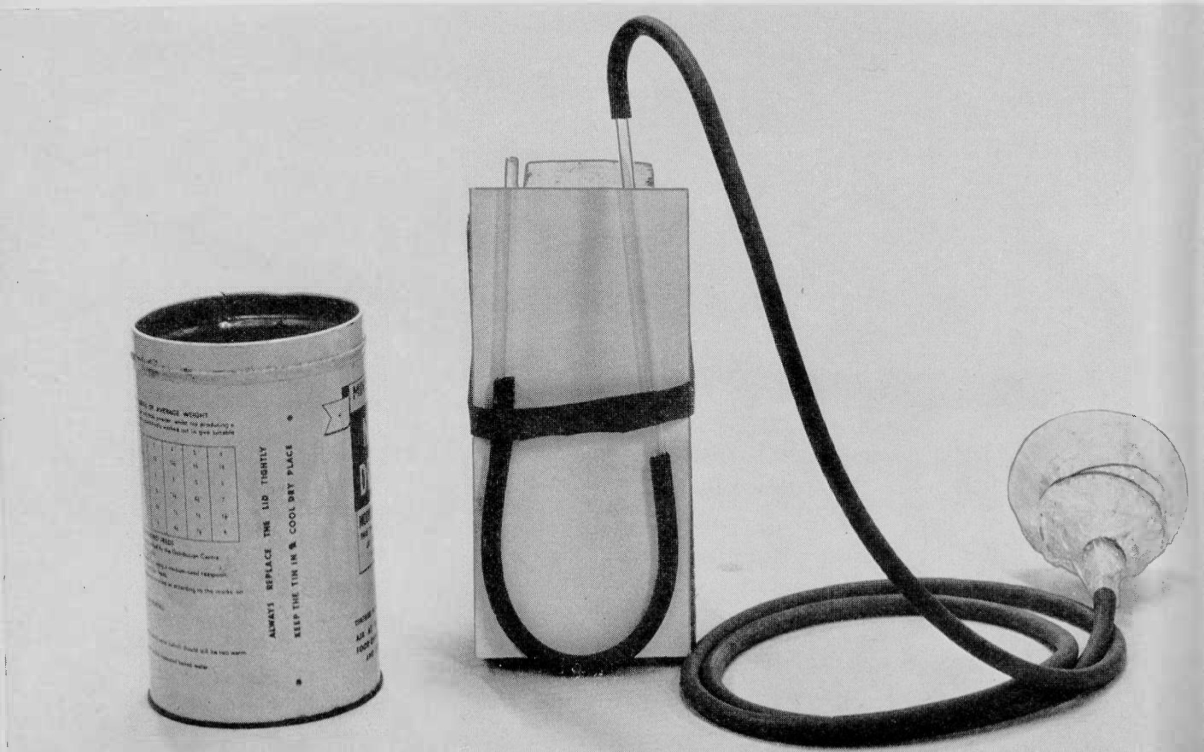
13. Water pressure A

Early on in their work with water, young children can appreciate the movement of water from one level to another. The kind of simple apparatus with which they may work is illustrated here. Older children can use this same apparatus and introduce an element of measurement into their discussions by recording the relative heights of the reservoir and the jet.



14. Water pressure B

When quantitative work is introduced into their experiments, children often become eager, not only to devise new pieces of apparatus, but also to apply apparatus in new ways. On the left of this illustration is a conventional adaptation for studying the effects of height of water upon pressure. This is measured according to the jets of water which come from uncovering each hole in the can in turn after a fresh refilling of the can. (It is difficult to get significantly different results by the technique of covering all the holes with a length of sticky tape, and then peeling this off rapidly to expose all the holes almost simultaneously.) On the right of the photograph, a simple manometer is illustrated. Before children use this, they will need to discover how it works, and best of all, to make up their own versions of this apparatus. Clear plastic tubing can be substituted for the two pieces of glass tubing, though the conventional U-bend is avoided by the use of rubber tubing in this version. The apparatus is clamped to a housebrick by a large rubber band. The diaphragm over the funnel is of thin plastic material. This apparatus provides a means of indicating the variation in pressure with depth, irrespective of volume. Children can test the same volume of water in differently shaped containers—a tall narrow jug, a wide shallow tray, and so on.

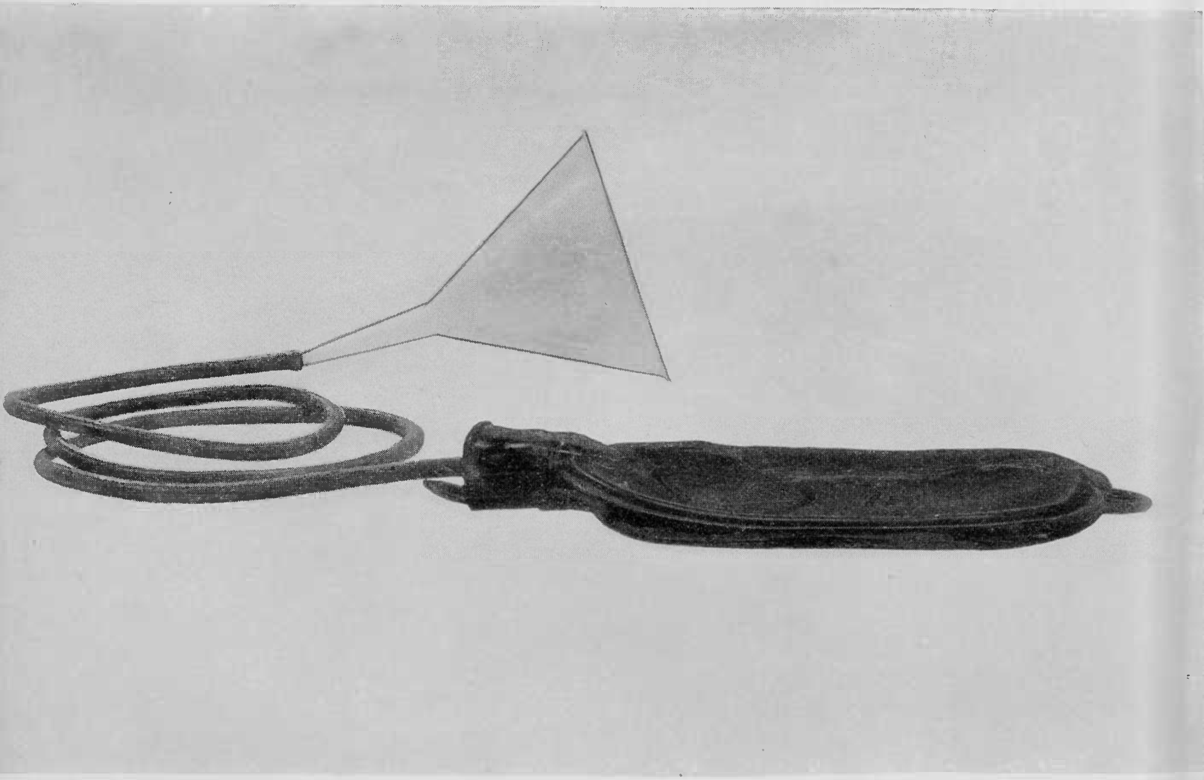


15. Controlling water pressure

This illustration shows three means of controlling the flow of liquid. It is included to remind teachers that a good way of helping children to understand how something works is often to give them related pieces of equipment rather than to explain. Here, the steps towards the evolution of the common tap can be traced. Once children take in this technique of tracing a path from the simple to the more difficult via pieces of apparatus, they will be quick to use it themselves.

16. Simple hydraulic lift

The basic equipment for making a simple hydraulic lift is illustrated here. The hot-water-bottle bag takes the load and water is fed to it through the funnel and tube. The funnel should be large and the tubing at least four feet long to give sufficient head of water. This apparatus will take a load of up to four housebricks quite easily. The rubber tube should be wired to a glass insert through a rubber bung, which should be forced as far as possible into the opening of the hot-water-bottle. The efficiency of the apparatus will depend on the efficiency of both these joints. With a sufficient head of water the effects of raising and lowering the water level can be studied in relation to movements of the load.

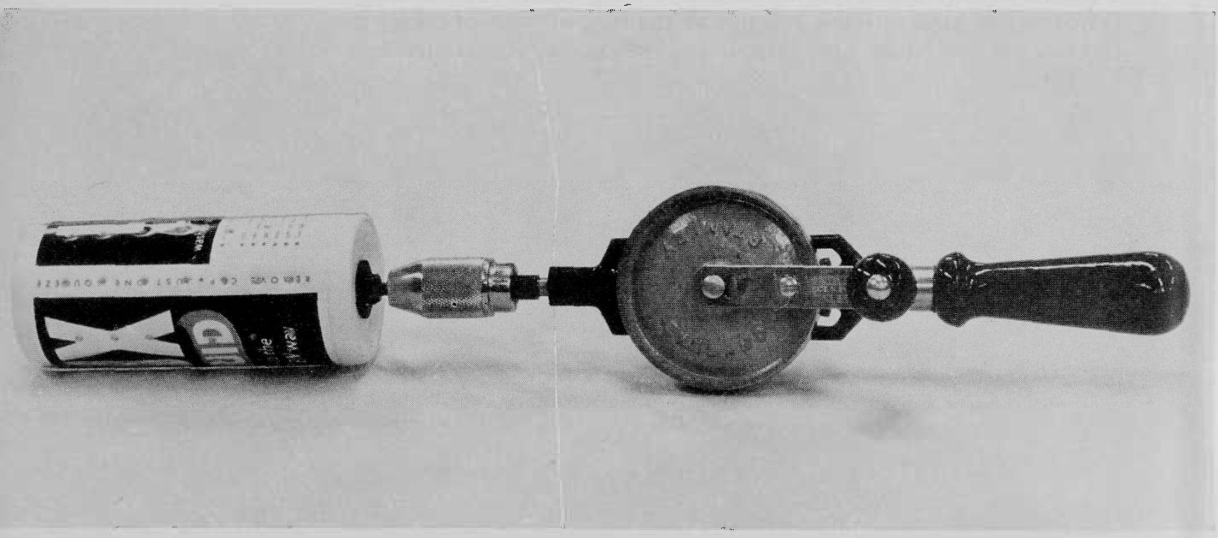


17. Testing detergents

Much that goes on in everyday life will inspire children in their questioning and thinking. Illustrated here is a piece of work done in an effort to answer the question, 'Which detergent washes whitest?' Similar approaches to many other questions will provide both interesting and stimulating science work. The samples of detergent are contained in the tubes held in Terry clips to the simple holder. The plastic beakers provide washing and rinsing tubs. The spatulae form paddles of the type that might be found in the rotary model washing machines. Numerous conditions can be varied in the tests—not only the time of washing, the number of revolutions of the agitators, and the temperature of the water, but also the amounts of detergent and the hardness of the water. The limiting factor in this kind of work will not be the lack of ways of taking it further, but how much time there is and how energetic and alert the teacher is.

18. Spin dryer

The experiment shown in example 17 led naturally to the question, 'How does the spin dryer work?' A crude effort at an experiment to find the answer is illustrated here. The detergent container, with many holes pierced in it, is revolved in the chuck of the drill. It is held in the drill by a nut, bolt, and washer pushed through the bottom of the container. In spite of its obvious limitations, this piece of apparatus was of considerable value in starting the experimenters talking and thinking.



Section 8

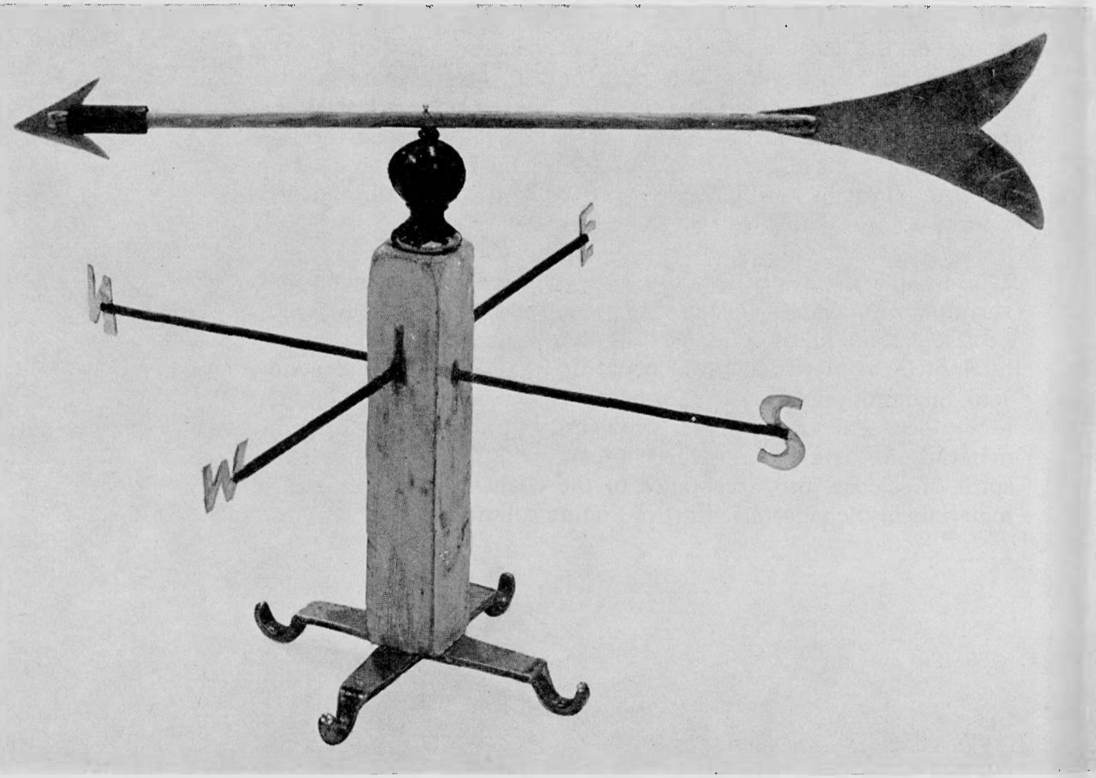
Weather and soil studies

Weather studies

The keeping of weather records by schools goes back a long way. Some of the early object-lessons were concerned with weather phenomena. However, it has been only in recent years that the possibilities of using apparatus made by children in these studies have been seriously considered. The crude data it yields can be used alongside the more precise information gained from standard apparatus. It seems hardly necessary to say that we are all influenced by and aware of the changes in the weather. Yet not all schools have exploited the possibilities they hold for scientific investigations, even though the evidence is available to every school whatever its surroundings. In the illustrations which follow there is a record of how a certain group of children thought about the subject and attempted to solve their problems at first hand. These endeavours took them not only to books for help and to adults to try to find out how others had solved similar problems, but also to seek everyday materials for constructing their apparatus. This is the essential spirit of science, this acceptance of the challenge of ideas and of materials in the vigorous effort of finding solutions.

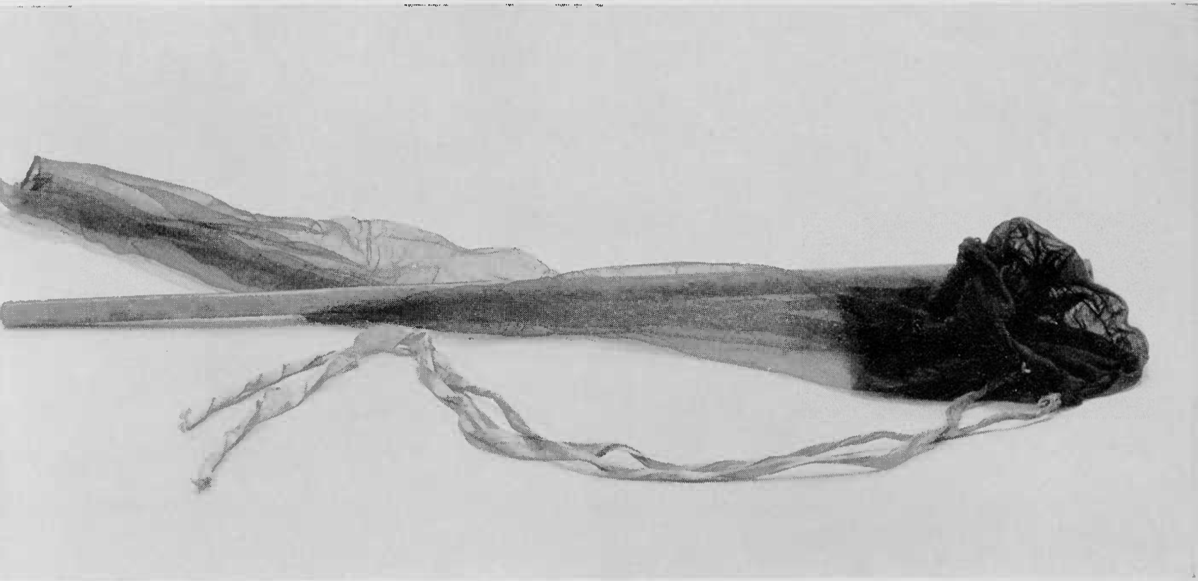
1. Weather vane

The weather vane illustrated here is a fine example of the creative use of odds and ends of materials. The metal base is a coat hanger, the central pillar is a piece of scrap wood, and the letters for the cardinal points are of cardboard, with aluminium cooking-foil stuck on to give permanence; the completed letters have been put into the split ends of pieces of cane, and these, in their turn, have been inserted into the pillar. The top support for the vane is a wooden door knob screwed down into the central pillar. The bearing itself is made from a glass bead, and the vane from split cane, with the arrow-head and the tail cut from cardboard and covered with aluminium foil in the same way as the letters. Obviously, there will be many variations on this theme, and the range of ingenuity that children show is perhaps one of the most encouraging features of this work.



2. Wind sock

The wind sock is a familiar feature of many aerodromes. It is not surprising, therefore, that children should try to make an adaptation of this device with a nylon stocking. The illustration shows a successful attempt. Either end of the 'sock' has been wired open and the whole apparatus is tied to a stick when it is in use.

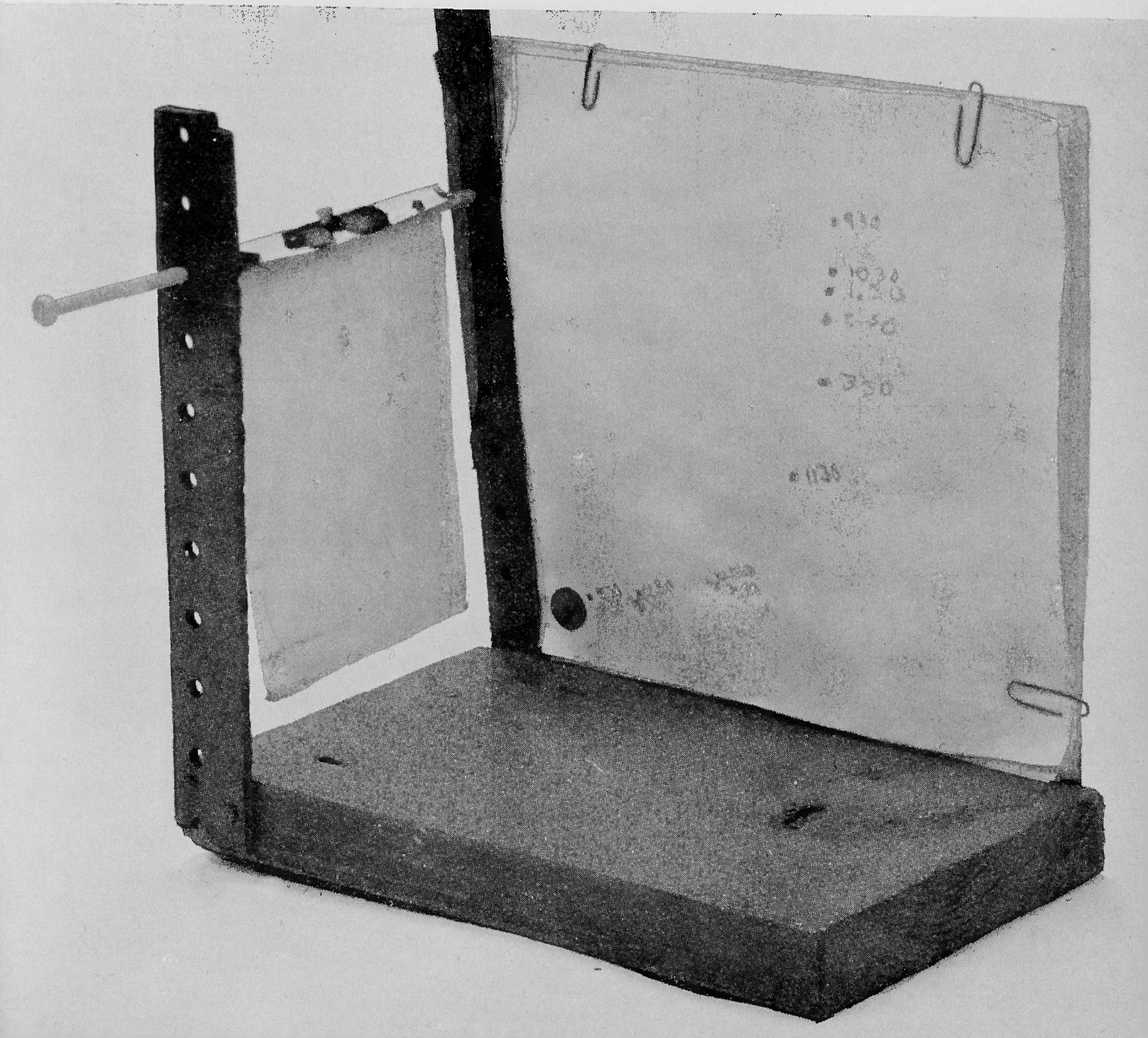


3. Anemometer A

The measurement of wind speed is a fascinating subject for children. Once they start to think and talk about this, their ingenuity will inevitably inspire them to make apparatus for their investigations. This illustration shows a very conventional attempt at wind speed measurement. The main part of the apparatus is made from scrap wood, the bearing from glass beads, and the cups from discarded plastic drinking-mugs which a child had obtained from a nearby café. Problems of balance and sensitivity in this type of apparatus often arise. This is good, as it causes children to look round for other means of solving the problem of wind speed measurement.

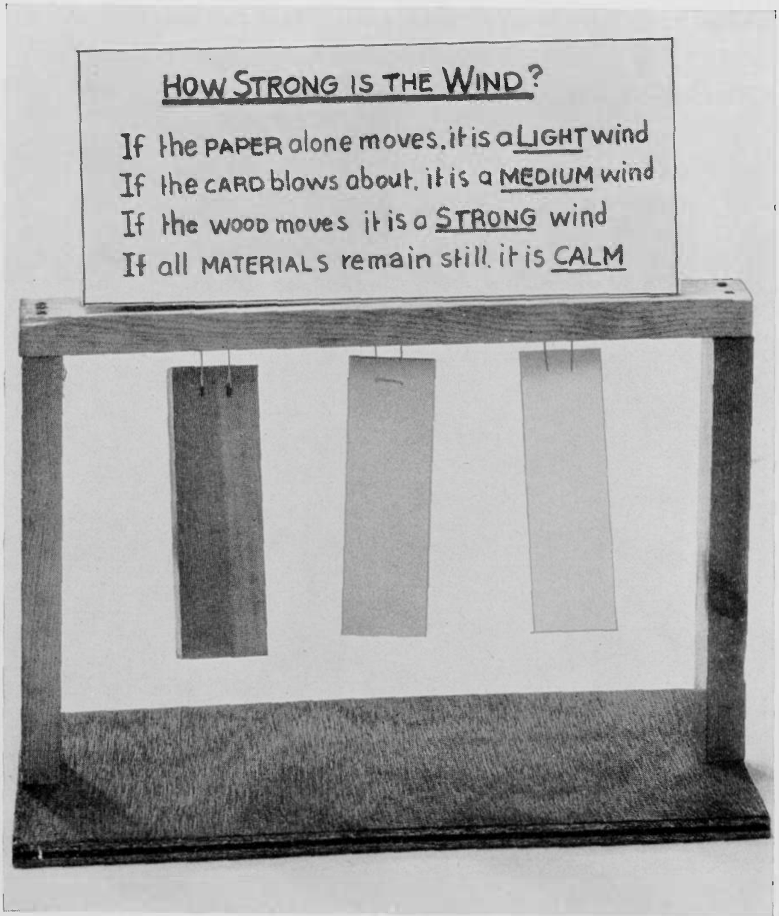
4. Anemometer B

This apparently crude attempt to make an alternative to the anemometer proved to be an extremely effective piece of apparatus. The swinging door was made from a piece of tin plate, cut with tinsmith's snips, and several experiments were necessary to produce the right dimensions for a suitably sensitive door. The rest of the construction is obvious from the photograph. The sheets of paper pinned to the side provided a means of making direct recordings of the results. Again, the possibilities for varying the construction of this apparatus are very great and children are not slow to explore them.



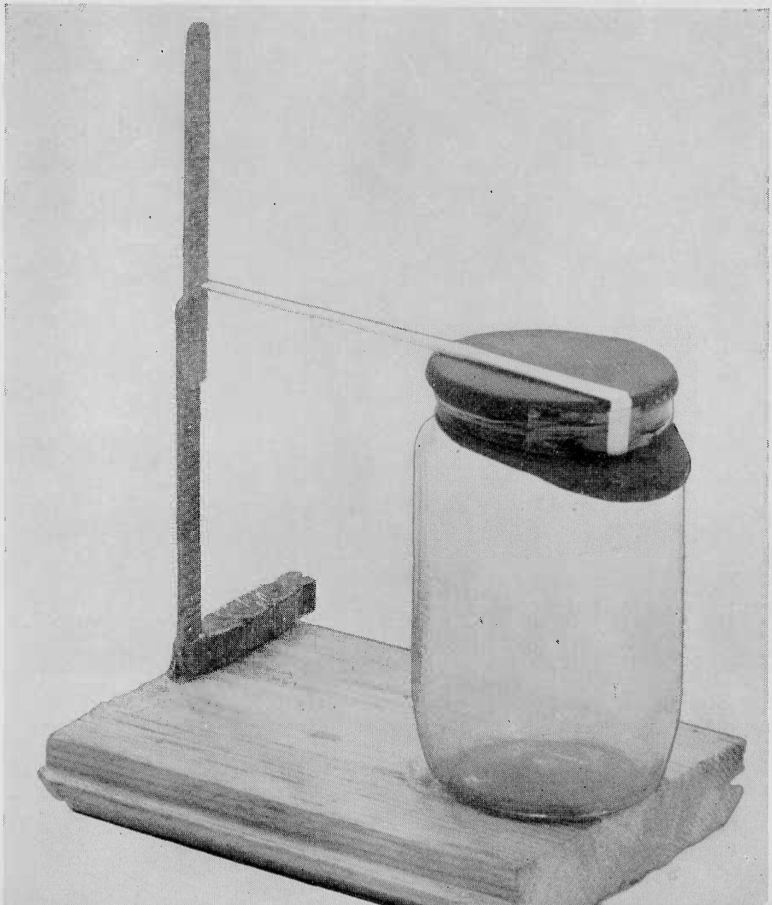
5. Anemometer C

The apparatus illustrated shows a variation on the swinging-door type of anemometer. Quite young children will use this means of wind speed measurement most effectively. They will also gain considerably from the experimentation which they will need to make with a variety of materials and sizes of materials to obtain their results.



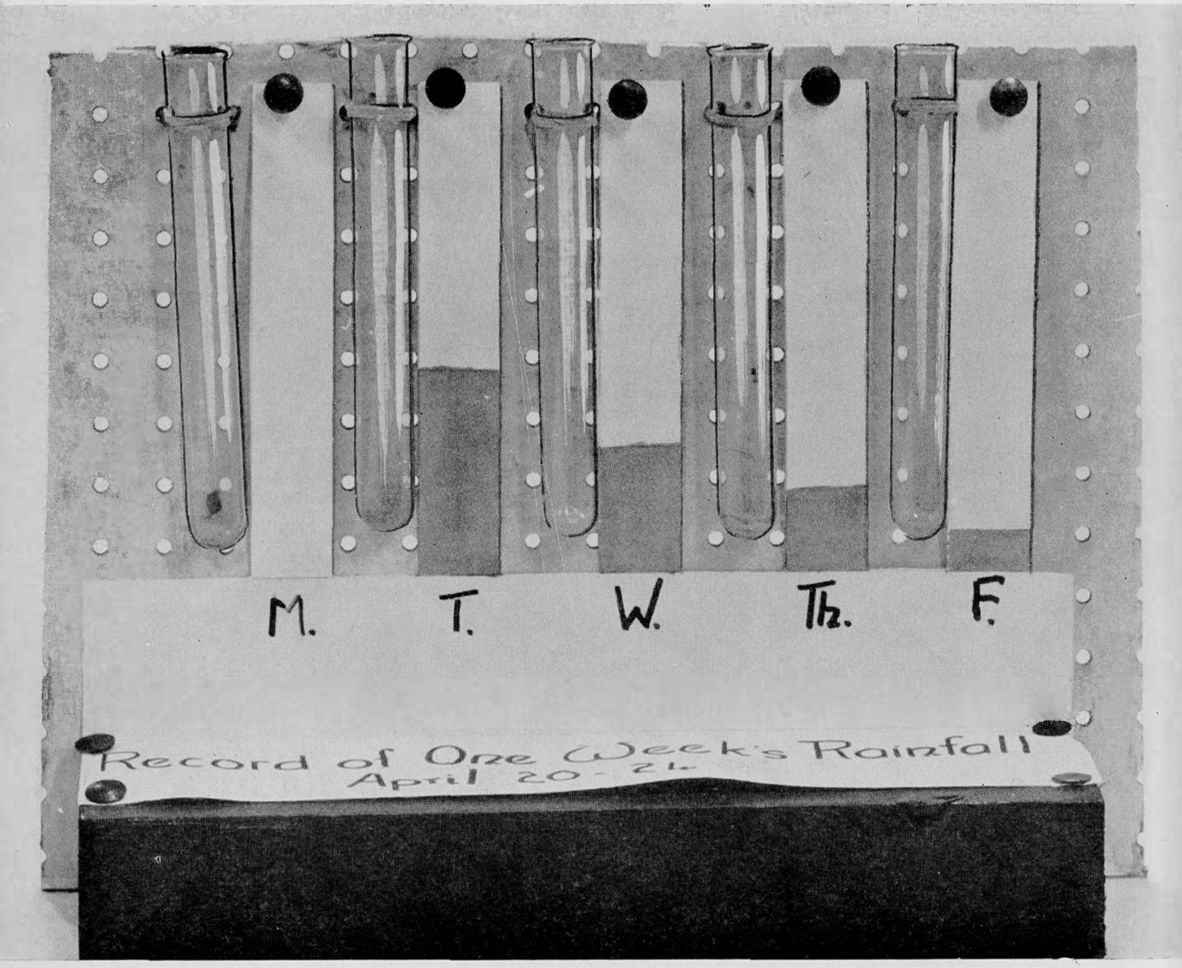
6. Barometer

This illustration shows an attempt to investigate and measure pressure changes in the atmosphere. The spring peg, strapped with Sellotape to the wooden offcut baseboard, supports the calibrated scale which is marked onto lollipop sticks stuck together. The jar itself has a diaphragm of rubber stretched tightly over its mouth and tied on to make an airtight fixing. A small piece of cardboard, under the straw which acts as a pointer, moves in sympathy with the movements of the diaphragm, caused by variations in atmospheric pressure, and so in turn the pointer too records these movements of the diaphragm. There is no doubt that apparatus such as this will barely do more than show that a variation does take place, but this is all that is required of it, for this factor alone will provide a thinking and talking point for the children and the teacher. This is the kind of subject that older children may be studying, and making apparatus like this is an obvious way by which they may start to refine their studies and use more accurate equipment.



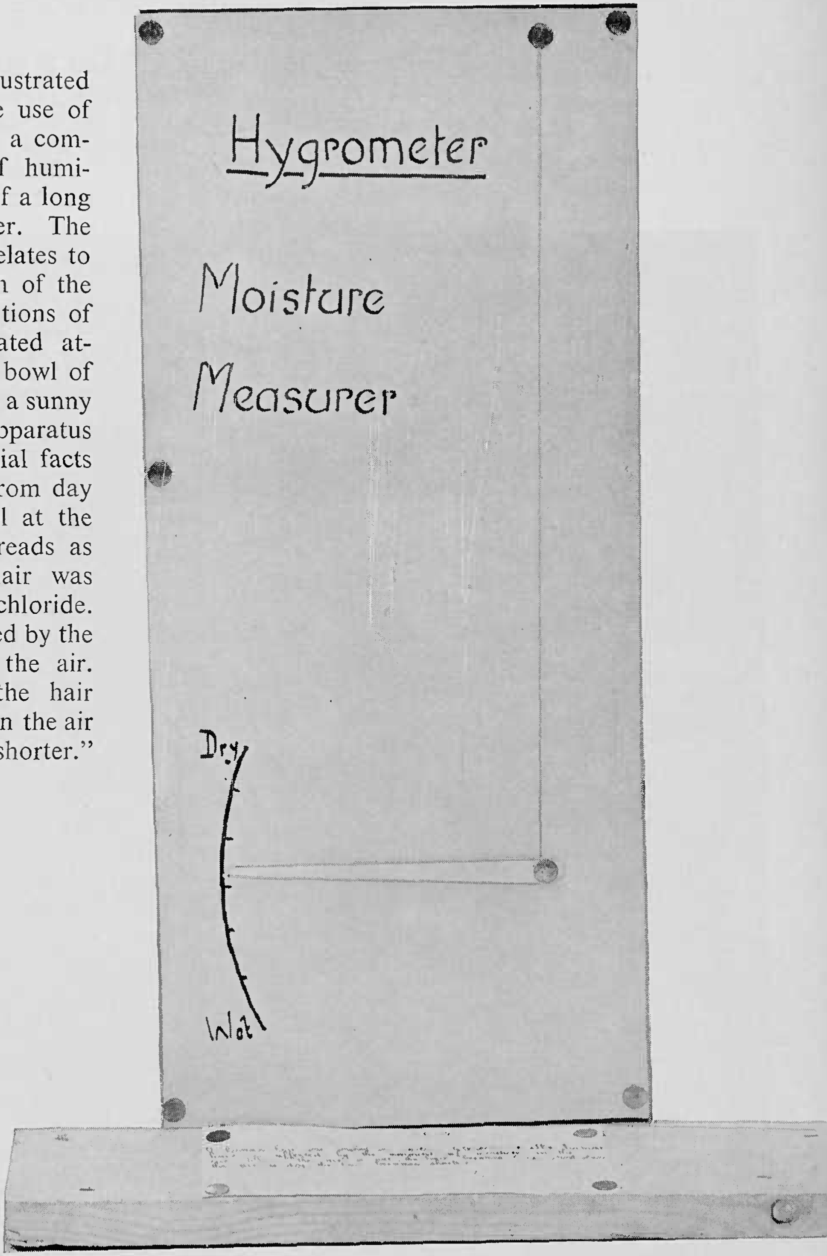
7. Rainfall recording

Rainfall recording is undertaken in many different ways. When left to their own devices, children will most often use a direct means of showing variations. This illustration shows this admirably. The pegboard nailed to the block of wood supports test-tubes held into place with elastic threaded through the holes in it. The white strips of paper provide the markers.



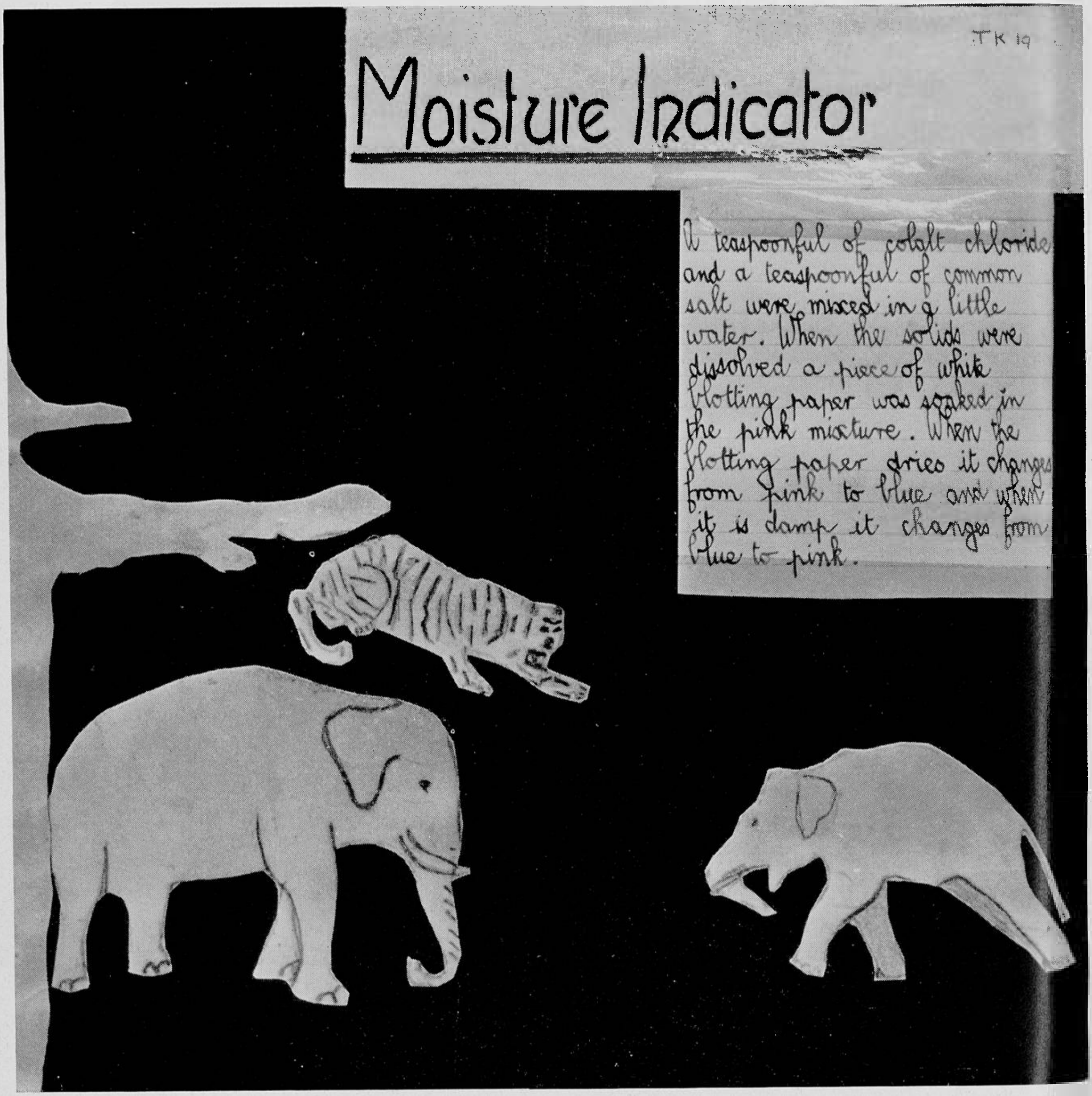
8. Hair hygrometer

The hair hygrometer illustrated here shows an admirable use of simple means to produce a comparative measurement of humidity. It consists simply of a long hair attached to a pointer. The calibration of the scale relates to the changes in the length of the hair under varying conditions of humidity, from a saturated atmosphere provided by a bowl of hot water to the dry air in a sunny window. This type of apparatus will bring out the essential facts of changes in moisture from day to day. The pupil's label at the foot of the hygrometer reads as follows: "A human hair was washed in carbon tetrachloride. The human hair is affected by the amount of moisture in the air. When the air is wet, the hair becomes longer, and when the air is dry, the hair becomes shorter."



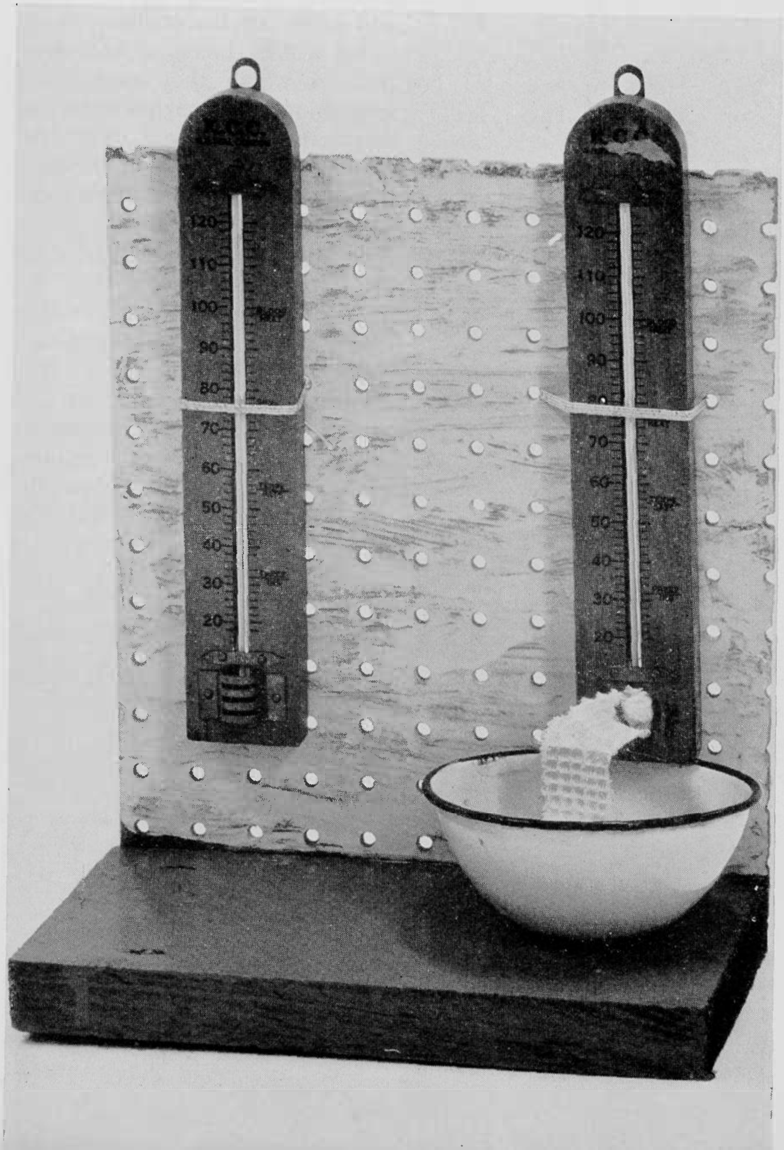
9. Chemical hygrometer

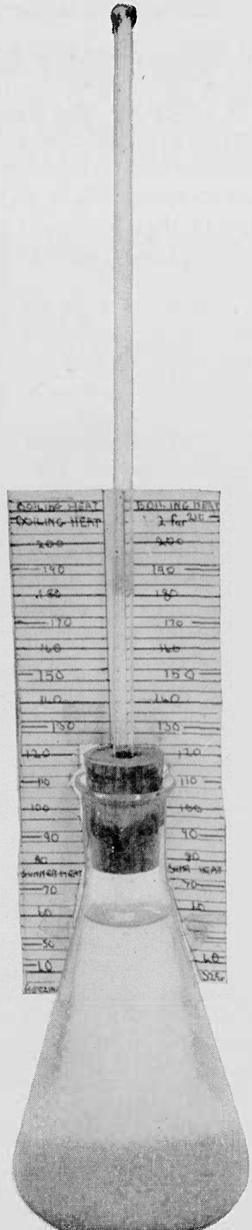
Another simple moisture indicator is illustrated here. The shapes are cut out of white blotting paper, previously soaked in a solution of equal parts of common salt and cobalt chloride in a little water. Under dry conditions this will be pink, and under wet conditions, blue.



10. Thermometer A

When they refer to books, children will almost inevitably become acquainted with the conventional theories about a subject. This in turn will influence the design of pieces of apparatus that they construct. Shown below is a child's attempt to produce conventional wet and dry bulb thermometers. The construction speaks for itself and serves as a reminder of the effective use to which simple materials can be put. However, teachers will vary in their opinions of the ability of children to use the necessary calculations and may prefer to provide tables of results instead.



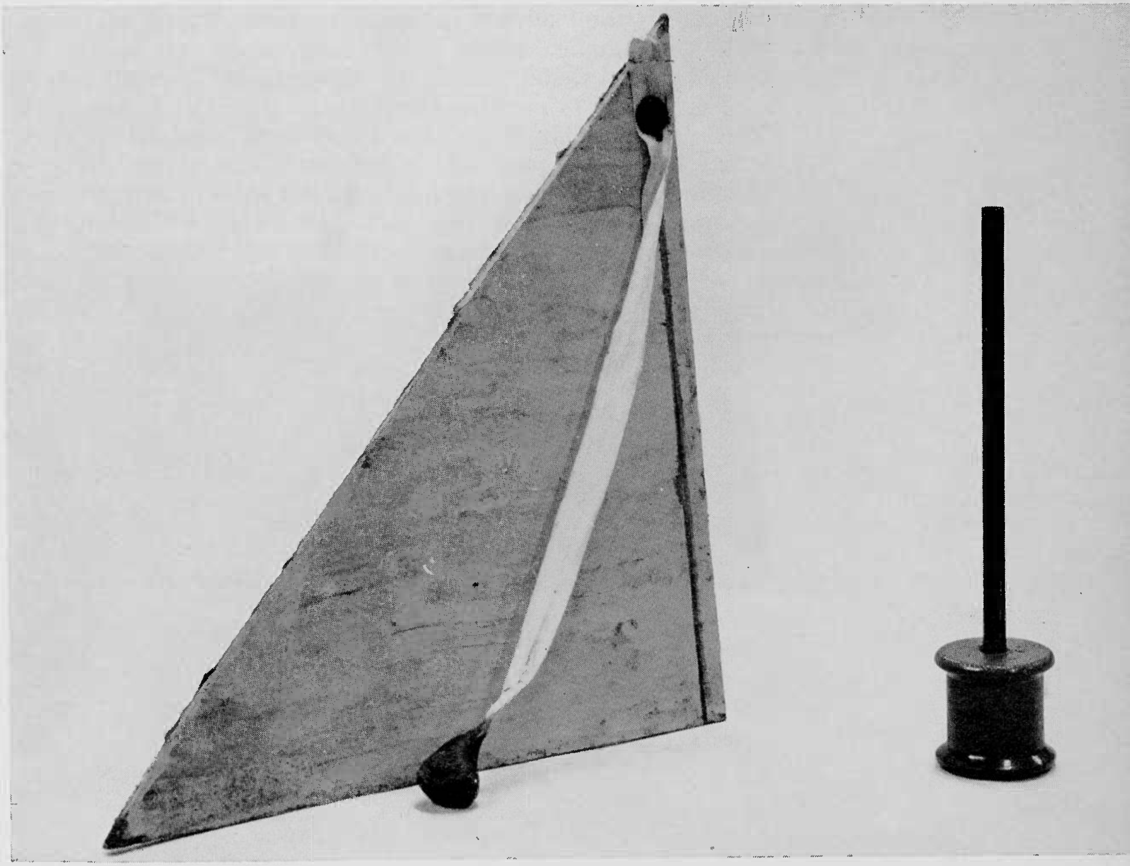


11. Thermometer B

In their search for solutions to the problems of their work children will need opportunities to produce apparatus which—as the teacher may know beforehand—will not really work. It is of the greatest importance that the teacher should stand back. From these kinds of trials, the most powerful teaching opportunities will arise, for the children themselves will have created the situation in which they may learn something. The partial failure at thermometer making illustrated here brings out this point strongly. Children may soon discover the unsatisfactory nature of water as a liquid for thermometers. This illustration shows too that the scale cannot be borrowed from a classroom thermometer and applied to another instrument. It is essential that both children and teachers view such situations as this not as failures or mistakes, but as part of the process of scientific learning and achievement.

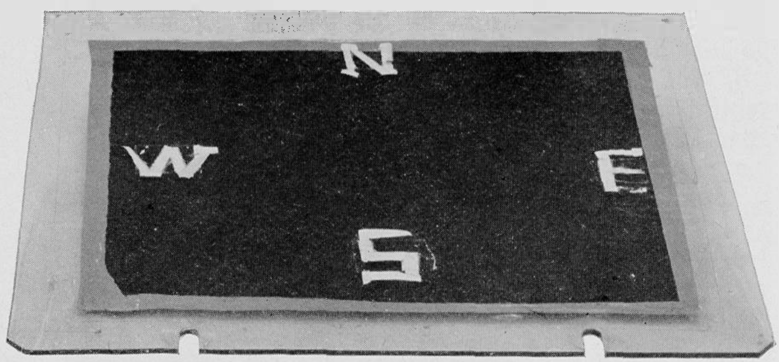
12. Shadowstick and height measurement

In so much of this work the investigation of one situation often provides inspiration for work in another. On the right of this photograph is a portable shadowstick which children adapted for their use. This led to an investigation of the measurement of heights, using devices of this kind. In turn it gave the teacher an opportunity to pursue the subject. On the left of the photograph, a development of the children's thinking is illustrated by another device for the measurement of heights. This kind of overlap is probably one of the most encouraging features for both teachers and children.



13. Cloud recording

Some children were faced with the problem of recording the direction in which the clouds moved. This proved a difficult one for them and led them to consult books in search of an answer. They found the help they sought, and interpreted the apparatus in terms of present-day materials. Essentially, their solution was to substitute a plate of clear Perspex for a piece of glass, and to use black drawing paper as the background to their reflector. The cardinal points were superimposed on the Perspex, and then, when the apparatus was suitably aligned, a picture of a section of the sky could be obtained against the black background. Thus they found it much easier to observe cloud movements, and more precise recordings resulted.

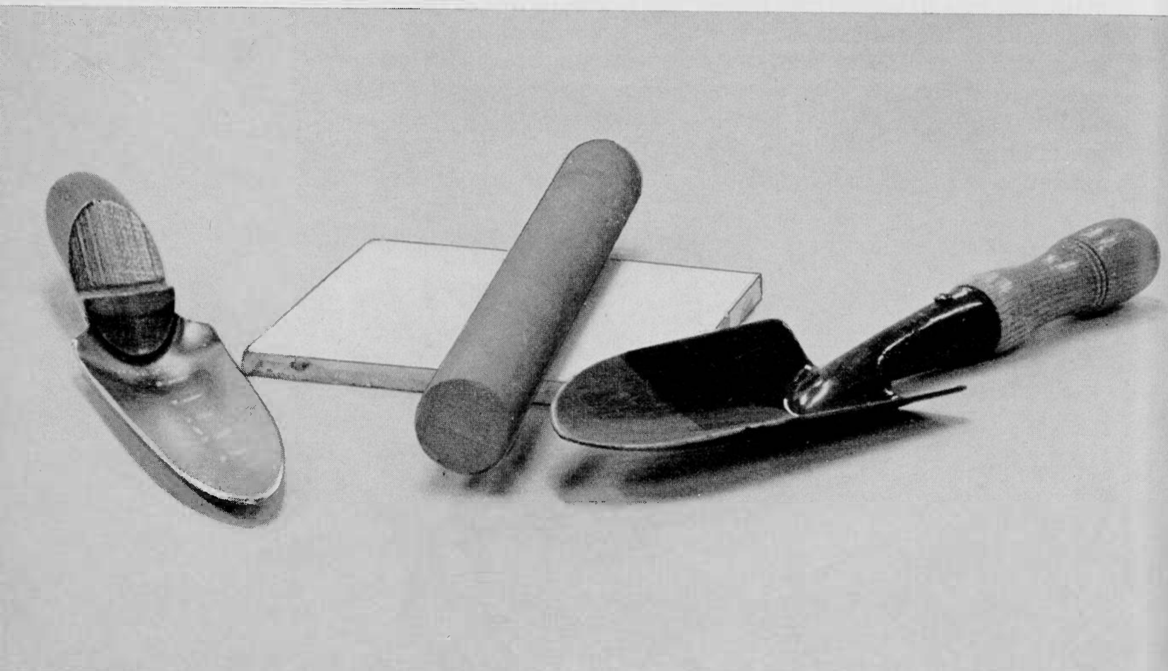


Soil studies

Like the study of weather, the study of soil is a possibility for children in any school, no matter where it is situated. It is, too, the third of the great common environments of living things. Therefore it is one of the fundamental studies which children are likely to undertake. The apparatus for such studies is simple and commonplace. There is a considerable amount of support in textbooks at teachers' level, but much less at the children's level. However, this is not altogether a bad thing, as it will enable many children to come fresh to this study, and to devise means to undertake it for themselves. They can, too, assess the physical properties of soils, and draw up scales of comparison for themselves. The feel of soil is an important means of assessing some of its qualities, and children will naturally use it effectively. Perhaps because this subject has not been studied widely in the five to thirteen age range, it is all the more important to take up its possibilities.

14. Basic equipment

The basic apparatus for soil study is easily assembled. The first necessity will be a hand trowel for obtaining samples. A roller for crushing soil samples can easily be made from a length of ash broomstick. A white tile is important as a background against which to conduct all manner of examinations of soil samples, not only for colour and particle size, but also for the reaction of soils to various conditions. On the left of the photograph is a narrow sampling trowel with its blade marked in inches from 1 in. to 6 in. This is a very useful tool in soil study, particularly when it is desired to add precision to results.



15. Soil sieves

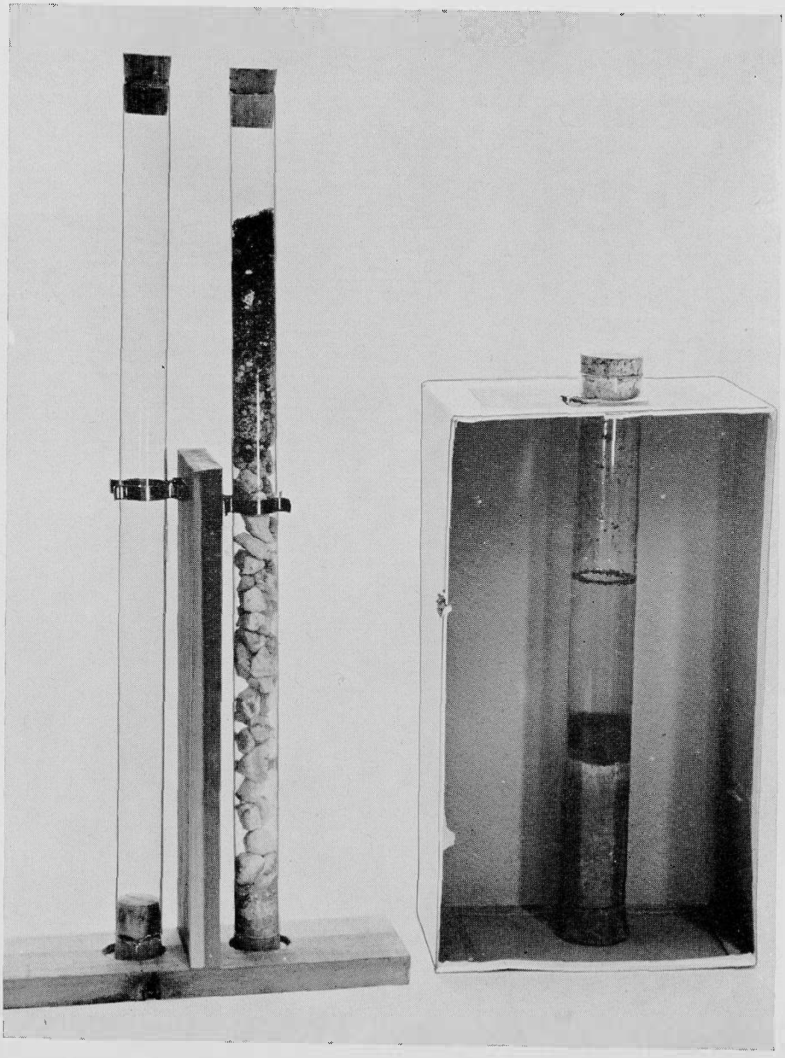
On obtaining soil samples, an early investigation that children will undertake will probably be a simple mechanical analysis of the soil. You can either make suitable sieves for this purpose quite easily from boxes with the bottoms removed and replaced by mesh, or obtain boxes commercially made for this purpose which will rest one inside the other. Four grades of fineness of mesh will probably do all that is necessary for most children's investigations. The illustration shows two box sieves of different coarseness, a culinary sieve, and a piece of fine copper gauze for measuring the finest particles. The results of an analysis of a soil sample dealt with by this apparatus are shown in the foreground in the four jars. Analysis work need not be confined to one example but may cover a large number, including, for example, soil from the back gardens of all the children in the class, or from a variety of sites and excavations around the school, and so on.

16. Soil profiles A

The idea of the soil profile is something which needs to develop naturally in the child's mind on a basis of his or her comparative studies. It is doubtful if the production of soil monoliths will be a starting point, for this is more likely to come much later on, as a climax to the work. However, when a series of samples has been obtained and put into containers as shown in the illustration the first step towards it has been taken. It is important that teachers should encourage children to use helpful methods of setting out their own discoveries.

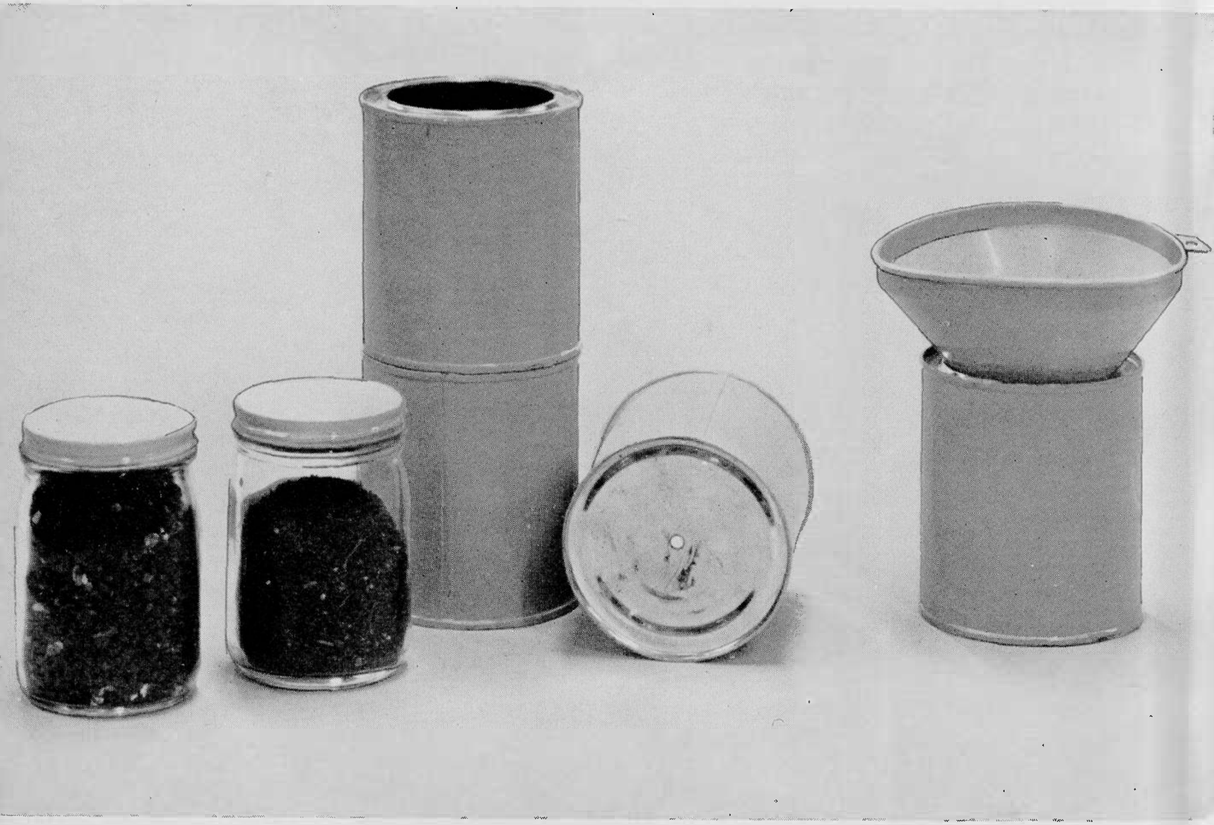
17. Soil profiles B

Two advances on the stage of thinking illustrated in example 16 are shown here. On the right of the illustration we see how a simple analysis is made by shaking the soil with water. A 2 in. glass tube, corked at both ends, is supported in the shoe box stand whilst the contents separate. The apparatus on the left illustrates a simple device for producing a dry profile from another sample of soil. The use of this simple type of wooden stand is recommended for this kind of work. It not only holds the tubes firmly but will allow comparative work to be set up quite easily.



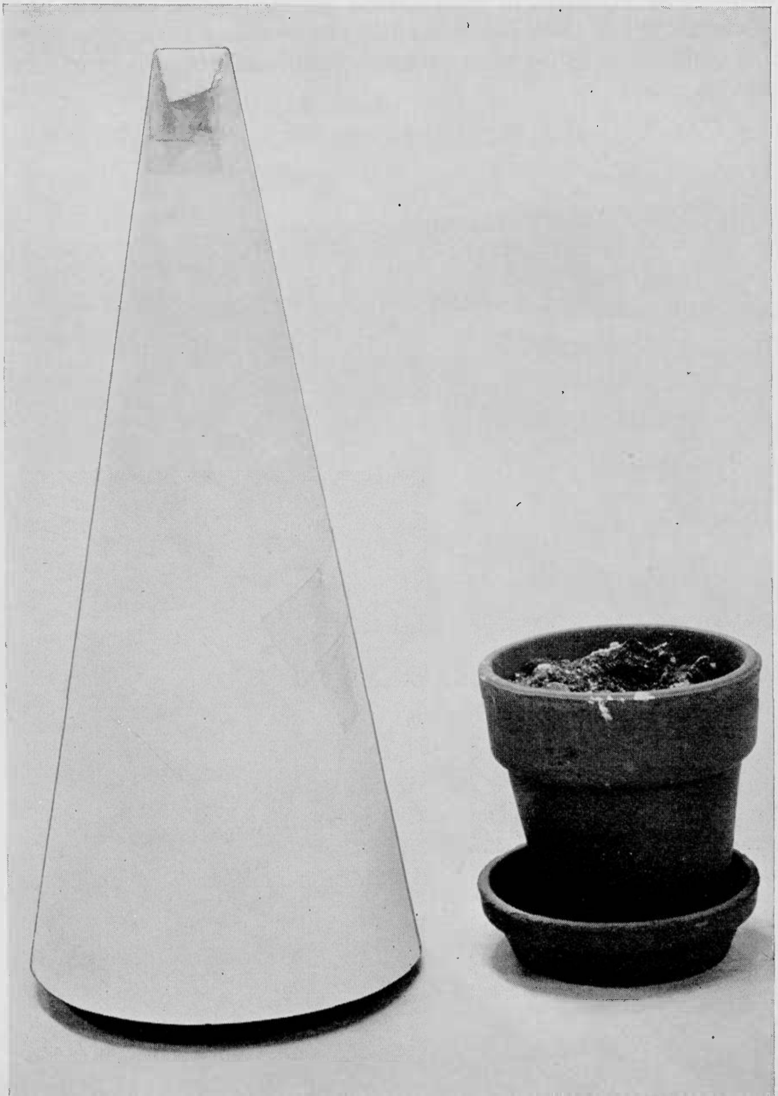
18. Soil testing

The water-retaining properties of soil will probably be investigated. This can be done by very simple means. Standard sized tins make admirable containers, both for the samples and to receive the resultant water which drains through various samples. This illustration shows how they are used. Funnels for similar work can be cut from the tops of large Polythene containers, and so a simple soil-testing equipment may be set up for this aspect of the work.



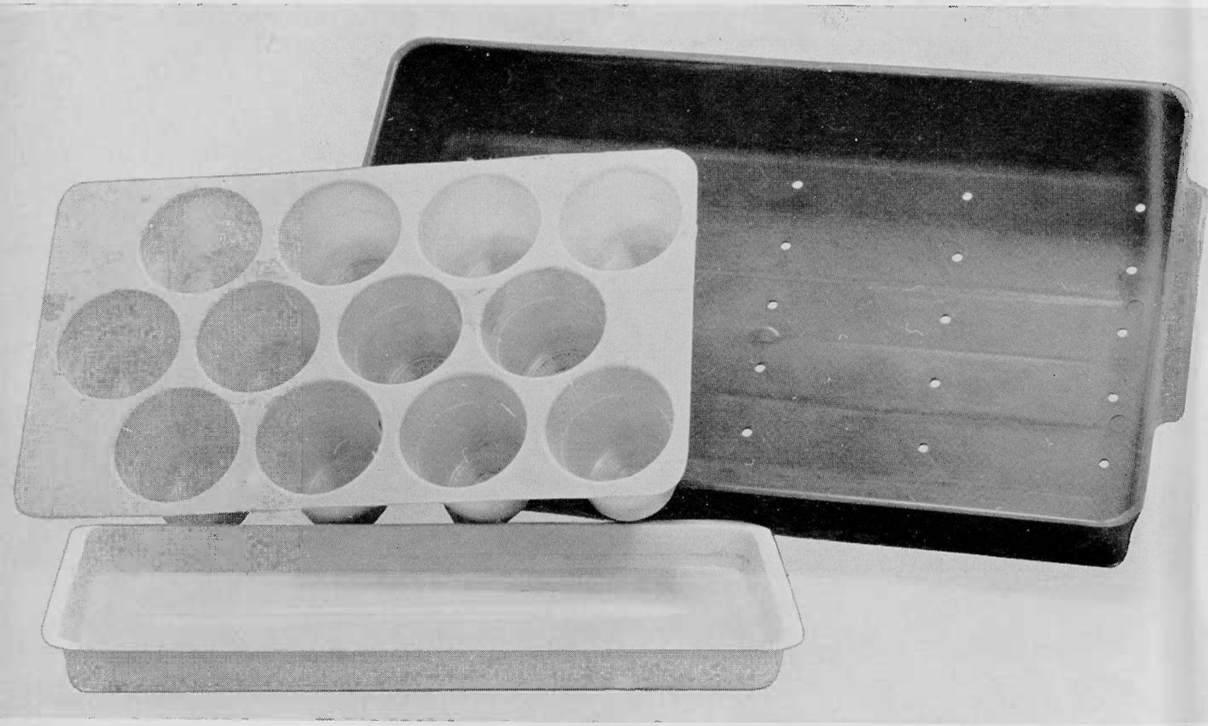
19. Soil—growth tests A

A study of growth in various types of soil is often undertaken by children of all ages. This photograph is a reminder to teachers that they can have comparative studies not only on soil samples, but also on a range of climate types and soil samples. Longer hours of darkness can be introduced by the use of hoods of various kinds. Humidity conditions can be intensified by the use of a clear plastic hood, and so on. In the past, studies have sometimes been limited to mere germination experiments. It is suggested that there is much more that can be done in this kind of study than is sometimes undertaken.



20. Soil—growth tests B

This photograph has been included as a reminder to teachers that some modern plastic products obtainable from the nurseryman will be extremely useful for children's work on soil. Plastic seed boxes, individual germinating cups, and shallow germinating trays will not only be useful as such, but also adaptable for other purposes. Thus, the seed box will store soil samples and large particles, whilst the individual germinating cups are excellent as sorting containers for various purposes. A shallow tray is helpful in the mechanical analysis of soil by shaking. In the present approach to science children are expected to be inventive in their use of old materials and to put them to new uses to suit their purposes. No less will teachers need to be inventive in their search for alternative uses for new material. When there is a partnership in invention between teacher and child, some of the most exciting educational progress in science results.



Appendix I

Teachers' essential equipment

1. Tools

1	Hand drill 0-$\frac{1}{4}$ in. chuck
1 each	Jobber's twist drill carbon or H.S.S. $\frac{3}{32}$ in.
1	,, ,, $\frac{1}{8}$ in.
1	,, ,, $\frac{3}{16}$ in.
1	,, ,, $\frac{1}{4}$ in.
1	Bradawl: size A $1\frac{1}{4}$ in.
1	Bradawl: size B $1\frac{3}{4}$ in.
2	4 in. G-clamps
1	$\frac{1}{2}$ round 10 in. cabinet file, with handle
1	Hammer No. 2 Warrington
1 pair	Pincers 6 in.
1	Steel ruler
1	Coping saw
1	10 in. tenon saw
1	Screwdriver 3 in.
1	Screwdriver 8 in.
1	Surform file No. 101
1	Try square $4\frac{1}{2}$ in.
1	File 10 in. hand second cut
1	File 6 in. triangle second
1 pair	Universal pliers, electrician 6 in.
1	Junior hack-saw
1 pair	8 in. tinman's snips (Gilbow)
1	Adjustable spanner up to $\frac{1}{2}$ in.
1	Hand vice
1	Bib wire stripper

2. Other materials

6 sheets	Glass paper M 2
6 sheets	Glass paper $1\frac{1}{2}$
6 sheets	Glass paper 1
1	Tin Evo-Stik adhesive
1	Tube Croid liquid glue
1 lb each	Oval nails, 1 in., $1\frac{1}{4}$ in., $1\frac{1}{2}$ in., 2 in.
1 lb each	Panel pins, $\frac{1}{2}$ in., $\frac{3}{4}$ in., 1 in., $1\frac{1}{4}$ in.
	Clean rags
1 pt	Tin aluminium paint
2 dozen each	Steel countersunk screws: $\frac{1}{2}$ in. $\times$ 4, $\frac{5}{8}$ in. $\times$ 6, 1 in. $\times$ 6, 1 in. $\times$ 8, $1\frac{1}{4}$ in. $\times$ 10, $1\frac{1}{2}$ in. $\times$ 10
1 box	Resin cored solder
1 sheet	Perforated zinc 22 S.W.G.
7 lb	Potter's plaster or dental plaster
2 dozen each	Cheese head or round head, as available, bolts and nuts and washers: 2 B.A. $\times$ 1 in., 4 B.A. $\times$ $\frac{3}{4}$ in., 6 B.A. $\times$ $\frac{3}{4}$ in., $\frac{1}{4}$ B.S.F. $\times$ 1 in., $\frac{5}{16}$ B.S.F. $\times$ $1\frac{1}{4}$ in., $\frac{1}{4}$ Whit $\times$ 12, $\frac{1}{4}$ in. Whit wing nuts
	Softwood offcuts

Appendix II

Standard manufactured equipment

While the essence of the project is to encourage children to devise and construct their own equipment from simple materials, there also comes a time when some children will need and demand more sophisticated apparatus. With this in mind, we have drawn up a very extensive list so that teachers who wish to buy formal equipment will know better what to requisition. It is unlikely that any primary school will ever need more than a fraction of the apparatus listed here!

Cubes wood 1 in. side	Hardwood	Stopclock	
,, ,, ,,	Ash	Metronome	
,, ,, ,,	Beech	Iron weights, imperial	¼ lb
,, ,, ,,	Ebony	,, ,, ,,	½ lb
,, ,, ,,	Oak	,, ,, ,,	1 lb
Cubes metal 1 in. side	Aluminium	,, ,, ,,	2 lb
,, ,, ,,	Brass	,, ,, ,,	4 lb
,, ,, ,,	Copper	,, ,, ,,	7 lb
,, ,, ,,	Iron	Iron weights, metric	50 gm
,, ,, ,,	Lead	,, ,, ,,	100 gm
,, ,, ,,	Marble	,, ,, ,,	200 gm
,, ,, ,,	Tin	,, ,, ,,	500 gm
,, ,, ,,	Zinc	,, ,, ,,	1 kg

Slotted weight set, imperial	
,, ,, ,, metric	
S hooks	1 in.
,,	$1\frac{1}{2}$ in.
Single sheave pulleys, plastics	6 in.
Double ,, ,, ,,	6 in.
Triple ,, ,, ,,	3 in.
Universal frame	
Scale pans	
Springs, steel	
Hydrometers, simple	
Weighted glass bulb	
Lift pump	
Force pump	
Plane mirrors 4 in. × 3 in.	
Glass block	
Right-angled prism	
Ray box	
Lenses for above	
Colour filters for above	
Lamps for above (12 V)	
Lenses, focal length 10 cm	
,, ,, ,, 15 cm	
,, ,, ,, 30 cm	
Lens holder	
Colour filters: 1 sheet each colour, red, green, blue, yellow, magenta, peacock blue, purple	
1·5 V bulbs	
2·5 V ,,	
3·5 V ,,	
6·5 V ,,	
Wave form helix	
Wave form spiral	
Sonometer wires	
Tuning forks C	
,, ,, D	
,, ,, E	
,, ,, F	
,, ,, G	
,, ,, A	
,, ,, B	
,, ,, C′	
Magnetic iron ore	
Magnet set	

Bar magnets 7·5 cm Eclipse
Cylindrical magnets 15 cm
Brass stirrups
Magnetic needle 10 cm
Stand for above
Soft iron rod
Soft iron wires
Iron filings
Plotting compasses
Pocket compass
Pith balls
Cell plates, zinc
,, ,, copper
,, ,, carbon
Daniell cell
Leclanché cell
Nife batteries
U-bends
Bell
Buzzer
Bell push
Telephone receiver
Microphone
Ammeter 0-3 amp
,, 0-5 amp
,, 0-10 amp
Milliammeter 0-100 mA
,, 0-500 mA
Voltmeter 0-6 V
,, 0-12 V
,, 0-25 V
Battery charger
Copper wire, bare 22 S.W.G.
,, ,, ,, 18 S.W.G.
,, ,, enamelled 22 S.W.G.
,, ,, cotton covered 22 S.W.G.
,, ,, ,, ,, 18 S.W.G.
Constantan wire, bare 22 S.W.G.
,, ,, covered 22 S.W.G.
Nichrome wire, 22 S.W.G.
Bell wire, single 22 S.W.G.
,, ,, ,, 20 S.W.G.
Fuse wire, 1 amp
Insulating tape $\frac{1}{2}$ in.
Terminal block
Flexible wire
Crocodile clips

Lampholders, M.E.S.
,, S.B.C.
Aspirator, Polythene 5 litres
Lever balance
Evaporating basins 75 cm^3
,, ,, 175 cm^3
Basins, stainless steel 80 cm^3
,, ,, ,, 250 cm^3
,, ,, ,, 450 cm^3
Beakers, 100 cm^3
,, 250 cm^3
,, 400 cm^3
,, 500 cm^3
Bell jars, knob top T.F. no spout
,, ,, stoppered, T.F. no spout
Test-tube brushes, head $2 \times \frac{3}{4}$ in.
Bowls, Polythene
Clamps, Nivoc
Boss heads
Mohr clips no. 3
Bunsen clips
Corks, assorted
Cork borers, set of 6
Tally counter
Filter papers Grade 1, 9 cm
,, ,, ,, 2, 9 cm
Flasks, 250 cm^3
,, 500 cm^3
Funnels 9 cm
Thistle Funnels 20 cm
Polythistle heads
Iron wire gauzes 4 in.
,, ,, ,, 5 in.
Glass tubing cutter
Battery jars
Asbestos mats 6 in.
,, ,, 9 in.
Measure 500 cm^3
Pestle and mortars 15 cm
Litmus book, red
,, ,, blue
Test papers, universal
Glass rod 6-7 mm
Spatulae 4 in.
Funnel stands, double
Retort stand and rods
Test-tube stands 8 holes

Tripod stands $6 \times 4\frac{3}{4}$ in.
Rubber stoppers, solid 15
,, ,, ,, 17
,, ,, ,, 19
,, ,, ,, 21
,, ,, ,, 23
,, ,, ,, 25
,, ,, ,, 27
,, ,, ,, 29
,, ,, ,, 30
Rubber stoppers, 1 hole 15
,, ,, ,, 17
,, ,, ,, 19
,, ,, ,, 21
,, ,, ,, 23
,, ,, ,, 25
,, ,, ,, 27
,, ,, ,, 29
,, ,, ,, 30
Rubber stoppers, 2 holes 15
,, ,, ,, 17
,, ,, ,, 19
,, ,, ,, 21
,, ,, ,, 23
,, ,, ,, 25
,, ,, ,, 27
,, ,, ,, 29
,, ,, ,, 30
T pieces 50 mm
Y ,, 50 mm
T pieces, polypropylene
Y ,, ,,
Test-tubes
Tongs, light iron
Troughs, circular 6×4 in. deep
,, ,, 9×5 in. deep
,, ,, 12×5 in. deep
,, rectangular $8 \times 6 \times 6$ in.
Glass tubing 6-7 mm
Red rubber tubing 6·5 mm
PVC tubing 6 mm
Watch-glasses 9 cm
Aquaria, $24 \times 12 \times 12$ in.
Diffusers
Thermometer
Petri dishes
Petri dishes, plastic 90 mm

Appendix III

Furniture and equipment

Practical work at any stage in education puts demands upon space, whether it be for storage, practical activities, or the economics of the sharing of facilities and materials by various groups and classes. Various attempts have been made to improve this situation and some of the suggestions are detailed below.

The construction can be carried out by anyone, as the material advocated is slotted metal angle. This merely needs cutting to size with a hack-saw and bolting together with the bolts and nuts supplied. Some retailers will cut the material to size for a small extra charge. Most standard gauge angle is sold in 10 ft lengths and with this in mind, the units of materials have been kept within the limits needed to make for an economical use of the angle. As it is usual to buy a pack of ten lengths of 10 ft, total lengths of material have been given for each item, so that teachers can work out what will best meet their needs for a given expenditure. Shelving can either be made from suitable wood for supports and a covering of hardboard or an extra piece of angle as a support and a sheet of hardboard as a covering. Again, most shops will supply the material cut to size for a small extra charge.

Little extra skill is called for to construct these pieces of equipment from ordinary plain $1\frac{1}{4}$ in. or $1\frac{1}{2}$ in. angle iron which is commonly sold in 4, 5, and 6 ft lengths for general use. A cheap source of similar material comes from scrap dealers in the form of the side irons of bedsteads. These are usually 6 ft 6 in. long and cost about 1s each, delivered. However, the necessary tools for drilling the angle iron will be called for, as well as simple workshop facilities such as a stout bench and vice. Adequate fastening will be obtained from quarter-inch nuts and bolts—hexagon headed bolts are easier to use than the mushroom headed variety.

The manufacturers of slotted angle market sets of wheels which simply bolt to the lower angle pieces. These sets of wheels are excellent when heavy loads and/or hard wear are anticipated. Less expensive sets of wheels can be mounted in wooden blocks which, in turn, may be bolted to the lower frame.

1. Trolleys

(*a*) WORK TOP TROLLEY

3 ft long × 2 ft wide × 2 ft 6 in. high (without wheels). Three shelves, top with a thick wooden support to a hardboard covering. The lower two shelves for storage of material and apparatus. In some schools where corridors are narrow it has been found better to reduce the width to 1 ft 6 in., though this restricts both the storage and the work top area. When the 2 ft width was used four children could work at a time.

Materials

6 pieces, 3 ft 6 pieces, 2 ft (or 1 ft 6 in.—see notes) 4 pieces, 2 ft 6 in.	} 40 ft of angle

1 set of wheels
Suitable timber and/or hardboard for shelving

(*b*) STORAGE TROLLEY

2 ft long × 1 ft 6 in. wide × 3 ft 9 in. high (without wheels). In schools where storage space in the classroom is limited, it has been found that a movable storage unit is helpful, particularly if it is of a size that will fit into a recess in a corridor or store room. In this unit there is provision for five shelves giving about 15 square feet of shelf area.

Materials

4 pieces, 3 ft 9 in. 10 pieces, 2 ft 10 pieces, 1 ft 6 in.	} 50 ft of angle

1 set of wheels
2 thicknesses of hardboard as coverings for the shelves, or suitable timber

(*c*) TOOL TROLLEY

Base 3 ft long × 1 ft 6 in. wide. Apex ends formed by two 2 ft pieces supporting a 3 ft top rail.

It is usual for tools to be shared in schools and the need both for availability and easy checking can be met with the provision of a trolley unit. The model above consists of a trolley base with two 'A' brackets at either end supporting a top rail. This forms a framework to which a covering of pegboard can be fixed with small nuts and bolts. Washers will be needed on the inside to give a grip in the holes of the angle. Standard pegboard fittings serve as hooks, etc., for the tools. Draw round the outline of each tool with a spirit marker/felt pen to facilitate quick checking.

Materials

3 pieces, 3 ft
4 pieces, 2 ft } 20 ft of angle
2 pieces, 1 ft 6 in.
1 set of wheels (lighter types will do well)
2 sheets of pegboard 2 ft × 3 ft; nuts, bolts, and washers to suit; pegboard fittings as required

2. Storage and display shelves (free-standing)

2 ft 6 in. wide × 1ft 8 in. deep × 5 ft high.
This unit consists of a free-standing angled framework supporting shelves of hardboard, supported or unsupported according to the load. The legs, formed by the 5 ft angle pieces, should be stood on small rectangles of hardboard to prevent damage to floor coverings. Some makers provide plastic feet for this purpose.

Materials

4 pieces, 5 ft
6 pieces, 2 ft 6 in. } 45 ft of angle
6 pieces, 1 ft 8 in.
Pieces of hardboard or timber for shelving

3. Work bench for heavy work

2 ft 6 in. high × 2 ft 6 in. wide × 2 ft 6 in. long.
If this bench is fitted with a stout wooden top and the ends of the legs stand on either plastic feet or pieces of hardboard it will take heavy strains quite easily. A useful addition is a metal worker's vice which can be bolted to the top. The lower supporting rail also acts as the support for a shelf.

Materials

12 pieces, 2 ft 6 in. = 30 ft of angle
Pieces of wood at least 1 in. thick, preferably of hardwood, for the work top
Wood for the lower shelf
Small pieces of hardboard to form floor pads under the legs

4. Room dividers

Teachers have found that the re-arrangement of the layout of furniture in their classrooms can make for more effective working. Occasions arise when it is helpful if they can physically segregate groups of children within the classroom. This is particularly the case when they are introducing new work or methods of working. This has arisen in classes where the teacher has felt it best to begin the Nuffield approach first with a group, then later with the whole class; and also when it has been convenient to have markedly different kinds of work going on at the same time. It has also been found useful as a device to rationalize the accommodation in some temporary teaching spaces that pressure of numbers in schools has brought about.

(*a*) SCREEN TYPE DIVIDER

This consists of a main section 4 ft × 4 ft with feet at either end supported to the main frame by stays. The whole screen can be covered with Essex Board. This is a soft board which easily takes drawing pins, etc., and so makes the divider into a display area as well. The Essex Board is easily bolted to the main angle frame with $\frac{1}{4}$ in. nuts, bolts, and washers. Alternatively the frame can easily be covered with curtain material.

Materials

Main section	4 pieces, 4 ft
Feet	2 pieces, 2 ft
Stays	4 pieces, 1 ft 3 in.

Essex Board 4 ft × 4 ft for the panel or suitable fabric to cover

(*b*) PAIRED L-SHAPED DIVIDERS

This design has been found useful in large rooms where the teacher wanted to set up 'corners' for various different sorts of work. The sections can be either bolted together using cross struts for a fairly permanent unit or double nut devices for less permanent ones.

Materials

Main sections	8 pieces, 4 ft	35 ft of angle
Struts	2 pieces, 1 ft 6 in.	

(*c*) WORKING BOOTH UNIT

In some situations teachers have wanted to set up a permanent working area. The needs have varied from that of housing a small animal unit satisfactorily, to providing a working area where children's experiments could remain for longer periods than they could normally do. Others feel it is a good means of providing a store for equipment and materials in a tidy manner, separate from, yet within the classroom, and under the teacher's control. The unit consists of two sections made up as for the simple divider with the addition of a centre strip. These form the ends and shelf beams. Three 5 ft pieces make the front, and the back remains open for working access. A further 5 ft piece, parallel with the front centre piece and 2 ft back from it, forms a shelf, when covered with hardboard. Cover with Essex Board or curtain fabric.

Materials

2 end sections	10 pieces, 4 ft
1 front section	3 pieces, 5 ft
Shelf	1 piece, 5 ft

Essex Board or fabric to cover as desired
Hardboard 5 ft × 2 ft for the shelf—timber to support if needed. (Use this in 2 ft pieces at about 1 ft intervals.)

For very heavy loads add 2 legs to both of the 5 ft shelf members; pieces of $1\frac{1}{2}$ in. square timber will be ideal, from floor to the angle iron acting as the bearer.

Appendix IV

Storage of apparatus and equipment

Stacking units 1

A useful, simple, easily constructed unit of storage for small articles and glassware can be made as follows:

Materials

Any timber about $\frac{3}{8}$ in. thick by 4 in. or 5 in. wide is preferable. Wood from orange boxes may be suitable. Hardboard offcuts may be used for two sides and any timber up to $\frac{1}{2}$ in. in thickness for the others. Corner posts of about $1\frac{1}{4}$ in. square material will be essential. The overall finished size of the storage units should be 15 in. $\times$ 15 in. $\times$ 6 in. (to the top of the corner posts).

Method of construction

Cut the corner post material into 6 in. lengths, cut the covering material (it should not exceed 5 inches in width) into 15 in. lengths. Assemble this as for a box without a lid. (If very thin material is used, the bottom will need fixing to $\frac{3}{8}$ in. square pieces of wood nailed around the inside of the tray.)

General note

The storage trays will stack one on top of the other. These 15 in. square units seem to fit most conveniently into the average classroom. Up to eight such units may be safely stacked by children. It is essential to remove or add the boxes one by one to avoid breakages. Labelling makes identification of the contents easier for all users.

Stacking units 2

Commercially produced stacking storage units are available in many sizes. These are usually constructed from stout galvanized wire welded to form a crate or deep tray. A lug at each top corner usually locates with the mesh of any unit placed upon a lower one, thus locking the units securely one to the other in a stack. Costs vary greatly, not only with size, but also according to the strength of the materials used. In many areas it is possible to obtain containers no longer used by commercial undertakings because of changes either in the size of the products or methods of handling. Purchase of new units is expensive; but used or surplus units can usually be had for about a quarter of the price when new.

Stacking units 3

Industrial storage units made from reinforced fibre board have been used with success. These units are usually made for the storage of small components and serve equally well in the form room for apparatus and material storage. A number of firms produce this equipment at reasonable prices (sometimes the units are listed as bins or trays). Particulars of products in this field can usually be had from ironmongers, tool dealers, builders' merchants, or industrial suppliers, and are worth enquiring about.

Large-scale approaches

The 'pupil discovery' approach which typifies work in the Junior Science Project has thrown up many interesting new lines of thought in hitherto well defined areas of work. One of these which has demanded further investigation is the child's need, first, to experience situations in life-sized dimensions, then later to work at the smaller scale. This in turn calls for a consideration of suitable and safe rigs and materials. The various components of portable physical education apparatus can be put to a considerable number of uses in science. Suitable extra mounting-blocks or loads or supports can be provided from sections of 6 in. square oak or elm fence posts. A six-foot post cuts into four sections, each 1 ft 6 in. Eight such pieces will provide material for most situations. It is worth while rough-planing and sanding the blocks and finishing them with a coat of floor seal or varnish. The weight of the block might be marked on each, both in exact and 'round number' terms. A half-inch diameter hole bored through the block at one end makes a secure fixing point.

Fixed, outdoor physical education apparatus provides an excellent safe, rigid fixing or support for large-scale experiments. Hoists, pulleys, bridges, structures, and materials can be tested in many ways, using the fixed apparatus as the main base. Small shackles make convenient means of fastening. These, together with ring bolts, spring clips, and cordage can be obtained from yacht chandlers. In the interests of safety it is important to buy rope and cordage of known breaking strain if large-scale work is to be undertaken. Most manufacturers will supply this information on request. If shackles are used in linkages, pliers or a spike will be useful for releasing them if they have tightened under a load.

Acknowledgements

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Miss A. V. Martin
E. M. Martin
N. G. Masson
Miss E. H. Maxwell
Miss J. M. Mills
Mrs O. M. Milnes
W. Moffett
H. Morgan
R. F. Morgan
J. W. Morris

H. G. U. Nawell
Miss M. F. Naylor
R. Nisbet
D. H. Noble
A. Nockels

A. G. O'Hagan
E. Oliver
R. Owen

J. T. Padgett
Mrs J. M. C. Palmer
D. K. Palmer
R. Parker
J. Partridge
A. Pearson
Miss M. E. Pick
Miss M. Pook
Miss H. Porter
Miss M. Punton

J. F. Reed
C. R. Reynolds
Miss M. C. Roberts
R. F. Roberts
A. J. Rose
Miss M. C. Ruddell
W. Rudge
C. T. Rutlege
R. Rylands

Miss B. Schofield
W. Scott
Mrs E. Seaman
J. Seymour
Miss J. Shaw
Miss E. Simms
Sister Mary Edith
Miss W. Small
V. R. Smeltzer
S. Smith
T. Smith
R. Spencer
R. A. F. Springate
G. Stanford
Miss K. E. Steer
F. B. Stokes
Miss D. U. Stonehouse
Miss J. Stringer
Miss M. Swailes
J. M. Swales
Mrs A. G. Swift

H. W. Terry
C. E. Thompson
W. Thornley
M. S. Tickell
E. L. Trendell
Miss M. E. Trickett
Miss P. Tunstall
H. Turner
J. C. D. Twiston-Davis

Miss P. J. Vickers

Mrs M. Wade
A. Wallis
W. L. White
B. Whiting
D. Wightman
The late Mrs A. Williams
Mrs J. Williams
Mrs H. Windle

Schools involved in pre-pilot trials

Abbey Road County Junior School,
Darlington

Allendale County Secondary School,
Hexham, Northumberland

Ambergate Special School,
Grantham

Ballygomartin Boys' Secondary School,
Belfast 14

Ballyholme Primary School,
Bangor, Co. Down

Ballynahinch Secondary School,
Ballynahinch, Co. Down

Bangor Nursery School,
Castle Park, Bangor, Co. Down

Barrow Grove County Primary School,
Sittingbourne, Kent

Beaver Green County Primary School,
Ashford, Kent

Bell's Close R.C. Aided School,
Newcastle-upon-Tyne 5

Bellingham School Camp,
Northumberland

Billingborough County Secondary School,
Sleaford, Lincs.

Birchfield Infant School,
Liverpool 7

Bishop Goss R.C. School,
Liverpool 3

Boosbeck County Primary School,
Saltburn, Yorks.

Borough Road County Primary School,
Darlington

Bourne Primary School,
Bourne, Lincs.

Braniel Primary School,
Belfast 5

Braunstone Frith Junior School,
Glenfield, Leicester

Brinkhill Primary School,
Clifton Estate, Nottingham

Butler Street Junior School,
Liverpool 6

Caldecote Junior School,
Braunstone, Leicester

Cemaes County Primary School,
Anglesey

Chiltern Edge Secondary School,
Reading

Chipping Norton Grammar School,
Oxon.

Claremont County Secondary School,
Newcastle-upon-Tyne

Connaught Junior Boys' School,
Bristol 4

Corbridge C. of E. Aided Junior School,
Northumberland

Corbridge County Infants' School,
Northumberland

Corbridge County Secondary School,
Northumberland

The Dragon School,
Oxford

Dunkirk Primary School,
Nottingham

Elsdon Aided C. of E. County Primary School,
Newcastle-upon-Tyne

Eyres Monsell Infants' School,
Simmins Close, Leicester

Fair View Infants' School,
Gillingham, Kent

Fynamore School,
Calne, Wiltshire

Gilmour (Springwood) Junior School,
Liverpool 19

Glapton Primary School,
Nottingham

Halewood Mackets County Primary School,
Liverpool 25

Harrowby C. of E. Infants' School,
Grantham

The Headlam School,
Newcastle-upon-Tyne 5

Highbank Infants' School,
Nottingham

Huyton Park View County Primary School,
Liverpool

The Lafford School,
Billinghay, Lincoln

Lawn Secondary School,
Swindon, Wiltshire

Llanfechell County Primary School,
Anglesey

Little Bytham Primary School,
Lincs.

Lylehill Primary School,
Templepatrick, Co. Antrim

Lyminge C. of E. Primary School,
Folkestone, Kent

Marlborough Secondary Modern School,
Woodstock, Oxon.

Marsh Road County Junior School,
Middlesbrough, Yorks.

Mersey Street Primary School,
Belfast

Milford Junior School,
Nottingham

Molehill Copse County Primary School,
Maidstone, Kent

New College School,
Oxford

New Parks House School,
Leicester

New Silksworth County Junior Mixed School,
Nr. Sunderland

Newbiggin-by-the-Sea West County Junior School,
Northumberland

Newstead County Infants' School,
Guisborough, Yorks.

Orangefield Primary School,
Belfast 5

Otterburn County Primary School,
Newcastle-upon-Tyne

Padstow Secondary School,
Bulwell, Nottingham

Park Grammar School,
Swindon

Pencarnisiog County Primary School,
Anglesey

Providence County Junior School,
Guisborough, Yorks.

Rhosneiger County Primary School,
Anglesey

Richmond Lodge School,
Belfast 9

Rise Carr County Primary School,
Darlington

St. Anne's C. of E. Controlled School,
Grantham

Segsbury County Secondary School,
Wantage, Berks.

South Hylton Junior School,
Nr. Sunderland

Stockton Wood Road Infant School,
Speke, Liverpool 24

Strandtown Primary School,
Belfast 4

Swansdowne Infant School,
Nottingham

Thorpe-on-the-Hill C. of E. Controlled School,
Lincs.

Twydall County Primary Junior School,
Gillingham, Kent

Walbottle East County Secondary School,
Northumberland

Whithall Infant School,
Leicester

Wincheap County Primary Junior School,
Canterbury, Kent

Windlehurst County Primary School,
St. Helens, Lancs.

The Windley Junior School,
Nottingham

Witham-on-the-Hill C. of E. Primary School,
Nr. Bourne, Lincs.

Woodstock Infant School,
Leicester

Local Education Authorities involved in pilot trials

Anglesey
Birmingham
Bristol
Cardiff
Carlisle
Dorset
Edinburgh
Essex (Chelmsford)
Kent (Folkestone)
Leicester
Liverpool
London (Norwood)
N. Ireland (Belfast, Co. Derry, and Co. Down)
St. Helens
West Riding (Skipton)

Area leaders involved in pilot trials

H. Boyd
J. M. Branson
Dr M. Collis
G. N. Copley
Dr J. Duffey
The late W. Easton
H. Faulkner
Miss J. P. Imrie
R. Jones
C. McAdam
G. V. Pape
Dr G. Reith
A. J. Rose
A. Royle
Miss B. G. Sneyd

The second phase areas established in September, 1966

MATHEMATICS AND SCIENCE AREAS

Blackburn
Bolton
Bournemouth
Bradford
Buckinghamshire
Cornwall
Croydon
Derby
Derbyshire
Durham
Gloucestershire
Hillingdon
Hull
Lancashire
Leeds
Leicester
Newport
Norfolk
Nottingham
Plymouth
Rochdale
Southport
South Shields
Stoke-on-Trent
Sussex
Tynemouth
Uxbridge
Wallasey
Walsall
Warwickshire
Wiltshire
Wolverhampton
Yorkshire

SCIENCE AREAS

Doncaster
Lincoln
Middlesbrough
Somerset
Solihull
West Sussex
Wakefield

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H. Boyd
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R. K. Brinkler
L. Cook
Mrs M. N. Cornish
Dr M. Donaldson
The late W. Easton
A. E. Elsom
L. F. Ennever, S.I.
Mrs W. Fawcus
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M. Leishman
W. K. Mace
Miss B. Mogford
R. Morgan
A. Pearson
Miss M. E. Pick
R. J. Revell
A. J. Rose
D. F. Wright

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