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SCOTTISH SCHOOLS SCIENCE EQUIPMENT RESEARCH CENTRE

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(**continued** on back inside cover)

SSSERC is an independent national advisory centre, solely controlled and largely financed by Scottish Regional and Islands Councils as Education Authorities.

ERRATUM:
Please note that on page 9 Fig. 1 caption is incorrect. The caption should read "Curie point engine (rotates anti-clockwise)". The direction arrow in diagram should also be pointing in opposite direction.

INTRODUCTION

Editorial

Fellow - farewell!

With this issue we say goodbye to Ian Downie who, for the last two years, has held a SSSERC Research Fellowship in Microelectronics Applications for Schools. Ian left the Centre in mid August, returning across the water to his old authority, Fife. There he has taken up a post as a Curriculum Development Officer at the Glenrothes TVEI Centre. We wish Ian every success in his new post.

We shall miss him greatly, not only personally but for the additional expertise in electronics and programming which he brought into the Centre. We are sure that he will be equally missed by those who had got into the habit of 'phoning and writing for his advice and support on both hard- and software engineering problems.

We did try, very hard, to get non-EA, national funding to keep the post going. Had we been successful, Jim Jamieson our Assistant Director might not now be pedalling so hard, trying to cover both physics and electronics. Just as importantly the funding would have been recognition of the need for proper, day to day technical support for the introduction of electronics courses into Scottish schools. The amounts involved were relatively small compared with the central government cash which has poured into the 'soft' side of educational computing. So, Scotland remains without even a token equivalent to the MEP "Control and Technology Domain" or its successor MIT, now busy with in-service work south of the border.

The fellowship may have been an encouraging start but the latest hiatus indicates that we still have a lot of persuading to do. We are sure that Ian will not be miffed that we should use the occasion of his going as an excuse for that last wee moan. Indeed he wrote much the same thing in "The Final Word" the final section of Microelectronics Monograph No.5.

"MeMo 5"

As this Bulletin goes to press "SSSERC MeMo 5" is on its way back from the printers. It should be in the schools before the end of September. Its subject is control, and not just that of purse strings. It begins by giving general background on industrial process control and goes on to describe the construction of a simple sequence controller which can remember sets of instructions. Finally it deals with some aspects of software engineered control and the use of extensible control languages. As with other titles two copies of the MeMo are being sent to every Scottish secondary school, one copy for each of the science and technical departments.

More mundane matters

Saturday Opening

Saturday morning opening resumed at the beginning of September. We will continue opening from 9am to 1pm on the first two Saturdays of each month until further notice.

Erratum - Bulletin 152

In our description of the lamp frame in the "Workshop" notes of Bulletin 152 we incorrectly quoted 600 mm as the length of the 'Grolux' fluorescent tubes. This dimension should have been 900 mm as correctly stated in the "Components List" at the end of the article. We apologise for the error and for any inconvenience we may have caused.

Olympus microscopes

In the "Trade News" section of Bulletin 152 we announced the setting up of a direct marketing, microscope division of Olympus Optical Co.(UK). Griffin & George have asked us to point out that Olympus microscopes for schools are still listed in the Griffin catalogue and will continue to be supplied by Griffin & George.

OPINION

What do they mean?

At a recent point in time I happened to be perusing, educationally-wise, current documentation of summative conclusions for the purposes of consultation. These were targeted for full, frank discussion in an ambience conducive to a useful exchange of views, viz. the draft reports of Joint Working Parties on subjects at Standard Grade.

As always in the van on such topics, the Chemistry JWP have again been stressing the importance of language in teaching and learning. "Thinks!" [1], this, surely is but part of a general problem? For anyone to use poorly this magnificently flexible language of ours is to deny its purpose, that being the communication of thought and meaning.

If the careful, communicative use of words betwixt teacher and pupil be so important, why such sloppiness in the use of written and spoken words by adult educators in, supposedly, communicating with each other? Both in attendance at recent meetings and in some printed material passing through the Centre, we see scant regard for the following principles:

> "The final cause of speech is to get an idea as exactly as possible out of one mind into another".

> "Do but take care to express yourself in a plain easy Manner, in well-chosen, significant and decent Terms, and to give a harmonious and pleasing Turn to your Periods; study to explain your Thoughts, and set them in the truest Light, labouring as much as possible, not to leave them dark nor intricate, but clear and intelligible".

The first is by G.M.Young, the second Cervantes in the Preface to Don Quixote. Both are quoted by Gowers in his prologue to "The Complete Plain Words" [2].

This present "Opinion" is on particularly dangerous ground. As Fraser points out, in his revision of Gowers [q.v.], pomposity does not pay.

In modern mis-parlance, it can be counter-productive. The tables, scenario-wise, can too easily be turned. Recently we were castigated all the way from Hong Kong. This was for printing "velocity" when we should have used "speed". A fair cop, we thought, proof that somewhere, somebody still cares about accuracy of expression.

The lonely path of the pedant is thickly obstacle strewn. That is why we must also poke fun at ourselves. Of that we have been mindful, on the few times we have commented herein on quality of writing and ease of reading. To be otherwise is only to invite deserved and proper ridicule. Besides, in the readability stakes, technical authors start with both natural handicap and excuse. Try "magnetometer" for syllables size in your Fog Index. We can, sometimes, plead for leniency under the special rules governing communication between experts. The writing of which we complain is that which means to communicate non-technical thoughts to teachers, and doesn't.

The best antidote to unauthorised authority, out from where ere it creeps, must be humour. Alistair Fulton put it better when describing the huge, yet largely unrecognised, contribution made by the Goons to the British educational system.

> "Their organised anarchy was a perfect preparation for twitting authoritarianism. Your average authoritarian wouldn't recognise a joke if it sat in his muesli".[3].

We may be facing a growing threat from a new breed of educational authoritarian. Authority often rests on nothing more than an unshakeable personal belief in an inalienable right to tell other folk what to do. We literally approach the ridiculous when the authority of educationalists may rely on others having no idea what they mean. Overstatement? Try the examples on the next page, and judge for yourself.

For obvious reasons, our samples are not fully identified as to their source. We will say that bar one they have been taken from the first pages of recent Joint Working Party papers. As scene-setters (I know, I know, that's a cliché) they oft portend further and greater ill. I also know that we will be counter blasted with salvos of old chestnuts, on quotes out of context and other guff.

All the same, folk really should use language to convey thought and not to hide the lack of it. We could have done our worst. We might have stormed those other battlements of educational sloppiness and illiteracy, flow-charts and diagrams!

First we have that classic, the preambling statement of the obvious:

> "Computing is one of the most rapidly growing branches of modern technology".

Gerra'way!

Now, the incestuous coupling of noun with verb so as to ensure an inherited defect in meaning:

> "It should enable pupils to develop their powers of analysis and synthesis by the critical evaluation of both existing applications and new developments".

Then, we have the very stuff of the educational smoke-screen:

> "In defining the Areas of Study the diagrammatic representation of the Course Structure should be borne in mind as clearly illustrating the integrative nature of the course".

> "It is not intended therefore to provide a detailed, prescriptive list of devices to be studied conventionally, but rather tc indicate the range of activities by identifying some components and devices which could be appropriately used".

This next is the finale, a real broadside. It covers the spectrum from verbo-pomposity to pompous verbosity, all in one sentence. It could have made three or more. Would that it had not been written at all.

> "Elements in this propitious ambience include the required teacher learning provisions, the availability and full accessibility of resources, an administrative structure and process which encourages such an approach, a certain individual style, and, time for forward planning, implementation and assessment".

That sort of writing is very hard to justify. As you may have noticed, with all those long words even our word-processor finds it so.

If having read this stuff, you agree that it ought not to be allowed, why don't join us as members of SCAT* ?

References

1. Bluebottle, "The Goons" BBC Radio.

2. Sir Ernest Gowers, "The Complete Plain Words - Know, say and convey what you mean", 1975 revision by Sir Bruce Fraser, 1985 reprint by Pelican, ISBN 0 14 02.0554 3. (Would that this were standard issue to curriculum developers and examination panels).

3. "Alistair Fulton's Notebook", Times Educational Supplement Scotland, 1986.

Footnote

* "SCAT" - Scottish Campaign against Authoritarian Twittering. (SCAT is a division of SSSERC).

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RESOURCE NEWS

In this bulletin section we give information on some resources for science education which are, at least to us, new.

Primary Science

An event as important as ASE's latest publishing milestone deserves first mention. We refer of course to the new journal from the Association for Science Education - "Primary Science Review". This is the official primary science journal of the ASE. The first issue attracted sponsorship and was sent free to all primary schools.

That first issue pointed to special categories of ASE membership open to primary teachers and primary schools. For teachers the annual subscription rate is £8 and for primary schools £12. For that, in addition to "Primary Science Review", subscribers will get "Education in Science" and the broadsheet "ASE Primary Science" with its practical teaching ideas.

Further information for primary teachers is available by writing "FREEPOST" to the ASE address given on the inside cover of this issue. The SSSERC Bulletin does not usually penetrate the primary sector (we can't afford all that postage). Secondary science departments might like to inform or remind friends and colleagues in primary teaching of the availability of these new resources.

"Animals in Schools"

In Bulletin 142 we gave advice on policy and practice in this area. In that article we mentioned the potential benefits of positive relationships with animal welfare agencies. For our part we have been keeping in touch with the Scottish Society for the Prevention of Cruelty to Animals. Recently we had a visit from a senior inspector who bore welcome news.

This was that the SSPCA were acting as distributors in Scotland for the revised (2nd edition) RSPCA booklet "Animals in Schools". We find this second edition a most useful and concise guide to the subject. Although we would have slight differences in approach and emphasis for minor aspects of the subject, there is nothing of substance that we would not fully endorse.

The SSPCA is able to offer a discount so that the cost of the booklet, which has a cover price of £1, may be as low as 25p per copy if bought in bulk by an EA. Further details on this offer (and of other SSPCA publications or RSPCA titles which are SSPCA distributed) are available from the SSPCA headquarters address given on the inside cover of this bulletin.

Presentation aids for chemists

Earlier in the year the Royal Society of Chemistry announced a number of aids and guides for "teachers, authors and laboratory workers". The items included a range of chemistry stencils for symbols, formulae and stereo structures. As is the way with drawing aids none of these chemistry stencils could be called cheap. Even the least expensive, the "Chem.Art Universal 3.5", is £12.00 with others for perspective diagrams of structures costing as much as £26. Against those high initial costs must be weighed the recurring expense of dry lettering. If you have an on-going requirement for high quality chemical presentation then purchase of at least some these stencils may prove cost-effective. Other possible customers could be science or resource centres rather than individual teachers.

Also available from RSC is a series of publications covering teaching and writing for publication in chemistry and related subjects. Titles include "Chemical Demonstrations - A Sourcebook for Teachers" and "The Chemist's English". The latter is described as "a semi-humorous" book on good English in scientific and technical writing. I'm not sure how anyone can be only "semi-humorous" (funny-analogue rather than funny-digital?). Perhaps the author of the RSC publicity blurb had not read the book?

Further information on RSC aids and guides is available from the RSC's office at the University, Nottingham.

Canolfan y dechnoleg wahanol

Yes its Welsh. To you - Centre for Technology, Alternative. We have before in these pages plugged that interesting quarry in mid-Wales. A number of recent curricular and other developments have given a new impetus to the publishing and book-selling activities of the Centre for Alternative Technology. The CAT bookshop has now produced an annotated booklist. This is available on request with 60p in postage stamps or free if you already know of some of the books and are ordering at least £3 worth. The Centre prefers payment with your order, a non-rubber cheque will do, but they will accept LEA official orders.

Books and booklets are available on the usual alternative energy topics of sun, wind and water as well as a wide range of environmental issues. As you might expect, not all of the publications' contents would meet with universal approval in school science departments. On the other hand the CAT is one of the few central sources of material to set against the publicly subsidised outpourings of the SSEB, CEGB, UKAEA et.al.

In response to some renewed interest in modelling alternative energy mechanisms we have again being reading and dabbling. Perhaps because of a lull in general interest since the late sixties and early seventies, several of the more readable titles on the subject of alternative energy are now, sadly, out of print. Hopefully the latest renewal of effort by CAT may lead to some of those gaps being filled.

Environmental & Conservation Resources

Two other sources of material for schools which deserve to be more widely known are the Earthlife Association and the International Centre for Conservation Education. The former concerns itself with the vital issue of rainforest conservation and produces a "Rainforest Resource Pack" for schools. A subscription to the Association costs £12.50.

ICCE grew out of the World Wildlife Fund and IUCN international education project. It carries out conservation training and of interest to schools is its catalogue of audio-visual materials.

TECHNICAL TIPS

Glass thermometer protection

Abstract

Two methods of thermometer protection are outlined; the first and more expensive option uses brass slot cases, the second a cheap and cheerful application of heat-shrink sleeving. An earlier bulletin article on an anti-roll device is also referenced.

Introduction

How many mercury or alcohol-in-glass thermometers did your classes demolish last session? Our further work on protection for vulnerable glass thermometers was triggered off by an enquiry from a teacher in Dunoon Grammar school.

Protection methods

Slot cases

One, expensive, option is to enclose the thermometers in brass slot cases as supplied by S. Brannan & Sons Ltd. A space is left for reading the scale and small holes around the bulb housing reduce thermal inertia. An example is shown in figure 1. At £3.68 + VAT (Cat. No. 47/732) for the 155 mm version and £3.95 + VAT for the 305 mm with a minimum order charge of £25, you can see why we sought a cheaper alternative.

Heat shrink sleeving

R.S. Components supply clear heat-shrink plastic sleeving in a variety of bore sizes from 1.6 mm to 50.8 mm (stock no. 399-934, £4.05 for 5 x 1.2 m lengths of bore 6.4 mm) This polyolefin tubing will shrink by more than 50% of its diameter when heated. It is claimed to have high mechanical strength, with a maximum continuous operating temperature of 135 °C. It is resistant to splitting, corrosion and attack by organic solvents. It is commonly used for sleeving joints in electrical cable. The 6.4 mm bore was found to be suitable for covering most sizes of thermometer.

Fitting the sleeving

The sleeving should be applied as follows. Slide a length of the material on to the body of the thermometer starting at the bulb end. A smidgin of wet soap will assist the application if the fit is tight. Try to avoid smearing the bulb as the sleeving is to be shrunk at this point. Cut the sleeving, allowing an excess of approximately 5 mm at the bulb end and 20 mm at the other.

You are now ready to shrink the sleeving. For this you will require a hot soldering iron. Using the body of the iron (not the soldering bit) gently rub the sleeving around the bulb of the thermometer. Remember to keep an eye on the liquid thread as you do this. Overheating may push the liquid up to its limit in the bore or break up the thread. Rotate the thermometer making sure that the sleeving shrinks evenly from a point just above the bulb to the end of the 5 mm excess.

There is no need to shrink any of the sleeving which covers the scale marks. Now do the same around the top of the thermometer to a distance of about 10 mm on the excess. When the sleeving is still hot, use a pair of flat-nosed pliers to bend it at right angles to the thermometer. Allow this portion to cool in the bent position until the plastic has set. The finished article is shown second from the left in Fig.1.

The right angle prevents the thermometer rolling off the bench and the 5mm excess at the bulb end protects it when used as a stirring rod. We dropped a thermometer from about 2 metres on to its sleeved bulb end. It bounced! If the thermometer falls flat on the floor it may still break, but at least the mercury or spirit filling and broken glass will be contained.

We looked at the effect of the plastic sleeving on thermometer response times. There was noticeable delay, a sleeved thermometer taking about 10 s longer than an unprotected one to react to a 40 °C change.

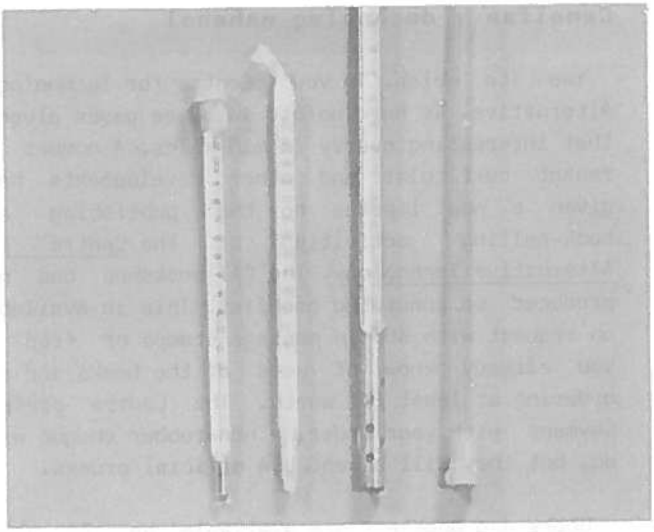

Fig.1 - Some protective measures

Shown from left to right are: a thermometer with a square, anti-roll end cap, heat-shrink sleeving, a slotted case and finally the type of plastic thermometer case from which end caps come.

We hope that this hint will, if not eliminate, reduce the number of 'accidents' and breakages. It but adds to the list of suggestions for reducing thermometer turnover (Groan!) which have already been published (see reference). Some of those ideas were sent in by teachers and technicians. We would be glad to hear of any other simple ideas for protecting apparatus against breakages. That would include fragile items other than thermometers.

Reference and anti-roll

An anti-roll device and an idea for protective storage were published in SSSERC Bulletin No.75. Similar devices have also appeared in the "School Science Review". Amongst the best and simplest of these was the fitting of a folded slip, a flag as it were, of p.v.c. tape at the top of the thermometer stem.

Since that time suppliers have responded to a campaign mounted by SSSERC and others. Thermometers are now quite often supplied complete with some sort of anti-roll provision. For example in figure 1, note the square end cap which comes with the thermometer tube. "Ah" - we hear some of say - "that's what its for!".

The brachistochrone

Pupils may be surprised that the quickest means of travel between two points is not always by the shortest route. One such case worthy of study is when the moving object is under the action of a constant gravitational force and the destination lies diagonally downfield from the starting point. Analysis of the problem can provide a means of distinguishing between acceleration, velocity and average velocity. The key is to realise that the average velocity for the journey has to be maximised. Suppose the journey took the shortest route, then the acceleration throughout would remain constant at a value of, say, a_s. In order to increase the average velocity from the value over the shortest route, the route should be changed so that the initial acceleration is higher than a_s - getting the speed up quickly.

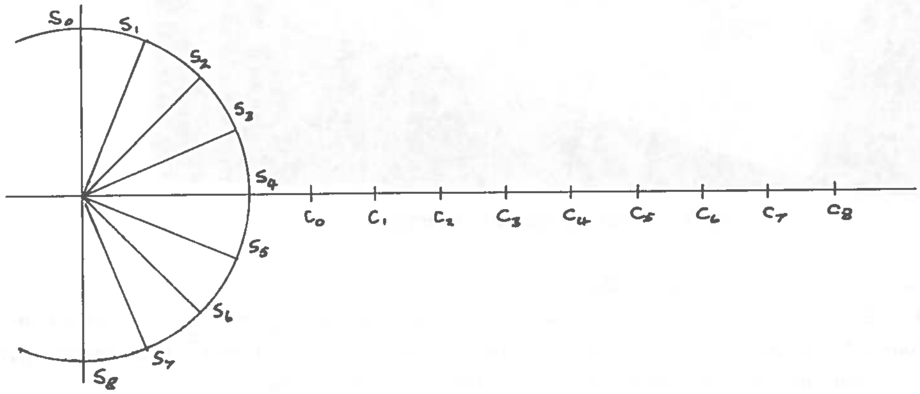

Fig.1 - Geometric construction of cycloid, parts 1 & 2

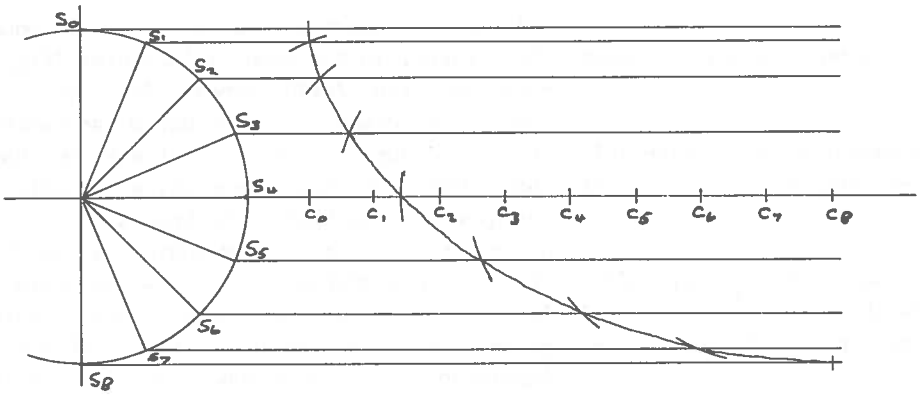

Fig.2 - Geometric construction of cycloid, parts 3, 4 & 5

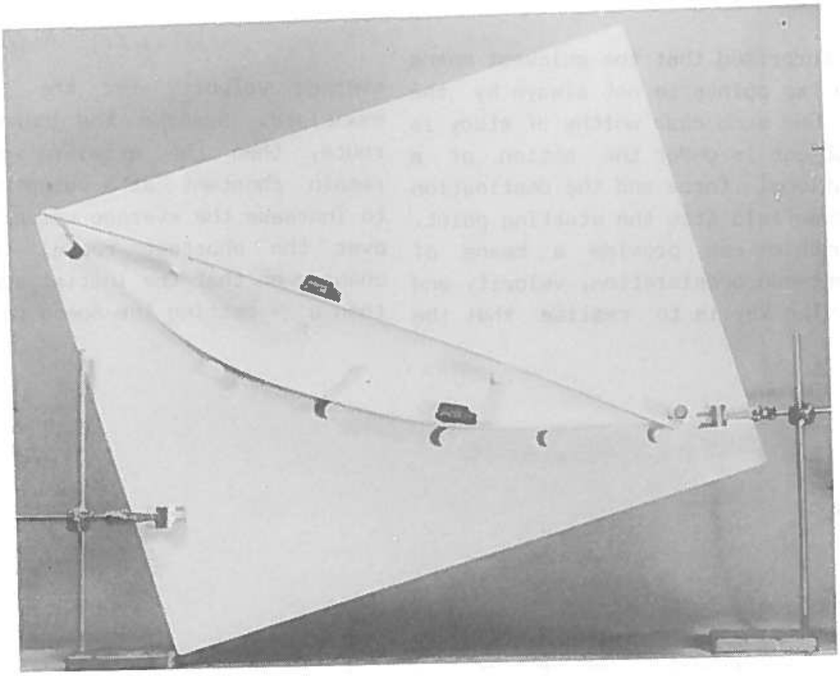

Fig.3 - Photograph of tracks

The answer to what is known as the brachistochrone problem is a curve called a cycloid - the curve followed by a point on the rim of a rolling wheel. It can be demonstrated by measuring the time taken by model cars to run down flexible tracking from one level to another along different trajectories.

Construction

A geometric means of drawing a cycloid is shown overleaf and described below:

1. Draw a semicircle, diameter d, and divide into 8 equal sectors. Label points S_0 to S_9 as shown (Fig.1).

2. Project a centre line from S_4, mark off a length d, and divide this length into 8 equal divisions of d/8. Label points C_0 to C_8 as shown (Fig.1).

3. Project 8 lines, from S_0 to S_3, and from S_5 to S_8, parallel to the centre line (Fig.2).

4. From each point, C_0 to C_8, construct an arc of diameter d to intersect the nine projected lines in turn (Fig.2).

5. Join the intersects with a smooth curve to obtain the cycloid.

A sheet of hardboard can be used as a mount for the tracks. In the model illustrated (Fig.3), the board measures 20x30 inches. The cycloid curve should be drawn on the board and marked by a series of pegs to support the track. We used one inch dowelling for the pegs, which were screwed and glued to the board. The tracks were made out of plastic, 16 mm, lipped edging, as used to edge shelves. Such edging is sold by hardware shops. Two strips should be butt jointed together and glued to a third retaining strip (Fig.4). Thus fashioned, the track should be fixed to the pegs on the board.

Fig.4 - Cross section of track to show fabrication from lipped edging

Tracks of other shapes should be fastened to the board for comparison and might include: (1) a straight track; (2) a track with initial incline which is steeper than the cycloid's; and (3) a track with an initial incline which is less steep than the straight track. In our version, small model cars whose length is about 2 inches were used as the vehicles.

Practical investigations

With Standard Grade Physics in the offing, teachers may soon be looking for topics for practical investigations. This could be one. One approach might be to let the pupils suss out the cycloid route for themselves. Another approach might be to start with a cycloid track and to pose a number of questions: observe the variation in speed; determine the relationship between the journey time and the start position on the track. Results from the latter exercise are quite startling.

Acknowledgement

The idea for this article came from the section on 'String and sticky tape experiments' in a recent issue of the American journal, 'The Physics Teacher' [1]. It jogged my memory of undergraduate lectures - I'm usually happy to let those neurones slumber!

Reference

1. 'The Physics Teacher', Vol.23, No.6, September 1985, "The Brachistochrone - or, the longer way round may be the quickest way home".

Curie point motor

This idea is also adopted from 'The Physics Teacher' and is based on articles published earlier this year by George Barnes [1,2].

The Curie point is the transition temperature between paramagnetism and ferromagnetism. When an unmagnetised piece of a ferromagnetic substance is placed in a strong magnetic field the domains within are aligned with the field. The material exhibits magnetisation - it becomes observably magnetised. When the substance is heated beyond its Curie point the domains vanish; it has become paramagnetic and the observable magnetism has gone.

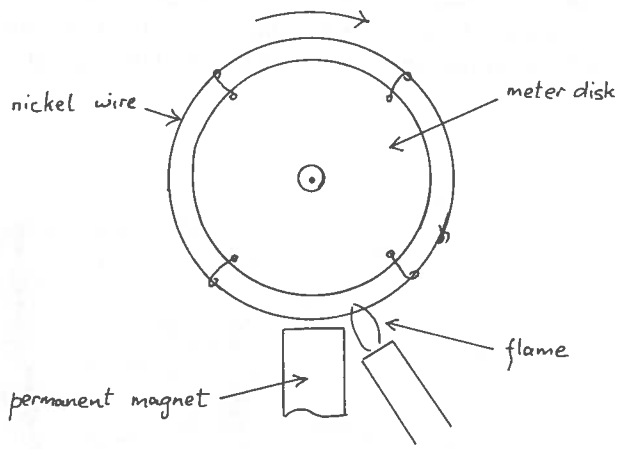

Fig.1 - Curie point engine (rotates clockwise)

Nickel wire is used in this demonstration because it has a lower Curie point than iron, their points being 356°C and 760°C respectively.

One way of making a Curie point engine is to attach a single-turn ring of nickel wire to a fine rotatory mechanism so that it can turn about a vertical axis. A pole of a permanent magnet should be mounted close to the nickel wire so that the wire is magnetised and attracted to the permanent magnet. The resultant torque on the rotatory mechanism in this condition is zero. If a cool flame is then played on the wire to one side of its nearest approach to the magnet, the magnetisation in that part of the wire which is within the flame is destroyed. There is an unbalanced torque on the rotatable mechanism, which therefore starts to turn.

As the torque is small the rotating mechanism must have a very fine suspension and be as 'friction free' as can be contrived. One suitable is that which is found within electricity meters - such a meter should be stripped down and the rotatory part, complete with suspension bearings, removed. Unfortunately, it is impracticable to remove the frame which supports the suspension - a suitable frame has to be home-built. Of the two sorts of meter, that with the square cross section face is easier to dismantle than that with the round face.

Second hand electricity meters are available from SSSERC at £3 each (Surplus item number 357).

An 'F'-shaped frame to support the rotating mechanism (Fig.2) can be built with 9 mm cross section brass bar; the length of the upright is 150 mm; that of the cross supports, 80 mm. The frame should be fixed on a firm base, such as 6 mm sheet steel measuring 80x100 mm. The parts can be fastened together with 4 BA screws using an appropriate tapping drill (3 mm) and tap.

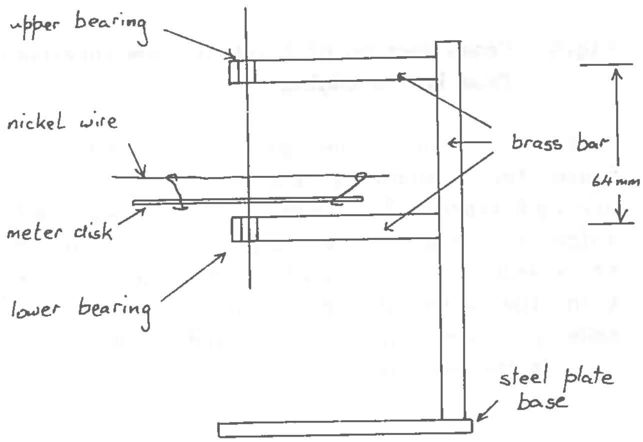

Fig.2 - Support for rotating mechanism

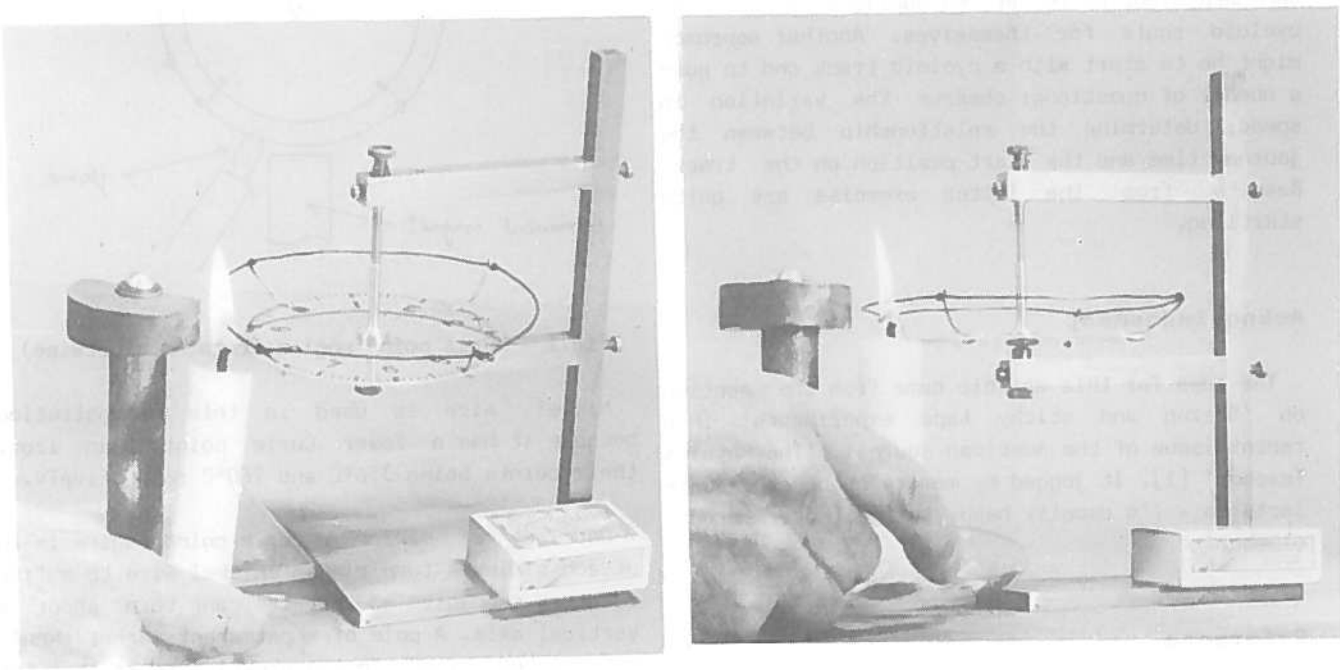

Fig.3 - Curie point engine

The nickel wire should be mounted about 15 mm out from the rim of the meter's disk. Four holes should be drilled through the disk, each near the rim, and one hole per quadrant. These holes are used to support wire spokes which hold the nickel wire out beyond the disk. In our trials we first of all tried using copper wire for the spokes, but found that copper annealed and became misshapen in the heating. So the copper was replaced with nickel, which proved to give better support for the nickel ring, but at the expense of an asymmetry in the turning effect.

The spokes were found to give an improved support when they were raised at an angle of about 30º above the horizontal, elevating the nickel ring above the plane of the disk. The wire spokes were fastened to the disk and wire ring by being bent over with a pair of pliers. The construction of the device can be seen clearly in the photographs in Figure 3.

Nickel wire can be obtained from BDH; a 250 g reel of 1.25 mm diameter wire costs around £10. In our trials we used 22 s.w.g., which is close to the diameter which BDH can supply at present.

A smallish flame should be used as the source of heat. Suitable sources are a candle, or a small, solid fuel burner as used to heat a model steam engine. The flame from a bunsen is possibly too large and hot. The effectiveness of the motor depends on the ability of the hot wire to cool down to a temperature which is well below the Curie point before it reapproaches the magnet.

Many variations in the design could be tried. For example, the ring of nickel wire could be replaced by a series of ten or twelve small loops of wire staggered round the perimeter of the disk. Another possibility is making an oscillatory engine by hanging a piece of nickel at the end of a pendulum and placing a permanent magnet near to it - as the nickel swings up towards the magnet it passes through a flame, demagnetises, and swings away due to gravity.

A rate of rotation of about 1 revolution per minute should be expected for the engine described in this article - for those who work solely in SI, about 10 mHz. Pupils who disparage the economic importance of the device should be asked to work out its efficiency.

References

1. 'The Physics Teacher', Vol.24, No.2, February 1986, "Demonstrating the Curie point of nickel", G. Barnes.

2. 'The Physics Teacher', Vol.24, No.4, April 1986, "Rotary Curie-point heat engine", G. Barnes.

* *

D-A and A-D conversion Notes for CSYS Physics

The newish section of the CSYS Physics course incorporates most of the analogue and digital electronics which is outlined in SCDS Memoranda 53 and 59. There is mention in these memoranda of D-A and A-D conversion, but there is possibly not enough detail either to follow the theory or to build working circuits. As the CSYS course includes objectives on these topics, and as the background theory is unfamiliar to many teachers, SSSERC has prepared a set of notes on experimental details and theory.

The notes are called **"A-D and D-A Conversion"**. They may be obtained on application to SSSERC at a nominal charge of 40 p, to cover the cost of photocopying and postage.

Topics described in the notes are:

- the binary weighted D-A converter using resistors and a summing amplifier;
- the D-A converter with an R-2R ladder network and summing amplifier;
- driving resistor network D-A's from TTL devices;
- using the ZN425 device for D-A conversion;
- the counter ramp A-D converter;
- the architecture of the ZN425 device;
- a test circuit with the ZN425 device as a counter ramp converter;

precautions required in grounding analogue and digital devices;

review of other methods of A-D conversion.

* *

Servo mechanisms

Readers are reminded that SSSERC has available notes on servo mechanisms, again as resource material for the CSYS Physics course, and for Higher Engineering. There are two sets of relevant notes, both sets costing 40p each:

"Servo motors - Angular position control"

"Servo motors - Speed control"

* * * * *

EQUIPMENT NOTES

pH meters for Standard Grade

Abstract

This article outlines possible strategies for the provision of pH measurement, particularly at S3 and S4. It includes a tabulated market survey and précis results from pH meter evaluations.

Introduction

Chemistry departments will almost certainly possess a pH meter, perhaps shared with Biology. The use of such a meter will probably have been largely confined to S5 and S6. Now, with a Standard Grade Chemistry syllabus at the consultation stage these instruments look set for wider usage. There will be the problem of providing pH measurement for lower forms whilst also ensuring the availability of reliable pH instrumentation for senior classes.

If the existing meter is given a lot of hard use, it will run a bigger chance of damage. There may be a single death blow because of careless handling. Alternatively there may a gradual deterioration in the speed of probe response and output span - the probe having a lower mV output per pH change. Such longer term effects would eventually render the system unsatisfactory for most tasks at SYS level.

Probes and electrodes do deteriorate slowly even during storage; some manufacturers quoting shelf-lives of 12 months. In practice, probes may give adequate performance for several years. If you are lucky enough to have a meter with a slope control the gain can be tweaked up to compensate for smaller signal outputs from the probe. Detailed advice on such technical matters as well as on recommended methods of probe storage and rejuvenation is given in our guide on school pH meters and probes [see reference 1].

However in meeting broader requirements of both junior and senior practical work, there are a number of possible approaches and buying policies.

Possible Strategies

(a) Purchase a second probe for use with the same meter, and relegate the older probe to Standard Grade work.

(b) Purchase a second meter and probe. Reserve one system for use in Standard Grade work.

(c) Reserve pH instrumentation for use by senior classes with the use of liquid indicators and some special pH papers for the first examination work.

The second probe option

A replacement probe can be purchased every three or four years or when the performance of the younger of the two falls below an acceptable level. It can then be handed down. All of this assumes that probes are looked after reasonably well. Glass electrodes may run greater risk of harm when supposedly safely stored than they do in use. During periods of non-use the aqueous solution in which the glass electrode or probe is stored may dry out. The gel on the surface of the glass may then be damaged beyond rejuvenation [1].

A second system

This doesn't need to have a high performance. A meter and probe suitable for lower school use can now be purchased reasonably cheaply. Recent advances in electronic techniques, principally the use of large scale integrated circuitry, has led to much instrumentation becoming cheaper in real terms. pH meters are no exception.

'Disposable' systems

In fact the 'throw-away' age has arrived even in this field. A complete system, meter and electrodes, in a pen-like package has recently come on the market. These integrated meter-probe assemblies at £30 to £35, now cost about the same as a typical replacement for a conventional probe. We have subjected a sample to our test procedures and it performed satisfactorily.

Small, conventional systems

Less revolutionary but still not outrageously priced are small, basic digital pH meters. A number of these are now available, reading to 0.01 pH, complete with probe and selling at about £75.

Antimony electrode meter

Again this is relatively novel and is illustrated in Fig.1. This system is not only reasonably priced but is apparently resistant to both physical and chemical damage. The antimony metal which replaces the special glass as the pH sensitive electrode is virtually indestructible. Would you really be relaxed letting S3 spend an afternoon jabbing a brittle glass electrode into a gravelly burn? With this type of electrode your blood pressure will not be raised.

Fig.1.

Horticultural meters

We have also examined the cheap, soil pH meters sold by garden centres. These are of the type occasionally waved around by those Bill and Ben look-alikes at "the Beechgrove". Such meters sell for about £10 each. In our tests, confusing results were obtained when measurements were attempted in aqueous solutions and buffers. Consequently we do not recommend this type of meter for such laboratory based work.

Relegate old, buy new

Alternatively if the existing meter is old and the worse for wear, its performance may still be adequate for Standard Grade. A modern meter could then be purchased for CSYS work.

The indicators route

A totally different approach is the use of a full range indicator followed by the appropriate narrow range paper. The former could be universal indicator as paper or solution, the latter comes as strips sold in boxes of 100 or 200 strips at typical prices of £4.25 per box. Each set spans a range of about 3 pH units with a discrimination of 0.3 or 0.2 units. Six boxes are needed to cover from pH 1.8 to 12.0.

With paper strips a whole class can be making measurements at the same time and the initial capital outlay is much reduced. The 'running costs' will also be much lower provided you do not make too many measurements. Forty pairs of pupils each making 20 measurements in the course of a year will consume about £18 worth of test papers. Setting that against the replacement of the probe, say £25 over three years barring accidents, the difference in costs is slight. The meter does have the advantage that an unlimited number of readings can be made, to a greater degree of precision, at no additional cost. It is desirable also for pupils at Standard Grade to be exposed to some instrumentation.

Another composite possiblity is the use of Universal indicator solution, or paper, with the narrow range requirement met to some extent by the less well known Yamada's Indicator. The latter has distinct colours for pH 4 to 10. The recipe is given below:

Thymol blue	5 mg
Phenolpthalein	100 mg
Bromothymol Blue	50 mg

all dissolved in ethanol and made up to 100 cm^3. 0.05 M sodium hydroxide is added until the mixture is green and the lot made up to 200 cm^3 with de-ionised water.

Colour changes are:

pH	4	5	6	7	8	9	10
	red	orange	yellow	green	blue	indigo	violet

pH meters - a buyer's guide

If a school opts for the purchase of a replacement or additional meter, what are the features to look for? A wide range of meters has been tested at this Centre and by CLEAPSE School Science Service in co-operation with SSSERC. Full SSSERC or CLEAPSE test reports are available for the models listed in tables 1 & 2. Note that some manufacturers list their prices without the probe and in these cases an extra £25 - 30 should be added. The two common types of connections are BNC and coaxial.

The choice of meters available to schools is wide and no 'best buy' is singled out. In any case some extra facilities will not have the same desirability for all teachers. It is possible to divide our outline specification in two. Firstly we indicate those features required to undertake the suggested practical. This basic specification is followed by a description of extra facilities which may be useful in more demanding or specialised applications. As with other aspects of pH measurement, these issues are treated more fully in the SSSERC guide [1].

Specifications

A: Features considered essential are:

(i) safety in operation,(mains powered models). Lack of space precludes detailed description of SSSERC requirements. Separate guidance, applicable generally to school laboratory equipment, is in preparation.

(ii) readability of not more than 0.1 pH units over most of the range. This should cover virtually all school uses. The activities for Area 3, Topic B of the draft Standard Grade Chemistry suggest the measurement of the pH of a variety of acids and alkalis from the lab. and home. For a few of these cases this will be below 2 or above 12.

Many **analogue meters** have scale divisions sufficiently large for easy interpolation down to 0.1 and some to 0.05. A few are fitted with a mirror to remove parallax errors. Others have expanded scales where a narrow part of the pH range is expanded to cover the full scale allowing easier reading of small changes. This can be particularly useful in biological and biochemical investigations where, for example, small changes in pH are used to monitor enzymic reactions.

Digital meters, competitive with or cheaper than analogue counterparts, may read to 0.01 pH. With these meters, once a steady read-out has been attained, the need to estimate has been removed. However they bring their own problems. They don't give as good a sense of the direction and speed of change as do analogue meters. Small changes in the output from the probe cause a continuously changing last digit which may confuse young pupils. When standardising the meter and probe pupils often try to set the read-out to exactly 4.00 or 7.00. Not only is this time consuming, but is probably also a waste of time. This is because most of the buffer solutions used in schools are quoted as being accurate only to within 0.02 pH units.

(iii) well designed, robust case. Controls should be well laid out and it should be easy to set a desired value with the "buffer set" controls when standardising in a buffer solution. Equally a chosen setting should not be too easily disturbed.

(iv) suitably sized probe with a protective skirt. For most purposes the general-purpose combination probe is preferred. When fitted with a protective skirt it should enter easily into a boiling tube. Polymer bodied probes are sturdier than the older glass stemmed type. Gel-filled probes require no maintenance in the form of filling. For particular applications, e.g. measurement of fresh waters or of protein solutions, special probes or indeed two separate electrodes are recommended.

(v) 'low battery' warning for battery powered models.

(vi) clear operating instructions. If possible these should be on the meter case in abbreviated form as well as in longer form in a card or booklet.

(vii) suitably high input impedance. Most probes have a resistance of the order of 100 - 300 MΩ at 20°C, almost entirely due to the resistance of the glass electrode. The input impedance of the meter must be several orders of magnitude higher, otherwise the response will be slow, noisy and in error. Note also that the resistance of the glass electrode approximately doubles for every 7°C fall in temperature. To be able to cope with most probes, over a range of temperatures, the input impedance should be of the order of 10 Ω (100 GΩ) or greater. If this impedance is high enough the meter will also be suitable for some more exotic applications, e.g. with ion selective electrodes.

B: Features which can be useful, but are by no means necessary for Standard Grade work include:

(i) temperature compensation controls. Most measurements are made at, or close to, the same temperature normally that of various solutions at room temperature. The error resulting from neglect of temperature correction is very small. Typically it is about 0.003 pH units for each pH unit away from pH 7, for each degree away from the temperature for which the meter has been set. For example, if measurements were made at 45°C on two solutions of pH 6 and 13 with a meter previously set for 20°C the errors resulting from not applying temperature corrections would be :

1 X 0.003 X 25 (=0.075) and
6 x 0.003 X 25 (=0.45) respectively.

Thus compensation can often be ignored for measurements close to pH 7 and with small temperature differences. Alternatively, the necessary corrections can found in tables or graphs supplied by the manufacturer. This process is fine for single readings, but would be unsuitable for continuous recording.

(ii) slope controls. These are useful in that compensation for the reduced output of ageing electrodes can be made, thereby prolonging the useful life of electrodes (see "Introduction" and ref.[1]). This control should not be readily accessible to pupils. Models with a rotary control on the outside of the case are fine for research labs, but not so convenient in a school laboratory. There the fiddling hands of pupils may alter the setting. Calibration in two buffers will then have to be repeated. The best arrangement for school use is a preset potentiometer inside the case and accessed with an instrument screwdriver.

(iii) millivolt scales. Models fitted with this facility cost very little extra. Such meters can be used in redox work as accurate high resistance voltmeters for measurement of cell e.m.f.s. The commonly found range 0 - 1400 mV is usually adequate for such purposes, but some meters have a second range of 0 - 2800 mV.

(iv) output for chart recorders or computer interfaces. On school meters this is commonly an analogue type intended to drive either a chart recorder or a demonstration meter. It is often 1.4 V fsd which can be fed straight into the analogue port of a BBC microcomputer. A few pH meters have a bipolar output, eg -0.70 to 0 to +0.70 V. With these an offset is needed before interfacing to the analogue port. An output is not essential for Standard Grade work, but is useful for either longer term logging or in providing a large screen display for demonstrations. Note that very few of the digital meters in the schools' price range have such an output.

pH probes (combination electrodes.)

It will be noticed from tables 1 & 2 that probes are sometimes included in the package. Where this is not the case the manufacturer usually recommends a particular probe.

However there is little reason why you shouldn't purchase a cheaper probe elsewhere, either at the time of purchase of the meter or as a replacement.

Most modern meters have a zero point at pH 7 and any probe with an E^o value of 7 can be used with the meter if the plug on the probe lead matches the socket on the meter. Coaxial and BNC are the two commonest types of connector. An additional but slight problem concerns the output of the glass electrode. This is nearly always close to the theoretical Nernstian value of 58.16 mV / pH at 20°C. Small differences because of quality control variations will produce only small errors in the read-out. Compensation for these can be made as for ageing effects (see p.12) with an external slope control. On meters without this facility, it may be possible to identify and use an internal preset.

Table 3 shows a range of prices for some general purpose probes available from several suppliers.

Rampant badge engineering causes further complication for prospective purchasers. One of our evaluation samples had a self-adhesive label, bearing model name etc., which covered another similarly styled but different name. There was no certainty that the lower stratum was the original.

A contemporary problem, not unique to pH meters, is the pace at which models of instruments disappear completely from the market or are replaced. The number of times this happened during the Summer alone meant this article being redrafted several times. The updated models will be evaluated in the near future and test reports made available.

For reasons we do not fully understand the prices of a few models have risen very steeply since the test dates. In several cases increases have outstripped inflation manyfold. If being charitable,we would attribute some of the increase to currency movements. To-day we would almost certainly omit these from our testing programme and from any list of recommended models.

Finally the commercial! Available from the Centre are individual test reports on some 30 pH meters. Once you have decided on price range or particular features please get in touch for further advice and/or copies of relevant test reports together with background notes on test procedures.

Reference

1. SSSERC, "School pH meters & probes - Advice on their use, maintenance and the diagnosis and remedying of faults", 1984. (Available from the Centre at £1.20 including postage).

model/ supplier & price	probe incl.?	pH scale(s) divisions (readability)	millivolt	batt./ mains	outputs	other features	comments
Astell PMA 101 £93	Y Co	2-12 by 0.1 (0.05)	none	B	none	T, C	price includes batt.; buffers & case.
Griffin 20 'Student' £58 £78	Y Co Y BNC	0-7 & 6-14 by 0.2	none	B	none	none	no meter as such. Dial is turned till LED lights. PP3 excl.
Griffin 40 £98	Y BNC	0-14 by 0.5 (0.2)	0-1400 mV	B	0 ±60 mV	none	PP9 excluded BE - £34.83
Harris Envir. £85	N Co	0-14 by 0.2 (0.1)	none	B	none	C	PP6 excluded
Harris S-range £84	N Co	0-14 by 0.2(0.1)	0-1400 & 0-2800 mV	B	1.4 V	T	PP9 excl.
Irwin EA0331 £96	N Co	0-14 by 0.2 (0.1), 3.5-10.5 by 0.1 (0.05)	0-1400 & 0-2800 mV	B	0-50 mV	T	two PP3s excluded
Irwin EB0331 £108	N Co	0-14 by 0.2 (0.1), 3-11 by 0.1 (0.05)	0-1400 & 0-2800 mV	M	0±150 mV	T	
Irwin RA1909 £98	N Co	2-12 by 0.2 (0.1)	none	B	none	T	PP6 included
Kent IML7015 £121	Y BNC	0-14 by 0.2 (0.1)	0 ± 400 mV centre zero	M	none	T, S	probe stand & buffers included
Phoenix PHM4 'antimony' £58	Y	2-12 by 0.2 (0.1)	none	B	none	none	Sb electrode includes PP3 & buffer pH 7.

Table 1 - Analogue pH meters (continued over)

model/ supplier & price	probe incl.?	pH scale(s) divisions (readability)	millivolt	batt./ mains	outputs	other features	comments
Schott CG727 £168	Y U or 4 mm R - £41	0-14 by 0.2 (0.1), 4-10 by 0.1 (0.05)	0 ± 1400 mV	B	59 mV/pH	T, S	mirror scale price incl. PP3, buffers, KCl soln. & beakers
Unilab 093.613 £40 (Portable)	N U	0-14 by 0.2	none	B	none	none	PP3 included, case extra £3.50
Unilab Envir. meter 421.010 + 423.002 £42	N Co	0-14 by 0.2 (0.1)	none	B	0-100 mV	none	part of Environ. Kit. Two PP3 incl.
WPA C6 £80	N BNC	0-14 by 0.2 (0.1)	none	B	none	none	PP3 included
WPA C6/T £88	N BNC	0-14 by 0.2 (0.1)	none	B	none	T	PP3 included
WPA C14 £112	N BNC	0-14 by 0.2 (0.1)	0-1400 0-2800 mV	B or M (BE)	1.4 V	none	PP3 included
WPA C16 £120	N BNC	0-14 by 0.2 (0.1)	0-1400 0-2800 mV	B or M (BE)	1.4 V	T	PP3 included
WPA C18 £130	N BNC	0-14 by 0.2 (0.1)	0-1400 0-2800 mV	B or M (BE)	1.4 V	T, S	PP3 included

Table.1 - Analogue pH meters (continued)

Key

N - probe not included

Y - probe included

Co - coax socket

BNC - BNC socket

U - UHF type socket

m - miniature jack socket

R - replacement

B - battery

M - mains

BE - battery eliminator

T - temperature compensation

S - slope control

C - checkpoint

incl. - included

excl. - excluded

Column 3 entries e.g. "by 0.2 (0.1)" represent 'scale division' and (estimated readability).

model/ supplier & price	probe incl.?	pH scale 0 - 14 by	millivolt	batt./ mains	outputs	other features	comments
Accurex 5003 £139	Y BNC	0.01	0 - ±1999 mV	B	0 ±70 mV	T, S	incl. PP3 & buffers
Bibby SMP1 £195	Y St R - £42.75	0.01	0 - ±1999 mV	B	none	T, S	incl. case, batt., buffers, probe-lead & strap
Camlab HI/8114 £120	Y R - £36.60	0.01	none	B	none	T, S	incl. case & thermometer (Hg)
Eirelec Sigma £125	N BNC	0.01	none	B	none	T, S	optional extras: temp. probe £34.00 (-30 to 199°C); case £14
Gallenkamp £162	Y St R - £40.81	0.01	none	B	none	T (auto), S	incl. miniature batteries R - batts. £7.70
Griffin Model 60 £140	Y BNC	0.01	± 1.99 V	B	±70 mV(pH) 0-2 V (mV)	T, S	extra: PP3 batt., case £14.77
Griffin Model 80 £299	Y Co R - £54.50	0.01	±1.999 V	M	0-140 mV	T	also measures temperature
Harris S-digital £84	N Co	0.01	0 - ±1.999 V	B	0 - 1.4 V	T	PP9 extra
Harris A/D interface £79	N Co	0.1	0 - 25 mV & 0 - 25 V	B	to micro.	none	needs micro. Can plot on screen
Irwin RA1910 £195	N m	0.01	0 -±1999 mV	B	none	T, S	extras: batt., temp. probe £45.25
KM7000 £105	Y BNC	0.01	none	B	none	T, S, C	incl. case & buffers

Table 2 - Digital pH meters (continued over)

model/ supplier & price	probe incl.?	pH scale 0 - 14 by	millivolt	batt./ mains	outputs	other features	comments
L.T.H. DPH1 £170	Y BNC	0.01	none	B	none	T(auto), S	incl. case, PP3 & temp. sensor Optional extra: Nicads + charger £55
pHT 'Mini' £75	Y BNC	0.01	none	B	none	T, S	incl. PP3, buffers & carry case.
Portec PI 8070 £89	Y BNC	0.01	none	B	none	T, S	excl. PP3
RS Components 610 540 £89	N BNC	0.01	none	B	none	T, S	similar to KM7000. batt. extra
Unilab 713.001 £82	N Co	0.01	± 1.999 V	B	none	T, S	incl. PP3 Optional Nicad £5.35; charger £9.04
Unilab 713.002 £90	N Co	as 713.001, but fitted with projection socket					
Whatman Microsensor £35 'disposable' pen		0.1	none	B	none	none	incl. 4 x 1.4 V Duracells
WPA CD58 £150	Y St	0.01	none	B	none	T, S	incl. PP3 & buffers
WPA CD60 £110	N BNC	0.01	none	B or M (BE)	none	T	incl. PP3 & BE - £10
WPA CD62 £130	N BNC	0.01	none	B or M (BE)	none	T, S	incl. PP3 BE - £10

WPA CD64 - similar to CD62, but can also function as a millivoltmeter (0 - ±1999 mV)
£145

Table 2 - Digital pH meters (continued)

Key

As for Table 1 but with the addition of: St - stick type pH device.
Column 1 prices are rounded to the nearest whole pound.

Manufacturer/ supplier	model	body type	ref. electrode filler	plug type	price
Chemetric	CC	glass	liquid	BNC	£28.50
	CB	polymer	gel	BNC	£29.50
Griffin	PHP-100-010Y	polymer	gel	BNC	£27.32
	-030C	polymer	gel	coax	£27.58
Harris	C 58030/5	polymer	gel	coax	£30.53
Irwin	RG 0331	polymer	liquid	coax	£41.30
Kent IML *	PHP-120-010R	polymer	gel	BNC	£36.44
	-030L	polymer	gel	coax	£31.57
	PHP-140-010D	glass	liquid	BNC	£33.17
	-030U	glass	liquid	coax	£31.16
soil spear -	PHP-160-010M	glass	liquid	BNC	£42.39
	-030G	glass	liquid	coax	£42.39
Orion (MSE)	OR910600 (GX series)	polymer	gel	BNC	£28.00
Russell	CE 7L	polymer	gel	BNC	£31.00
Portec	CE7 11	polymer	gel	BNC	£23.00
Unilab	424.011	polymer	gel	coax	£21.07
WPA	EL19A	polymer	gel	coax	£35.00
	EL19B	polymer	gel	BNC	£35.00

* - prices as supplied by Griffin.

Table 3 - pH probes

SURPLUS EQUIPMENT OFFER

Is there a fifth fundamental force?

Earlier this year a startling proposal was made that in addition to the four long established forces of nature, (gravitational, electromagnetic and the strong and weak nuclear forces) there was evidence for a fifth force which makes itself felt in the interaction between neutral masses at separations up to hundreds of metres. It would have a range of activity overlapping that of gravitational forces. The evidence comes from measurements of G, which appears to have a value which is up to 1% higher at sites deep underground as compared to sites on the surface of the Earth.

This tale of modern research may spark off interest in one item in our ballot, namely the apparatus for performing the Cavendish determination of G. Unfortunately the apparatus is incomplete. The main parts are there however, two lead balls and the suspension housing. Let not the lack of the suspension mechanism deter you from buying this exciting piece of equipment.

This, and many other items on the list, were donated by the Physics Department of Napier College, to whom we offer thanks. The oscilloscopes, marked "ex B.T." are of high quality and of fairly modern manufacture. We have several of each type in stock. They are highly recommended. We are grateful to British Telecom Scotland who gave us the opportunity to buy these CRO's at very reasonable prices. We have checked them over and repaired some as necessary. It should be noted that with donations and privileged purchases our charges and mark-up are usually only to cover our handling, checking and repairing costs.

In general this offer is subject to the conditions laid down in Bulletin 116. However all of the entries in this issue are **subject to our ballot procedures.** Entries should preferably be submitted on a postcard and with an indicated order of priority.

Items marked "NC" are offered at no charge.

Ballot Items

Item 430	Digital timer (made for British Telecom), 4 digits 3 ranges:- 10 µs-9.999 s triggering on both edge and level sensitivities; separate controls for start & stop; auto or manual reset; 12 V d.c. or 240 V a.c. @ 50 Hz. modern design	£15
Item 448	Leybold Timer 240 V.electro-mechanical, graduated in centi-seconds facility for auto. on/off.	£2
Item 449	Labgear Rate Meter. D/4152/a (no tube)	£2
Item 450	Panax Rate Meter. RM 202 (no tube).	£2
Item 451	Panax Scaler 102ST.	£2
Item 452	Panax Scaler 102ST.	£2
Item 453	WPA Long Scale Galvo. KN90 EDSPOT.	£2
Item 454	Rings closed,for retort stands, int.dia. 82 mm, stem length 140 mm.	N.C.
Item 455	Tripods, 24, one lot.	N.C.
Item 456	Copper calorimeters, various sizes, one lot.	N.C.
Item 457	Aluminium calorimeters, various sizes, one lot.	N.C.
Item 458	Leslie's cube (tin plate) cylindrical cans and constant level tank, 150 ml., one lot.	N.C.
Item 459	Hope's apparatus (no thermometers).	N.C.
Item 460	Pullinger's expansion apparatus	N.C.

Item 461 Linear expansion apparatus by Harris (P24552/0). £2.50

Item 462 Rotating tube and solenoid for hysteresis cycle. 20p

Item 463 Ticker timers by Harris, Nuffield item 108/1 6-12 V ac 50 Hz. 20p

Item 464 Cavendish torsion balance, incomplete, housing and lead balls only, no suspension mechanism. 20p

Item 465 Griffin demountable transformer, 1 lamination missing. N.C.

Item 466 Rectangular glass blocks, 114 x 65 x 18 mm. 20p

Item 467 Perspex blocks, rectangular, 114 x 73 x 18 mm. 20p each

Item 468 Perspex blocks, semicircular, 100 mm dia. 20p each

Item 469 Perspex blocks, biconvex, one radius 98 mm, one 178 mm. 30p each

Item 470 Griffin ray box, cast aluminium body, low voltage. 50p

Item 471 Dynamics trolleys, Rollo and Harris. 30p each

Item 472 Pressure and flow apparatus, Griffin & George. 50p

Item 473 Resistor sliding contact, enclosed type, 113 Ω 2 A. 30p

Item 474 Resistor sliding contact, enclosed type, 980Ω 0.3 A. 30p

Item 475 Resistor sliding contact, enclosed type, 1040Ω 0.6 A. 30p

Item 476 Resistor sliding contact, 11.25Ω 5 A. 30p

Item 477 Resistor sliding contact, twin coils, 1520Ω 2 A. 30p

Item 478 Resistor sliding contact, twin coils, 102Ω 2 A. 30p

Item 479 Resistor sliding contact, twin coils, enclosed, 120Ω 2.5 A. 30p

Item 480 Wire-wound potentiometer, boxed, 12.5KΩ 500 mV. 30p

Item 481 Voltmeter, 0-100 V dc, with 4 mm sockets, dial 140x120 mm. 50p

Item 482 Voltmeter, 0-300 v dc, with 4 mm sockets, dial 140x120 mm. 50p

Item 483 Whirling table, G&G, handle and adaptor missing. N.C.

Item 484 Electronically maintained tuning fork. £2

Item 485 Plastic lens holder, self centring, for lens 10 mm to 75 mm diameter. 20p

Item 486 Plastic lens holder for lens 100 mm diameter. 20p

Item 487 Universal interference apparatus with cover and Lloyd's mirror attatchment, complete with lamp and lamp housing. £2

Item 488 Resonance tubes, 305 mm length, 30 mm diameter. 50p

Item 489 Pulley wheels, assorted diameters some plastic, mostly aluminium, approx. 40, one lot. £2

Item 490 Platinum resistance bridge. £1

Item 491 Two way and intermediate switching model on free-standing board, 915x655 mm, for demonstration. £2

Item 492 Two dimensional model of two-stroke petrol engine, on board 670x520 mm. 50p

Item 493 Radford smoothing units, type ALT, low tension. 50p

Item 494 Radford smoothing units, type AHTR, high tension. 50p

Item 495 Elastic cords, for dynamics trolley. N.C.

Item 496 Kodak RC paper, F3, 10x8" Box of 100 sheets. £6

Item 497 Kodak RC paper, F2, 10x10" Box of 250 sheets. £10

The oscilloscopes covered under Items 498 to 500 inclusive have BNC inputs. They came to us without leads but these have been made up and will be supplied at cost. The prices shown include that of the lead.

Item 498 Telequipment oscilloscopes, ex. B.T.; dual trace; time base-0.2 s/div.-0.2 µs/div. with x5 and 1/5 controls, 1-2-5-10 step switch and continuous adjustment; Y amplifiers 5 mV/div - 20 V/div 1-2-5-10 step switch and continuous adjustment; add and subtract function; external X facility; beam finder; 5" screen; BNC inputs, lead to 4 mm supplied; front panel cover; carrying handle. £44

Item 499 Gould Advance oscilloscope, model 03/3000a, ex B.T.; dual trace; time base 1 s/div-0.2 µs/div with step switch, 1-2-5-10, and continuous adjustment; Y amplifiers 5 mV/div-20 V/div with step switch, 1-2-5-10 and continuous adjustment; add and subtract facility; external X facility; 5" screen; BNC inputs, lead BNC to 4 mm supplied; carrying handle. £44

Item 500 P.O. telecommunications oscilloscope, ex B.T.; single trace; time base 0.5 s/div-1 µs/div with step switch, 1-2-5-10 and continuous adjustment; Y amplifier, 5 mV-20 V/div with step switch 1-2-5-10; external X facility; 5" screen; BNC inputs, lead to 4 mm supplied; carrying handle. £34

Item 501 Telequipment oscilloscope, model S51E; single trace with long persistence tube; 5" screen; 4 mm inputs. £10

End of ballot

Third party offer - microscopes

We recently received information on a forthcoming offer of second-hand microscopes. These will be available during October of this year. The firm selling the instruments is Finlay Microvision the main UK importing agent for Kyowa microscopes. 'FM' were at one time based in Ayrshire.

As a result of a trade-in deal with a University, they will have 110 to 120 'H' Grade/SYS specification instruments of which to dispose at £65 each. These are all Vickers M14 microscopes with the following specification:

> Stand and mechanics: monocular angled head and plain stage, coarse and fine focussing with rack and pinion substage condenser mount. Dust cover.
>
> Optics: x3, x10, x40, x100 (oil) objectives with x8 Huygenian eyepiece. Abbe condenser with auxiliary flip-top lens (convenient for illuminating lower power objective) and iris diaphragm. Built-in 240 V 15 W illuminator.

The one caution we would give concerns spares for the M14. Vickers used a type of objective with a long body. Optical spares will have to be bought from Vickers and they will not be cheap. Objectives from other manufacturers will fit the nosepiece (many objectives have standard RMS threads), but will have different working distances and not be parfocal.

However, the price of £65 plus VAT (which EA's may reclaim) and delivery seems very reasonable for a second hand model of the quality of the M14. We were told that the instruments will all be given pre-sale servicing. Confirmation of this and other details could be sought by writing to Mr.S. Sharples at the Finlay Microvision address given on the inside front cover of this bulletin.

Philip Harris Ltd., Lynn Lane, Shenstone, Staffs, WS14 OEE Tel. (03552) 34983 (from Scotland) or (0543) 480077 (direct)

International Centre for Conservation Education, Greenfield house, Guiting Power, Cheltenham, Glos. GL54 5TZ Tel. (04515) 549

Irwin-Desman Ltd., 294 Purley Way, Croydon CR9 4QL Tel. 01-686 6441

Kane-May Ltd., Swallowfield, Welwyn Garden City, Herts. AL7 1JP Tel. (07073) 31051
(Scottish agents - Mackay and Lynn Ltd.)

Kent IML, Oldends Lane, Stonehouse, Gloucester GL1 3TA. Tel. (045-382) 6661

LTH Electronics Ltd., Eltelec Works, Chaul End Lane, Luton, Beds. LU4 8EZ. Tel. (0582) 593693

Mackay and Lynn Ltd., West Bryson Rd., Edinburgh EH11 1EH Tel. 031-337 9006

MSE Scientific Instruments, Manor Royal, Crawley, Sussex, RH10 2QQ Tel. (0293) 31100
(Scottish Agents - Norlab Instruments, -J.T. Sinclair & Co., -P. Stevenson Ltd..)

Norlab Instruments, Site 9, Kirkhill Industrial Estate, Dyce, Aberdeen Tel. (0224) 724849

Phoenix Measurements. (As for Accurex)

pHT Measurement Ltd., PO Box 37, Stockport, Cheshire SK2 6HP. Tel. 061-445 2943

Portec Instrumentation Ltd., 23 Cochran Close, Crownhill, Milton Keynes MK8 0AT. Tel. (0908) 564262

Royal Society of Chemistry, Distribution Centre, Blackhorse Road, Letchworth, Herts. SG6 1HN

RS Components Ltd., PO 99, Corby, Northants, NN17 9RS Tel. (0563) 201201

Russell pH Ltd., Station Rd., Auchtermuchty, Fife KY14 7DP. Tel. (03372) 8871

Schott. (UK agents - Camlab, address above.)

Sinclair J.T., 8 Dixon Place, College Milton North, East Kilbride Tel. (03552) 36051

Stevenson P. Ltd., 40 Potterrow, Edinburgh EH8 9BT Tel. 031-667 9225

SSPCA, 19 Melville Street, Edinburgh EH3 7PL

Unilab Ltd., Clarendon Rd.,Blackburn BB1 9TA. Tel. (0254) 57643

Whatman Labsales Ltd., Coldred Rd., Parkwood, Maidstone, Kent ME15 2BR. Tel. (0622) 674821-4

WPA Ltd., The Old Station, Cambridge Rd., Linton, Cambs. CB1 6NW. Tel. (0223) 892688

S.S.S.E.R.C.

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