

STS

Scope includes
Science,
Technology
and Safety

SSERC Bulletin

For those working in science or technology education

ISSN 0267-7474

ISSUE 204

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The Lemmon motor

Jack Lemmon died last year. In the '60s movie *How to murder your wife* Lemmon plays a strip cartoon artist on a New York newspaper who is successful because he draws what he sees. Lemmon himself acts the part of a crime-buster. In one of his stories, the *Sky Scrapper Gaper Caper*, the gangster's moll has a stolen diamond embedded in her belly button. She and the other bad guys are played by actors. The hero and his pals play the goodies. They rampage through the streets acting out their plots. All of the scenes are captured on film, later to be hand drawn for the resulting cartoon strips. What is reality? There is sufficient in these sketches to satisfy any observer. The streets drawn are actual streets, as are the buildings, onlookers and passers by. Lemmon is the hero that he is because everything that he draws has actually happened. Readers like that.

This movie theme has a lesson for us teachers. It instructs us that we should always back up what we teach with practical demonstrations. It influenced me when I began teaching. Recalling that Lemmon, as a cartoon artist, would never draw a scene he hadn't acted out, I forged a determination to underpin every lesson with practical work. The kids liked that - practising rather than preaching.

Some days before teaching my first Higher lesson on electric motors, I recall rehearsing the setting up of a fractional horse power motor on the bench. Seeing it run sweetly, I turned down the armature supply voltage. Step by step the speed reduced. That was fine and expected. Then I turned down the field supply voltage and, blow me, the motor ran faster! This was inexplicable and bothersome. The workings of the electric motor were clearly not adequately understood - not by me at any rate.

So, off went I to ask the teacher of Engineering Science. "Oh!" he said, "That's quite wrong! A motor will slow down when the field is reduced!" "Oh no it doesn't!" said I. "Oh, yes it does!" said he. Tired of the pantomime dialogue, I phoned a friend. This was another teacher of Engineering, who was unsure what should happen but loaned me a book. Therein, in a morasse of equations and opaque prose, lay the tale of back e.m.f. and its effect on a motor's speed.

For some years afterwards I wondered why those teachers so misunderstood their subject. Sad to say, I was later to find, the scope of such misunderstanding extended widely across electricity. It turned out that many science and engineering teachers did not try to back up their chalk and talk with demonstrations. From this sort of experience comes a better understanding of the importance of practical work - it directly helps the teacher to understand the concepts he or she is trying to teach. The events so witnessed offer the teacher inspiration and in turn they may challenge pupils by paradox.

Negative feedback is a process of self-correction within a system. Learning and teaching can be regarded as a system. In an ideal world, teachers would be wise beyond any need for correction. Experience would suggest, however, that no-one is so clever as to understand even school-level science without recourse to the laboratory bench. Had I not turned down the field voltage and seen and heard that motor speeding up, what bol...ks would have been taught!

If it is Science or Technology that we seek to teach, then let it be by what we practise. Thanks Jack! And, oh aye - Aristotle - you were no sae bad yersel, big man!

Funding announcement

In support for Science Year, and of the Science Strategy for Scotland, the Scottish Executive has announced additional funding for science activities and resources totalling £5 million for the financial year ending 31st March. At the time of writing, these monies were being distributed to the Education Authorities. The funds are *ring fenced* for science projects so as to assist schools in line with the objectives of the Science Strategy.

Distribution of funds has been based on pupil numbers and Councils' allocations are tabulated below. There clearly will be difficulties, for some Councils or schools, in spending these funds sensibly and effectively if delivery and invoicing were insisted on before the end of March. These funds are *spent, or distributed to schools*, (our emphasis) within this financial year. Because of the tight timescale this latter option is significant in practical terms. *next col./*

COUNCIL	ALLOCATION
Aberdeen City	£162,800
Aberdeenshire	£293,200
Angus	£120,800
Argyll & Bute	£107,000
Clackmannanshire	£47,600
Dumf. & Galloway	£180,000
Dundee City	£126,800
East Ayrshire	£121,800
East Dunbartonshire	£116,200
East Lothian	£90,600
East Renfrewshire	£97,400
Edinburgh	£309,000
Eilean Siar (W/Isles)	£40,800
Falkirk	£133,000
Fife	£339,600
Glasgow	£471,000
Highland	£268,400
Inverclyde	£79,800
Midlothian	£83,800
Moray	£98,200
North Ayrshire	£137,800
North Lanarkshire	£319,400
Orkney	£29,400
Perth & Kinross	£141,000
Renfrewshire	£166,600
Scottish Borders	£123,800
Shetland	£36,000
South Ayrshire	£111,200
South Lanarkshire	£300,800
Stirling	£90,800
West Dunbartonshire	£93,200
West Lothian	£162,200

Table 1 Additional science funding by EA.

Some Councils have already indicated that they intend distributing their slice of these monies to schools on a 'cluster' basis. That is, the funds will go to groups of primary schools in association with a particular secondary. Where facilities for roll-over into next financial year have not been exhausted this strategy will allow for a more measured approach to placing orders for goods and services.

We know that the educational suppliers would be pleased to hear of such an approach. We've already had comment and complaints from firms about the practical impossibility of meeting end of year delivery deadlines on this sort of scale.

The Executive has indicated the priorities for such spending and in so doing has quoted from the Science Strategy.

For example:

Science should be taught in a safe, modern environment that promotes effective learning. In many schools, there has been relatively little investment in science equipment and accommodation in recent years.

Councils were not asked for detailed plans showing how this money will be spent but will, in due course, need to report on their use of the funding. There are no restrictions on how the monies are used so long as expenditure is focussed on the objectives of the science strategy, and supports delivery of the National Priorities for Education. There is more than a hint that most of the funds should be spent on resources, accommodation and facilities, staffing or staff development.

We understand that further tranches of funding for science education may well be forthcoming next financial year. We trust that a longer period may then be available in which schools may come to decisions on their own science spending priorities. Educational suppliers, too, are likely to appreciate some smoothing out of demand for deliveries over the year.

On the move - again

SSERC's lease on our premises within the Faculty of Education Edinburgh University comes to an end quite soon. We are currently arranging other accommodation and should be able to make an announcement soon as to our new address details. Clearly there may be some consequent disruption of the service but we shall try to minimise this as far as is practicable.

Science Year

Science Year in Scotland is being run by the Scottish Executive Education Department (SEED). A contract for management and coordination was awarded to the SETPOINT network in Scotland. SEED has also established a small, Steering Group and the SETPOINTS have appointed three individuals, on part-time contracts as National Coordinators. They are: Fiona Selkirk, Anne MacKinnon and Rebecca Crawford. Fiona is designated as 'Scottish Science Year Coordinator' and she has part-time administrative support.

The four SETPOINTS have some specific funds for Science Year. They, in turn, have each appointed an individual to work in the SETPOINT on regional initiatives which support Science Year.

The Science Year Scotland office is based in the Glasgow Education Business Partnership (EBP) office (see Address List on back page for contact details).

SESEF launch

What is "SESEF"? This is the *Scottish Earth Science Education Forum* which had its first formal Steering Group meeting in mid January and was officially launched at a reception thereafter. Its overall aims are to promote learning and teaching in the Earth Sciences, including geology, physical geography, meteorology, astronomy, geophysics and oceanography in Scottish schools and colleges. For contact details see the listings on the back page.

Diary dates

ASE Scotland will hold their Annual Conference at Jordanhill School and Jury's Hotel on March 1st to 3rd.

The National *Chemistry Teachers' Day* at the University of St Andrew's will be held on Friday 7th June, 2002. The *Institute of Biology Education Meeting* will be at Stirling University on the 6th of June and the Institute of Physics equivalent *Physics Education Day* at Stirling will be held on the 29th of May.

The three *Edinburgh Summer Schools* (biotechnology, chemistry and physics) will be held in the week of the 24th to 28th June, 2002 on the King's Buildings Campus of the University of Edinburgh.

As part of Science Year in Scotland, an international conference on Science Education is planned for October of this year - more details to follow.

Laser attack

We continue to get several reports a year on attacks with laser pointers. There is generally no risk of direct harm to the eye from this misuse, but it can cause distress and anxiety. This article provides information about the effects and the extent of risk.

On the latest incident, the facts as first reported to us related to an assault on a member of staff by two boys wielding a laser pointer. The victim was left traumatised after having had laser radiation directly aimed at her face. On being taken to hospital, she was too badly shocked to allow an eye examination there and then. She then returned to hospital some days later, resulting in the finding of corneal damage, but no damage to the retina. However the victim was reported still to have no sight in one eye and partial sight in another. She remained in shock, experiencing great pain.

The school reported the injury to the Health and Safety Executive (HSE), this being a statutory requirement of RIDDOR¹. The incident was subsequently investigated by HSE, who provided SSERC with relevant facts.

There were several aspects of this case that did not agree with the type of harm that laser pointers are known to be able to cause. Each of these is discussed in turn. We are pleased to learn that the victim has now made a good recovery. Her eyesight has returned without, it seems, any impairment apart from some damage to her cornea. Whether this damage had existed, undeclared, at the time of the assault, or was caused indirectly by the assault, is unclear.

1. Blindness: The retina can be permanently damaged if optical radiation incident on it exceeds a threshold. This can cause blindness. It is generally believed that radiation from a laser pointer would be incapable of damaging the retina. In a laser assault, the victim would automatically blink, shut his or her eyes, or turn away. Any exposure to the radiation would be, in all likelihood, momentary. During the period of exposure, there would be a relative movement between the laser source and victim's head resulting in the focused image moving in a random fashion across the retina rather than being fixed on one part. These physical responses limit the period of exposure on any part of the retina. Because of these factors, and the low intensity of this type of laser radiation, the threshold would not be reached and the retina could not be damaged.
2. The accident history from many laser pointer assaults and self-inflicted incidents is reassuring. There has been one recorded instance of measured damage to the retina. The injury was self-inflicted. The victim, an 11-year old girl from Arizona, stared into the beam from a Class IIIA² laser pointer for 10 s to prove that the light would make

her pupil dilate. It actually appeared to cause a lesion in her retina, impairing her eyesight. 18 months later, the lesion had faded and her eyesight had recovered.

3. The cornea (conjunctiva) can be damaged by UVB ultraviolet radiation³. Occupational illnesses include welders' arc blindness, and snow blindness. The condition is associated with severe pain. Being in the visible red part of the spectrum, radiation from the laser pointer could not have harmed the cornea directly. However what might have happened is that the victim rubbed the eye excessively, causing abrasions to the cornea. This might have been the cause of the pain she experienced.
4. There are no pain receptors on the retina.
5. A momentary exposure to laser pointer radiation may be dazzling. It can impair vision temporarily, a condition sometimes called 'flash blindness', and cause after-images. These conditions may persist for several hours. They have no lasting effect; normal sight returns eventually. During this period, some physical activities dependent on eyesight, such as driving, may have to be curtailed.
6. Anyone exposed to direct radiation from a laser pointer is liable to become alarmed and experience stress. If flash blindness persists, the victim may well start to wonder whether his or her eyesight has been permanently damaged. The above information may be used to provide reassurance that there is really no significant risk of permanent damage.
7. Medical experts broadly agree that there is no realistic risk of harm to the eye from an accidental exposure to radiation from a Class 2 laser product and that even Class 3A (5 mW) devices are most unlikely to cause eye injury in most circumstances of use. This presumes that the natural aversion responses (blinking, turning the head, etc.) would automatically protect the exposed person. However it would be clearly dangerous to stare deliberately into a 5 mW laser – or even into a Class 2 laser, where the radiant power output is limited to 1 mW.
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cont./over

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13. Schools are reminded that they are restricted to working with Class 2 lasers in laboratories. These lasers may be used by children (Years S3 to S6) under supervision.

The information provided above should reassure schools that this restriction to Class 2 products offers a large margin of safety.

On an ocular exposure

Since the publication of Circular 7/95 in 1995 permitting the use, by pupils, of lasers in schools, SSERC has not received a single report of a pupil getting an exposure from a direct laser beam resulting from laboratory usage. We do, however, continue to get several reports every year of persons, usually members of staff, being assaulted with laser pointers. The following action should be taken after a laser exposure.

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3. Where the exposed person is only dazzled and experiences temporary after-images (as would be expected in all cases), the incident need not be reported to HSE under RIDDOR. However where as in this case the exposed person claimed to experience an extensive loss of sight and required to have an eye examination, then a RIDDOR report should be submitted.

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Transformation Kit

The firms BioRad and Pfizer have co-operated to supply equipment to the SAPS Biotechnology Education Project and Initial Teacher Education Institutions in Scotland. This equipment is currently in use for training purposes. We understand that schools also now have been written to directly with the offer of discounted prices on, for example, the BioRad pGlo Transformation Kit.

It is important to note that the instructions which come with this kit were written for the North American market. As they stand, they do not conform to the current safety guidelines on the use of micro-organisms issued to Scottish schools and non-advanced FE Colleges. A suitable alternative Technical Guide has been prepared by the SAPS Scotland Biotechnology Project. We recommend that this should be used, instead of the guide supplied with the kit itself.

Disinfectants

The Code of Practice on Safety in Microbiology, drawn up by the old Strathclyde Regional Council, is under active review at present. This code has been widely adopted in Scotland as part of the educational employers' response to the requirements of the COSHH Regulations. One reason for the review is that some disinfectants are no longer available.

For example, clear phenolics (such as 'Stericol'), used in discard jars for Level 3 work, are no longer being manufactured and suppliers' stocks are running out. In line with advice from other agencies we would now recommend the use of 1% Virkon for this application once a school's supply of clear phenolic is used up.

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COSHH a brief Guide to the regulations
HSG97, HSE, ISBN 0 7176 1446 8

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* * *

Strain Gauges

Some information to support the Higher Physics Student Material on the strain gauge

The resistance value for a typical, unstressed gauge is $120\ \Omega$. If the gauge is stressed, the fractional change in resistance might be anything up to about 0.5% of its unstressed value. That is, the resistance should change to about $120.6\ \Omega$ if the gauge is extended, or $119.4\ \Omega$ if the gauge is compressed.

The upper working limit may be no greater than 1%. If the hacksaw blade to which a gauge is attached is flexed beyond this limit, the gauge could peel off.

These resistance changes can be measured with a digital multimeter set to measure Resistance on its $200\ \Omega$ range. Before wiring up the bridge circuit shown on page 36 of the Student Material [1], we suggest that you first connect a multimeter across a single gauge and measure its resistance while flexing the hacksaw blade.

Regarding the bridge circuit (Fig. 1), if the hacksaw blade is flexed the out-of-balance current is around $\pm 6\ \mu\text{A}$ with the resistor in series with the microammeter (digital multimeter, $200\ \mu\text{A}$ setting, shunt resistance = $1\ \text{k}\Omega$) shorted out. The multimeter has a resolution of $0.1\ \mu\text{A}$ on this setting. This is sufficiently sensitive to load up the hacksaw blade with successive small weights and provide a set of measurements of current against mass. The sensitivity can be increased by $\times 2.7$ if the supply voltage is changed from $4.5\ \text{V}$ to $12\ \text{V}$. This is as high as the supply voltage should be taken to prevent problems caused by gauges self-heating.

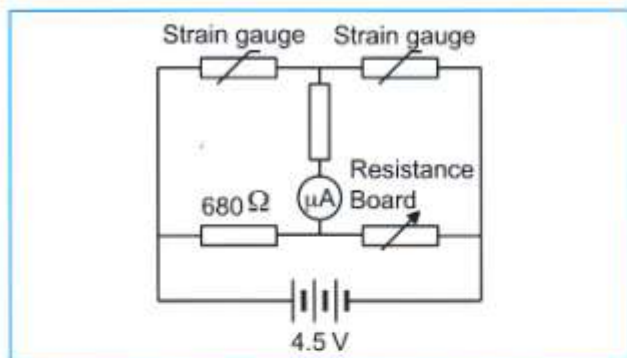


Figure 1 Electrical circuit with a pair of strain gauges in an out-of-balance Wheatstone bridge.

If you do not have a microammeter, or digital multimeter with a $200\ \mu\text{A}$ range, then measure the out-of-balance voltage instead of out-of-balance current¹. Use the $200\ \text{mV}$ range on a digital multimeter. From a theoretical analysis, and with a $4.5\ \text{V}$ supply, a fractional change in gauge resistance of 0.5% should generate an out-of-balance p.d. of $11\ \text{mV}$.

¹ With bridge circuits, nearly always it is the out-of-balance voltage that is measured rather than the out-of-balance current. The measurement of current was superseded by voltage ages ago. In this respect the Higher Still course is antiquated.

Strain gauges are stocked by general distributors such as Rapid Electronics and RS Components. Work with a gauge length of $8\ \text{mm}$. This is quite large, implying that it should be easier to handle than miniature versions. Rapid stock two types at $8\ \text{mm}$ with attached leads: Types 11 and 23 for bonding to mild steel and aluminium respectively. They have an unstressed resistance of $120\ \Omega$. The order codes are 78-1105 and 78-1110, priced $\text{£}2.90$ each. Select the type to suit the metal to which the gauge is being bonded. The thermal expansivity of the metal is matched by the electrical properties of the gauge type.

Information on bonding gauges to metal and connecting wires was published in SSERC Bulletin 171. Details of a strain gauge bridge circuit with differential amplifier were given in Bulletin 185 (pp 11-20). A theoretical analysis of bridge circuits was provided in Bulletin 150.

Reference

- 1 HSDU, Physics: Electricity and Electronics (H): Activity 7: The Out-of-Balance Wheatstone Bridge: Applications: Part C: Strain Gauge.

Alpha Radio Receiver

At the heart of Unilab's Alpha Receiver Board¹ lay an integrated circuit made by Ferranti, the ZN414 Radio Receiver IC. It had been designed to receive AM radio broadcasts. The Alpha Board is widely used in physics departments in support of the Standard Grade Physics Telecommunications Unit. It has also often been used in construction projects in Technology, and in science clubs. On account of the fact that this chip is no longer being manufactured, Unilab has replaced the board with a new product, known as an 'FM Radio Receiver & Tuner' (order code F50450, priced $\text{£}30.84$).

There is however an equivalent device to the ZN414 known as an MK484 Radio IC. These are sold by Rapid Electronics (order code 82-1026, price 55p). A data sheet is available from Rapid. It is a straight replacement for the ZN414 except that the pin-outs of the two i.c.s are exact mirror images of each other (Fig.1). That is to say, while the ZN414 has a conventional 'D' shape profile when looked at from above on the Alpha Board, the MK484 presents a backward-facing 'D' shape profile. The MK484 may be used in school based construction projects.

Confusingly, the pin-out diagram in the last Rapid catalogue is wrong (April 2001 to September 2001, page 479). The correct pin-out is shown in the datasheet and current catalogue from Rapid.

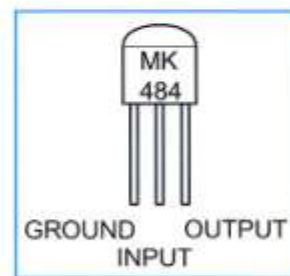


Figure 1 MK484 pin-out.

¹ Unilab Alpha Receiver Board, Cat. No. 223.220

Some PIC products from Revolution

A wide range of new educational products is being devised by Revolution Education Limited. Many of these products are based on inexpensive, digital microcontrollers, sometimes known as 'PICs'. Most have applications in technology education, but some would be of use in Science.

Revolution, the company that brought the *Basic Stamp* to Higher Technological Studies, now produce a number of innovative packs which should bring new life to those teaching the subject at Standard Grade. The new boards can all be programmed in *PBasic*, which is a definite plus. We asked the SQA (Scottish Qualifications Authority) if pupils would be at a disadvantage if the *Stamp* boards were not used. The answer was no. Pupils will be examined on *PBasic* programming and the use of inputs and outputs. Unfortunately the new packs may make the old boards redundant. It is a pity the authors of the new HSDU arrangements were unable to include these innovations. With the new look PIC and interface packs, Years S1 - S2 can be introduced to cutting edge technology (to coin a cliché). But why stop there? We have long been advocates of introducing control technology to both primary pupils and their teachers. Now the tools are to hand. The costs are reasonable. Perhaps this could be a way to enthuse pupils from P7 through to S2 and get them to consider Technological Studies as a course choice.

PICAXE Buffer Box Interface

Lots of Technology Departments are stocked with buffer boxes to use with BBC Microcomputers. The computer may be obsolescent, but the buffer box need not be discarded. This Revolution product lets you use any parallel port, BBC buffer box with a PIC microcontroller. Through this route, the buffer box can be used with a modern PC.

The *PICAXE Buffer Box Interface* comprises a PIC interface, control software on a CD ROM and lengths of connecting cable with 25-way and 9-way D-type connectors for fitting to the buffer box, PIC interface and PC computer. The interface connects to a serial port on the PC.

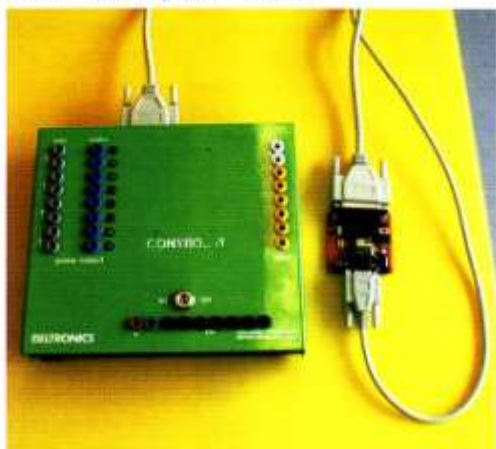


Figure 1 A Deltronics Control IT BBC buffer box (left) connected to a PICAXE Buffer Box Interface (right). Cable with 9-way, D-type connector goes off to PC computer (not shown).

Setting up is straightforward (Fig 1) The cables are connected from the computer via the interface to the buffer box. Once programming software is installed, a program can be written, downloaded to the PIC and then run. What could be simpler? We ran the system with several programs such as the ubiquitous Traffic Lights sequence. Of course it could be used to control other electronic circuits using the *PICAXE* chip.

So, what practical purposes does that old buffer box serve?

- Offers 4 mm connector access.
- Enhanced protection through additional buffering.
- Internal power supply for driving loads.
- Lets you use your existing applications that run off the buffer box.

PICAXE 18 and 28 Starter Packs

These are probably the most versatile of the new packs from Revolution. Each pack comprises:

- standard interface board containing a *PICAXE* microcontroller and ULN2803A Darlington driver,
- 3-wire download cable, and
- CD ROM with software and manuals.

The system is simple and amazingly inexpensive. You don't need complex ancillaries such as programmers or erasers. You just run the programming editor software on your PC, write a control program in a simplified version of *BASIC* language, hook up your 3-wire download cable from the *PICAXE* board to the serial port on your PC and squirt the program into the microcontroller. The *PICAXE* board may then be disconnected from your PC to operate remotely.

The *PICAXE-18* has 8 digital outputs, 5 inputs (3 with analogue functions) and 2 serial interface pins for 2-way communication. A reset function is also provided. The outputs are buffered through a Darlington driver IC. Each output is rated at 800 mA.

Its big sister, the *PICAXE-28*, has 8 digital inputs, 8 digital outputs and 4 analogue inputs - a total of 20 I/O lines for the user.

The standard interface board in the *PICAXE-18 Starter Pack* is provided with pairs of holes on opposite edges of the PCB. Inputs and outputs may be connected by soldering wires directly to these holes. Instead, screw terminal blocks, which Revolution supply, can be soldered to the boards. This allows wires to be temporarily connected. Yet another way can be seen in our illustration, showing some ribbon cable terminals soldered to a *PICAXE-28* board (Fig. 2). This indeed is how the 28 board is supplied.

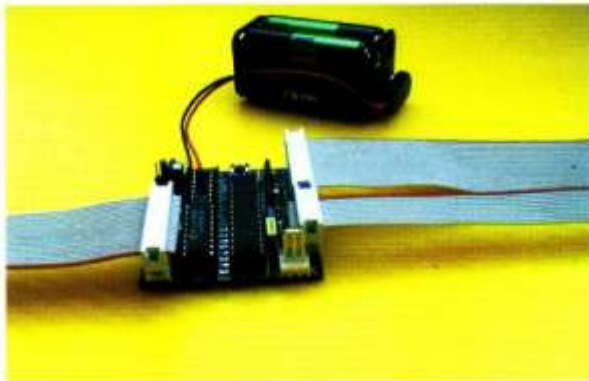


Figure 2 PICAXE-28, with unterminated ribbon cable connectors. The small ribbon cable at the front, reader's right, is the 3-wire link to a PC. The broad ribbon cables are inputs (reader's left) and outputs (to the back, reader's right).

Rather than using BASIC language programming, PICAXE can also be programmed with flowcharts using Crocodile Technology software.

In testing PICAXE, one system we built was a quiz game controller. Old buffers may recall the hard-wired version we published in Bulletin 119 with its many multivibrators and logic gates. One PIC does away with all of that. All you need are a set of input switches and output LEDs, one each per contestant, hard-wired to a PICAXE board. Details can be sent on request.

iButton

A report on the iButton Datalogger can be found in the accompanying issue of *Science & Technology News* (No. 24). The device basically is a programmable microprocessor and temperature sensor housed in a 16 mm stainless steel can. It is a single function device for logging temperature.

In the remainder of this article, we will mention another iButton product known as an RSA iButton Lock. This coin-sized device stores a unique serial number that opens only those locks programmed to respond to it. The associated lock has a touch point for the iButton key.



Figure 3 iButton probe, serial lead to PC, iButton Key (coin-size) and key fob (Clockwise from bottom left).

When the lock and key touch, information stored in the key is extracted. If this is what the lock is looking for, the lock opens.

Revolution produce a kit, *PIC-Plus: iButton Lock*, with a pre-programmed PIC and iButton. There is a full set of parts with PCB. Components need to be soldered in place, but this shouldn't be difficult. Because the method of programming an iButton is fairly complex and may be outwith the needs of the curriculum, it is easier to program a PIC to communicate with an iButton, rather than directly program an iButton. This is what *PIC-Plus* lets you do.

And what use is it? iButtons are used to operate locks rather like swipe cards. But unlike a card, the button is not affected by rain, or magnetic fields, and is highly durable. We have built a model simulating a lift where touching an iButton to the probe operates LEDs and a solenoid. The latter closes a microswitch, starting the lift motor. The pre-programmed PIC in the kit has a time delay of about 10 seconds, sufficient for this demonstration. The chip could also be programmed to operate a more complex electronic system or model.

Further information

For additional information on these and many other PIC-based products, please refer to the Revolution website at www.rev-ed.co.uk.

PRICES:

Buffer Box Adaptor	£35
PICAXE-18 Starter Pack	£12.61
PICAXE-28 Starter Pack	£15.61
PIC Plus Kit: iButton Lock Kit	£8.00

Contact lens warning

The following warning on arcing injuries was reportedly published in the *Electrical Industry Bulletin*, Issue 32, 2001.

Arcing caused by electrical sparking or welding causes several well known hazards: ultraviolet radiation, molten metal spluttering and heating. There are other hazards that may not be so well known:

- An electrical worker threw an uncovered electrical switch into a closed position resulting in an electrical spark.
- A welder threw open his protective face shield to better position a welding rod. The rod contacted metal and produced a spark.

Nothing very unusual. But both had been wearing contact lenses. On returning home they had removed the contact lenses and the cornea of the eye had been removed along with the lens, causing instant blindness.

Arcing generates microwaves that had dried up the fluids between the eye and contact lens. It is painless and the workers had been unaware of their injuries until they had removed their contact lenses. If working with high energy electrical systems or welding, it may be unwise to wear contact lenses.

WARNING - Contact lens article above has been proved to be an urban myth. See HSE report :-
<http://tinyurl.com/article-debunked>

Shoogled - nae stirred

We revisit an old timer, the 'Magic Bottle' demonstration, which is suggested for use as part of an introduction to Redox reactions and we evaluate an alternative form of melting point apparatus - the Thiele tube.

The 'Magic Bottle'

One use for the simple demonstration described below is as an introduction to the important topic of redox reactions for students of Standard Grade or Intermediate 2 chemistry. It features a bottle partly filled with a colourless liquid (see Figure 1) which when shaken for a few seconds turns blue (Figure 2). Upon standing the blue colour fades and the solution becomes colourless again. This process can be repeated many times but, after a while, each recovery to the colourless state may take longer.



Figure 1 Bottle pre shoogled



Figure 2 Bottle post shoogled

What's the secret?

The bottle contains alkali, glucose, water and the dye methyl-ene blue. Glucose is a reducing agent and in alkaline solution it reduces the methylene blue. This explains why, when left undisturbed, the solution changes from blue to colourless. When the mixture is shoogled (shaken) however, oxygen in the air oxidises the dye, which turns the solution blue. On standing, the blue colour fades as the glucose in the solution again reduces the methylene blue to its *leuco* or colourless form.

Preparation

To a suitable bottle add:

- 200 cm³ of 0.1M sodium hydroxide (irritant) - 0.1M is used, because a less concentrated solution of alkali prolongs the action of the glucose.
- 6 g of glucose,
- 0.5 cm³ of methylene blue.

Stopper, mix and then allow to stand undisturbed before use.

Technical tip

Since the glucose is gradually degraded by the alkali it is preferable to make up the solution shortly before it's needed. However, the mixture can be readily rejuvenated by the addition of more glucose.

The Thiele Tube

An alternative to the simple 'boiling tube' set-up, and to proprietary electrical melting-point apparatus, is evaluated.

We were asked recently if the use of a Thiele tube was an appropriate method for determining melting points at Advanced Higher level. To that end, we decided to compare this method with the more traditional school boiling-tube method and for good measure with our rather old but still functional Gallenkamp electrical melting point apparatus.

What is it?

The Thiele tube (Figure 1) is in essence a boiling tube with a side limb. In use, the tube is filled with a non-volatile liquid (we used vegetable oil) to a level no more than one centimeter above the upper inlet of the sidearm. A thermometer is fitted into a slotted cork and a capillary tube, loaded with a sample, is attached to the thermometer with a small rubber band. The capillary tube is then positioned so that the filled portion is adjacent to the mercury bulb. The rubber band is placed about 0.5 cm below the top of the capillary tube (but not in the oil, otherwise the rubber band will degrade and the capillary tube may move or fall off). (cont./page 9)



Figure 1 An empty Thiele tube



Figure 2 A Thiele tube set-up in use. (cf. Fig.3).

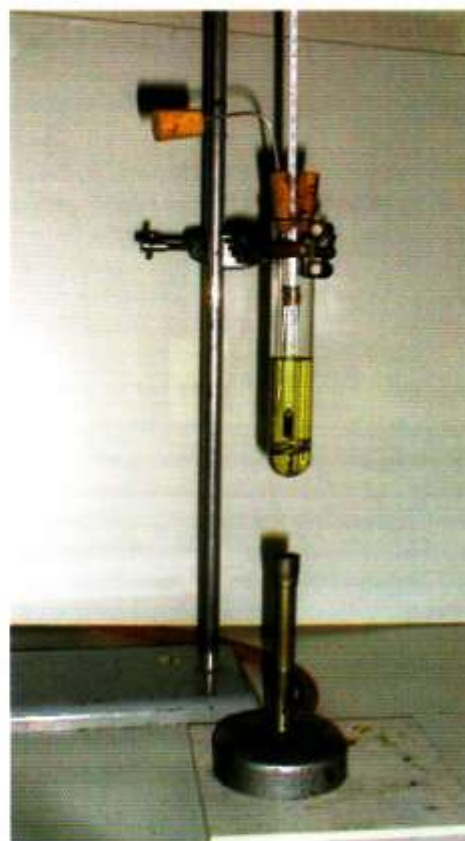


Figure 3 Conventional boiling-tube apparatus.

The cork holding the thermometer is supported by a clamp so that the thermometer bulb can be centered about 2 cm from the bottom of the straight portion of the Thiele tube (Figure 2). All of which is very similar to the setup for the boiling tube method (Figure 3).

So what are the alleged advantages of the Thiele tube. Well, it's all to do with circulation. Heat is applied to the side arm rather than the base of the tube. A convection current is thus set up and this ensures even heating of the sample without stirring.

To assess the effectiveness of the Thiele tube, we carried out a melting point determination for benzoic acid (mp 121.5° – 123.5°C). The result obtained was compared with results from the boiling tube method and from proprietary electrical melting point apparatus. See Table 1.

Method	Melting point (°C)	Approximate cost (£)
Thiele tube	120-124	8.00 to 10.00
Boiling tube	120-123	0.50
Electrical	118-123	250 - 450 (new)

Table 1 Comparative results and costs for the three alternative pieces of apparatus.

Summary

We found the *Thiele* tube relatively simple to set up and use but not strikingly so. The results were similar to that obtained using the boiling tube method. Both of these methods performed very well compared to the proprietary electrical apparatus costing several hundreds of pounds.

Whilst the results indicate that the Thiele tube is suitable for determining melting points of substances in school chemistry practical work, the same can also be said for the boiling tube method. Was the Thiele tube significantly easier than the boiling tube method to set up and use? We didn't think so. At twenty times the cost of a boiling tube, it is also a somewhat expensive alternative.

Biotechnology Summer Schools follow-up programme

A short report is given on the first in a series of follow-up symposia for the highly successful Summer Schools.

For the last four years, around 200 Biology teachers and FE lecturers in Scotland have had the opportunity to attend a Biotechnology Summer School hosted by the University of Edinburgh. The participants experience a week of laboratory based practical sessions, lectures, discussions and relevant visits to update them in this fast growing field. The overall aim is to enable them to introduce some of the new biology and biotechnology courses into their schools and colleges.

These Summer Schools are sponsored by *Unilever* and *The Wellcome Trust* and actively supported by a number of other organisations and individuals. It is now apparent that this sort of activity may provide one powerful model for at least some elements of an entitlement to high-quality, practice-based, CPD. This is something which science teachers have been led to expect post McCrone and after publication of the Science Strategy for Scotland.

On the 4th of December 2001 an extension to this programme of continuing professional development began. Teachers and lecturers who had attended a previous Summer School were invited to attend a follow up symposium. They were also invited to bring along some of their 6th Year pupils.



Figure 1 Back to school? Drs Sally John (AstraZeneca) and Gerry Graham (Beatson Institute) presenters in the morning session trying out *finding the genes* during the afternoon lab session at the symposium.

This event was sponsored by the Wellcome Trust and took place in Dollar Academy. Support and staffing were provided through the school, the SAPS Scotland Biotechnology Project and SSERC. The themes for the day were centred on the topic *Issues in Human Genetics*.

In the morning, speakers from The Beatson Institute for Cancer Research and from AstraZeneca described the impact which the Human Genome Project could have on cancer treatment as well as on human therapeutics. Both presenters were skilful communicators and linked their talks well into basic biological ideas. In the afternoon, the participants carried out a practical activity on *finding the genes* and there were discussion sessions on an issues web site and on the use of animals in genetic research.



Figure 2 Teachers, lecturers and advisory staff trying out a practical in the laboratory session.

There certainly seemed to be a large measure of agreement from the participants, whether teacher, lecturer or student, that this event was extremely worthwhile and was providing them with the type of support which they require. Their message to the organisers was an emphatic "more please"!

Funding, from the Wellcome Trust, is in place to continue this update programme in others areas of the country. Details on further events with programmes and venues will be announced in due course.

Resource Notes

The Scottish Environmental Protection Agency (SEPA) now has a website with a schools section (Address List page 12). This section of their website provides an introduction to SEPA's work in education along with links to other relevant areas of the SEPA web site. The agency does not produce educational material specifically targeted at schools but the following publications are particularly relevant to education and are available online:

Information Leaflets

- Air Leaflet
- Radioactivity Leaflet
- Waste Leaflet
- Water Leaflet

Environmental Issues Leaflets

- Acidification
- Biodiversity
- Climate change
- Development on greenfield sites

Environmental leaflets cont./

- Endocrine disrupters
- Eutrophication of surface waters
- Depletion of natural resources
- Ozone depletion
- Pollution of recreational waters
- Toxic chemicals in the aquatic environment
- Toxic chemicals in soil
- Water pollution by oil

Modifications of Benedict's and Fehling's Reagents

Benedict's reagent has been reported, falsely, as a reliable test for alkanals. Some relevant modifications to Benedict's and Fehling's reagents are described and discussed in terms both of efficacy and safety.

Several texts and other sources have advocated using Benedict's reagent in place of the more corrosive Fehling's for testing sugars and for distinguishing between alkanals and alkanones. In Bulletin 196 [1] we discussed using an alternative such as Sandell's Reagent. We also pointed out that Benedict's worked fine for reducing sugars, but barely reacted with ethanal and not at all with other alkanals.

The article describes a simple way of:

- (i) modifying Benedict's so that it 'works' with alkanals as well as with sugars and
- (ii) using Fehling's at dilutions so great that the reagent is no longer corrosive, thus allaying safety concerns.

In Bulletin 196 [2] we gave the findings of tests carried out on Barfoed's, Benedict's, Sandell's and Fehling's reagents or solutions and compared their contents from a safety stance. A summary of those results is provided below.

Description	Barfoed's	Benedict's	Sandell's	Fehling's
Medium	0.18M ethanoic acid	0.9M sodium carbonate	0.4M sodium hydroxide	1.9M sodium hydroxide
pH	4.3	10.2	12.9	13.3
Ligand	ethanoate	citrate	EDTA	sodium or potassium tartrate
Reducing sugars detected	Yes	Yes	Yes	Yes
Alkanals	No	No	Yes	Yes

Table 1 Summary of properties and actions of the various test reagents for reducing sugars and alkanals.

From the data in Table 1, it seems fairly clear that one major factor determining the oxidising power of each reagent is its pH. It occurred to us that perhaps Benedict's might be made more effective in detecting alkanals were we to increase its pH somewhat. Similarly a major objection to the use of Fehling's is its highly corrosive nature, yet Fehling's is very effective in these tests. Suppose we were to lower the pH of Fehling's by means of dilution, would it remain effective in detecting various alkanals? So as to investigate these possibilities we tried changes to two of these well known reagents. Further probing of this effect of pH could well make for an interesting investigation at Advanced Higher level.

Modified Benedict's

Benedict's reagent was made up with the addition of an equal volume of 1M sodium hydroxide. The resultant reagent solution was then ca. 0.5M with respect to hydroxide ions in addition to sodium carbonate already present. This raised the pH from about 10 to 12.5. A positive test was then readily obtained with propanal with which the conventional form of the reagent yields a negative result. This exercise was repeated using an equal volume of 0.5M sodium hydroxide achieving a final concentration in the working reagent of 0.25M. Again a positive test result was observed. Both of these somewhat more alkaline variants of Benedict's reacted faster than Sandell's reagent, although they were still slower than Fehling's reagent.

Modified Fehling's

Fehling's reagent was used diluted fourfold. This meant a working concentration of hydroxide ions somewhat less than 0.5M. An eightfold dilution was also trialled. This latter variant had an hydroxide concentration < 0.25M. Even at the lower of these two concentrations propanal and glucose were both readily oxidised.

Summary

We recommend in addition to Sandell's as alternatives to Benedict's and Fehling's:

- i Benedict's slightly pepped up, but with the alkali content still low enough for it to be classed as *Irritant* rather than *Corrosive*. (Strictly, this extra alkaline reagent cannot be called Benedict's).
- ii Diluted Fehling's - each of the solutions no1 and no 2 can be diluted beforehand (possibly stored and labelled as "*Fehlings No 1 (one eighth strength)*" and "*Fehlings No 2 (one eighth strength); IRRITANT*". The two parts are then mixed in equal volumes just prior to use to give the diluted reagent.

Apart from being less hazardous this diluted form of Fehling's has other advantages. The *three Es* apply, namely:

Economy - less reagent is used; *Environment* - less copper compounds are to be disposed of; *Effectiveness* - the resulting colour is a paler blue and the colour change is more readily seen. Often pupils take too much of the normal strength reagent so that copper(II) is in excess and isn't all reduced. A dark brown, through dark green to light green, results instead of the expected brick red copper(I) oxide as a clear positive result.

Finally, we see little reason not to allow senior students (post 16) to use, with due care, *proper*, full-strength Fehling's.

Philip Harris and Unilab - what's afoot?

We called Harris to establish what is likely to happen with various parts of the firm since its recent purchase by Findel from Navarra. At the time of our enquiries the position seemed to be as follows:

Manufacturing at Blackburn on the one-time Unilab site will cease and instead will be contracted out (possibly overseas but we aren't certain on that).

The Harris and Unilab product ranges will remain basically the same as before. We are of the opinion, however, that both are product ranges which have been moribund for some time. So, the news that the ranges will now be redesigned is most welcome. The new owners intend to develop new products - quote: "Findel are happy to spend money on development."

A product design facility will be retained but at present its location has not been decided upon. Some apparatus has already been redesigned; the old power supplies have been superseded by a new Space Saver Range.

Lots of money has been spent on stocking up and it is asserted that 99% of the Harris product range is available for immediate sale. Quick order turn-round and delivery are now being achieved.

Unilab and Harris products will be advertised in separate catalogues. The absence of Unilab products from the 2002 Philip Harris catalogue, which should already be in schools, does not signify anything. A catalogue from Unilab will be issued shortly.

Alpha Switched Display

The IC in the popular Switched Display & Decoder Alpha Board (Unilab, 223.124) is an MC14495P, which is now obsolete. We have failed to find any stockist of obsolete ICs who can supply this chip. The only source of supply we know of is Unilab. We understand that they are able to replace a defective 4495 with a working one if you send them the whole board for repair, but are not prepared to supply schools with discrete 4495s because their own source of supply is uncertain. You are still able to contact Unilab at their Blackburn address.

Free Physics simulations

This illuminating, free CD ROM is produced by Glasgow University Physics Department. The scope covers Higher and Advanced Higher concepts and theories.

New DJB Alba products

A first disk for Biology, with 13 experiments, has been introduced by DJB. The Alba Datalogger is now truly cross-curricular, there already being 4 Physics and 1 Chemistry disks. Also new is an ultrasonic rangefinder, at £115, which connects directly to a PC's serial port.

Sparklets cartridges

These are needed to power the CO₂ Capsule Rocket and certain makes of dynamics trolleys demonstrating Newton 3. We understand that they are now hard to find in High Street shops, but are available from the dot com outlet Cucinadirect.

Rollo dynamics trolleys

Rollo, who for two decades supplied directly to schools, or through Griffin, no longer manufacture trolleys, but are still in business and able to repair them, or supply parts.

Polymer news

Lovers of the factoid will be thrilled to hear that researchers at MIT (the Massachusetts Institute of Technology) have developed a germicidal polymer. This has been named, somewhat snappily, as:

poly(4-vinyl-N-alkylpyridinium bromide)

This polymer rivals *Domestos* in that it is claimed to kill 99% of common disease causing organisms. It could be used to permanently sterilise items such as countertops, doorknobs and possibly even surgical instruments.

SAFETY FLASH

Ironically, just as Jim Jamieson had finished the leader article on the front page with its references to motors and back e.m.f. we received a report of an accident involving just such a motor.

Fractional horse power motors have separate power connections: one for the rotor (armature) and one for the field coils, usually via 4 mm sockets. The teacher disconnected the leads supplying the field coils from the low voltage power supply while the motor was running. He simultaneously touched the metal pins of both plugs and received a severe electric shock due to the high voltage induced as the motor continued to turn.

Tests on another motor in our lab show that the EMF across a 1 kW phantom load exceeded 50 V a.c. at 300 Hz for about 1 s until the motor stalled. There was an initial spike of 200 V. It is clearly dangerous.

Control measures (see SSERC website):

- Fit a hazard label to the apparatus.
- Use leads with retractable, shrouded plugs (e.g. RS 531-330, or 737-954).

Addresses

CucinaDirect: W: www.cucinadirect.co.uk

djb microtech, Delfie House, 1 Delfie Drive, Greenock, PA16 9EN. T/F: 01475 786540, W: www.djb.co.uk

Philip Harris Education:

Findel House, Excelsior Road, Ashby Business Park, Ashby-de-la-Zouch, Leicestershire, LE65 1NG. T: 0845 120 4520 F: 01530 419 492, W: www.philipharris.co.uk/education

HSE Books, PO Box 1999, Sudbury, Suffolk, CO10 2WA. T: 01787 881165, F: 01787 313995, W: www.hsebooks.co.uk

Rapid Electronics, Severalls Lane, Colchester, Essex, CO4 5JS. T: 01206 751166, F: 01206 751188, W: www.rapidelectronics.co.uk

Revolution Education Ltd., Business Innovation Centre, Innova Park, Mollison Avenue, Enfield, Middlesex, EN3 7XU. T: 020 8350 1315, F: 020 8350 1351, W: www.rev-ed.co.uk

Rollo Industries Limited, St Andrews Works, Bonnybridge, Stirlingshire, FK4 2EJ. T: 01324 812469.

RS Components Limited, PO Box 99, Corby, Northants., NN17 5UB. T: 01536 201201, F: 01536 201501, W: <http://rewwww.com>

SAPS Biotechnology Scotland Project, Institute of Cell & Molecular Biology, Univ. of Edinburgh, Darwin Building, King's Buildings, Mayfield Rd., Edinburgh, EH9 3JR. T: 0131 650 7124, W: www.saps.plantsci.cam.ac.uk

AND AT: Quest Biotech Laboratory, Dollar Acad., Dollar, FK14 7DU. T: 01259 743753.

Science Year Scotland Office at Glasgow EBP Freephone number: 0800 731 2773

E: scotland@scienceyear.com

W: Science Year (UK) site:

www.scienceyear.com/about/

W: (direct): www.setpointscotland.org.uk

SEPA: W: www.sepa.org.uk/education

SESEF (Scottish Earth Science Education Forum): T: 0131 650 4849, E: sesef@ed.ac.uk, W: www.scottishgeology.com

SUMMER SCHOOLS:

(Biotechnology): Louise Russell, LT Scotland, Gardyne Road, Dundee, DD5 1NY.

(Chemistry and Physics): Julie Urquhart, St Mary's Land, Moray House Institute, Holyrood Road, Edinburgh, EH8 8AQ.

Unilab (address for repairs): Hutton Street, Blackburn, Lancs., BB1 3BT. T: 01254 681222.

University of Glasgow, Department of Physics and Astronomy, Glasgow, G12 8QQ. (Contact: Prof. Miles Padgett, T: 0141 330 5389, E: m.padgett@physics.gla.ac.uk)

CLEAPSS

Model Risk Assessments for Design and Technology

2002 Edition now available. Scope includes crafts and home economics
From SSERC at £10.00 plus £5.00 p&p