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The Bulletin is published by
SSERC, St Mary's Building,
23 Holyrood Road,
Edinburgh, EH8 8AE
Tel: 0131 558 8180
Fax: 0131 558 8191
E-mail: sts@sserc.org.uk
Managing Editor:
John Richardson

Strategic review

A lot has happened since the Scottish Executive published its Science Strategy in August 2001.

We have a new Minister for Enterprise and Lifelong Learning (and nearly a'thing else). One of the previous incumbent's parting shots was an article in *Business A.M.* reiterating her belief in the importance of science and skills in the economic and cultural lives of Scots. The Royal Society of Edinburgh has followed up a key element in the Strategy and accepted the Executive's invitation to convene a Science Advisory Committee. That group now has a practising teacher as one of its members. The Royal Society of London has continued to be active also, not only south of the border but across the UK. The Westminster Parliament's Select Committee on Science and Technology is part way through its investigation into science education 14 to 18. Sir Gareth Roberts' report to HM Treasury on Science, Engineering, Technology and Mathematics skills was published in April. Science Year is half-way through.

This is perhaps a good time to review and reflect on what progress has been made in improving Scottish science education. When the Executive published the science strategy it made some key commitments to Scotland's science base. Stating a political will is, of course, relatively easy. Keeping to one's commitments by following through and delivering was aye the tricky bit. It is for the science and technology community to encourage and assist with the next phase of implementation. We need to ensure, before any more high-profile initiatives or debates divert the collective political and educational attention, that we see a number of elements of the Science Strategy carried through in practice.

Much of the activity already announced has been welcome. It has probably contributed to partial achievement of some of the declared objectives. Our own major interests lie generally in school and college science education. More specifically our core business, to use the jargon, is to assist with - and support - the provision of adequate facilities and resources for learning and teaching in science and technology. Over the years we've also been sucked into related activities, such as health and safety advice, training and ICT applications. It may be useful then, in this and subsequent bulletins, to review progress - or any lack of it - in these areas.

Firstly, what about our own key concern, kit? What has been done about funding for equipment and apparatus?

A number of reports, pre-dating the Science Strategy, stressed the need to replace obsolete and worn-out science education equipment. The Executive has begun to tackle this problem but it got off to a somewhat bumpy start. The first announcement was of a figure of £10 million or so for new equipment. In practice school science seems to have seen little, if any, of that money. It is best left to readers to speculate as to where it went. The next slice of funding was £5 million - which was nice. Most, if not all, of this has probably gone to support educational elements of the Science Strategy (not just kit). It was a bit of a scramble though. The entitlements were announced late in the financial year. The notice to each Council on their share of the latest *tranche,* £3 million or so, has been much better. That letter was dated 1st May (see over). Discounting the original, ghostly, £10 million, a total of £8 million has been disbursed thus far. This was the figure spat out of the rumour mill a while ago. So, is that it then?

If so, it isn't enough. Scottish science education will have been let down. Informed estimates suggest that, after twenty years or more of neglect, school science needs £15 million a year for five years if we are to make a real difference. That's equivalent, in total, to the initial capital costs of just one major Science Centre. Meantime, the number of young people taking up the physical sciences continues to decline. The uptake of biological sciences is slowing.

A clichéd schools' verdict on the Science Strategy, thus far, seems unavoidable:

> *"An encouraging start, but a sustained effort is needed to make further progress."*

* * *

News and comment

More money for science

In support of its national priorities for the development of science education in schools, as set out in the Science Strategy for Scotland, the Scottish Executive has announced further funding for science activities and resources totalling £3 million for the financial year ending 31st March 2003. This is *new money* and is additional to the £5 million announced early in 2002 (see Bulletin 204). As before, these 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 again been based on pupil numbers. Councils' allocations are tabulated below.

COUNCIL	ALLOCATION
Aberdeen City	£97,640
Aberdeenshire	£175,980
Angus	£72,500
Argyll & Bute	£64,210
Clackmannanshire	£28,560
Dumf. & Galloway	£108,040
Dundee City	£76,140
East Ayrshire	£73,050
East Dunbartonshire	£69,750
East Lothian	£54,310
East Renfrewshire	£58,440
Edinburgh City of	£185,440
Eilean Siar (W.Isles)	£24,440
Falkirk	£79,750
Fife	£203,760
Glasgow City	£282,570
Highland	£161,050
Inverclyde	£47,920
Midlothian	£50,290
Moray	£58,910
North Ayrshire	£82,630
North Lanarkshire	£191,580
Orkney Islands	£17,670
Perth & Kinross	£84,560
Renfrewshire	£99,980
Scottish Borders	£74,290
Shetland Islands	£21,630
South Ayrshire	£66,680
South Lanarkshire	£180,450
Stirling	£54,480
West Dunbartonshire	£55,930
West Lothian	£97,370
TOTAL	£3,000,000

Table 1 *Additional science funding by EA. See the equivalent table on page 2 of Bulletin 204 for the 2001-02 allocations.*

Institute for Science Education

Plans for an *Institute for Science Education in Scotland* (*ISES*) are at an advanced stage. Nine of the Scottish Universities and a number of other partner organisations have signalled their support for this proposal which has been put forward by an Advisory Board to the Faculty of Science and Engineering at the University of Edinburgh.

The University is assigning some of its Knowledge Transfer grant monies to the development of the Institute and has taken the lead role in its foundation and promotion. Although the Institute will probably be housed in Edinburgh's Science and Engineering Faculty, the firm intention is for national coverage for ISES through its various members or partners and their activities. A core activity will be the provision of high quality professional development for teachers and technicians.

The ISES implementation group has a wide and varied membership which includes representatives from other universities, a headteacher and others from the school sector, ADES, the Scottish Earth Science Education Forum (SESEF), the Scottish Centre for Biotechnology Education, SAPS, SEED and SSERC. At the time of writing the group was in the process of appointing a Development Director for the Institute.

SCBE appoints staff

The Scottish Centre for Biotechnology Education (SCBE), see above, is based alongside staff of the SAPS Scotland project within the Institute of Cellular and Molecular Biology in Edinburgh. SCBE also works with other members of the SAPS team at the Quest Laboratory in Dollar. The Centre has now appointed a Project Manager to take forward this type of collaborative work. A Post-doctoral development officer with experience of appropriate gene technologies is also to be appointed. Initially they will adapt a number of protocols from the USA to make them more appropriate for use in Scottish courses.

And, finally - SAPS, SCBE, the Faculty of Education in Edinburgh, SSERC and SCBC (the Scottish Colleges Biotechnology Consortium) have jointly submitted a tender for a Pilot Option Module for the Chartered Teacher Programme. The bid was developed under the auspices of the Institute for Science Education Scotland.

Science 5-14 news

After a somewhat faltering start, the pace of the *Improving Science Education 5-14* national project has now picked up significantly. A Project Manager has been appointed and will be in post by early June. Three Development Officers each from different authorities should also be in post by late July or early August. They will work closely with both LT Scotland staff and with the SSERC team which is developing the next phase of the SOLSN (Science Online Support Network) project.

A SOLSN development site is already available for inspection and comment - see www.solsn.org.uk. User names and passwords are available, on request, to any Scottish teachers, technicians or EA officers.

RSE/SEELLD Fellowships

The Royal Society of Edinburgh, with the support of the Scottish Executive Enterprise and Lifelong Learning Department, is inviting applications for a number of Science Fellowships for Teachers, starting late 2002/early 2003.

Applicants must be members of teaching staff in a Scottish secondary school. Science Fellowships will fund the appointment of a temporary replacement to enable a Teaching Fellow to take leave from his or her own institution, while still continuously employed with his/her present employer.

Applicants may choose a company for the placement or one of the organisations provided on the RSE list (see p.16). Fellowships will normally be tenable for up to three months or one academic term. Once appointed, Fellows will be required to devote their full time to the placement project.

These fellowships will be of interest to teachers in chemistry, biology, physics, electronics, engineering, computing and careers. The Scottish Executive hopes that the scheme will enhance the transfer of ideas from commercial or industrial organisations to the education system, benefiting both the schools and individual teachers.

The closing date for applications is the 30th of August 2002. For more details contact the RSE's Research Awards Manager (see the text box on the back page).

* * *

Gas cylinders and regulators

Both of these components must, by law, be examined regularly.

Cylinders

Usually the cylinders are on hire from a supplier, eg BOC, who also fills them with the appropriate gas. Being the owner the supplier has the responsibility for pressure testing the cylinder.

However users should carry out a visual check on each occasion of use. If there are obvious problems such as:

- damage to the threads
- if the regulator doesn't seat properly or
- if the spindle valve requires great force to turn off the supply,

return the cylinder to the gas supplier.

Regulators

These are usually owned by schools, who will then have the responsibility for testing them. In discussion with the HSE on this subject, their opinion was that gas cylinder regulators are most unlikely to cause problems, but should be professionally checked at "appropriate intervals". There is no actual figure stated in legislation for the length of the interval as this depends on the amount of use and abuse which the regulator might receive.

A specialist HSE inspector who had worked for many years in the compressed gases industry considered that an inspection at intervals of 5 or 6 years was adequate for regulators which might be used between six and ten times in a year - especially when compared with the heavy use of regulators in industry. He also added that:

- *the design of gas regulators is such that they should always 'fail to minimum danger' and shut off;*
- *he only knew of one instance where a regulator failed catastrophically and that was on an old device which was being constantly turned on and off several times every day;*
- *modern diaphragms last a long time.*

Replacement

If the regulators are older than 20 years they should be replaced. Such regulators may be marked BS 5741, or have no BS marking at all. Some a bit younger would be stamped with BS EN 585 or BS 7650. They will probably be more than 5 years old and will need testing soon. Regulators purchased since around 1998 carry the marking BS EN ISO 2503.

The rotary pressure adjusting control knob can be screwed completely out of some older regulators; such regulators should also be replaced. Modern ones have captive control knobs.

RECOMMENDED CHECKS AND TESTS

On each occasion of use make a visual inspection for obvious signs of physical damage to the valves, casing, couplings and threads.

Check also that the regulator is suitable for use with the gas in the cylinder; the colour codes for the contained gas have changed (see entry for *Gas Cylinders* in the *Hazardous Chemicals Manual CD2* for fuller details). The correct means of identification is by reading the name stamped on the cylinder.

Annually, or if there is reason to suspect a leak, carry out a simple leak test

Wear goggles for this test. With the regulator fitted to the cylinder attach a short length of rubber tubing to the outlet and close the open end with a laboratory screw clip. Apply a dilute solution of detergent over the joints and the outside of the regulator, adjust the output pressure to a very low value, say 0.5 bar. Afterwards remove detergent solution with a damp cloth and dry the regulator. If any leaks are indicated by the appearance of small bubbles, then the regulator should be returned to the supplier or other firm for fuller testing.

Every five years have a test made by a competent engineer

For example Freshford Ltd currently quote £10 plus carriage. If a repair is also needed, this will cost an extra £40. If you purchase a new regulator, have it tested at five year intervals, ie at 5 years and 10 years after purchase and consider replacement after 15 years of age. If an EA can collect all its regulators together the cost of transport can be greatly reduced. Freshford make regular visits to universities in Scotland.

BOC sell regulators with a 5 year expiry date stamped on them and strenuously recommend that they are replaced every 5 years. Note that this is a recommendation and not a legal requirement.

Also, in the case of nitrogen, check that the regulator is designed to withstand the higher pressure of 230 bar now supplied in cylinders instead of 137 bar. *It is vital that you do not use a new cylinder of nitrogen with an old regulator which may not have been designed to cope with higher pressures.* BOC state that most regulators sold in the UK since 1987 should be suitable. The maximum inlet pressure for which the regulator is designed is usually marked on the regulator. If you are uncertain on this point, check with the gas supplier before you use it.

Suppliers of regulators include Freshford, Northern Technical & Chemical Services and Wescol (Scottish agent: Express Fuels).

Van de Graaff generator hazards

Excepting to persons with certain medical conditions, there is little risk of harm from electric shock from a Van de Graaff generator whose dome does not exceed 25 cm. Two cases of shock are analysed - a direct spark to the body from a charged dome, and an unintended discharge of a charged person. The first of these leads to a limit for maximum dome size. The article finishes with guidance on how to run the machine safely.

We discuss firstly the risk of harm to pupils with unusual medical conditions[1]. Listed below are cardiac conditions which may place someone at increased risk of ventricular fibrillation[2]. Subjects with any of these conditions should not receive electrical discharges from this equipment:

- coronary heart disease (e.g. angina, history of heart attack)
- cardiac rhythm disorders
- intra-cardiac conduction pathway anomalies
- presence of an implanted cardiac pacemaker
- hypertension (high blood pressure)

Regarding epileptic subjects, the risk of seizure is unlikely, but epileptic subjects should not be allowed to take that chance.

There is no evidence to suggest that persons without any such medical condition are at risk of ventricular fibrillation on getting electric shocks from a small Van de Graaff generator. This is underpinned by a theoretical understanding, which indicates no significant risk of harm[3].

[1] Based on correspondence with a medical inspector of the Health and Safety Executive

[2] An uncoordinated, rapid, electrical activity of the heart; there is no effective pulse and death ensues rapidly.

[3] In the absence of an electrical fault condition in the apparatus itself.

Figure 1 *The Frederiksen Van de Graaff generator (product code 3700.50) (suppliers include DJB, Nicholl, PASCO (SF-9722) and Scientific & Chemical (XES 080 010)).*

Having a 22 cm diameter dome, this machine should be incapable of causing a severe shock.

Physiological effects

The physiological effects of electrostatic discharges [1] depend on the spark energy (Table 1). This, in turn, is dependent on the capacitance of the system and the stored charge, or potential with respect to earth.

The capacitance of the human body lies between 100 and 300 pF.

Spark energy (mJ)	Physiological effects of electrostatic discharges
1	Smallest spark energy felt
10	Some find 10 mJ uncomfortable due to muscular contraction. Others can accept several hundred millijoules before experiencing sharp muscular contraction
1000	Affects everybody severely There is an accident history of people being rendered unconscious by discharges of several joules

Table 1 *Effects of electric shock as quantified by spark energy.*

If the charging voltage is greater than 1 kV, which it is with a Van de Graaff, then the thresholds of perception and pain can be related to the capacitor discharge. Respective values would seem to be around 0.5 mC and 8 mC [2, 3] by extrapolating from a graph in the relevant British Standard.

Van de Graaff shocks

If the field strength between two flat or large radius conducting surfaces exceeds 3 x 10^3 kV m^{-1} then a spark occurs [1]. Related to this [4], the theoretical maximum potential that the dome of a Van de Graaff can reach is $3a \times 10^6$ volts, where a is the radius of the dome in metres. Some values are shown in Table 2. The capacitance of the dome and stored electrical energy are derived using $C = 4\pi\varepsilon_0 a$ and $E = {}^1/_2 CV^2$.

It should be appreciated that the values for stored energy and potential will seldom be attained. They may hold when the air's relative humidity is abnormally low, such as sometimes occurs after the passage of a cold front, or in a *fohn* wind. In other words, these tabulated values are the highest a machine can reach. On a typical day, values will be lower; the machine will be much safer.

Dome diameter (cm)	Capacitance (pF)	Maximum potential (kV)	Maximum stored energy (mJ)
20	11	300	500
25	14	375	980
28	16	420	1370

Table 2 *Electrical properties related to dome diameter.*

There are two ways whereby the user can get a shock – from coming too near to a charged dome, or from an unintended discharge while being charged deliberately.

A person will get an unintended shock by carelessly coming too close to the charged dome. Most of the stored energy on the dome may then discharge to earth through the person's body giving the unintended shock. If we set a limit on the stored energy that should reside on the dome to be 1 J, then the maximum dome diameter is 25 cm. There is, so far as we are aware, just one product on the educational market that breaks this limit. It is the newly designed STE model with a dome diameter of 28 cm. (We have raised this with STE.)

Another means of shock occurs when a person - usually a pupil – is deliberately charged up and gets unintentionally discharged. In such a system, the electrical properties of the human body play a significant part. The highest potential reached is governed by the minimum radius of external body parts. The value might be 5 mm with a pinkie. The system voltage comprising dome and body might then reach $V = 3a \times 10^6$ V = 15 kV. With the body's capacitance of 300 pF, the energy to be discharged = $^1/_2 CV^2$ = 34 mJ and the charge stored on the person = CV = 4.5 mC. A sudden discharge of this amount of energy and charge would certainly be noticed. It would probably be disagreeable. It might even verge on being painful, but is unlikely to have any other direct effect.

Do bear in mind that any person getting a shock is at risk of harm from jerking or falling over in fright. There is then an indirect risk of a blow to the head, or damage to muscles, bones, or other parts.

Operational rules

In consideration of the above, the following rules should be applied:

1. Beforehand the teacher should check the appropriate records held at school for any relevant heart condition.
2. Before using the equipment, the teacher should warn the class that it should not be used by anyone with such a heart condition.

Figure 2 *The STE Van de Graaff generator (product code 10178) (dealers include Anderson Scientific (10178), Griffin (XJE-350-V) and Scientific & Chemical (XES 030 010)).*

Having a 28 cm diameter dome, this machine may be capable of causing a severe shock.

3. Charge only one person at a time to limit the charged capacitance of the system. The severity of the electric shock increases with capacitance. The shock can increase with the number of persons being charged simultaneously.
4. Persons being charged should be limited to volunteers. It is generally inadvisable to attempt to charge everyone in a class, whether singly, or together in a chain (as explained above).
5. Because a human body has capacitance, do not let someone touch a charged dome, then walk away. In these circumstances such a person may carry quite a lot of charge and experience a disagreeable and possibly unexpected electric shock on touching earth. Any other person touching such a charged person is also at risk of getting a shock.
6. The dome may be safely discharged by touching it with an earthed, metal conductor mounted on an insulated stand or handle. If this is operated properly, the experimenter should not receive a shock.
7. The dome should be discharged immediately after every operation ensuring that it never stands idle in a charged condition.

8. The dome may be safely discharged through the human body by arranging that the person getting the discharge is in poor contact with an earthed conductor. Instruct him to place one hand, palm down, firmly in contact with the benchtop, which is presumed to be wooden, or of similar, low conductivity. The dome may then be discharged by bringing the other hand up to it, either by direct skin contact with the dome, or through a hand held metal wand or sphere. Break contact with the dome before breaking contact with the bench. These directions assume that the benchtop insulation resistance is at least one megohm to earth, which is usually the case. By following these instructions the dome should be safely and completely discharged with the person experiencing only a slight physiological effect.
9. The demonstration with hair standing on end may be done safely by adapting the above procedure. Begin with the generator off and dome uncharged. Instruct the pupil to stand on an insulated platform (such as a plastic basin) and place one hand on the dome while ensuring that no part of the body or clothing is in contact with the bench, or another pupil. Start the generator and run until hairs stand on end. Stop the generator and instruct the pupil to place his free hand on the wooden benchtop while still keeping his other hand firmly on the dome. Wait several seconds until completely discharged. Remove hand from dome, step off the platform and walk away from the apparatus. The dome at this stage will not be carrying a charge and will be safe for another person to touch.
10. The demonstration of lighting a Bunsen flame by discharging through a human body to the Bunsen funnel would seem also to be fairly harmless provided that the Bunsen funnel does not have a low resistance path to earth, which is usually the case. Test lighting the Bunsen with an insulated lead. If the air discharge path is small and the accompanying sound is slight, it should be safe to use a human body for the discharge path.
11. If the capacitance of the system were to be greatly increased, for instance by connecting the dome to a Leyden jar, the stored electric energy can increase to a dangerous extent.

All science staff should be trained in how to work with the Van de Graaff generator, being made aware to avoid a direct path through the human body to a good earth (an earthed conductor of low resistance).

References

1 BS 5958: Part 1 : 1991 *Code of practice for control of undesirable static electricity* Part 1 *General considerations* BSI.
2. PD 6519 : Part 2 : 1995 *Guide to effects of current on human beings and livestock* Part 2 *Special aspects relating to human beings* BSI.
3. *Preventing electric shock* Bulletin 173 SSERC 1992.
4. Berg R.E. *The Physics Teacher* 28 5 (May 1990) pp 281-5.

Brady's reagent

This Advanced Higher Chemistry prescribed practical activity (PPA) includes a recipe and safety information for Brady's reagent.

Whilst working our way through this practical we noticed that, in the Teacher/Lecturer/Technician Guide [1], Brady's reagent is described as containing concentrated sulphuric acid, which is correctly identified as a corrosive solution. Unfortunately, in the 'Student Instructions', it states – "Brady's reagent also contains sulphuric acid, which is irritating (our emphasis) to the eyes and skin". Brady's reagent is in fact a corrosive solution. Students need to be made aware of this and that sulphuric acid is classified as:

IRRITANT at concentrations ≥ 0.5 M to < 1.5 M

CORROSIVE at concentrations ≥ 1.5 M

In addition, we noticed that the recipe for Brady's reagent detailed in the PPA support material is different from that given in the SSERC Hazardous Chemicals CD2. Both are given below for comparison.

HSDU: *Unit 3 PPA2: Preparation of Brady's Reagent (T or TECH):* Dissolve 2.5 g 2,4 dinitrophenylhydrazine in 5 cm^3 concentrated sulphuric acid. To this mixture add 50 cm^3 methanol carefully and with cooling. Warm the resulting solution to dissolve any remaining solid and add 10 cm^3 water.

SSERC (Hazardous Chemicals CD2): Preparation of Brady's reagent (T or TECH): Wear rubber or plastic gloves and eye protection. Suspend 1 g of 2,4-dinitrophenylhydrazine (DNPH) in 50 cm^3 of methanol (HIGHLY FLAMMABLE & TOXIC) and add 2 cm^3 of concentrated sulphuric acid (CORROSIVE) and stir well. Filter if cloudy. It is easy to avoid raising dust as the hydrazine is stored moist. The mixture is CORROSIVE, HIGHLY FLAMMABLE & TOXIC and should be labelled accordingly.

The most notable differences between these recipes are that the SSERC version requires a smaller volume of concentrated sulphuric acid, less 2,4 dinitrophenylhydrazine and does not require heating (the heat generated during the addition of the concentrated sulphuric acid helps to dissolve the 2,4 DNPH). These are all plus points in terms of safety and cost. But does the SSERC version produce similar results to that obtained when using the PPA recipe? Well, yes it does. We tested both versions of the reagent and found the results to be comparable.

Reference

1. HSDU, Advanced Higher Chemistry, Unit 3, PPA 2, *Identification by Derivative Formation.*

Texas datalogger

This is an outline review of the Texas Instruments calculator-based datalogger CBL 2 wherein its ease of use, functionality and speed are compared with computer-based instruments.

The *CBL 2* is used in conjunction with a Texas Instruments (TI) graphics calculator, the *TI-83 Plus* being the preferred model[1], and electronic sensors made by the US company Vernier. With around 40 good quality sensors to choose from, the scope of the measurement system is extensive. It covers the 3 school sciences, biology, chemistry and physics. It can be run in any of the standard modes: variable versus time, A against B, a dependent variable against a keyboard entry, etc. It can log very fast or slow. Logging can be begun with a keyboard press, or triggered automatically. Its functionality is fairly complete.

Where it really scores is on price. The cost of the 2 essential components, a *CBL 2* and *TI-83 Plus*, is £171. This price includes sensors for temperature, light and voltage. Compare that with a reasonably priced computer-based datalogger, say the *Alba*, and an inexpensive laptop, and the bill comes to £978. That is nearly 6 times greater! If you want a class set of dataloggers, then the *CBL 2* may be an affordable option[2].

The hardware is simple and quick to set up. Taking up minimal bench space, it can be set up alongside other equipment with little inconvenience. It's portable and may be used in almost any situation – in a lift, on a bicycle, in the playground, or on a field trip. It would be a convenient instrument for many studies – human physiology, sports science, fairground physics, rocketry and environmental monitoring, to think of a few.

What's the rub? Relative to computer-based instruments, it is slow and ponderous to operate. The calculator keyboard has 50 keys. Since most of the keys have 3 functions, the total number of keyed functions is an amazing 135. The keyboard can take a long time to learn and understand. Unless used continually, the keys, their positions in the keyboard, and their purposes may be quite readily forgotten. For this review, the *TI-83* was used for three extended periods each a month or two apart. On the two occasions when the reviewer had so returned to work with the calculator, he had to spend several hours relearning how to operate it.

Good features	Poor features
Relatively inexpensive - sufficiently inexpensive to buy in class sets Does not require a computer (but can be used with a computer) Large range of (mostly) high quality sensors Highly portable Occupies a small area of workbench Relatively inexpensive OHP viewer (*ViewScreen*) allowing teacher demonstration with whole class viewing Based on a widely available graphics calculator that many pupils should already be familiar with through Maths, and may in fact own Long life battery operation with auto power-down, no mains supply required Excellent graphing package for computer-based analysis (Vernier's *Graphical Analysis*) Excellent documentary support from Vernier on experiments	Slow and ponderous Operated from a complex keyboard which takes time to understand Can often be confusing to operate and is much harder to run than computer-based dataloggers User has to learn how the graphics calculator works to operate the datalogger Many of its operations are obscure; much recourse to the Instruction Manuals is needed Unless used regularly and often, the user is liable to forget how to proceed Operation consists of a confusing sequence of keypresses (sometimes a number, or cursor key, or ENTER key, or special function key such as STAT, STAT PLOT, STO, etc.) If the operator makes a mistake, then several steps have to be redone, or even a fresh start made The program can hang up often Graphs and characters are at low resolution - display resembles a 1980s computer

Table 1 *Comparative review of the CBL 2 relative to computer-based interfaces and dataloggers.*

Software	Datalogger	Number of Instructions	Time to execute instructions and log data for 10 s (s)	Time to execute instructions (s)
DataMate	Texas *CBL 2*	14	115	105
Alba	DJB *Alba*	10	45	35
Data Studio	PASCO *500*	12	45	35

Table 2 *Speed trials on 3 dataloggers. Each was set to carry out the same task.*

1 Other Texas calculators, such as the *TI-82*, run reduced versions only of the datalogging software *DataMate*. They should be avoided, but consult your dealer.

2 But this price scoring may well be un-sound. It overlooks the government's national plan to put one computer for every four pupils in each secondary school, the cost being borne by central funding.

Dataloggers

A comparative test was set up with the *CBL 2* and two computer-based dataloggers (Table 2). In each system one change was made in the default logging settings, a physical quantity was logged for a period of 10 s and the resulting graphical display was optimised. One result shows that the number of instructions required did not differ significantly between either the calculator or computer-based dataloggers. (The calculator has many special function keys which a standard computer lacks. This should give it an advantage. In fact, the *CBL 2* required a few more keypresses.) The other result showed that the *CBL 2* is 200% slower than computer-based dataloggers doing comparable tasks. It is a sluggish instrument to run.

The other grave disappointment is the display, which resembles one on a 1980s computer.

The *CBL 2* can be used in demonstrations with the *Silver Edition* of the *TI-83 Plus* graphics calculator and a TI *ViewScreen* projection screen sitting on an underlit overhead projector. Data can also be transferred from the graphics calculator to a computer (PC or MAC) for class display with a computer projector. There is an excellent software package from Vernier, called *Graphical Analysis*, which facilitates this data transfer from the calculator (see following review).

Summary

Summarizing this review, the 3 big plusses are the wide scope of application, simplicity of hardware set-up and, relatively speaking, very low cost, allowing high quality data-capture on a budget. But the 3 big negatives are that it is not simple to use, its operation is slow, and its display is primitive.

In our opinion this is an instrument for the committed enthusiast rather than the normal science teacher, for whom a computer-based datalogger would be the preferred choice. It needs to be used continually and often so as to learn, but not forget, how to operate it.

Comparative equipment	**Texas Instruments or Vernier calculator-based items**	**Computer-based items**	
		DJB *Alba*	**PASCO**
Platform	*TI-83 Plus* Graphics Calculator £54.95 £512 (10 pack)	Laptop (Toshiba *Satellite Pro 4600*) £795	Laptop (Toshiba *Satellite Pro 4600*) £795
Demonstration platform	*TI-83 Plus Silver* Graphics Calculator £79.95		
Demonstration viewer	TI *ViewScreen* £109.95	Portable projector (3M *MP7640I*) £1619	Portable projector (3M *MP7640I*) £1619
Datalogger	TI *CBL 2* (includes temperature, voltage and light sensors) £115.95	*Alba* Interface S1-1000.00 £183	*500* Interface £299
Voltage sensor			CI-6503 £14
Temperature sensor		C1-1000.00 £19.50	CI-6505B £56
Light sensor		K1-1200.00 £32	CI-6504A £73
Ultrasonic motion sensor	TI *CBR* £74.95	B1-2000.00 £115	CI-6742 £105
Force sensor	DFS-BTA £103.35		CI-6747 £147
Exercise heart rate sensor	HER-BTA £95	H3-1060.00 £32 and H3-1060.10 £36.50	CI-6543B £85
Software		Supplied with *Alba* at no extra cost	*Data Studio* CI-6870C (single user) £122 CI-6871C (site licence) £429
Additional software for analysing *CBL 2* data on computer	*Graphical Analysis* (site licence) £69.95		
Wire link to computer	TI *Graph Link for Windows* £17.95		

Table 3 *Comparative costs of CBL 2 versus computer-based interfaces and dataloggers. Most of the sensors for the CBL 2 are made by Vernier. There are around 40 sensors, only a few of which are listed above. These sensors comprehensively cover biology, chemistry and physics.*

There is a significant risk that, in some departments, once bought, it will either be underused, or sit in a cupboard unused.

Suppliers

Comcal (Scotland) Ltd.
Oxford Educational Supplies Ltd.
Shaw Scientific Education (UK) Ltd.

Graphical Analysis

The new version of Vernier's software offers powerful computer graphing facilities. Even so, it is simple to use and is very reasonably priced. We recommend it, strongly.

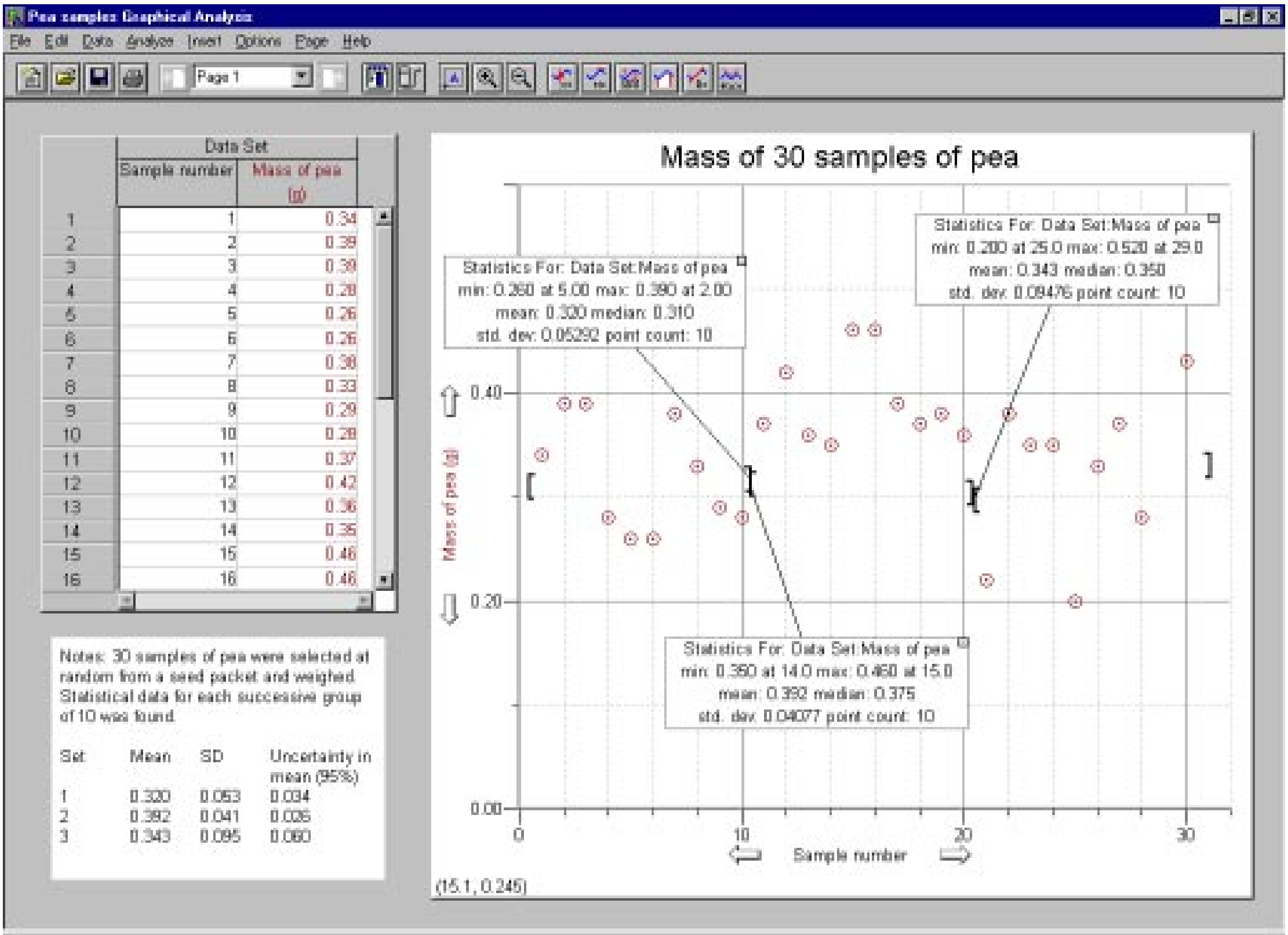

Figure 1 *Example of the default screen display on Graphical Analysis (Version 3), with added data and statistical analysis.*

Review

Graphical Analysis is a program for MAC or Windows produced by Vernier, a US company specializing in scientific computer products. The original version first appeared in 1982. That and *Version 2* have been deservedly popular in America. *Version 3* has just been released and is stocked by several UK suppliers. It is extraordinarily good and ought to be a standard utility package in every science department.

On starting up the program, 3 windows appear. At top left is an empty table and, below it, a text box. Occupying the right hand side of the screen, is an empty graph. There is a cursor sitting in the top cell of the table. On typing in a data pair, a corresponding point appears on the graph. If more data is entered from the keyboard, so more points appear on the graph. It is as simple and elementary as that!

In all, there are several ways of entering data:

- Keyboard entry.
- Importing a text file (e.g. consisting of a table in Microsoft *Word*, or text file created by *Alba*).
- Copying data from a spreadsheet (e.g. Microsoft *Excel*), or text (e.g. table in Microsoft *Word*) and pasting into *Graphical Analysis*.
- Transferring data from a Texas Instruments graphing calculator (with datalogger).

Proceeding from an initial graph, commands for editing the graph and table and analysing the data appear by positioning the mouse in the relevant part of the screen and clicking, or by clicking on a toolbar icon, or selecting from a pulldown menu. No operation is obscure or complicated. It really is all as easy as pie. Yet there is considerable depth of analysis and the display can be refined in almost any way the user wants.

For the purchase price of just under £70, the school gets a site licence. This allows students to run the program on their home computers.

Each window can be copied and pasted into a *Word* document. Thus it is very simple to copy tables and graphs out of *Graphical Analysis* and paste them into lab reports. It is equally simple transferring data the other way – copying data in text tables or spreadsheets and pasting into *Graphical Analysis*.

Anodising aluminium

Advice is given on how to carry out this chemistry practical.

We recently received an enquiry from a school following up poor results obtained when trying to dye anodised aluminium. Demonstrating this process is a suggested activity within the Chemistry Intermediate 1 syllabus (see *Unit 2: Everyday Chemistry, (a) Metals – Corrosion*). Below are details of a method that we have thoroughly tested and which has consistently given us good results. We suggest the use of aluminium sheet (Griffin & George A/1690/50 £9.70 or Philip Harris B5A40964 £9.57) or aluminium takeaway food containers as both of these produced good results. Aluminium drinks cans, although plentiful and 'free' are not recommended since they have internal and external coatings. These are very difficult to remove and they inhibit the anodising process.

Apparatus/Reagents

Aluminium metal sheet or food 'takeaway' container
Low voltage power supply, variable 0 to 16 V
2 x 4 mm test lead
10 cm square (max. 7 mm thick) piece of wood with two 4 mm holes drilled 5 cm apart
500 cm^3 beaker
1M sulphuric acid (IRRITANT)
Industrial Methylated Spirits (HIGHLY FLAMMABLE)
Various coloured dyes (clothes dyes, waterproof drawing ink)
Distilled water
Forceps or tweezers

Preparing the Aluminium Strip

1. Cut out 2 strips, 2 cm x 6 cm, from an aluminium sheet or food container. Attach a crocodile clip to each of these.
2. Clean and de-grease the aluminium strips by immersing in a beaker of Industrial Methylated Spirits (IMS) (HIGHLY FLAMMABLE) for about 1 minute. (Mineralised IMS is fine.)
3. Remove the aluminium strip from the IMS, handling the crocodile clips only. Once the aluminium has been so cleaned <u>*do not touch it*</u>. Rinse it with distilled water and use immediately.

Anodising the Aluminium Strip

1. Add about 300 cm^3 of 1M sulphuric acid (IRRITANT) to a 500 cm^3 beaker. Aim to leave about 1 cm of the aluminium strip above the level of the acid and ensure the crocodile clips are kept out of the acid (Fig. 1).
2. Fit two, 4 mm test lead plugs through the holes in the square of wood and fit the crocodile clips holding the aluminium strips to these. Taking care not to touch the strip to be anodised, place the assembly in the beaker of acid.

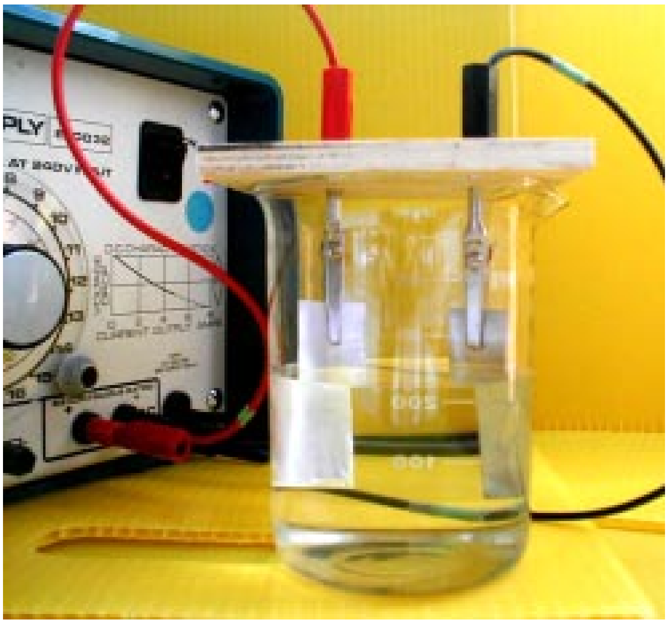

Figure 1 *Aluminium being anodised.*

3. Connect the aluminium strip to be anodised to the positive terminal on the power supply.
4. Turn on the power supply and adjust to 15 V. An aerosol of acid may be produced but, if this does occur, the 'wooden lid' will contain it. Leave running for 30 minutes.
5. Prepare the dyes for use. The dyes work best if they are hot but <u>*not boiling*</u>! So start warming them up before you stop the anodising process.
6. After 30 minutes switch off the power supply. Disconnect the anodised aluminium strip and rinse with distilled water (Take care! The crocodile clips and acid can get very hot).
7. Place the anodised aluminium in the hot dye solution for about 10 minutes, moving it every minute or so. Then, using tweezers, remove the aluminium from the dye solution and wash it under a running tap to remove any excess dye. Drop the aluminium into a beaker of boiling water and leave for 10 minutes to seal the dye.

Figure 2 *Examples of dyed anodised aluminium strips.*

To obtain the best results use fresh sulphuric acid for each strip of aluminium to be anodised.

Dyes

We found that *Dylon* clothes dyes (one tin in 250 cm^3 of water) and *Pelikan* and *Uno* waterproof drawing inks (slightly diluted) worked well. The best colours were blue, purple and red. We also managed to produce a navy blue effect using black *Quink* ink.

Safety

Hazards with the substances used in this practical are tabulated opposite.

Wear eye protection and work in a well-ventilated laboratory. Ensure any acid aerosol produced during the anodising process is contained or work in a fume cupboard.

When making up dye solutions other than the water soluble types named herein: Wear appropriate gloves, eye protection and a PVC apron. Avoid inhaling any dust and, preferably, use a fume cupboard.

Substance	Hazard
Industrial Methylated Spirits (IMS)	HIGHLY FLAMMABLE - forms explosive mixtures in air; keep away from sources of ignition. TOXIC by inhalation, swallowing and skin contact. The liquid and vapour are dangerous to the eyes because of the methanol content.
Sulphuric acid 1M	IRRITANT - Dilute acid is harmful to eyes and skin and repeated contact can cause dermatitis.
Dyes	Many dyes are IRRITANTS and HARMFUL. Some are CARCINOGENS - many of low potency, but others have high potency and their use should be avoided. The dyes suggested here are of low hazard as should be others purchased from reputable craft shops. Material Safety Data Sheets (MSDS's) should be supplied upon purchase. Avoid Direct Blue 14 (Tryptan Blue), Direct Brown 95, Direct Blue 6, Direct Black 36. Sudan I, II, III and IV are suspect carcinogens, with the evidence against Sudan IV being more reliable.

Biology

New microbiology resources

In the last issue, we carried a short piece on disinfectants and, in passing, we mentioned an updating exercise on the old Strathclyde Code of Practice on Safety in Microbiology. A new edition of the code is now at the final draft stage and is out for proofing. This has been due largely to the efforts of Jim Stafford, one time at the Higher Still Development Unit (HSDU), now back with East Ayrshire Council, and Kath Crawford of the SAPS Scotland Biotechnology Project. Also at that asymptotic stage, loathed by any editor, are electronic versions of the Microbiological Techniques Cards originally published in print form by SSERC and HSDU (see Figure 1 below).

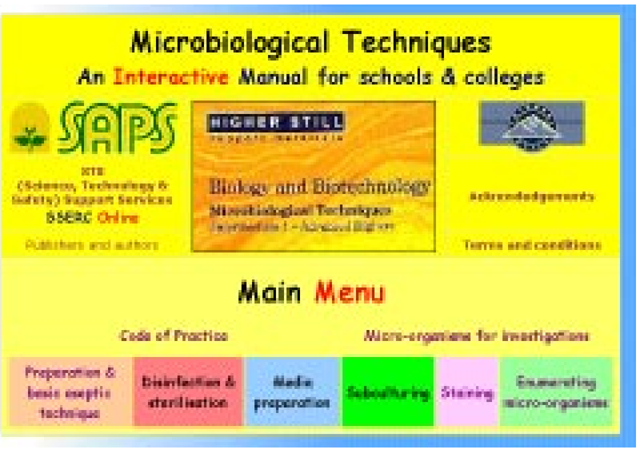

Figure 1 *Main menu page for electronic version of the Microbiology Techniques publication.*

These have been largely the work of Ian Birrell at SSERC with advice and help from Kath Crawford and Kirsty Menzies of the SAPS project. The electronic version of the techniques cards uses web pages to allow rapid retrieval of information on any particular technique. This is the same approach we adopted for our well-regarded Hazardous Chemicals CD.

With this new resource we've taken things one stage further and added a large number of original photographic images (see Figure 2 for an example). These photographs supplement the excellent line drawings based on Jim Shield's (of Balfron High School) original graphics. For convenience we've included a copy of the Code of Practice (as a *Word* file meantime) and there is a link to a web page version of the fuller list of micro-organisms from SSERC Bulletin 194. We shall be making arrangements soon for the distribution of this new resource on CD-ROM.

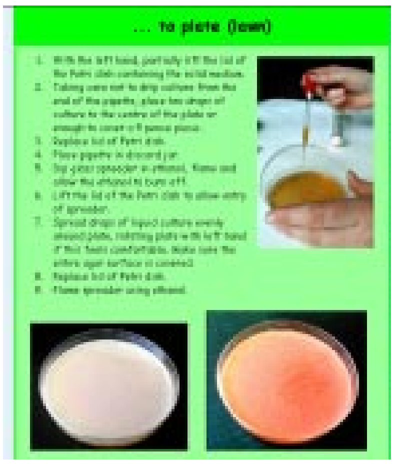

Figure 2 *Part page for a sub-culturing sequence with original photographs.*

Biology

Microscope illumination

A simple device - a "turbid cube" - is described which may be used to demonstrate the proper use of a microscope condenser and iris diaphragm.

Recently, some money has again been coming the way of science education (see page 2). So, we've increased the level of our testing activity. One category of kit we've been looking at has been microscopes for school and college use. The results from that programme will be published, once the suppliers have had the chance to comment on drafts of our reports. These new testing programmes have also led us to re-visit some of SSERC's earlier publications on the specification, selection and use of suitable instruments. Sadly, our discussions with teachers and technicians suggest generally poor levels of understanding on how to properly set up instruments and use them effectively. This is unfortunate since some biology courses now have a formal requirement on teaching the proper use of microscopes.

In any worthwhile article on effective educational usage of the optical microscope, emphasis should be placed on the need for careful illumination. There can be difficulties, however, in attempting explanation of what is needed. Often a teacher is reduced to sketching two-dimensional diagrams or simply waving his or her hands in the air. Direct demonstration of what is happening to the light appears impossible. It ain't necessarily so. In an earlier Bulletin issue [1], we described the preparation of a 'turbid cube' made from polyester casting resin which was impregnated with a small amount of magnesium carbonate. The tiny particles suspended within the plastic scatter the light. This is the Tyndall effect. Most of us are more familiar with this effect when dealing with colloidal suspensions in liquids.

With such a device, ray paths can be made visible and the control settings to achieve proper illumination can be directly illustrated (see figures 1 and 2 below). Some years ago we streamlined the preparation of our turbid cubes by substituting a colloidal suspension in a liquid rather than using particles suspended in a solid. We simply took the lid section of a plastic coverslip box, filled with it water and added a few drops of milk. The photographs shown here were taken using such a box. To improve the photographic results we substituted colloidal graphite (*Aquadag*) for the milk. The latter is more than adequate though for direct observation.

So, why bother? What can we show using such a turbid cube? Quite a lot. For example, figures 1 and 2 illustrate the use of a focussing Abbe condenser to focus the light source at the specimen plane and the role of the associated iris diaphragm as an aperture stop. It is also possible to show, in a mirror illuminated instrument, how the apparent size of the light source changes when first the plane and then the concave sides of the mirror are used. This in turn explains why the concave mirror is used to illuminate fully the relatively large field of view with a low power (x4 or x5) objective. Other uses include revealing the whereabouts of the eyepoint or exit pupil (also known as the *Ramsden Disc*) above the eyepiece. It is also possible to see the different diameter and position of the eyepoint, depending on whether a widefield or Huygenian eyepiece is in use. Simple contrast enhancement methods can be shown, from the simple expedient of tipping the mirror to obtain oblique illumination, through the use of patch stops on filters for dark-ground illumination and on to the use of coloured filters to achieve optical staining or *Rheinberg* illumination.

On modern instruments many of these effects will be apparent with the built-in illuminator (figures 1 and 2 were so obtained). In other cases it may be necessary to use a high intensity source such as a slide projector. Teachers should ensure that no-one actually looks down the microscope when such a source is in use.

Reference

1. *Turbid cubes*, Biology Notes, Bulletin 129, SSERC, 1981.

Acknowledgements

The stimulus for us to experiment with variations on the turbid cube theme came from course materials produced by the Royal Microscopical Society based in turn on two separate, original articles by Haselmann and Thomson published in the society's "Proceedings".

Figure 1 *Faulty illumination where the condenser isn't properly focussed at the specimen plane and the iris diaphragm has not been sufficiently closed down so as to illuminate about two-thirds of the back plane of the objective. This results in lower than necessary resolution and poor contrast.*

Figure 2 *Correctly illuminated specimen and objective with the condenser focussed and the iris diaphragm properly adjusted. This should assist in achieving optimum resolution with good contrast and adequate control of glare.*

Constant Force Spring

This interesting device can be used to apply a constant force on a dynamics cart.

This does what it says. A nylon line attached to the device exerts a constant force whether it is being extended or retracted. The way it works is that a ribbon of pre-stressed spring material is wound round two side-by-side drums forming a pair of spring coils. As one coil winds round one drum, the other unwinds (Fig. 1). There is then effectively a constant torque T on each drum. A pulley wheel, radius r, is attached to the spindle of one of the drums. The tension on the line is T/r. It too is therefore constant.

Figure 1 *Photograph of a Constant Force Spring (McMaster Carr product 61115A1) in a home-made mount.*

Constant force springs are made in the US by Hunter Spring. (They are also *called nega'tor spring motors.*) We bought the smallest in the range for testing (Fig. 1). It has a cable tension of 0.375 lbs (or 1.69 N). These are obtainable from a US hardware stockist, McMaster Carr (order code 61115A1, price $59.17) and were brought to our attention by an article in an American journal - *The Physics Teacher* [1].

Figure 2 *Photograph of a PASCO Dynamics Cart attached to a Constant Force Spring.*

It can be used to exert a constant accelerating force on a dynamics trolley. The spring should be fixed to one end of a dynamics track (Fig. 2) and the line extended so that, on release, the cart is drawn back to the spring. By monitoring the cart with an ultrasonic rangefinder, or with light gates, a value for acceleration can be derived. Our tests confirmed that the acceleration was constant and that there was a linear relationship between acceleration and inverse mass (Fig. 3).

The product would be more useful in physics education if a stepped pulley wheel with 5 or more steps could be fitted to the spindle on one of the coils. Since the cable tension is T/r, the applied force could then be changed easily.

The device was also used to give a vertical lift or descent, but the results were disappointing. Nevertheless as a mechanism for exerting a constant force on a dynamics cart, it has proved to be effective. Details of how to mount it can be found on our web site.

Warning

Finally a warning that the device is not suitable for use with those pupils who could not be trusted to behave responsibly.

Reference

1 G R Reich and A Bradshaw, *Using Nega'tor Springs as a source of constant force*, The Physics Teacher, Vol. 40, March 2002.

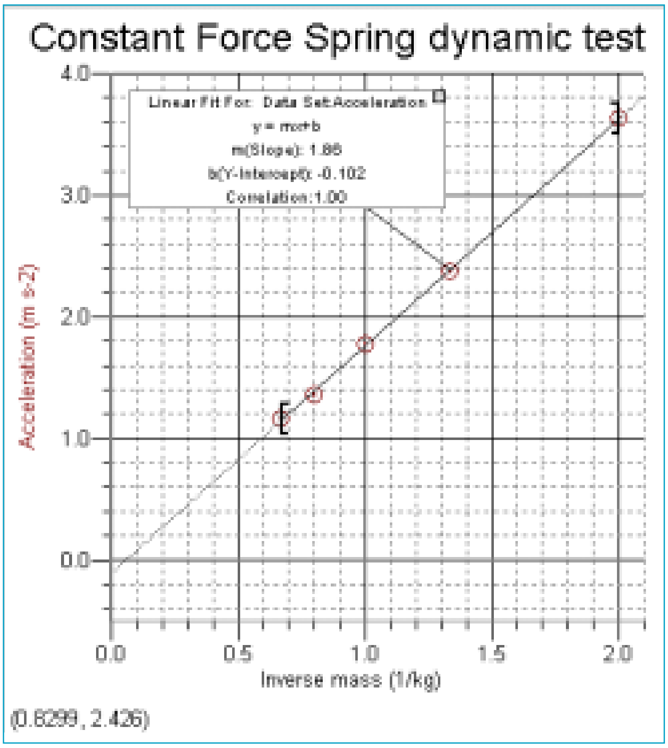

Figure 3 *Linear relationship between acceleration and inverse mass (using Vernier's* Graphical Analysis *(Version 3)).*

Laser diode modules

The specifications of laser diode modules continue to improve, yet they drop in price. This is good news for customers. Here is a review of a selection of Class 2 devices.

Roithner, an Austrian distributor of opto-electronic products, now stocks several types of inexpensive Class 2 laser diode modules. Those that may be of particular use in schools are listed and shown here (Table 1) (Fig. 1). The prices quoted are in euros. Goods may be purchased either by credit card, or by sending an international money order. If placing an order let Roithner know what you want to buy firstly before arranging payment.

LJ laser diode modules

LJ laser diode modules (LDM) are reasonably robust. They are housed in metal barrels 29 mm long by 12 mm diameter. This is just sufficiently large to be held in a lab clamp. Flying leads are securely anchored at the rear. The supply voltage lies between 3 and 6 V DC. The current is 25 mA. Suitable power supplies would be AA, C or D cells, or a voltage regulated supply.

Like many other laser diode modules, the barrel makes electrical contact with the positive supply. If the barrel were to be in electrical contact with earth and the supply negative were to be earthed, then the supply would be short-circuited.

The beam quality is fair, but poorer than on some HeNe types. The collimator lens can be adjusted to focus the beam at any distance down to a minimum size of 2.5 mm. The cross-section is rectangular. The beam may also be expanded to subtend an angle of 6°. This is a useful feature. There are many applications where it can be useful to work with a divergent beam of laser radiation.

LJ LDMs are available in 8 wavelengths from 635 to 850 nm. The one listed at the top of our table would be the preferred buy for a school laboratory. Having the shortest available wavelength, it appears to be brighter than the others because of the human eye's photopic response. At only 34.50 euros, LDM635/1LJ would be hard to beat as a general purpose school laser. It is sold as a Class 2 laser. I have checked its optical power. It is indeed just under 1 mW.

Figure 1 *Laser diode modules LM-04 (left) and an LJ type (right).*

Part no.	Wavelength (nm)	Optical power (mW)	Beam cross-section	Note	Price (Euro)
LDM635/1LJ	635	1	4 x 2.5 mm^2	Focusable	34.50
LDM650/1LJM	650	1	4 x 2.5 mm^2	Focusable Modulable, DC to 10 kHz	26.45
LM-03	650	1	Circular dot 4-6 mm @ 5 m		9.10
LM-04	650	1	Line, 55 deg. divergence	Suitable for ray optics	9.10

Table *A selection of laser diode modules presently available from Roithner.*

The other listed LJ laser (LDM650/1LJM) appears less bright because of its longer wavelength, but it can be modulated to 10 kHz and used to transmit a digital signal.

Low cost LDMs

There are two Class 2 low cost LDMs costing around 9 euros each. The metal barrel, which is in electrical contact with the positive supply, is between 8 and 9 mm in diameter. It can be held in the boss head of a clamp stand. The leads are fragile. They attach by solder to a circuit board and have no strain relief. Before use we recommend that the LDM is mounted in a wooden block to clamp it (Fig. 2). The leads should be attached to a small circuit board you would have to make, including a protection diode. To this circuit board should be attached a stronger pair of flexible, flying leads with 4 mm connectors to either a 4.5 V battery, or 5 V regulated supply. (For details, please see our web site.)

The beam quality of LM-03 is fair. The sample we bought produced a uniform, oval light patch 4 x 3 mm at 30 cm, diverging to 7 x 5 mm at 3 m. The measured power was 1.2 mW. This is slightly above the Class 2 limit, but not dangerously so.

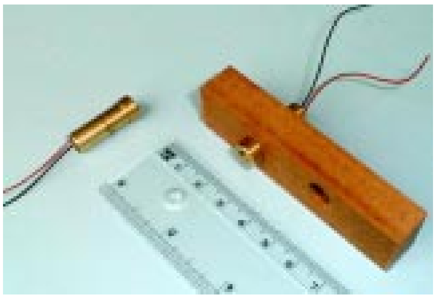

Figure 2 Two LM-04 line generators, the one on the right being fitted to a hardwook block, which serves as a clamp.

The other low cost LDM, LM-04, is much more interesting. It generates a line. If oriented to produce a vertical sheet of radiation, it becomes an excellent substitute for a ray box. We bought in three of these for testing. The worst beam of the three is photographed here with a semi-circular block (Fig. 3). The beam width is 3.5 mm at the aperture, 3 mm at 10 cm, reducing to 1 mm at 50 cm – the region where it would be used in ray optics. Beyond 50 cm it diverges to 3 mm and 8 mm at 1 m and 2 m respectively.

The line is generated by diffraction. The beam appears to be continuous up to 50 cm. Beyond this point, fringing appears, the mark to space ratio gradually increasing to about 1:1 at 2 m.

Remarks

For years we've been proselytizing that the laser should become the preferred source of optical radiation in school labs.

The emergence of really cheap lasers should now make this idea practicable. It really is high time the ray box with its tungsten filament lamp was replaced by a laser line generator.

Safety

Pupils in years S3 and upwards are permitted to work with lasers. Up to, and including, S5 they must be continuously supervised. Pupils and students must be shown how to handle lasers safely. The laser must be in Class 1 or Class 2 only. It must be held in a clamp. The main laser beam or line should be terminated with a screen at the end of the working area.

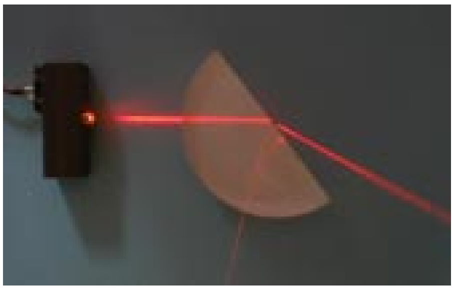

Figure 3 *The LM-04 line generator used as a ray source. Shows refraction at a semi-circular block.*

PASCO Laser Ray Box

A laser ray box is made by PASCO (model no. SE-8505, at £351). It projects 5 parallel rays of laser radiation across a flat surface, the sources being 5 Class 2 laser diode modules. With a wavelength of 635 nm, the rays appear stunningly bright, the photopic sensitivity being about 20% at this part of the spectrum (compared with 11% and 5% at 650 nm and 670 nm respectively). Each ray has a uniform width of 2 mm. Rays are 18 mm apart (one is out by 1 mm), maintaining parallelism. Vertical divergence is a mere 7 cm in 1 m. The product quality is high. It would make an excellent demonstration raybox.

Ultraviolet LEDs

UV LEDs were recently invented and have begun to be more widely available. We bought in a few and report here on what we found.

The first two LEDS listed (Table 1) are in the typical round, clear epoxy packages we expect of LEDs. The third is in a metal can with protective window. This presumably, though the data sheet omits to say so, is a filter preventing emission of any visible radiation.

Radiation intensity falls off to either side of the peak value. The spectral halfwidth is usually the width in nanometres of the spectrum at 50% of its peak value. For HUUV-510-10, the 50% boundaries are 385 nm and 405 nm whereas for RLT370-10 they are 364 nm and 376 nm. Of course the boundaries for 1%, 0.1%, or 0.01% are much further away from the peak value than those for 50% of peak intensity. The human eye has a logarithmic response to light level and may be able to range across very many orders of magnitude. Thus what the eye perceives may be much broader than what the spectral halfwidth indicates.

The lower limit of the human eye's photopic response is usually taken to be 400 nm. Emissions from both B5-437-CVD and HUUV-510-10 extend well into the violet region of the visible spectrum. There is no perceptible visible emission from RLT370-10, except if viewed in a dark room.

Thus, of the three UV LEDs reviewed, RTL370-10 is probably the most useful. Because the radiation it itself emits is invisible It unambiguously shows fluorescence. Although still pricey, it and others like it are bound to become much cheaper, in the way that these things do.

Both B5-437-CVD and HUUV-510-10 make superb miniature sources of violet radiation. For direct viewing, they should be screened with a suitable filter (e.g. Edmund Scientific, E39-426 at £9.56).

UV LEDs are powered just as other LEDs are. B5-437-CVD and HUUV-510-10 have each a typical forward voltage and current of 3.5 V and 20 mA respectively. For RTL370-10 the respective values are 3.9 V and 10 mA.

The supplier of UV LEDs is *Roithner* of Vienna, Austria.

LED	Package	Peak wave-length (nm)	Spectral halfwidth (nm)	Luminous intensity or optical power	Appear-ance of emission	Price (Euro)
B5-437-CVD	5 mm round epoxy	395 [1]	- [2]	50 mcd	Violet	5.58
HUUV-510-10	5 mm round epoxy	395	20	150 mcd	Violet	5.75
RLT370-10	TO46 metal can with window	370	12	750 mW	Invisible [3]	51.75

Table 1 *A short selection of ultraviolet LEDs available from Roithner.*

Key: [1] The dominant wavelength so far as the human eye is concerned is 410 nm.

[2] Spectral halfwidth not specified. Visible part is violet only.

[3] The emission of violet light is just discernible in a darkened room.

Safety

The radiation waveband from 315-400 nm is known as 'UVA' radiation. If incident on the skin, UVA is probably carcinogenic to humans. Photosensit-ization can occur. If incident on the eye, the cornea transmits UVA, the lens absorbs strongly, allowing the rest (about 1%) to reach the retina. There is a risk of cataract formation. Chronic exposure prematurely ages the lens. The retina can be damaged by photochemical reactions from violet or blue radiation (380-550 nm) producing lesions. The threshold of this effect, called 'blue-light photoretinitis' depends jointly on light intensity and exposure period.

So, as with any ultraviolet source, do not look directly at a UV LED unless screened by a filter specified to block UV. Do not irradiate your skin, nor anyone else. Because the sources are small and collimated, it should be easy to locallize the emissions and prevent exposures. However because LEDs are very small, they are also easy to pick up, look into, or point at others. It is therefore recommended that each UV LED is mounted in a sizable box with cowl, marked 'UV HAZARD'. They should not be used unmounted, nor in open circuit boards. Intense violet or blue sources should not be stared at for a prolonged period.

News

Trade news

Oscilloscope offer

The Physics Department at the University of Glasgow have let us know that they have a number of 'quite good' 2-channel oscilloscopes they would like to place in good homes (schools). If you would like to take them up on this kind offer, please contact Matthew Trainer at:

m.trainer@gla.ac.uk

Revolution

The manufacturer of technology products, Revolution Education, moved from London to Bath at the end of last year. Please note their new address in the list opposite.

Euromicrovision

Euromicrovision, supplier of educational microscopes, recently ceased trading. The business activity has transferred to another company - Benetec Ltd (see address list opposite).

Jeulin VTT

We have received for testing a French datalogging system *Jeulin VTT*, which is available in the UK from Economatics. This multipurpose instrument can connect to about 25 sensors. The core of the system consists of the *VTT Console*. This has 17 keys for controlling its use, a 128 x 128 pixel LCD screen to display results or graphs, and inputs for 4 sensors. It has the following modes of use:

- *Datalogger, remote from computer.*
- *Direct reading instrument.*
- *Storage oscilloscope.*

Files can be transferred to a computer for analysis. The console can be operated directly from the computer. The *VTT Console* Starter Pack, which includes 5 sensors, costs £569.

Contact lenses - retraction

In the last issue we published a report saying that the fluids between the eye and a contact lens can be dried up with microwave radiation from electrical sparking or welding. We now understand that this story is a myth and apologize for any alarm it may have caused. The article had been published in haste and had not been checked out.

We are reassured that the warning did not fool many of you, judging by the response it elicited. We are particulary grateful to Karl Grice, PT Physics at Hazelhead Academy, who uncovered the story behind the warning. To see his account, look at our website.

Addresses

Anderson Scientific, Luzon House, Main Road, Cardross, Dunbartonshire, G82 5PX. T: 01389 841220, F: 01389 849180, W: www.andersonscientific-tech.com

Benetec Ltd., Microvision Department, Grosvenor House, 1 High Street, Edgware, Middlesex, HA8 7TA. T: 020 8381 1122 F: 020 8381 1133, E: Benetecinfo@cs.com W: www.drbtech.com

British Standards Institution (BSI), Chiswick High Road, London, W4 4AL. T: 020 8996 9001, F: 020 8996 7001, W: www.bsi.org.uk

Comcal (Scotland) Ltd., 11 Bath Street, Glasgow, G2 1HY. T: 0141 332 5147, F: 0141 332 8527, W: www.comcal.net

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

Economatics (Education) Ltd., Epic House, Darnall Road, Sheffield, S9 5AA. T: 0114 281 3311, F: 0114 243 9306, W: www.econmatics.co.uk/education

Edmund Scientific Ltd., 1 Tudor House, Lysander Close, Clifto Moor, York, YO30 4XB. T: 01904 691 469, F: 01904 691 569, W: www.edsci.com

Frederiksen - suppliers include DJB, Nicholl, PASCO and Scientific & Chemical.

Freshford Limited, 15 Turner Lane, Ashton-under-Lyne, Lancs., OL6 8LT. T: 0161 343 2091

Griffin & George, Bishop Meadow Road, Loughborough, Leicestershire, LE11 5RG. T: 01509 233344, F: 01509 231893, E: griffin@fisher.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

Instruments Direct Limited, Unit 14, Worton Road, Isleworth, Middlesex, TW7 6ER. Tel: 0208 560 5678, Fax: 0208 232 8669, Website: www.InstrumentsDirect.co.uk/pasco

McMaster-Carr Supply Co., 473 Ridge Road, Dayton, NJ 08810, USA. T: +1 732 329 3200, F: +1 732 329 3772, W: www.mcmaster.com

Nicholl Education Limited, 4 Westleigh Hall, Wakefield Road, Denby Dale, Huddersfield, HD8 8QJ. T: 01484 865994, F: 01484 860008, E: sales@nicholl.co.uk

Northern Technical & Chemical Services, Unit D44, Brunswick Business Centre, Liverpool, L3 4BD. T: 0151 707 8550

PASCO - see Instruments Direct

Oxford Educational Supplies Ltd., Unit 19, Weston Business Park, Weston on the Green, Bicestor, Oxon, OX25 3SX. T: 01869 344500, F: 01869 343654, W: oxford-educational.co.uk

Revolution Education Limited, 4 Old Diary Business Centre, Melcombe Road, Bath, BA2 3LR.

T: 01225 340563 F: 01225 340564

E: info@rev-ed.co.uk W: www.rev-ed.co.uk

Roithner Lasertechnik, 1040, Vienna, Austria, Schonbrunner Strasse 7 / B. T: +43 1 586 52 43, F: +43 1 586 41 43, W: www.roithner-laser.com

SAPS Biotechnology Scotland Project, Institute of Cell& Mollecular 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.*

Scientific & Chemical Supplies Ltd., Carlton House, Livingstone Road, Bilston, West Midlands, WV14 0QZ. T: 01902 402402, F: 01902 402343, W: www.scichem.co.uk

Shaw Scientific Education (UK) Ltd., PO Box 404, Aylesbury, HP19 9WD. T: 0870 241 6938, F: 0870 241 6939, E: info@shaweducation.co.uk

STE - see dealers (Anderson Scientific, Griffin, Scientific & Chemical)

Vernier, 13979 S. W. Millikan Way, Beaverton, OR 97005-2886, USA. T: +1 503 277 2299, F: +1 503 277 2440, W: www.vernier.com

Wescol Limited, PO Box 41, Unit 2, Brickheath Road, Wolverhampton, WV1 2RZ. T: 01902 351283

Scottish Agent: Express Fuels (Scotland) Ltd., 789 South Street, Scotstoun, Glasgow, G14 0BX. T: 0141 357 1111.

RSE/SEELLD Teacher Fellowships

This is a new scheme and is being run initially as a pilot. Other Universities and Institutions may be involved at a later stage.

Further details and an application form can be obtained from:

Ms Anne Ferguson, Research Awards Manager, The Royal Society of Edinburgh, 22-26 George Street, Edinburgh, EH2 2PQ Tel: 0131 240 5013 Fax: 0131 240 5024 E: aferguson@royalsoced.org.uk W: www.royalsoced.org.uk

Placements can be at a site of the Fellow's own choice but are also available at -

University of Edinburgh

University of Glasgow

Royal Observatory Edinburgh

Scottish Earth Science Education Forum

and at the Scottish Science Centres:

- Our Dynamic Earth, Edinburgh
- Sensation, Dundee
- Satrosphere Aberdeen