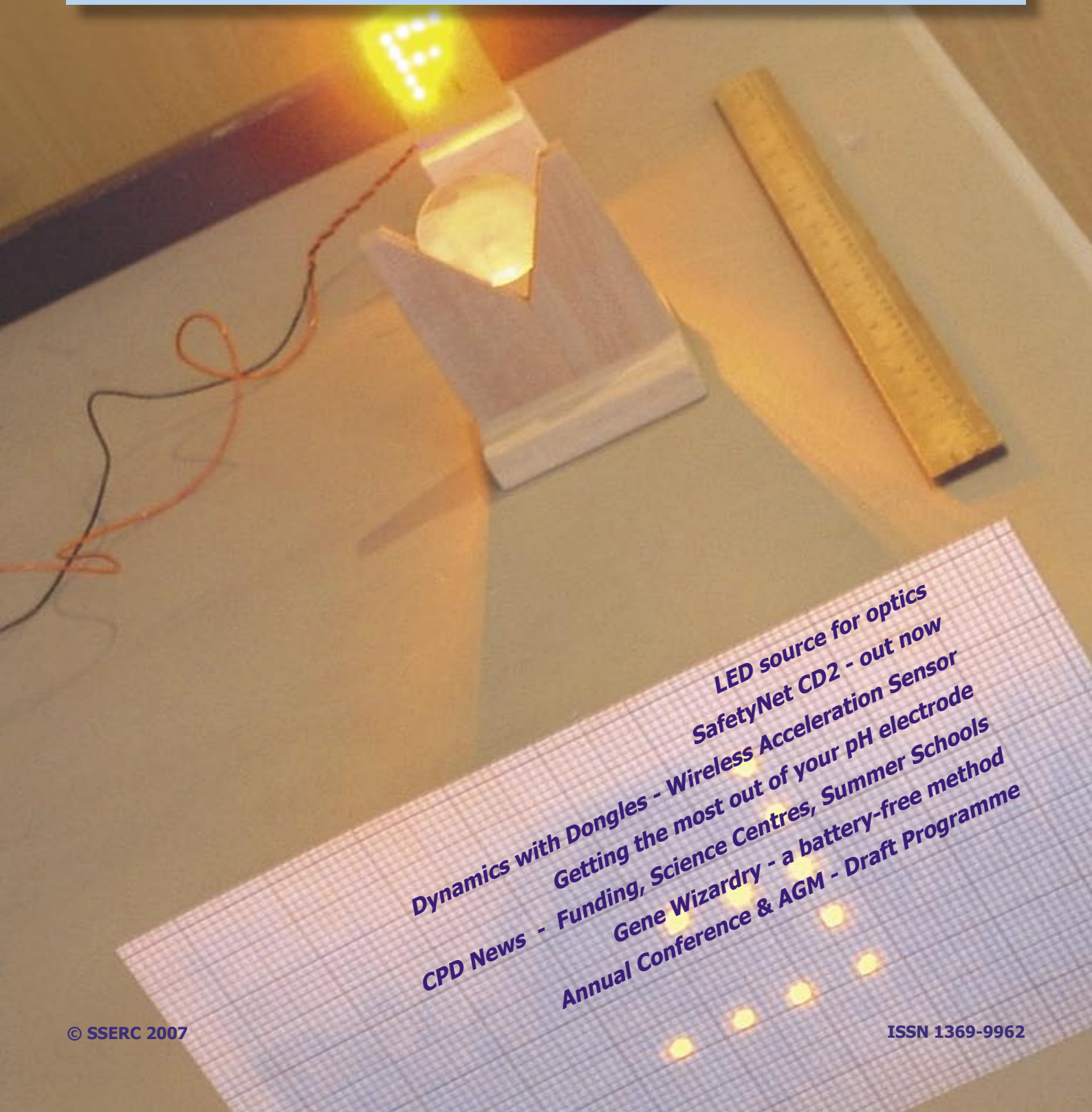
SSERC Bulletin

No. 222 Autumn '07

Ideas and inspiration supporting Science & Technology for all Local Authorities



LED source for optics
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Dynamics with Dongles - Wireless Acceleration Sensor
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ISSN 1369-9962

LED source for optics (cover story)

We describe the design of an array of 10 LEDs providing you with a source for many types of experiments in optics.

This idea of using an LED array as a source for the pinhole camera and other experiments in optics is the result of looking for a substitute for traditional sources such as the candle flame and carbon filament lamp. We are not alone in coming up with this invention. Se-yuen Mak [1], the able Chinese experimenter, pipped us in getting the idea published first.

Our light source has an array of 10 LEDs (Table 1) laid out in a pattern of the capital letter 'F', this character being chosen because of its top-bottom, left-right asymmetry. In the illustration (Fig. 1 & front-cover), the LED source is shown with a converging lens producing a real image on a paper screen. The lab need not be blacked out for the source is sufficiently bright to be usable in daylight.

The LEDs were mounted on 0.1" stripboard (72 mm high by 45 mm wide), whose strips run vertically. To minimise the number of cuts in strips and interconnections, two sets of 5 LEDs were each wired in parallel, and the two sets were wired in series with a 22 Ω resistor across a 5 V dc regulated power supply (Fig. 2). Thus there is about 1.9 V dropped across each LED and about 1.2 V across the resistor. The LEDs conduct about 10 mA each.

When wiring LEDs in parallel, all 10 LEDs must be taken from the same batch to ensure that each one matches the others for the same forward voltage.

Colour	Order code	Price (£)	Luminous intensity (mcd)	View angle (°)
Red – water clear	77-8976	0.18	2500	50
Orange – water clear	77-8972	0.18	2000	50
Yellow – water clear	77-8974	0.18	1300	50

Table 1 - Recommended choice of LEDs – all from Rapid Electronics.

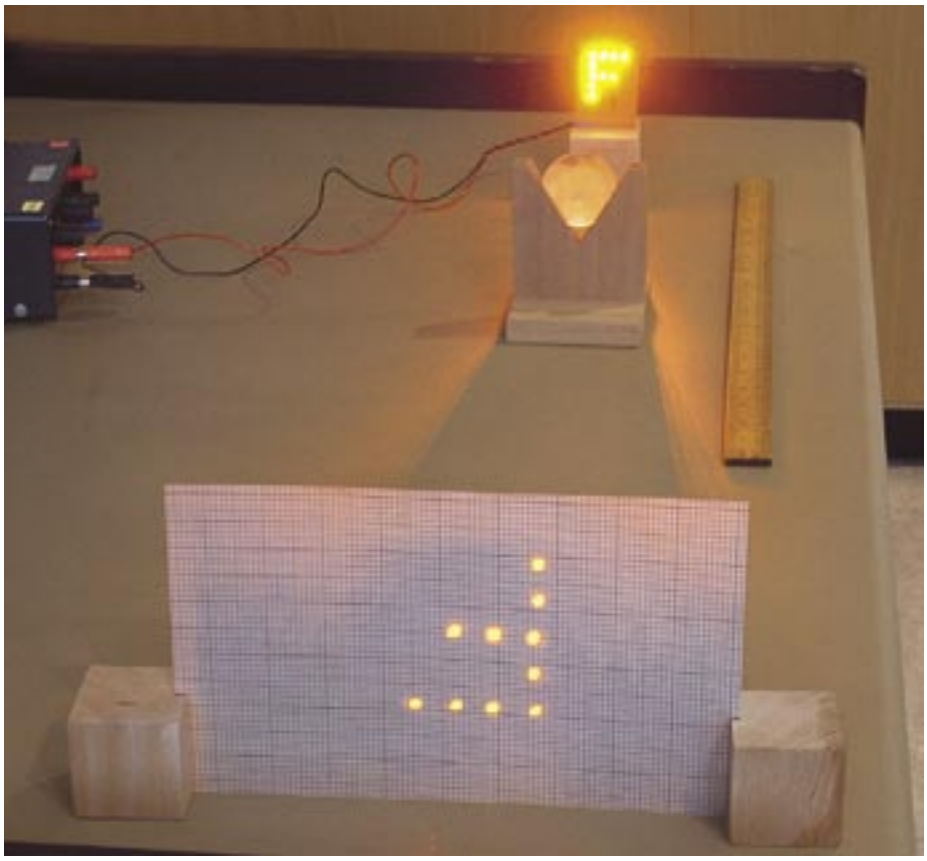


Figure 1 - A real inverted image of the letter 'F' with a LED array source and converging lens.

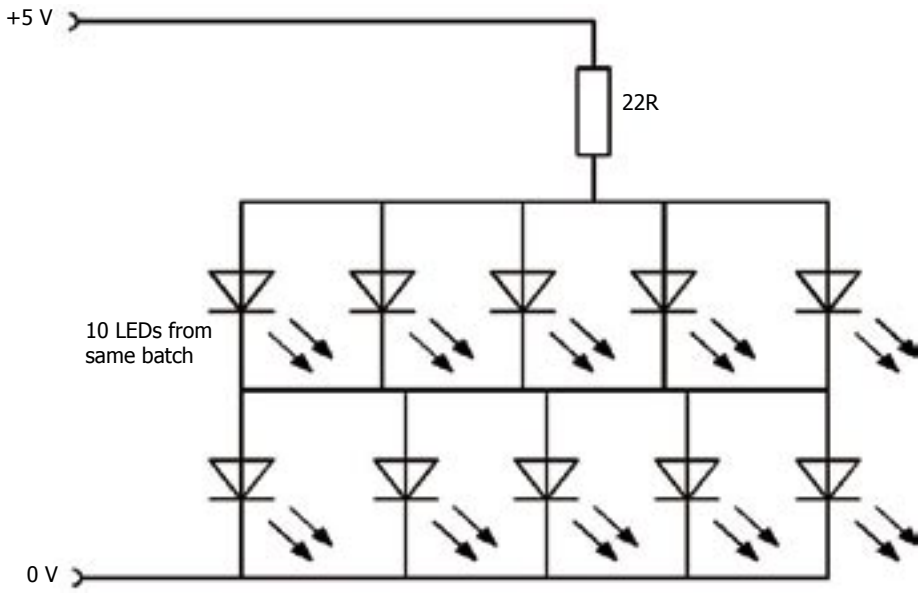


Figure 2 - Circuit diagram for a 5 V dc supply.

The vertical and horizontal separation between adjacent LEDs is 0.3" (Fig. 3). The 5 LEDs making up the vertical stroke of the 'F' are all in parallel. It can be seen that they are soldered across adjacent copper strips. Of the remaining 5 LEDs that make up the horizontal strokes of the letter 'F', 2 pairs are wired across adjacent strips and one LED, the top-rightmost of the 'F', is on its own.

The height above the benchtop of the letter 'F' source was determined by the lens holder we decided to work with. Having chosen to work with 50 mm diameter lenses held in the Harris lens holder B8A45408, this set the height of the optical axis at 90 mm. Furthermore, having chosen to mount the stripboard on a mirror support block (Harris, B8A44593), which measures 50 x 50 x 50 mm, the bottom of the stripboard when lodged within the support's slot is 44 mm high. This results in the mid-point

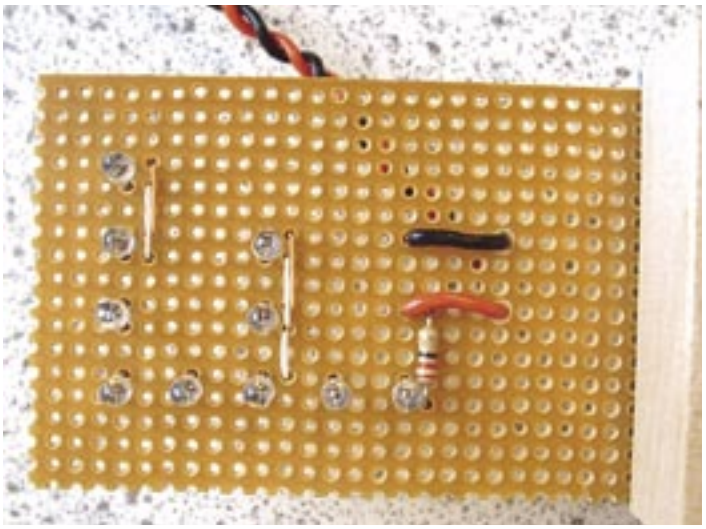


Figure 3 - Front view of stripboard with 10 LEDs forming the letter 'F'.

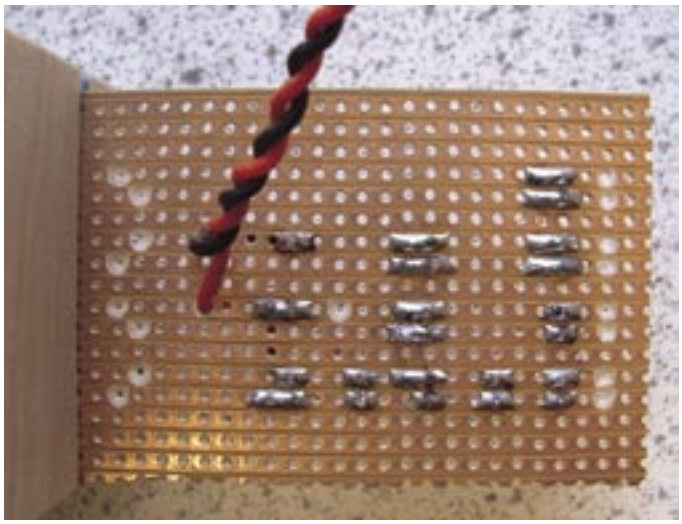


Figure 4 - Rear view showing layout, track breaks & interconnections.

of the letter 'F' being 46 mm above the bottom edge of the stripboard (Fig. 5) (or 18 0.1" holes).

Other designs

The main design criteria are:

1. Array shape: Numeral '4' is also suitably asymmetric, but the spacing between LEDs on the diagonal stroke is not in a simple ratio.

2. LED colour: The forward voltages of red, orange, yellow and yellow-green are less than or near to 2 V whereas for other colours they are 3 or more volts, requiring a different supply voltage and resistor, or a different circuit.

3. Power supply: The circuit should be designed around the chosen power supply, which is needed in class set numbers. For instance, if you choose to work with a 3 V battery of two 1.5 V cells, all 10 LEDs should be connected in parallel and wired in series with a 4.7 Ω resistor to the battery. But the battery current would be 100 mA, which is rather hefty. A better choice would be a 4.5 V battery of three 1.5 V cells and the circuit as here in Figure 2 except that the resistor value should be reduced from 22 Ω to 15 Ω.

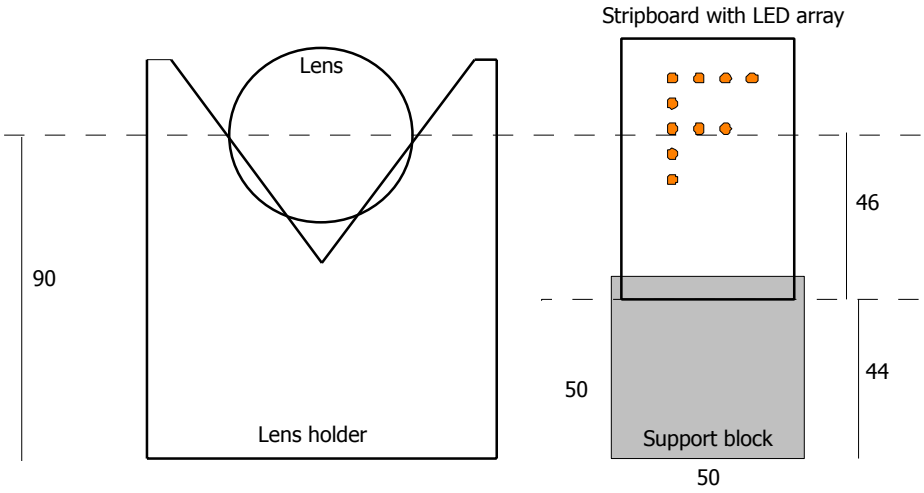


Figure 5 - The lens and lens holder set the height of the optical axis (dimensions in mm).

4. Lens and lens holder: The mid-point of the source should be at the same height as the mid-point of the lens, and depends on what type of lens holder you decide to use.

Applications - light source for :

- studying lenses and mirrors.
- use with the pinhole camera.
- use with a diffraction grating to measure the wavelength of light.

Reference

1. Se-yuen Mak, *A multipurpose LED light source for optics experiments*, The Physics Teacher, 42, 550-552, (December 2004).

SafetyNet CD - this year's update now being distributed.

Another year has gone by and this year's update of the SafetyNet CD should be winging its way to you by now. To the uninitiated the CD gives you most of what can be found on the Members area of the SSERC website on a single disc - no problems with web access! Why not mount it on your school or authority intranet so that the information is easily available to all. Just make sure that the information isn't accessible on the web. For up-to-the-minute information you can still access the SSERC website :-

http://www.sserc.org.uk/members/SafetyNet/Safety_MENU.HTM

There's 100 Mb more on this disc compared to last year - 15,500 files, 55,000 links, four more SSERC Bulletins, the last four Primary Bulletins, a Bulletin articles spreadsheet, major update on *Radiological Protection* advice, the final report on *CPD & Related Activities for Technical Support,* risk assessments from Fife and Dumfries & Galloway, biological reagents included in the main chemicals list of *Hazardous Chemicals* and advice on Van de Graaff generator hazards etc.

Dynamics with Dongles - A Wireless Acceleration Sensor

The *Vernier WDSS (Wireless Dynamics Sensor System)* is a wireless sensor that can measure acceleration in 3 axes and has force and altitude sensors. It can also act as a datalogger to record data. Data transfer is wireless, via *Bluetooth*. The sensor is supplied with *Logger Pro software* and a Bluetooth dongle that plugs into the USB port of a computer.

Figure 1 - The Vernier WDSS

Our first experiments involved attaching the sensor to a PASCO cart, found by SSERC to be the *Rolls Royce* of dynamics trolleys [1], and letting it roll down an inclined plane. Rather than obtaining the constant acceleration associated with a constant slope, the acceleration appeared very jittery. The trace in Figure 2 shows a period of acceleration when the cart was pushed up the slope, then allowed to roll back down. We believed the jittering to be due to imperfections in the cart's wheels, bearings and in the runway. Thus, we expected it to be less when the vehicle was moving slowly. This is borne out by our results.

The cart stops momentarily at roughly 3.75 s (Figure 3). Note that the acceleration before the cart stops has a slightly greater magnitude than that as it runs back down the slope. This is because friction is in the same direction as the component of weight when the cart travels up the slope but is in the opposite direction as it descends. Data was copied to *Excel* and accelerations were averaged over the period where readings were not subject to jittering. The experiment was repeated for different gradients, with the sensor zeroed on the slope prior to each run. In all cases, measured average accelerations lay within ± 0.07 ms^{-2} of theoretical values. It should be noted that the accelerations produced by a freely moving cart on an inclined plane represent only part of the range measurable by this sensor. The manufacturer's data suggests a range of ± 50 ms^{-2}, with an accuracy of ± 0.5 ms^{-2} and a resolution of ± 0.04 ms^{-2}.

Logger Pro software has a smoothing function, but even this was unable to remove the large fluctuations in acceleration. That said, the suppliers do not suggest that the wireless sensor is primarily designed for the type of experiment where a constant acceleration would traditionally have been measured using a double mask and light gate connected to a microprocessor or interface.

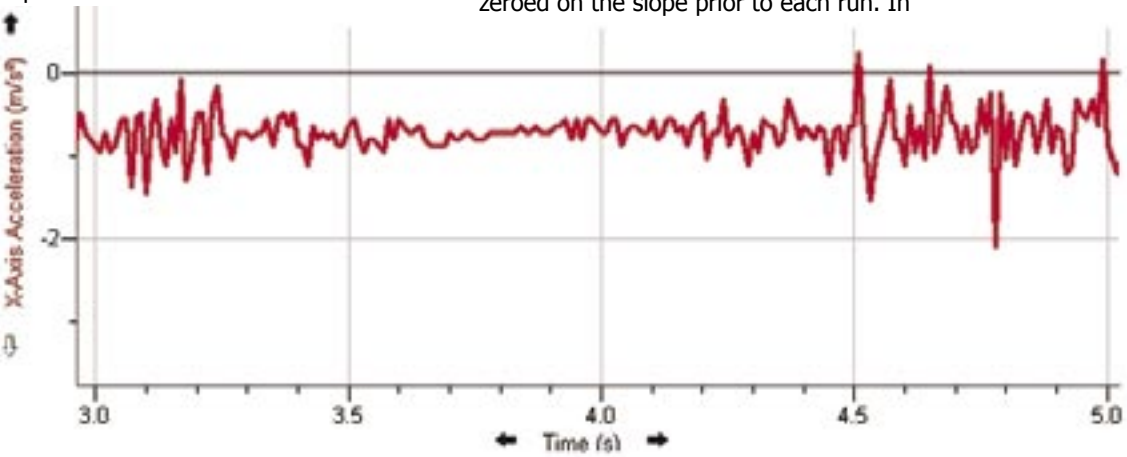


Figure 2 - Cart pushed up runway, allowed to stop and return back down

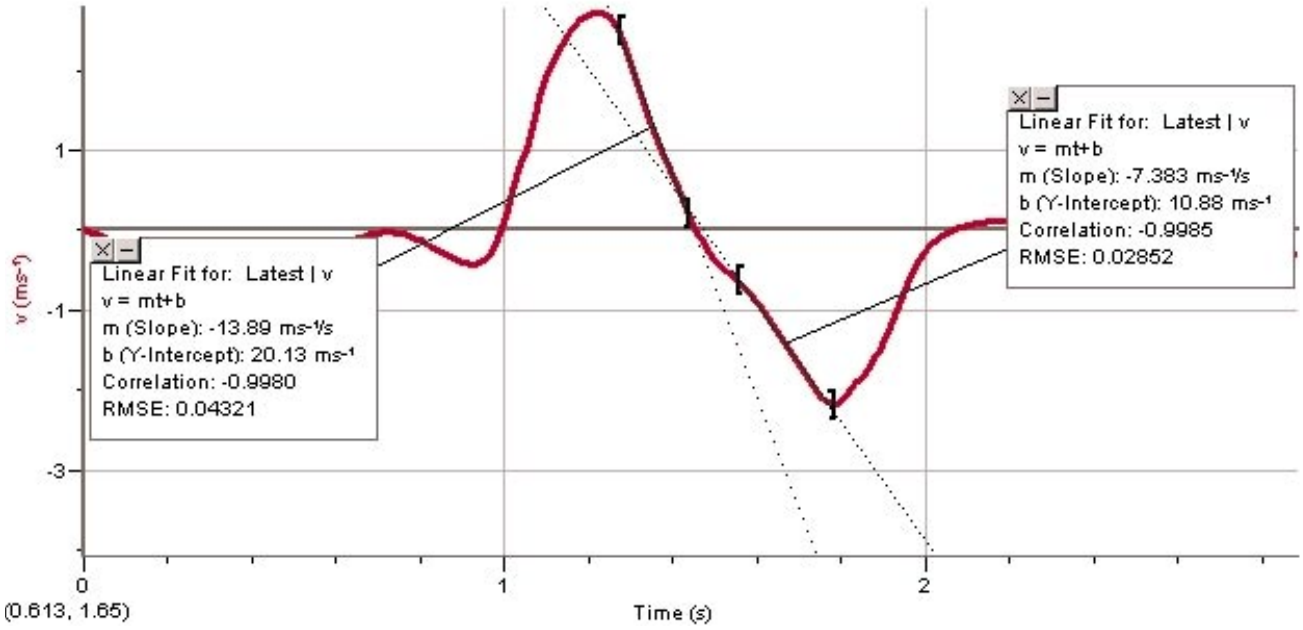


Figure 3 - Jumping (velocity versus time)

In fact, the sensor does not need to be moving to record an acceleration. If the device is zeroed on a flat surface then stood on end, it will register an acceleration of around 9.8 ms^{-2}. Placed on a slope of 30° to the horizontal, it should measure an acceleration of 4.9 ms^{-2}.

We then carried out a number of investigations using the sensor. Some, by their nature, were qualitative rather than quantitative.

Having zeroed the unit with the x-axis pointing upwards, it was placed in the tester's shirt pocket. The tester then crouched and jumped upwards, landing on the floor. We were also able to plot velocity / time graphs as *Logger Pro* can integrate acceleration with respect to time. (Figure 3)

Once again, the acceleration when travelling upwards is greater than that when travelling downwards due to the direction of the frictional force in each case.

We do not have space here to cover all the investigations we carried out. These included freefall, simulated bungee jumping, simple harmonic motion, f=ma (dragging the unit around by a string attached to the force sensor) and remote data logging on car and train journeys. Full details are given in the on-line version of this article [2].

We used the WDSS to investigate the relationship between angular velocity and central acceleration. It was mounted on a *PASCO turntable* that was driven by an electric motor, as shown in Figure 4.

The sensor is clearly marked with the position of the accelerometers, allowing us to measure their distance from the axis of rotation. Angular velocity was measured using a *PASCO Smart Pulley* and photogate connected via a *Science Workshop interface* to a laptop running *Data Studio*. The set-up allowed us to produce central accelerations of up to 60 ms^{-2}, above which the turntable, though held in place by bricks, attempted to amble round the laboratory bench. 60 ms^{-2} is in any case at the limit of the stated range of the WDSS. Data for acceleration was captured at a rate of 500 readings per second. The 5000 readings for each run were averaged. A graph of central acceleration versus angular velocity squared is shown below (Figure 5).

Figure 6 - WDSS mounted on radio-controlled car

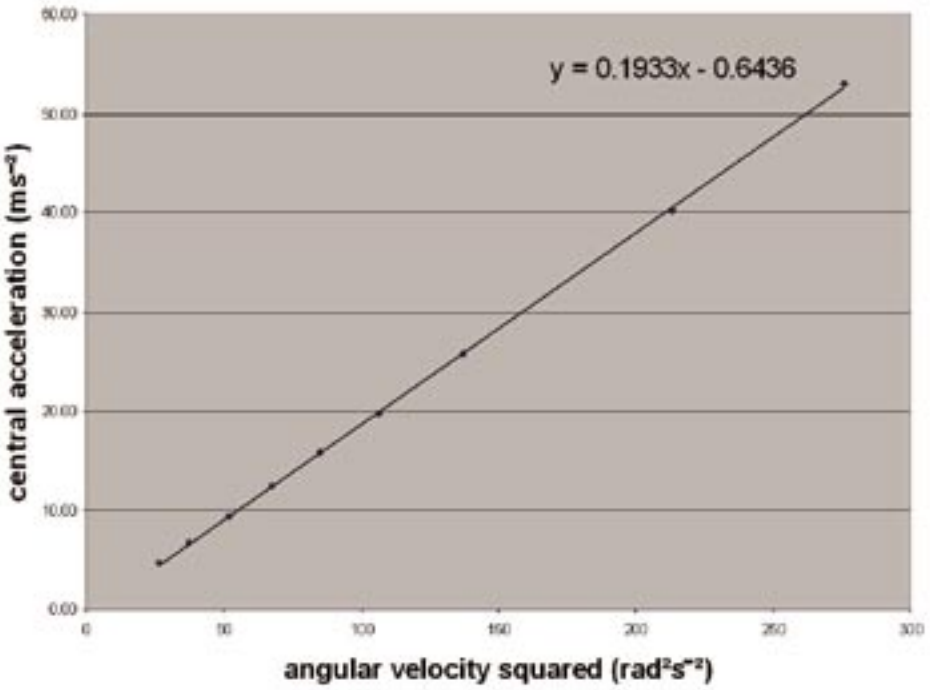


Figure 5 - Central acceleration experiment

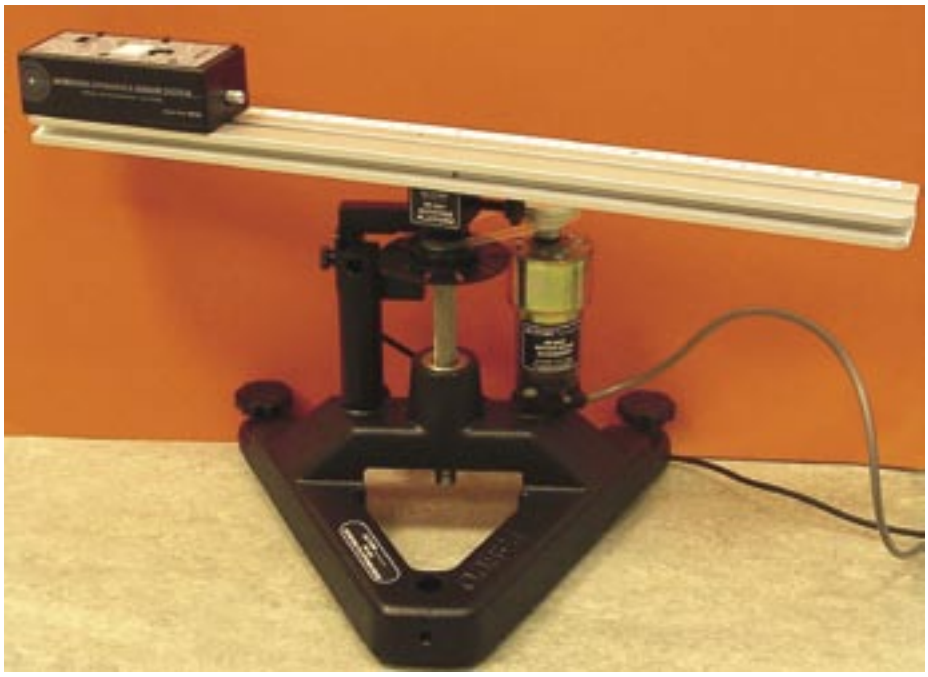


Figure 4 - Sensor mounted on PASCO turntable

Note that the gradient of the line should be the radius of rotation, measured by us as 192 mm ± 0.5 mm. We felt that the use of the Vernier Wireless Sensor System greatly enhanced the investigation of this relationship. Angular velocity could have been determined by timing a fixed number of revolutions, had a *Smart Pulley* been unavailable.

Borrowing an idea we had heard of from Steve Emery of IDS [3], a company that supplies the Vernier Wireless Sensor, we mounted the unit on top of a radio-controlled car. This was done using the *PASCO cart adapter*, held on to our model with self-tapping screws.

Bluetooth and radio-control frequencies do not interfere with one another. The natures of the drive system of the car and the floor it was running on were such that a graph of acceleration versus time was too noisy to interpret. We had more success integrating acceleration to obtain a velocity / time graph.

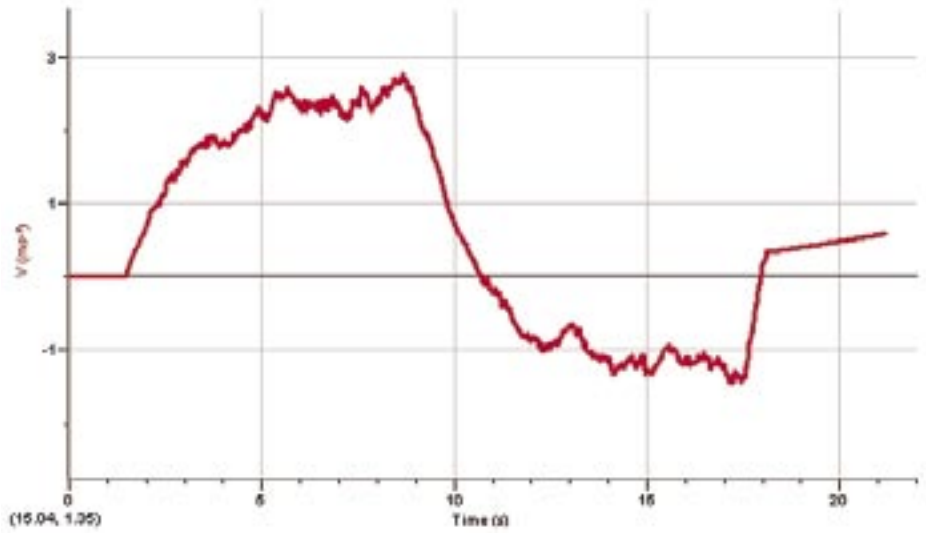


Figure 7 - Radio controlled car accelerating, slowing then reversing

Conclusion

The Vernier Wireless Dynamic Sensor System was an effective tool for the qualitative analysis of collisions, real life situations such as jumping or car travel and modelled ones like bungee jumping. Its sensitivity made it largely unsuitable for experiments with trolleys on runways. Good, quantitative data was obtained by averaging acceleration and by integrating acceleration to give change in velocity. Relationships such as that between force and acceleration, and angular velocity and central acceleration could be investigated effectively. Used with care, the *WDSS* would help pupils to understand velocity / time graphs. The supplied software, Logger Pro, was very versatile.

Our twelve year-old driver had some experience of negative numbers but no formal physics training. Nevertheless, he was quickly able to relate the graph he obtained to the course he had driven. Note, however, the apparent increase in velocity after around 18 s. The car was in fact at rest at this point but unless it is stationary on a gradient identical to that at which it was zeroed, the sensor will interpret the slope as an acceleration.

Following advice from the leaflet supplied with the WDSS, we investigated crumple zones. With the WDSS mounted on a PASCO cart, we monitored acceleration during collisions with a fixed wooden block. The cart was fitted with various bumpers and crumple zones.

It was placed on a runway of fixed length and height and always released with the front of the bumper at the same point on the runway.

We found that we had to limit the cart's run to 50 cm along a 4° slope to avoid the acceleration reading going beyond the sensor's limit when crashing into the wooden block.

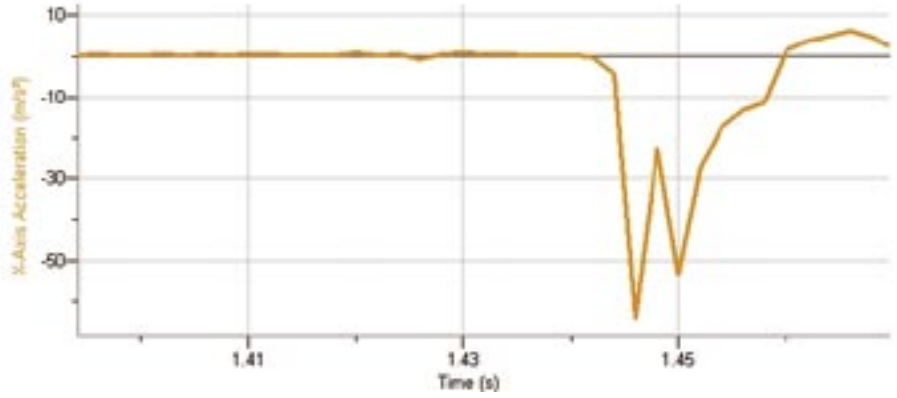


Figure 9 - Acceleration during crash into wooden block

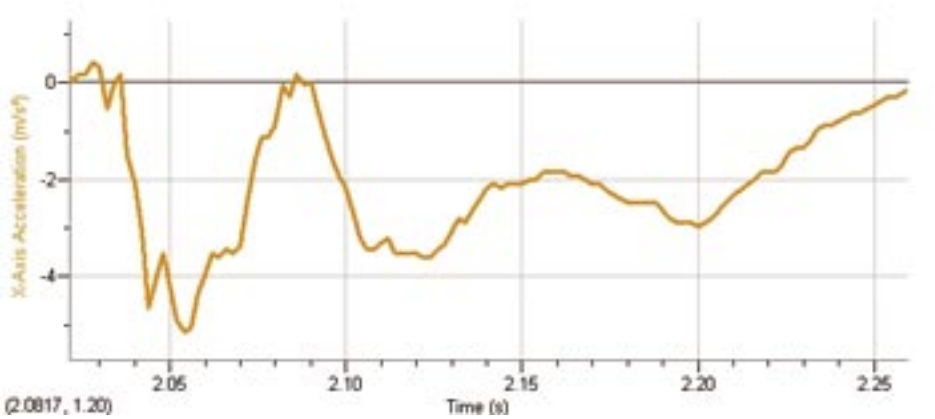


Figure 10 - As Fig 9, but with cart fitted with card crumple zone. Note different scales on graphs.

Figure 8 - Pimp My PASCO Cart

Circumstances did not permit us to verify the manufacturer's assertion that the unit would be suitable for the analysis of motion on fun-fair rides but we see no reason to contest this claim.

References

[1] *SSERC Bulletin 181*

[2] http://www.sserc.org.uk/members/SafetyNet/bulls/222/contents.htm

[3] http://www.inds.co.uk

Get the most out of your pH electrode

With careful storage and proper maintenance the life of an electrode will be increased and the accuracy of measurements greatly improved. Various models of both hand held and bench meters are available.


pH sticks

Desktop pH meter




pH sticks

Introduction

pH electrodes are supplied with rubber end caps that protect the bulb and help prevent drying out.

Before using a pH electrode a few simple checks are worthwhile:

- Ensure the rubber cap has been removed.
- Check for air bubbles inside the electrode. Carefully shaking the electrode down will eliminate these.
- Salt deposits around the electrodes are normal and can be dissolved by rinsing with deionised (not distilled) water.
- Do not wipe the electrode as this can create static charges that will interfere with the pH measurement.

When using the electrode, store it in a pH4 or pH7 buffer solution between readings to prevent it drying out.

Storage and Maintenance

- Due to the nature of its construction, a pH electrode should be kept moist at all times.
- For long term storage (more than 24 hr), the electrode should be immersed in a storage buffer solution.
- If possible store in a soaker bottle (see Figure 1) as it is possible to form an air lock if using a rubber cap, causing the electrode to dry out.

Recipe for storage solution

For every 100 cm^3 of pH4 buffer solution, add 10 g of KCl. (or see Table 1 for commercial storage solutions).

Figure 1 - Soaker bottle

- Never store the electrode in distilled or de-ionised water as this will cause ions to leak out of the bulb into the surrounding solution and render your electrode useless.
- Never leave the electrode out in the air as it will dry out - even with the rubber cap fitted.
- If the electrode is accidentally stored dry, immerse it for up to 12 hours (or overnight) in the storage buffer solution. Then check its operation.

Cleaning

General

The pH electrode can be cleaned, if necessary, by soaking in a solution of 0.1M HCl or 0.1M HNO_3 for 20 minutes.

Stubborn deposits and bacteria

Soak the pH electrode in a 1:10 dilution of a solution of thin 5% supermarket bleach solution for 10 minutes to remove.

Protein deposits

Soak the pH electrode in a solution of 1% pepsin in 0.1M HCl for 5 minutes to remove residues.

Oil and grease

Rinse the pH electrode in a solution of a mild detergent or methyl alcohol to remove oil and grease.

Mould

This occasionally grows in the storage buffer solution. It will not harm the probe and can be removed with rinsing.

After any of the above cleaning procedures rinse well in deionised (not distilled) water before use.

Figure 2 - Acids and alkalis

Buffer Solutions

Buffer solutions for storing and for the calibration of electrodes can be prepared from bottles, sachets or tablets (Figure 3). Suppliers' prices for buffers (and specialist cleaning solutions, soaker bottle prices etc.) can be seen in the following table.

Company	Anderson Scientific	DJB	Griffin	Phillip Harris	Scientific & Chemical	Timstar
Catalogue (page no.)	(70)	online www.djb.co.uk	05/06 (468)	07 (723)	07/08 (235)	07 (238)
Buffer Sachets (price/pk)	pk 25 x 20 cm^3 pH4, 7 or 10, **(£13.30)**	pk 5 x 20 cm^3 pH4, 7 or 10, **(£4.40)**	pk 25 x 20 cm^3 pH4, 7 or 10, **(£16.25)**		pk 25 x 20 cm^3 pH4, 7 or 10, **(£17.00)**	pk 5 x 20 cm^3 each of pH4 and 7, **(£10.50)** pk 5 x 20 cm^3 each of pH7 and 10, **(£10.50)**
Buffer Tablets (price/pk)			Pk 50 Tablets pH4, 7 or 9 **(£9.95)**			
Buffer Solutions			Twin neck, Coloured 0.5 l, pH4, 7 or 10, **(£9.60)**		Twin neck, coloured 1.0 l, pH2-10, **(£5.55)** 2.5 l, pH2-10, **(£8.50)** 5 l, pH2-10, **(£15.00)** Certified Solutions 1 l, pH4, 7 or 10, **(£9.70)**	
Cleaning Solutions		460 ml, **(£14.80)**	pk 6 x 80 ml, **(£23.85/pk)**	230 ml, **(£9.00)**		460 ml, **(£15.60)**
Soaker bottles		pk 2, **(£6.20)**	pk 4, **(£18.50)**	pk 4, **(£16.24)**		
pH Storage Solutions			230 ml, **(£8.65)**	230 ml, **(£8.00)**		460 ml, **(£15.90)**

Table 1 - Buffer solutions and storage

pH sticks

Figure 3 - Buffer solutions and tablets

'This is what CPD is all about'
- Summer Schools 2007 a great success:

Delegates once again rated Summer Schools in biology, chemistry, physics and primary science as highly successful. Funding was provided by the Scottish Executive through the *Support for Science Education through CPD* project to enable project partners[1] to organise and run the events. One hundred and five teachers and technicians from across Scotland attended the four Summer Schools, held in May and June. The photographs and quotes provide a flavour of some of the activities offered by the Summer Schools.

PGDE Science students from the Universities of Aberdeen, Edinburgh, Glasgow, Paisley and Strathclyde also had the opportunity to meet and work together at a residential school. 180 biology, chemistry and physics PGDE students came together in Edinburgh in early June. The programme provided opportunity for these new entrants to teaching to start to build professional networks as well as an introduction to high-quality CPD.

Best cpd a biology teacher could do.

These activities will have a real impact on my teaching.

Practical and networking sessions are excellent.

Got me thinking about my teaching, especially through talking to others.

It was brilliant to receive so many new ideas and resources--it has inspired me to have the confidence to share my new approach with colleagues.

Would highly recommend to others.

Supporting Scottish Science Education through CPD project: continuation of funding for 2007 – 2008

SSERC and its partners are delighted to announce that the Scottish Government has provided funding to continue the project *Supporting Scottish Science Education through CPD* until the end of March 2008. Under the umbrella of this project, a number of initiatives will continue to evolve:

- CPD for Support Staff Project
- Residential events (in 2 parts) for teachers and technicians (biology, chemistry, physics, cross-science, primary science)
- Experiential workshops for teachers and technicians
- Leadership Courses for new and aspiring Heads of Faculty
- PGDE Residential Schools
- ASE Scotland/Good Practice conference

For further information, see :-
SSERC website :- http://www.sserc.org.uk
or E-mail :- sheila.maclellan@sserc.org.uk

1 Development to Update School Chemistry (DUSC), Science & Plants for Schools (SAPS), Scottish Initiative for Biotechnology Education (SIBE), Institute of Physics (IOP) and The Association for Science Education for Scotland (ASE - Scotland)

CPD for Excellence - Events at Glasgow Science Centre

Glasgow Science Centre offers an exciting programme designed to improve teacher knowledge and provide inspiration for teaching science using cross-cutting themes.

The Polymerase Chain Reaction: *(Advanced Higher Biology)*
23rd October 2007, 9:45am-3:30pm. Cost: £12 +VAT

Expert virologists from the Medical Research Council will guide you through this practical workshop and share their experience of working in virology research.

Astronomy. Planet Earth: Astronomy (P1-S3)

30th Oct 2007 or 5th Feb 2008, 9:30am-3:00pm. Cost: £25 +VAT

Working with our expert astronomer you will participate in an immersive and engaging series of workshops that will revitalize the teaching of astronomy.

Meet the Gene Machine (S3-S6) (Standard Grade, Higher Biology, Modern Studies & Religious, Moral & Philosophical Studies)

Sep - Dec 2007. FREE EVENT – sponsored by the Wellcome Trust

- Lively pupil discussion event designed to stimulate debate about the ethical implications of recent advances in medical genetics.
- Teacher CPD twilight session with support materials to extend learning in the classroom.

Planet Earth: Astronomy Twilight Session (P1-S3)
20th Nov 2007 or 19th March 2008, 4:00-6:30pm.
Cost: £15 +VAT

Photo Credit NASA

To book any of the above CPD courses, call 0871 540 1003 or email laura.murray@glasgowsciencecentre.org

Visit www.glasgowsciencecentre.org for full details of their education programme and sign up to their e-newsletter to receive information on future CPD events.

Unlocking Creativity in Science (S1-S6), 28th Nov 2007 or 7th Feb 2008, 9:30am-12:30pm. Cost: £30 +VAT

Presenter: Dr. Carolyn Yates, Director of Cognitive Acceleration Programmes. This session will give all secondary science teachers practical ideas to help meet the challenges of developing the four capacities outlined in 'A Curriculum for Excellence'.

Winter Night Sky: Adult Education Night Class (GTC Accredited)

22 Oct - 19 Nov 2007 (Mondays), 7:00pm - 9:00pm. Cost £45 +VAT

This five-week beginners' guide to astronomy is presented in association with the University of Glasgow's Department of Adult and Continuing Education and presented under the glittering starts of the ScottishPower Planetarium.

To book this course only, call 0141 330 1835 or visit www.gla.ac.uk/adulteducation/

Education opportunities at Sensation, Dundee Science Centre

As a member of the Scottish Science Centres Network, Sensation exists to offer support to science learning and teaching in the region and across Scotland. The education programme offers engaging science and technology experiences for nursery, primary and secondary groups, both in the centre and in schools. A wide outreach programme is available for delivery in your school (incl. out of school clubs and science fairs), and all sessions are designed to support the capacities of *A Curriculum for Excellence*. For the activities available, see www.sensation.org.uk website with downloadable free materials, classroom posters and activities.

Teacher opportunities

Teacher familiarisation visits to Sensation's exhibition are always free of charge, during all opening hours including weekends.

Teacher placements: placements of up to five days at Sensation are available for primary and secondary teachers, in conjunction with Careers Scotland.

School staff team building: Sensation offers a relaxed yet inspiring location for fun, science-themed team building activities. Call Michelle on 01382 868603 for details.

Upcoming lecture - An Inconvenient Truth
12th October 2007

Humanity is sitting on a ticking time bomb. If the vast majority of the world's scientists are right, we have just ten years to avert a major catastrophe that could send the entire planet into a tail-spin of epic destruction involving extreme weather, floods, droughts, epidemics, and killer heat waves beyond anything we have ever experienced.

Ian Marchant, CEO of Scottish and Southern Energy plc, will give a local perspective on Al Gore's famous lecture. For info, please call 01382 868603.

A popular download

Molecular Machines sci-art exhibition:

4th September 2007 – 6th January 2008

With their beautiful structures and terrible effects, viruses are an intriguing area of research. *Molecular Machines* is a collaboration between scientists from the Medical Research Council Virology Unit and artist Murray Robertson, using images from virus research. The MRC Virology Unit employs state-of-the-art molecular and structural biology techniques to investigate viruses, building knowledge that will lead to the development of more effective treatments for viral disease - www.molecularmachines.org.uk

The *Adenovirus*

At a DNA Workshop (*Fotopress*)

Coming soon - International Polar Year

Schools activities in the amazing new *Magic Planet auditorium*. Sign up for Sensation emailings for details.

Magic planet auditorium

For events, activities & education enquiries, phone 01382 868609 or sign up for online email updates and to read Sensation's HMIE report.

The Wonderful Wizardry of Finding a Gene - Battery-free method

Introduction

In the last issue of the *SSERC Bulletin* (Issue 221, Summer 2007), a technique was described which could be used by pupils to carry out simple gel electrophoresis in order to simulate DNA profiling. The NCBE protocol which accompanies the original kit used for this technique recommends the use of three 9 V batteries to run each gel. However, as mentioned in the previous article, this can be cumbersome and somewhat expensive. NCBE now sell a 36 V mains transformer (Figure 1), which can be used safely with up to eight tanks at a time. This transformer is available from NCBE at a cost of £36. NCBE state that up to four gels tanks[1] can be run simultaneously with the connector provided (Figure 2a).

Figure 1 - 36 V p. supply before adaptation

In order to use the connector a few simple adaptations have to be made to the transformer as outlined in the link below and Figures 2a-c :

www.ncbe.reading.ac.uk/NCBE/MATERIALS/DNA/PDF/TransformerV1.1.pdf

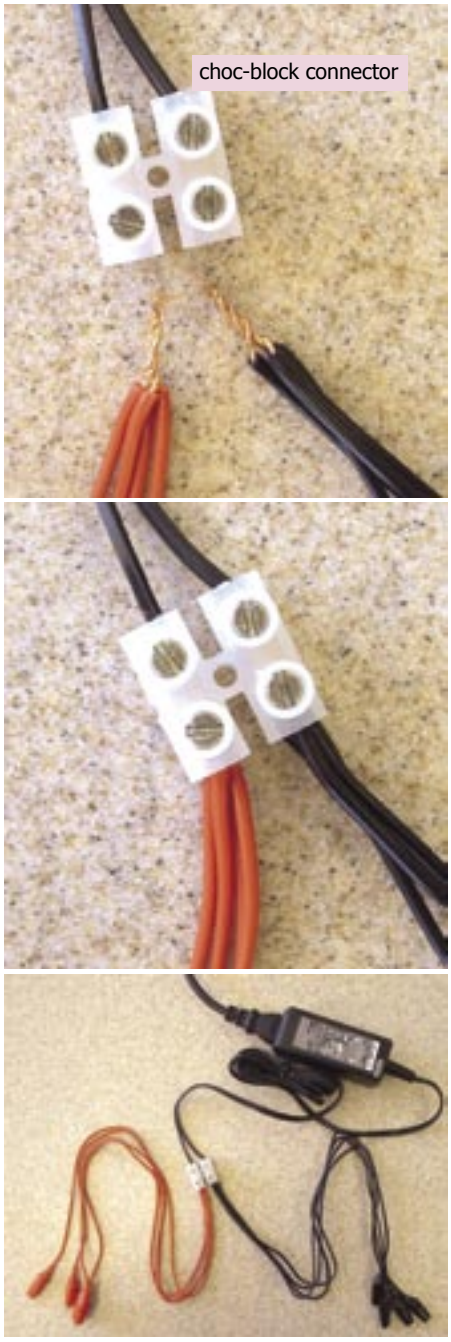
In addition, a three-pin mains power lead is required. This can be bought from any electrical supplier[2]. A connector box (Figure 3) may be built, if preferred, using the instructions within the following link:

www.sserc.org.uk/members/SafetyNet/bulls/222/Downloads/Box_template.pdf

Equipment Testing

In order to ensure that eight gel tanks could be run simultaneously in a safe manner, individual gel tanks were set up using standard NCBE protocols[3].

Instead of using three 9 V batteries, we attached the gel tank to the transformer and measured the current drawn when using TBE buffer, distilled water or tap water.



Figures 2a, b & c - Adaptations to connectors to allow up to 4 gel tanks to be connected to the one transformer.

It was found that one gel with 10 cm^3 of TBE buffer in the tank draws a current of around 0.012 A (see graph in Figure 4).

Given that the maximum recommended current which can be drawn is 0.41 A, it can be seen that the transformer will be well within its working limits when supporting the running of eight gels. We recommend the use of a maximum of eight gels with these transformers to avoid a tangle of wires.

Conclusion

The transformer supplied by NCBE allows the safe, simultaneous running of up to eight agarose gel tanks in approximately one hour and twenty minutes.

Figure 3 - SSERC connector box

In the *Wonderful Wizardry of Finding a Gene* protocol 3% agar is used, as opposed to the more expensive agarose gel, and is run with distilled water in the tank. Using the NCBE transformer means that each gel, when set up in a group of eight (Figure 5), will run fully within 30 minutes. Therefore, this allows a full class set of gels to be run safely within the allotted class time, at less expense and with greater ease than with individual 9 V batteries.

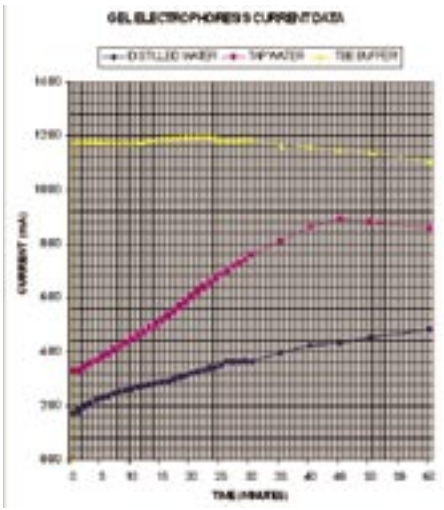


Figure 4 - Current drawn vs. time for running buffer (TBE), distilled or tap water.

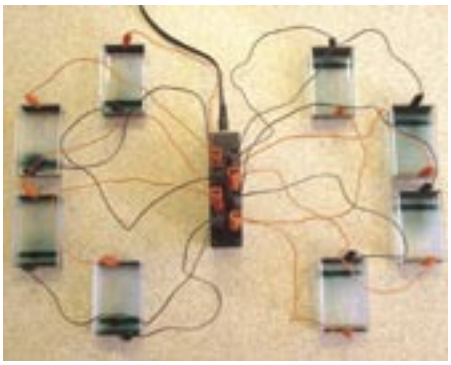


Figure 5 - Eight 3% agar gel tanks run simultaneously.

1 NCBE now also produce base units at a cost of £50 containing 8 of each of the following: gel tank, 4-toothed comb, 6-toothed comb, pair of wires plus crocodile clips, microsyringe dispensing unit. Link: www.ncbe.reading.ac.uk/NCBE/MATERIALS/DNA/baseunit.html

2 SSERC supplier was Rapid, each lead costing £1.45.

Link: http://www.rapidonline.com/searchresults.aspx?style=0&kw=23-6452

3 Link: http://www.ncbe.reading.ac.uk/NCBE/MATERIALS/DNA/PDF/LambdaTG.pdf

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Managing Editor - Fred Young

Annual Conference & AGM of SSERC Limited
Draft Programme – Breaking Down Barriers
Friday 30th November 2007 at the Glasgow Science Centre

Whispering Dishes area – 2nd floor
9:15 - 10:00 **Registration and coffee**

Science Show Theatre – 2nd floor
10:00 - 10:30 **Welcome & introduction**: Cllr. Walter McAdam MBE,
Clackmannanshire Council & Director of SSERC Ltd.
Fred Young, Chief Executive Officer, SSERC.
10:30 - 11:10 **Keynote Address: Breaking Barriers with Rocks**
Dr Stuart Monro OBE, Scientific Director, *Our Dynamic Earth*.

Clyde Suite - Ground floor
11:15 - 12:15 **Nationwide in 60 minutes – a science support map of Scotland**
Tour the exhibition where you will experience some of the many ways in which science education is supported in Scotland.
Visit each Science Centre, SSERC and partners, and try some hands-on activities.

Science Show Theatre – 2nd floor
12:20 - 13:00 **Supporting Scottish Science Education through CPD – A Partnership Approach**
Kath Crawford, Depute Chief Executive Officer, SSERC.

Whispering Dishes area – 2nd floor
13:00 - 14:00 **Lunch**

Science Show Theatre – 2nd floor
13.45 - 14:00 **Annual Report and General Meeting of SSERC Limited**
14:00 - 15:00 **Safety: No barrier to exciting science**
Exciting science performed above the SafetyNet of SSERC.
Closing remarks
14:05 - 15:00 **Board Meeting of SSERC Ltd.** (Directors & Officers of the Company)

Please return to: **Catherine Russell**, SSERC, 2 Pitreavie Court, Dunfermline, KY11 8UB E: catherine.russell@sserc.org.uk

I wish to reserve a place at the 42nd Annual SSERC Conference, 30th November 2007

Name _____ **Position** _____**Date** _____

Address _____

Tel. No. _____ **Email address** _____

I enclose my cheque/official order* in payment of the delegate fee(s) of £60 + VAT (£70.50) for members*/£80 + VAT (£94) for non members*

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