

Reviews

To cite this article: 2012 *Phys. Educ.* **47** 121

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TOY: AIR SWIMMERS

Helium balloon swims like a fish

An 'air swimmer' is a fantastic new toy perfect for any physics department. It is a helium-filled balloon that has two motors attached to it. One of the motors moves the tail from side to side, which enables the swimmer to be propelled forward. The speed of the tail is controlled by you as you rock the switch on the control one way then the other. The clever part of the air swimmer is the 'feeder fish' motor on the underside. You can control its position by moving it backwards and forwards along a ratcheted track. This makes it relatively straightforward to manoeuvre up and down.

The air swimmer is quite fiddly to set up. You will need a source of helium (disposable tanks are available, or you can go to a florist). Be careful—you have a fairly fragile one-way valve to negotiate in the foil of the tail. Once it is inflated you will need a second person to hold the balloon while you attach the feeder fish motor; the rest of the fins, tail, etc, are attached with sticky pads and elastic bands. Finally there is a little pouch in the feeder fish motor to enable you to add ballast to get the swimmer to float at about 1.5 m off the ground. Setting it up is not something to be done in a hurry.

It is huge fun and surprisingly easy to manoeuvre. In terms of physics teaching it is an absolute must for teaching buoyancy and is very sensitive to changes in temperature if, for example, you move it from shade to sun. Then there is



the mechanism by which the side-to-side motion of the tail results in forward motion, a possible investigation is how the tail speed affects the air swimmer speed, as well as a novel turning force when you move the feeder motor.

So far the air swimmer appears not to need a great deal of topping up in terms of helium; Nemo has been floating in my dining room window for the past five days with no visible means of support. For storage and transportation you can

insert a straw into the valve to let the helium out.

In fact, air swimmers are more suited to schools than the home—corridors and laboratories with high ceilings provide the perfect place for a swim, or a race if you happen to have the shark as well as the clownfish. They are bound to wow audiences at shows and open evenings—a must have for your department.

Helen Reynolds

WE RECOMMEND

Air swimmers

WMC

Rating: ★★★★★

Price: RRP £39.99 (but available for less)

Details: The company website can be found at <http://airswimmers.com/>, available online at a number of retailers, including Amazon and Firebox.

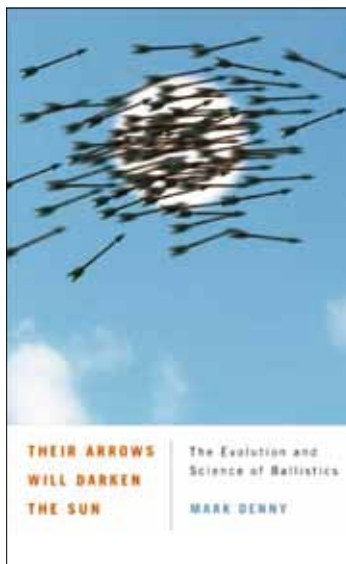
BOOK: THEIR ARROWS WILL DARKEN THE SUN

Ballistics book hits the spot

Denny has written a number of popular science books across a subject range that takes in beer, sailing and superstructures. This is an impressive feat that obviously keeps him busy in his semi-retirement. With a solid background in theoretical physics he is not afraid to go at problems with the full force of maths and it is this that makes his books more appealing to the physicist and physics teacher than, perhaps, to the lay public.

It would be very straightforward to take a section of one of his books, lift a calculation and use it with a class as an example. What is especially nice in this book is that the calculations, offered in a set of appendices, have a range of sophistication. For the ballistics of flight you can pick with or without air resistance, lift, the curvature of the Earth, etc, so there really is something for every level of audience.

Denny divides ballistics into three areas. Internal ballistics means launching, using man power or gunpowder. There is a lot of good historical material



here, which makes the narrative highly readable. External

ballistics is what happens when the object is launched (including a transitional phase, for example, when just leaving a gun barrel but being in the air blast that accompanies a shot) and in flight. Terminal ballistics is to do with the effect on the target, covering armour and other defences without getting too gory.

I found the level to be consistent and the story well told. With the maths tucked away in an appendix it was easy to pick up and read and go back to, and I learned a lot from it...I'm not sure how much more I could ask of a book on this topic.

Ken Zetie

WE RECOMMEND

Their Arrows will Darken the Sun: The Evolution and Science of Ballistics

Mark Denny

Rating: ★★★★★ Very readable but with enough maths to sink a battleship if necessary

Price: £15.50

Details: Published 2011 by The Johns Hopkins University Press
ISBN-10 0801898579, ISBN-13 978-0801898570

BOOK: PHYSICS EXPERIMENTS FOR YOUR BAG

Handy experiments for your lessons

Anyone who is a regular follower of the Frontline section of *Physics Education* or the equivalent in other journals will not be surprised by many of the experiments in this book. However, there are new twists on some old friends, which were somewhat

of a 'why didn't I think of that' moment.

Split into zero, low and expanded sections the book lists a wide array of experiments that a physics teacher may use. The first two are self-explanatory. These experiments have almost

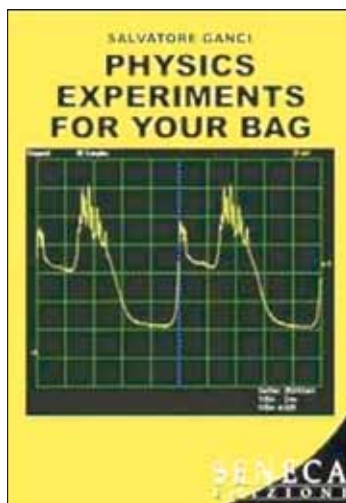
zero or no cost and are relatively easy to make. Some of the experiments described are classics and have been described in various forms elsewhere. There are some suggestions of freeware/shareware software, which were new to me, and others that have

been superseded or replaced by newer pieces of software, many of which have been published in reviews in this journal. This should not be seen as a negative point, as keeping up with the software available on the internet is almost impossible.

What is really good is that lots of simple easy-to-make/use experiments are brought together in one volume and one that does exactly what it says, i.e. fits in your bag easily.

Not all of the experiments are relevant to the modern physics syllabus, but many can be adapted to fit some corner of your work. At least five experiments are versions of experiments that I have demonstrated to classes, but I can now do them as class practicals because the versions presented are simple and easy to build at zero cost.

The experiments are roughly grouped together: optics, magnetism, etc. Towards the end, a series of expanded experiments, that might take a little more effort/cost to put together, are listed. Again there are some real gems in here; one demonstrating



$F=Bil$ was a much easier version of one that I have used for years and will be on my development list for the end of the school year.

While the book is one that I would recommend to any physics

department to buy, there is one major downside. The quality of the English used is below standard, both in spelling and structure. In some areas the translation literally has the reader scratching their head to understand what is being described. Even though re-reading will eventually get you to the intended outcome, this should have been proofread carefully before publication. This is not the same throughout, in some areas the translation is excellent, but where it has fallen below standard it does let the book down. If we ignore the quality of translation, which can be overcome, then this is a good book, hence the rating is for content only.

John Kinchin

WE RECOMMEND

Physics Experiments for your Bag

Salvatore Ganci

Rating: ★★★★★

Price: €19

Details: 113 pp, ISBN 978 88 6122 305 9, available from

www.senecaedizioni.com/index.php?pageid=prodotti&prodottiid=444

BOOK: QUANTUM PHYSICS FOR POETS

Physics has economic importance

The huge economic importance of quantum physics, estimated to underpin 60% of economic activity in developed economies, means that having more than a passing acquaintance with the ideas of quantum physics will be relevant to all those—poets (aka non-science specialists) included—whose working lives will take them up to and beyond the middle of this century.

This book has already garnered many enthusiastic reviews. They are well deserved. Teachers will enjoy reading this book. Their recollections (perhaps distant?) of their university physics lectures can be revived and refreshed so that their teaching of this wonderful and perplexing topic will inevitably be revitalized.

To whet your intellectual appe-

tite, turn to the end of the book and start by reading the two-page Finale.

The book is essentially in two sections. The first takes the reader on an intellectual journey from the apparent certainties of classical physics to the initial successes of the new quantum physics. Black body radiation, the photoelectric effect, Compton scattering, de Broglie's

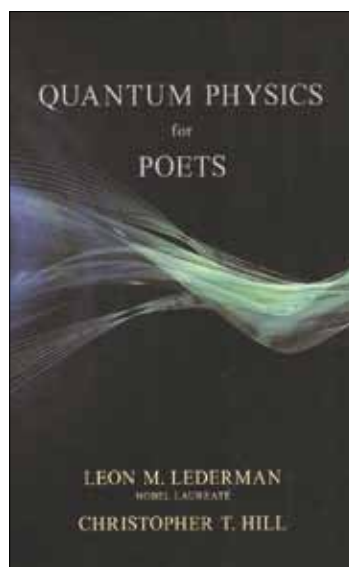
hypothesis, the Franck–Hertz experiment, double slit superposition of photons and electrons, Schrödinger’s wave functions and Max Born’s interpretation of them as probabilities; with the benefit of hindsight these are all fitted together into a coherent narrative so that the Copenhagen interpretation of what is going on appears as a natural outcome.

Then in the second section the authors delve further and with wonderful clarity introduce the reader to the Einstein–Podolsky–Rosen paradox, Bell’s inequality, Dirac’s prediction of antimatter (the economic benefit of PET scans already effectively pays for all the particle accelerators used for fundamental research), Feynman’s many paths approach (*Advancing Physics* teachers will appreciate the relevance of this part of the specification they are following), string theory, supersymmetry

and parallel universes. In isolation, many of these topics seem inaccessible. Here, by showing their logical interconnections, they become at first plausible, and on further readings reasonable and finally familiar.

The book is supported by excellent footnotes for those who want more detail and a good website. Given the target readership, professional niggles about non-SI units and the occasional loose phraseology can be set to one side. They do not really detract from the narrative.

Rick Marshall



WE RECOMMEND

Quantum Physics for Poets

Leon L Lederman and Christopher T Hill

Rating: ★★★★★

Price: \$28

Details: Published 2011 by Prometheus Books, 338 pp, hardback
ISBN 978 1 61614 233 9

EQUIPMENT: SEP COLOUR WHEEL KIT

Wheels investigate colour theory

Anyone who has been to school in the last century is likely to have seen the standard colour wheel, which turns white when rotating. As part of its ‘mixing colours’ publication SEP has produced a set of innovative colour wheels that demonstrate the effects of mixing colours and how inkjet printers combine a small number of inks to produce a wide range of colours.

The kit consists of two motor units and nine coloured CD-type discs. These are mounted on the motors using a mounting wheel. By combining the wheels



together, running them in pairs, students can investigate how the arrays of inkjet colours produce different colours.

Mounting the discs is very

easy, but only if you put them on correctly first time. My first attempt damaged the plastic disc mount. The small plastic lugs on which the disc is held are made of soft plastic and can be damaged easily. The damage was quickly repaired using a craft knife. If the disc is mounted squarely then it is a tight fit and the lugs do not get damaged. This is a minor criticism about a well made set of discs. I would have liked to see a spare disc mount provided so that students can carry out their own investigations. Many label manufacturers produce CD labels and

I can see a number of investigations by printing my own labels.

The activity is easy to carry out and certainly with a few more spare motors this could be part of a circus of experiments investigating colour. There were no problems using the apparatus and alongside the rest of the experiments highlighted in the mixing colours book it made for an interesting collection.

The apparatus is well made and easy to use. The cost of the unit is reasonable, especially as components can be used elsewhere. As with many of Mindsets' products, this has been well thought out and



WE RECOMMEND

SEP colour wheel kit

Mindsets

Rating: ★★★★★

Price: £21.50 ex VAT

Details: Product ID SEP 270, available from www.mindsetonline.co.uk/product_info.php?products_id=1009882

allows a significant amount of extension work to take place as unused CDs can be recycled and used with this apparatus.

John Kinchin

EQUIPMENT: SEP COLOUR MIXING KIT

Cheap colour mixing kit uses red, green and blue LEDs

Probably the simplest of the Mindsets products available, the colour mixing kit consists of a red, green and blue LED, and a holder to keep in place the LEDs and the button cells (not supplied as part of the kit). The LEDs are powered by holding the leads either side of the button cells. By combining the light from each of the LEDs, colour-mixing experiments can easily be carried out.

With apparatus such as this there is little that can go wrong. I did find that the intensity of the LEDs was different and some variation of distance was needed to make them the same brightness, but this is a minor quibble and one that takes little effort to solve.

At £1.95 the apparatus is not expensive. It would not be much cheaper to buy the LEDs separately and the holder is quite



useful, although it does take up valuable storage space. The button cells can be obtained from Mindsets or from electronics retailers at a similar price.



John Kinchin

WE RECOMMEND

SEP colour mixing kit

Mindsets

Rating: ★★★★★

Price: £1.95 + VAT

Details: Product ID SEP 240, available from www.mindsetonline.co.uk/product_info.php?products_id=1009740

SOFTWARE: DrDAQ

DrDAQ software gets an upgrade

It is more than 10 years since I first reviewed the earlier Parallel Port version of DrDAQ. Apart from now having a USB connection, this new version provides a number of improvements, although not enough to adequately serve the needs of current science education in schools.

DrDAQ, shown in figure 1, retains onboard sensors for sound (waveform and sound level), temperature (-10°C to $+70^{\circ}\text{C}$) and light (0–100 arbitrary units). Also, as before, via the set of screw terminals, it can sense resistance (0–1 M Ω) but only with a resolution of 250 Ω . Similarly it has a BNC socket for connection of pH or redox/ORP sensors through which measurements of pH and redox can be obtained. Automatic temperature compensation is provided for pH measurement by connecting an external temperature sensor in the external 1 FCC 68 type socket and using the two probes in tandem. In total, three external FCC 68 type sockets are available for connecting sensors, one more than before. There is now a BNC scope socket accepting signals in selectable ranges of ± 1.25 , ± 2.5 , ± 5 and ± 10 V with a 100 kHz bandwidth—a great improvement on the previous monopolar input. Also new, and a very welcome addition, is the signal generator, which is accessed via another BNC socket. This provides outputs of up to 1 V over the frequency range 0–20 kHz with selectable waveforms of sine, square, triangular, dc, ramp and arbitrary, the last of these



Figure 1. Pico Technology's USB version of DrDAQ.

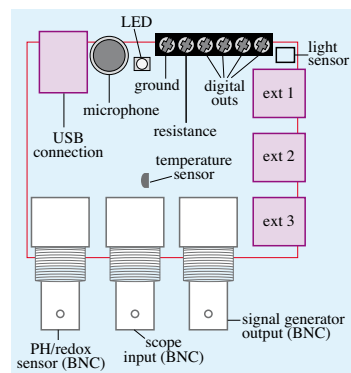


Figure 2. Lascells' DrDAQ sensor adapter.

being input from data or drawn on-screen. While previously there was just one digital I/O (input/output) port, DrDAQ now has four, two of which can provide PWM (pulse width modulation) output. These are ideal for the control of lamps and motors. When used as inputs these I/O ports can be used for pulse counting. A slightly odd addition is an RGB LED that can be set to one of 16.7 million colours via slider controls or a colour disc. I presume that it does have a use in displaying how coloured lights mix, although on my DrDAQ

neither the yellow nor the white were convincing.

While up to 20 DrDAQs can be used at the same time on one computer the channels on each will not be synchronized with each other.

Pico Technology can provide a small range of external sensors to use with DrDAQ: temperature sensor (-10 – 105°C); humidity sensor (20–90 %RH); oxygen in air sensor (0–100%); pH sensor (0–14 pH); redox sensor (± 1500 mV); Reed switch sensor; scope probes; magnetic induction coil (comes as a kit); and 60 or 600 A ac/dc current clamp sensor. These are all automatically detected on connection. In science education I suspect few teachers would wish to introduce current clamp sensors when they are trying to get students used to how ammeters are connected into circuits. They are also expensive.

Provision is made for the connection of own-design (DIY) sensors, which can be via the FCC 68 sockets if you terminate them with FCC 68 four-way plugs or indirectly through

a DrDAQ sensor adapter shown in figure 2, which has 4 mm sockets—available from Las-cells (see contact information at the end of the review). In the User Guide to the USB DrDAQ datalogger details are provided of the basics of how to construct such sensors, how to make them automatically detected and how to scale and calibrate them. I found it invaluable to be able to introduce students to the concept of calibration by the construction and calibration of their own sensors and the use of look-up tables that can deal with both linear and nonlinear situations. However, it is this lack of a significant range of ready-made sensors that I feel lets down this new version. Many of the dataloggers that I have can call on the use of between 30 and 70 sensors for use across the sciences. However, few of my other dataloggers do cater for usage of DIY sensors as DrDAQ does, so that might be something to bear in mind.

The oscilloscope software is PicoScope 6. It is easy to use. Channels (to access sensors) are activated by clicking on their on-screen buttons and their ranges, where appropriate, selected from displayed menus. There is a great improvement in time-base provision on this new version of DrDAQ with it ranging from $10\ \mu\text{s}/\text{div}$ to $100\ \text{s}/\text{div}$. It is more than fast enough to display the switch bounce of figure 3. Scaling and amplification are selectable for each connected sensor. Triggering is available with source, level, edge and pre-trigger time (% of screen) being selectable along with settings of auto(matic), repeat and single being those that schools would

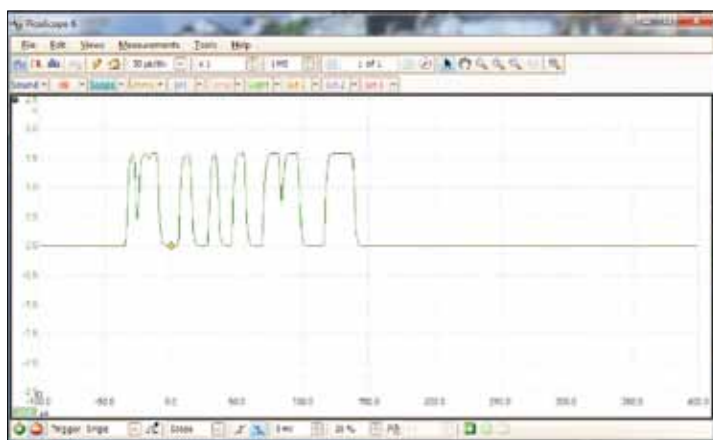


Figure 3. PicoScope 6 oscilloscope display showing switch bounce.

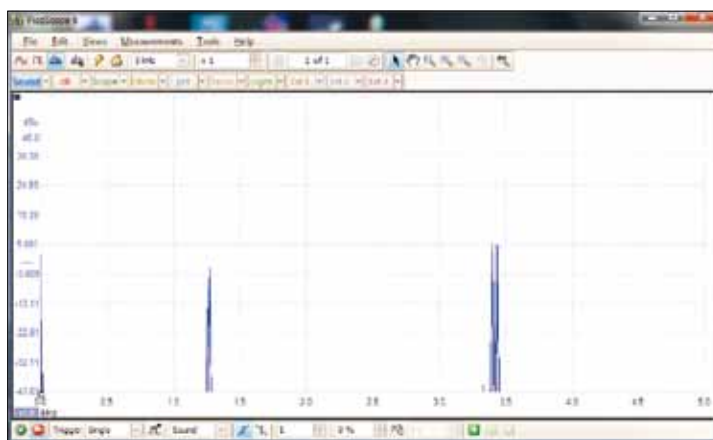


Figure 4. Frequency spectrum for a wind chime.

make use of. Zoom and pan facilities are available, as is autoseup, which selects the most appropriate settings to capture a signal—probably a feature to avoid when you want students to think about what settings might be best and why. However, useful if one is finding it difficult to get a sensible screen display. While most plots are likely to be of sensor readings against time, it is also possible to plot one set of sensor readings against another—what is referred to by Pico as an XY view. New for DrDAQ is a persistence mode in which screen captures are repeatedly overlaid to show up

differences. Alarm actions can be set up, such as a beep when a parameter's amplitude exceeds a certain value. Waveforms can be saved and stored in many formats, made available as references to compare with, and to export to spreadsheets, graphics packs and Matlab 4.

Rulers can be placed on screen to make measurements of amplitude, frequency and time, and many built-in measurements such as maximum, minimum, average, standard deviation, peak to peak, fall time, rise time, etc, are also available. There is a Math channel that enables

mathematical operations to be performed on input signals, so if you had both voltage and current signals input you could display the power transferred to a device by selecting their product. While there is a predefined selection to choose from it is also possible, through the equation editor, to define other operations.

A spectrum analyser is again available, plotting amplitude against frequency, and a plot for a wind chime is shown in figure 4.

A feature that has been removed from that of its predecessor, PicoScope 5, is the digital meter display. This facility was frequently used in schools to provide large digital meter displays of whatever sensors were connected, DIY ones included, and I see its deletion as a sad loss.

PicoScope 6 is an extremely comprehensive oscilloscope piece of software, used commercially by many companies and institutions. It was not developed just for schools, nor indeed was PicoLog. Its User Guide provides full details of all its features—far more than have been listed here—and how to operate them.

PicoLog software provides the slower datalogging facility in two modes—player for displaying previously recorded data and recorder for recording new data. It is again easy to set up to record from whichever channels are selected. Data from each channel can be displayed on separate graphs or combined on the same graph. Figure 5 shows the graph from part of an activity in which a sample of cola modelled stomach acid and an investigation was made of the effectiveness of various indigestion tablets, crushed

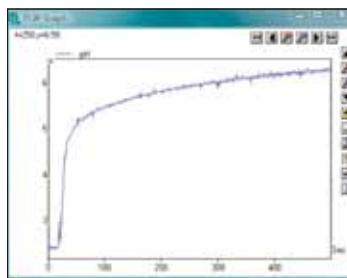


Figure 5. PicoLog graph showing how the pH of a sample of cola changed with time after a crushed Bisodol® indigestion tablet was added to the cola.

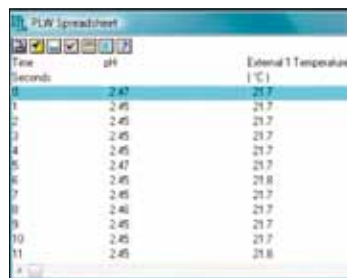


Figure 6. Scrollable spreadsheet/table view of the data obtained from the Bisodol® activity.



Figure 7. PicoLog recorder's monitor window.

or whole, being added to it. As with PicoScope, XY graphs can also be plotted. Sampling interval and maximum number of samples are initially selected, along with the channels/sensors to be used and any alarm settings required when channels' parameters would go out of specified ranges.

Then, during or after recording, the data collected can be displayed in the form of graphs or as a spreadsheet/table, as well as exported to other spreadsheets and databases.

During recording the sensor readings are also displayed on PicoLog's monitor window, as shown in figure 7, together with how many samples have been collected. Both graphs and tables can be scrolled and axes com-

pressed or expanded (effectively a zoom function). As with PicoScope, DIY sensors can be calibrated for use and mathematical operations can be made on data collected to generate new data.

The USB DrDAQ Data Logger User Guide, USB DrDAQ Data Logger Programmer's Guide, PicoScope 6 PC Oscilloscope Software User's Guide and PicoLog Data Logging Software User's Guide are all excellent and can be downloaded from www.picotech.com/document/document.html.

Print, copy, save and file-open facilities are available with both PicoScope and PicoLog, as are on-screen help files. Software updates are free to download from www.picotech.com/download.html and there is a library of science and electronics experiments, complete with students, teachers and technician notes on the experiments, available at www.picotech.com/experiments/science_projects.html.

For modern science education this new version of DrDAQ has unfortunately not progressed far enough, being let down particularly by its lack of compatible sensors. It also fails to provide on-screen details of the gradient

of graphs at any selected point, together with the area under a graph—useful with a force-time graph to provide a value of impulse. (A suitable force sensor can easily be made using the Honeywell FSG15N1A i.c. available from many electronic components distributors). It now lacks, as noted earlier, a large digital meter display. There is also no best-fit line or curve facility available and no snapshot facility to record data only on demand. These missing features are all present in most other educational dataloggers.

Chris A Butlin

WORTH A LOOK

USB DrDAQ (supplied with USB cable, software on CD-ROM and installation guide)

Pico Technology Ltd

Rating: ★★

Price: £99.00 + VAT

Details: Software and hardware requirements: Microsoft Windows XP (SP2 or later), Vista or Windows 7 (32-bit and 64-bit editions) and a computer with a USB port. Available from Pico Technology Ltd, James House, Colmworth Business Park, St Neots, Cambridgeshire PE19 8YP, UK, tel +44(0)1480 396 395, fax +44(0)1480 396 296, e-mail sales@picotech.com, www.picotech.com. The DrDAQ sensor adapter is available from Lascells Ltd, Walkmill Business Park, Sutton Road, Market Drayton, Shropshire TF9 2HT, UK, tel +44(0)1630 657 801, fax +44(0)1630 656726, e-mail sales@lascells.com, www.lascells.com

APP: iHANDY LEVEL

iPhone app superbly measures angles

This is one of five tools of the iHandy Carpenter, but I used it with an AS (16–17 years) student to investigate the equilibrium in a three force situation—as in the Tyrolean traverse.

In this situation it is easy to align the iPod with one of the cords and read off the angle. Then just align it with the other cord and read the angle, you do not have to find a vertical line.

The app can be calibrated and measures in angles or radians. The sensitivity can also be adjusted. This would be handy to measure angles of slopes and the starting amplitude of a simple pendulum, or any experiment where you need to measure angles.

If you wish you can upgrade to iHandy Carpenter, which costs £1.49 and in addition to the level includes a plumb bob, a surface level, a steel protractor, and a steel ruler, which measures by



sweeping the iPod or iPhone left or right.

It is possible to hold the measurement until it has been noted.

A review from O'Reilly Media 'Best iPhone Apps' says: 'Not only are these tools functional,

they're also gorgeous, with wood grain and lighting effects that make them seem straight out of Leonardo da Vinci's workshop.' A view from a carpenter I think.

Alison Alexander

WE RECOMMEND

iHandy Level

iHandySoft

Rating: ★★★★★

Price: Free

Details: Available from www.ihandysoft.com/level_free.html

EQUIPMENT: PHOTONICS EXPLORER KIT

Free optics kit given to schools

Created as part of a pan European collaboration of teachers and experts the Photonics Explorer kit is a class set of optics apparatus that will eventually be distributed to schools in Europe.

As part of the kit (a sample of which is shown in the photograph) there are three lenses of differing power, diffraction gratings, aluminum mirrors, polarizing filters, colour filters, an LED module, optical fibre and a laser module. To guide the teacher there is a comprehensive set of lessons on DVD. The photonics pack is designed to be used with classes as inquiry-based learning, allowing students the freedom to investigate a particular topic in a way that suits them and moving away from the teacher-led model, which is very common. The worksheets on the DVD allow this approach by picking a topic and suggesting investigations that can lead the student to understanding the physics that underlies it. A typical topic would have a teacher lesson plan and associated worksheets for the students. At least one of the worksheets will have the knowledge that the student needs to acquire before the topic is finished, the other sheets guide the student in the right direction to acquire that knowledge.

The apparatus is well made. I particularly liked the LED and laser modules, which were well thought out. Not much of the other apparatus is new but the pack is well put together and integrates with the ideas on the DVD. My only reservations would be with the plastic lenses, which may get



scratched quickly. I did like these lenses because the focal length is written on the bottom of the plastic mount. There was no evidence of a lens mount included, but this is simple to construct.

Inquiry-based learning is not new and optics does allow this approach to be used with little difficulty. This is a bold approach, especially considering the vast differences in curricula taught across Europe, but if it leads to a better understanding of one of the most exciting areas of physics then it will be worthwhile.

Apart from the possible fragility of the lenses, this is an

excellent kit and will be a useful way of teaching optics to KS3 (11–14 years) and KS4 (14–16 years). Some aspects could be used at advanced level teaching with a little adaptation.

The Photonics Explorer website has more information about the project, which will be updated over the coming months. It is envisaged that more than 3000 kits will be distributed free of charge across Europe, with about 10% in the UK. From my experience I would recommend you sign up as soon as possible.

John Kinchin

WE RECOMMEND

Photonics Explorer kit

Photonics Explorer

Rating: ★★★★★

Price: Free

Details: www.photonicsexplorer.eu/

WEB WATCH

Websites show range of physics

Graphing Challenge (www.theuniverseandmore.com/), written by Mathew Blackman, is an interesting site with a variety of v , a and s against t graphs. The viewer is asked to set the required values of the initial values to copy the graph. The idea is that you are presented with a graph and are asked to set three sliders to initial values of position, velocity and acceleration. When you press start the program plots your values and you can compare your graph with the original. If you are wrong you can press reset and the program presents you with your original values so that you can fine tune them—or change them completely. When you get your graph correct you move on to the next level and are presented with a more complicated example. Eventually you have to change the value of the acceleration partway through the graph. The last style of problem is a series of blobs in the graph area and you have to find a set of values to guide the graph through the field without touching any blobs.

The values of initial and new quantities are limited to inte-



The graphing challenge.

ger values over a small range. The most important thing to fix is the sign of the velocity and acceleration.

This would form an excellent basis for either an introductory lesson or a revision period on kinematics. The steady gradation in the difficulty of the tasks and the challenging final ones seem to me to work well. My only criticisms are that getting into the program is a little obscure and clearer instructions would help. The music is also irritating. Explore the program before using it.

The symphony of science website (<http://symphonyofscience.com>) is a series of songs containing quotes from famous scientists. *Onward to the edge* and *The quantum world* are of the most



The symphony of science.

interest in physics teaching. They would form an interesting introduction to a lesson or perhaps a finale in place of the dreaded plenary. It is possible to have the song in just the audio version or with video. It is also possible to download it in MP3 or other format, so avoiding any school networking problems. The website is interesting and useful but more as an introduction to the basic topic than for its serious content.

Finally, a website showing radiation patterns in five microwave ovens (www.evilmadscientist.com/article.php/microappalam). Warning—you may not like the language in some of their captions but the pictures are excellent.

Robert Strawson

Physicseducation

Add a spark to your teaching

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