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EQUIPMENT: PASCO XPLORER GLX

Make the most of your data



Figure 1. Home screen of *Xplorer GLX* showing the various functions available.



Figure 2. The *Xplorer GLX*, set up with an array of sensors and connected to a printer.

The Pasco Xplorer GLX – wow, what a gadget! Great portability and robustness, a good size and a greyscale 320×240 pixel (7.8×5.8 cm) display (figure 1), and almost everything you might wish to have on a datalogger for use with schools and colleges.

This hand-held device (figure 2) has eight sensor ports, four for its PASPort sensors (not included), two temperature-sensor ports (with two -10 to $+70$ °C fast-response sensors supplied), one voltage port (with a ± 10 V sensor supplied) and a built-in microphone. There is also a signal-output port and a loudspeaker. The signal-output port allows stereo headphones or amplified stereo loudspeakers to have waveforms of different types (sine, square, ramp and triangular) fed to their two channels, at frequencies from 60–5000 Hz and with differing phase.

While the PASPort sensors are designed for the Xplorer GLX main ports, the older Science Workshop sensors that may have been purchased with the 500 or 750 Interface can still be used, but will need connection via PASPort digital and analogue adaptors. The range of sensors available is enormous, from accelerometers to charge sensors, force sensors to ultrasound

motion sensors, light sensors to magnetic-field sensors, photogates (lightgates) to a Geiger–Müller sensor and many more, plus ones for use in biology, chemistry and environmental sciences.

Some need the digital adaptor to be attached, so be aware of this when ordering certain sensors. For the most part sensors are self-identifying and precalibrated, but manual recalibration is also possible. Sampling rates are dependent on the sensor, so the quoted 50 000 samples/s maximum sampling rate only applies when using the older Science Workshop sensors. Such a high sampling rate is rarely needed, so the more common 1000 or 5000 samples/s proved fine. Figure 3 shows the excellent resolution of the graphs obtained with a force sensor sampling at 5000 samples/s on a model Huygens Titan lander.

Almost all sensors can have their sampling rates selected and have averaging or smoothing of the data to differing degrees switched on or off. While the usual mode is to record continuously, manual sampling is also available. The PASPort sensors are reasonably priced when compared with those of other companies.

The digital display allows live data to

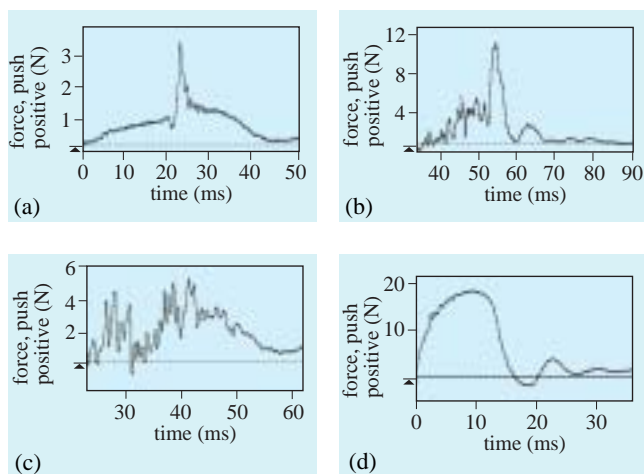


Figure 3. The Xplorer GLX displays the force–time graphs (impact signatures) made by a modelled Huygens Titan landing on (a) sand, (b) grit, (c) gravel and (d) clay.

be shown from up to six sources; it can also display any calculations being made. The analogue meter displays live data and incorporates an autoscale facility. The stopwatch is just that, showing elapsed time in minutes and seconds to 0.01 s. The timing facility will probably be well used in physics. Here, photogates, the ultrasound motion sensor, the rotary motion sensor, the Smart Pulley and the Geiger–Müller sensor (among others), can be set up. It is all very easy to do. I used a photogate with the Mylar tape set to record the motion of an air rocket at launch (figure 4).

The graphing of lines is good but does little more than join up the points and plot a linear best-fit straight line. I have no doubt that other best-fit options will become available in time. Multiple best-fits are available in DataStudio. The slope at any point is easy to see, as is the area under a section of a graph. The latter was of interest when investigating a model Mars lander impacting with and without gas bags.

The derivative with respect to time is also available, although with motion sensors one selects from displacement, velocity and acceleration, rather than the first

and second derivatives of displacement. Trigger levels are set from the graph with a value plus selection of a rising/falling edge. A special scope mode enables the emulation of a digital storage oscilloscope, collecting and displaying data in repeated bursts. Data plots for different sensors can be shown, as can those from subsequent runs. Autoscaling is available but there is also the option of manual scaling and moving the position of axes. The statistics of maximum, minimum, average and standard deviation can also be displayed. Tables of data are readily available to view for each sensor and run, and the same statistical analysis is available. Data can also be entered manually and edited prior to graphing.

Selection is mostly via the four function keys and the arrow keys. The alphanumeric keys can be used in the menus, but are mostly used to input to the calculator, which is not just for making the odd calculation! It can be used to assign variables and constants, set up equations and functions, and linearize data. The latter enables, for example, a voltage–time graph of resistance–capacitance decay to be displayed as a best-fit straight-line graph by converting the voltage data to $\ln(\text{voltage})$.

Collected data, calculations, notes, display configurations and sensor settings can all be saved in the Xplorer GLX's memory and selected from the data files screen. This allows the teacher to provide preconfigured activities. Both Flash ROM and RAM storage is available, the former for long-term storage and for upgrades of the firmware. Upgrading the firmware over the Web proved very easy. There is 10 MB of user-available memory. The GLX can also access a USB memory device for additional storage capability and file transfers.

Battery capacity through a 1700 mAh rechargeable NiMH pack, when not connected to the mains via the power adapter, appeared more than adequate for my forays to the rocket launching pad.

While most data processing can be done directly on the Xplorer GLX, Pasco provide their DataStudio Lite software free. It runs on a Windows PC or an Apple Macintosh. With this, data can be transferred from the Xplorer GLX via a USB socket for further processing. DataStudio Lite is a cut-down version of the full award-winning DataStudio software.

By connecting the Xplorer GLX to a Windows PC with the GLX Simulator running, the keyboard and screen are displayed, the keys are active and the screen shows what the Xplorer GLX screen has on it. Screen-dumping from here allows the development of worksheets and, with connection to a digital projector, the GLX Simulator provides the ideal large-scale demonstration tool. It is only available for Windows 2000 and XP.

Direct printing from the Xplorer GLX via a USB connection is made to a number of HP printers, a list being provided on the Pasco website. The Xplorer GLX can also be operated with a mouse and keyboard, again from the USB ports.

Details of a few simple activities are provided in the accompanying manual, which is well written and laid out. A separate 'Getting Started' CD-ROM provides a good tutorial on setting up and using the Xplorer GLX. The monthly *Physics Newsletter* is available on the Internet.

Overall, a great datalogger for both inside and outside the laboratory, which frees the user from a laptop or full-size computer for most of the work and discussion that school students are likely to need. One now has the freedom to launch rockets, conduct traffic-noise surveys, investigate sprint starts and shot-putts, make trips to adventure parks and do some really fun physics. With the addition of an array of best-fit line-graphing options and a Fast Fourier Transform (FFT) facility, I might then say that we had reached perfection.

Chris A Butlin

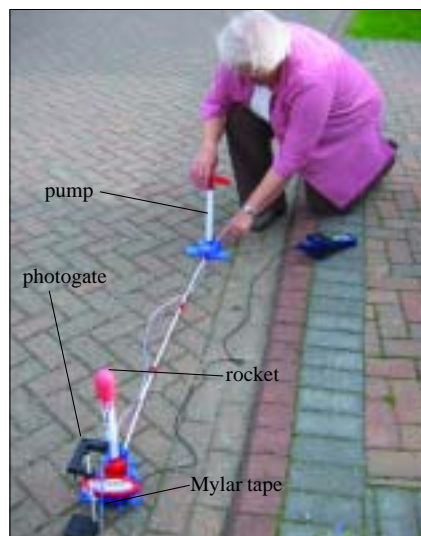


Figure 4. *The air-rocket launch set-up.*

WE RECOMMEND

Xplorer GLX

Pasco

Rating: ★★★★★ excellent

Price: £269 plus VAT, post and packaging (promotional offer). Includes two fast-response temperature (-10 to $+70$ °C) probes, ± 10 V voltage probe, AC power adapter, USB host connection cable, 'Getting Started' CD-ROM, user guide, battery, screwdriver and DataStudio Lite (includes the GLX Simulator)

System requirements: DataStudio Lite (free) requires Microsoft Windows 98, ME, 2000 or XP with a Pentium processor; Macintosh MacOS 8.6 or later, plus 16 MB RAM, 60 MB hard-disk space, CD-ROM drive and a USB port. Full version, incorporating features such as FFTs, a range of curve-fits and the capacity to synchronize QuickTime videos and data, is £87 plus VAT (single user) and £305 plus VAT (site licence). Free upgrades provided

Supplier: Feedback Instruments Limited, Park Road, Crowborough, East Sussex TN6 2QR. Tel: 01892 653322. Fax: 01892 663719. E-mail: pasco@fdbk.co.uk Web: www.fbk.com and www.pasco.com

EQUIPMENT: STRINGIN' IT

The standing-wave machine uses string to generate a colourful light show

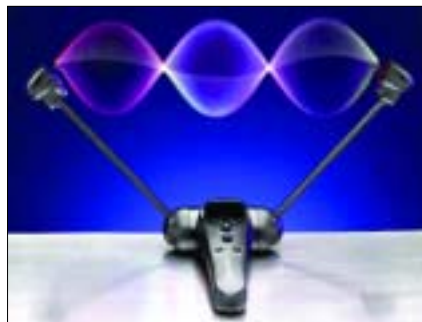


Figure 1. *Stringin' It looked good on the box, but this was as good as it got.*

Basically this is a standing-wave generator with a built-in strobe. There are two motors fastened to the ends of movable arms, which have a length of string between them, and beneath there is a bank of flashing LEDs (figure 2). You can change the position of the arms, the speed of the motors and the flash rate of the LEDs. It has potential but I found that the picture on the box was about the best it got (figure 1). Fiddle with the knobs and, yes, you can get interesting shapes in different colours, but the most stable pattern is three half waves and anything else either isn't that stable or doesn't last that long.

Slightly more annoying was the fact that it's supposed to run off four batteries but mine wouldn't. Luckily there's a socket for a mains transformer (not supplied) so I managed to get it going in the end. There's a manual mode where you control everything, and also a demo mode where it goes through various lights and motor speeds. To me demo mode just looked like it was in the process of breaking down (figure 3).

I was rather disappointed with this device and consulted a colleague who had also bought one, and found he was even more disappointed than I was. I also lent it to another colleague who let his stu-



Figure 2 and 3. *The bank of LEDs (top) and a typical pattern (bottom).*

dents try it out. They found it great fun, but didn't seem to learn much from it. The latter probably sums this gizmo up nicely: not really a demonstration tool for physics but good fun to play around with.

At \$32 (about £20) then it might be worth the money for open days but if you have to pay the import tax and the rather expensive carriage then it'll be a very expensive toy.

Gary Williams

HANDLE WITH CARE

Stringin' It P6-7800/ 3D Standing-Wave Machine

Arbor Scientific

Rating: ★★ fair

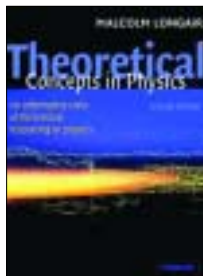
Price: \$32.95 (£20) plus postage and packaging

Supplier: Arbor Scientific, PO Box 2750, Ann Arbor, MI 48106, USA. Tel: +1 734 477 9370. Fax: +1 734 477 9373.

Web: www.arborsci.com

BOOK: THEORETICAL CONCEPTS IN PHYSICS

A refresher course in physics



This book is breathtaking and its aim is bold. It is the offshoot of a lecture course for final-year physics students to get them to appreciate the intellectual excitement and beauty of physics, and to appreciate how it fits together. It complements standard texts by offering an outline, rather than details, of each topic and of how proofs work, and so manages to tell the story of a physics degree in one book. The author's writing style is clear and his research into the history and development of topics such as thermodynamics and electromagnetism is exemplary.

I shall certainly reread the sections on the development of quantum mechanics before teaching it again and I will be com-

ing back to this book for many years. I'd heartily recommend it as a refresher and as a first-rate reference on the background of many of the topics we teach in school.

Gary Williams

WE RECOMMEND

Theoretical Concepts in Physics

Malcolm Longair

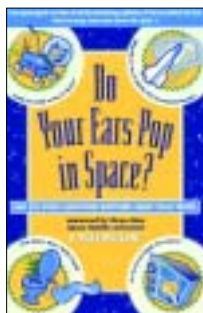
Rating: ★★★★★ excellent

Price: £29.95

Details: Published 2003, Cambridge University Press, 588pp (pbk) ISBN 0 521 52878 X

BOOK: DO YOUR EARS POP IN SPACE?

A question of space travel



This is a little gem. Written by a three-time shuttle astronaut, it covers the basics of orbital mechanics, but more importantly it tells you how a space toilet works and whether you feel like you're falling when you're weightless. As a personal insight it cannot be matched by knowing any amount of physics. Short and sweet!

Ken Zetie

WE RECOMMEND

Do Your Ears Pop in Space?

R Mike Mullane

Rating: ★★★★★ very good

Price: £9.50

Details: Published 1997, John Wiley, 256pp (pbk) ISBN 0 471 15404 0

BOOK: FULL MOON

Sit back and enjoy the ride



This is simply a collection of high-quality photographs from the Apollo missions. They are presented chronologically, unspoiled by text, with the details listed at the back. Otherwise, just indulge and enjoy the most wonderful views that a human has ever been privileged to see.

Ken Zetie

WE RECOMMEND

Full Moon

Michael Light

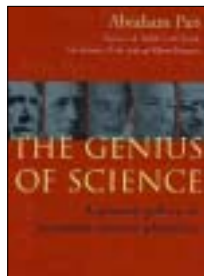
Rating: ★★★★★ excellent

Price: £12.99

Details: Published 2002, Jonathan Cape, 232pp (hbk) ISBN 0 224 06304 9

BOOK: THE GENIUS OF SCIENCE

A century of physics



Those familiar with Pais's biographies of Bohr and Einstein will need no encouragement to read this lovely collection of personal memories from some of the leading figures in 20th-century physics. The subjects range from the obvious – Bohr, Born, Dirac, Einstein and Pauli – to the lesser known (though deservedly covered here), such as Feigenbaum, Rabi, Uhlenbeck and Kramers. In *The Genius of Science* Pais offers intriguing insights and a broader view of the century than you get from his other books.

Ideal for Pais fans and for those who

enjoy reading histories – one for the library, but well worth dipping into.

Ken Zetie

WE RECOMMEND

The Genius of Science

Abraham Pais

Rating: ★★★★★ very good

Price: £27.50

Details: Published 2000, Oxford University Press, 364pp (hbk) ISBN 0 19 850614 7

BOOK: THE SIMPLE SCIENCE OF FLIGHT

In-flight entertainment



This is an excellent source for a bit of detail on flight, with facts and figures about birds and planes, and insight into the meaning of equations. A classic example is how bird wings can tilt to vary lift: forward thrust, making a continuously variable transmission. The diagrams make it all very clear.

Ken Zetie

WE RECOMMEND

The Simple Science of Flight

Henk Tennekes

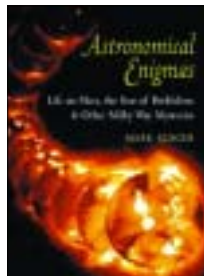
Rating: ★★★★★ very good

Price: £15.95

Details: Published 1997, MIT Press, 152pp (pbk) ISBN 0 262 70065 4

BOOK: ASTRONOMICAL ENIGMAS

Tackling the mysteries of the universe



At nearly 300 pages long this is a hefty book that would probably have benefited from using a bit less paper. It covers a range of enigmas, looking at questions such as: Stonehenge – was it an observatory? Can you buy names for stars? Is there life on Mars? Will we be the next dinosaurs? Some of the topics are quite up to date, there's a chapter on whether you can buy a plot of land on the Moon, for instance. The reading isn't too difficult and it would certainly be accessible for 16–18 year-olds and probably for stu-

dents who were a few years younger if they were interested.

I found it a bit boring in places: it almost had too much astronomy in it and not enough enigmas. Not that I find astronomy boring, but I was expecting a bit more controversy, a bit more made of the battle between science and hocus-pocus.

For students using this book there are a lot of useful touches. Each chapter has a section with suggestions for further reading, and some relevant websites. There's also a load of notes at the end,

as well as a good index and excellent colour pictures, along with their source. The chapters are split into headed sections that make it easier to read. This isn't an un-put-downable book, but the way in which it's presented makes it well worth looking at as a possible addition to a library.

Gary Williams

WORTH A LOOK

Astronomical Enigmas

Mark Kidger

Rating: ★★★ good

Price: £20 or less

Details: Published 2005, Johns Hopkins University Press, 256pp (hbk)
ISBN 0 8018 8026 2

SOFTWARE: SUREHIGHERPHYSICS

Curriculum support for physics

SUREHigherPhysics is software for the PC and Mac that complies with the Scottish Higher Physics curriculum. Higher Physics is normally a one-year course taught to 15–17 year-old students and covers three main topic areas: mechanics and properties of matter; electricity and electronics; and radiation and matter. The software is arranged in a similar fashion so pupils in Scotland would have few difficulties in navigating through the program.

The page layout is uncluttered and is divided into a number of panels: simulation, tool bar, graphics and text.

Simulations rather than animations are used. These allow a degree of interactivity so that experiments can be performed and variables altered by the user. These simulations mirror the real laws of physics and allow results to be collected by following instructions from the text panel. For example, the temperature of a gas can be changed by the user over a wide range, resulting in a change in pressure when examining the gas laws.

These results can then be manipulated in a number of ways. In the graphics panel there are often graphs that can be plotted, or the data can be exported by printing for hand plotting or inserting into a spreadsheet for further manipulation. Informative text then helps to establish relationships between variables while

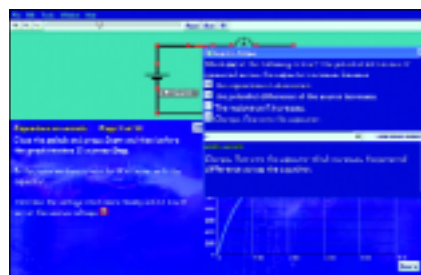


Figure 1. A simulation of a capacitor-charging experiment, the supporting text panel, graphical analysis and pop-up question-bank window.

using the plotted data.

Equations can be evaluated in various ways. Changing the values of variables allows the simple solving of equation values – just like using a calculator. It is possible to use the equation tool to rewrite equations by algebraic transposition. This is quite an advanced feature and takes a bit of getting used to.

Interestingly, some simulations can be viewed on two different levels, which relate the macro properties of physical behaviour to a deeper look into the underlying physics on the micro or particle level. For example, a gas law simulation will examine the relationship between the pressure and temperature of the gas. Zooming in using the microsim tool then enables the particle behaviour and the kinetic model to be examined.

Similarly, Rutherford's alpha scattering experiment can be viewed on the equipment (alpha source and gold foil), and zooming in shows the approaching alpha particle travelling straight on (in the majority of cases) while near misses are deflected through a variety of angles.

But *SUREHigherPhysics* does more than this. There is an extensive question bank of problems that are accessed directly from the text panel. A scoring method keeps track of how well the student has answered the questions depending on how many attempts were made. Fully worked solutions and constructive feedback are given depending on the type of error that is made. This is a good aid to formative assessment. The site-licence version allows pupil tracking so that the teacher can target intervention effectively and efficiently, and the questions and supporting text are fully editable by the teacher.

For the more inquisitive student, a series of investigations are included, which take learning a step further. In this respect, the whole program is probably more suited to enhancement and revision than to the first-time learner, or could aid

the presentation of a particular topic by a teacher in the classroom, perhaps by using an interactive whiteboard.

In some respects, the major drawback of this software is the scope of the whole program. There are many features that may not be immediately obvious and a student could get stuck in some of the more intricate areas.

The SURE team offers a full programme of continuing professional development and will visit schools on request.

Nick Forwood

WE RECOMMEND

SUREHigherPhysics

Counting Thoughts

Rating: ★★★★★ very good

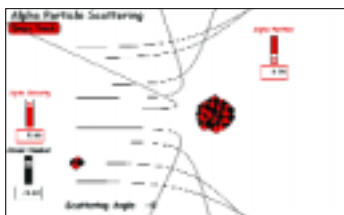
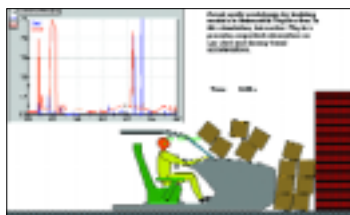
Price: £10 for a single-user licence, £250 for a site licence, or free for a limited time

System requirements: Microsoft Windows 98; MAC OS10.2 or later; 266 MHz processor; 100 Mb hard-disk space; 64 Mb RAM (128 Mb for Macs)

Supplier: www.countingthoughts.com

SOFTWARE: INTERACTIVE PHYSICS

Simulations made easy



Interactive Physics makes building simulations quick and easy for teachers and students alike.

There are, of course, two groups of users for this software: students and teachers. I can't recall a piece of software that allows you to model as easily as this, but I can't really see why you would want students to be able to. The ease of creating a model seems out of balance with

the complexity that is achievable and any understanding that students might gain from an activity using this software. While other software requires students to have a grasp of some of the maths behind a model to start with, having used this software what I previously felt was a bad

thing now seems to be a positive attribute. However, that is my only serious criticism of this product. The price is a bit high, the graphics a bit dated and it seems tailored to a US market, but these are minor points. Very simply, you start with an environment and you drag and drop items into it. They then behave as if in the real world and you can change their properties. You can add springs, blocks and just about anything really.

But why have a simulation when you can do the real thing? There are some situations that it would be good for – experiments that can't really be done because they are too big or too small – but generally I can't see a teacher using this in a class for modelling because it requires little understanding to create the model, and is not developing an understanding of the underlying mathematical model.

But what about teacher users? The real strength of this software is that it allows the teacher to build simulations that can be shown to the class. Given that it comes with loads of pre-built ones you get to see the full extent of what you can do. You may well ask a student to model something for an investigation, but you're much more likely to be building animations yourself to show the class. At £150 for a single-user licence it's not cheap, but I could see this getting used over and over again. In this situation of course you will already understand the physics, so it doesn't matter if you aren't necessarily learning as you create the model. In this context the ease of use is a massive advantage, allowing you to make complex models in a very short time.

The manual that accompanies the software is huge and there is a CD with tutorials, as well as the built-in help facility. You control the 'worlds' in which you create your objects and you can set the magnitude of the gravitational, electrostatic and air-resistance forces. I have a pretty good computer but I noticed that the animations started to slow down as I

added more objects, even in single figures. It also didn't take long to find glitches, such as a 'Required resource is unavailable' message. Given that students often run software on less powerful computers than teachers (the old network in the IT room versus your new laptop/desktop) this could be a problem, although presumably anyone buying a site licence would have had a good trial beforehand.

Each object you create can be controlled or measured, and you can bring in interactive sliders that allow you to set values and graphs that show position, velocity and acceleration. Objects can have forces applied to them and force fields can be defined. When you have made a simulation you can also export it as a movie. The quality wasn't quite as good as the simulation, but not far off. This makes it easy to distribute pre-determined – but not interactive – simulations via the Web.

I don't think this is the best piece of modelling software for promoting learning in students (I'd go for something like Modellus, which is free and available from phoenix.sce.fct.unl.pt/modellus), but for teachers creating simulations this is the best piece of software I've seen, even taking into account the odd glitch.

Gary Williams

WE RECOMMEND

Interactive Physics

MSc Software

Rating: ★★★★★ very good

Price: £125 plus postage, packaging and VAT for a single-user licence, or £499 for a site licence

System requirements: Microsoft Windows 95/98/NT/2000/XP; Macintosh OS7 or later

Supplier: Available from www.fable.co.uk/ip.htm (UK), or www.interactivephysics.com/home.html (elsewhere), which also has language support for tutorials and brochures

WEB WATCH: SOUNDS AMAZING

Let your ears do the work



Figure 1. The frequency analyser.



Figure 2. Wave-equation magic triangles.

Salford University have put together this website (www.acoustics.salford.ac.uk/schools), which is aimed at UK GCSE/Key Stage 4 students (14–16 year-olds) and which is intended as a resource for learning about sound and waves. Probably the first thing to say is that most of the pages need Flash installed before you can view them.

From the home page the navigation is pretty clear: there's a thing that looks like a radio on the left-hand side that tells you where you are and which topic you're looking at, and at the top of the page there's another display that tells you which page you are on within that topic. This means that the material is delivered linearly, but there are some optional branches.

The first section is called 'What is sound?' and it is a well delivered hook to get pupils started. The layout of the pages is simple and very visual, and there is a lot of interactivity and noise. In this section pupils learn about vibration, pitch and loudness, waves and the ear. The slides are noisy and you would want pupils to have access to a set of headphones and a microphone to make the most of things like the simple sound-level meter and the frequency analyser (figure 1).

The next section is about the nature of waves; it starts off with a short list of objec-

tives and some keywords before getting stuck into transverse and longitudinal waves, wavelength, frequency and wave speed. Again it's all very interactive and visual and kept to simple chunks. I wasn't hugely impressed with some of the graphics – some were unclear and one was quite confusing – but overall it was done well.

At the end of this section there is a short summary with links back to some of the pages and then a simple test, and there is also a link so that you can download a homework sheet. The layout of the questions on the screen is not as good as the rest of the site, but the level of the questions is appropriate for the target audience (although there are only four).

The wave equation is dealt with in the next section and, while I'm not a great fan of 'magic triangles', I think the graphic showing how these work is brilliant (figure 2). There's a well explained run-up to this and some revision of previous content. Some of the ideas seem a little more than was needed, but others are very novel and had approaches that I'd use in future myself. Again the lesson finishes with a summary and a short test, and there is a reasonable homework worksheet.

Wave behaviour is dealt with in the next section and it starts off well – the authors obviously realizing that language is



Figure 3. Guess the room by its sound.



Figure 4. The interactive teachers' area.

important, especially when introducing new words like refraction and diffraction. In this section there is a game called Guess the room (figure 3), which is great fun and really tests your ears – you listen to speech and music recorded in six different rooms, from an anechoic chamber to a reverb room, and try to work out which room it was. This is an excellent activity that emphasizes some of the everyday aspects of the subject matter.

Following the lessons, there are two sections: Recording Studio and Science of Sound. The Recording Studio has animations explaining how guitars, pianos, CDs, records, loudspeakers and microphones work and this last section also covers induction and alternating current. Analogue and digital are covered in this section too, with more good illustrations showing the advantages of digital signals over analogue ones. There is also AM and FM, and telecommunications...and generally so much stuff that there's a separate index.

Science of Sound is a short section looking at careers in sound-related fields and some nice extra bits like a video of a glass breaking with sound.

And that isn't all, there's also a teachers' area. Having been to many hundreds of teachers' areas you'll know that this is often rather an afterthought and it looks like the money ran out just as they started

thinking about the troops at the chalk face. You'll be slightly more impressed with this teacher area – I certainly was. The content here is pretty much the same but this time the Flash movies can be accessed in different ways. There's an interactive version that is pretty much the same as the student version with text, sound and animation (figure 4) and there's also a whiteboard version that doesn't have as much text and has no sound. Both come up as full-screen movies, meaning that they're ideal for use with a data projector. You can access the student worksheets from this section too and there's also information on experiment ideas.

In summary, this is a fantastic site – it isn't perfect but it's probably a lot further along the road than any site I've seen. Not only have they thought about the content, but they have also considered the delivery. You can use this material straight away and the pupils can go over the same content in a slightly more interactive manner and at their own speed. There are ways in which you can save Flash movies (find the SWF files in your temporary Internet folder for instance) and also embed them into PowerPoint using freeware – it would be worth the time to know how to do this because I'm sure you will want to use these resources again and again.

Gary Williams