EQUIPMENT: JOULE AND WATT METER

ALBA range gets a new recruit

Figure 1. *Investigating a drill on/off load with the ALBA Joule and Watt Meter.*

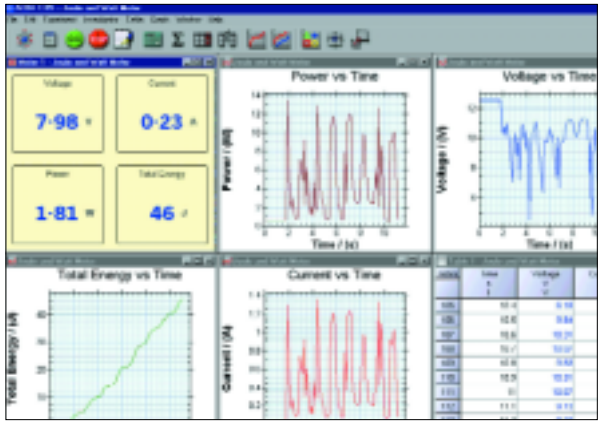


Figure 2. *Screen display from the Joule and Watt Meter.*

In past issues of *Physics Education* I commented on the ALBA Interface and Logger, the ALBA Ranger Ultrasonic Measuring device and the ALBA Power-Energy-Cost Meter.

Now djb microtech, producer of the ALBA range of equipment, has made a Joule and Watt Meter for low-voltage direct current (DC) devices that replicates most of what the Power-Energy-Cost Meter did for mains devices.

The Joule and Watt Meter connects to two analogue DIN sockets on the ALBA datalogger to sense voltage and current. Two power input sockets can connect to DC sources up to 16 V, 3 A and the output sockets can connect to the device under investigation.

When you want to use one or two more sensors, which would usually be connected to the two analogue DIN sockets, an input extension unit has been made available to allow this. Figure 1 shows the effect of placing a mini-drill under/not under a load being examined.

Information is displayed on a computer and the following are available to view: voltage, current, power and total energy meters, graphs of each of these against time, and a table recording such data. All of these, or just a selection, can be displayed. Figure 2 shows the whole array, although the table would need enlarging to show all its data.

Datalogging intervals from 2 ms to 10 min can be selected. Readings can be recorded continuously or by selecting a number dependent on the computer's memory. Smoothing of the data plot is also available.

Versatile technology

For students this meter can be used with their computers, or connected via a computer to a digital projector for whole-class display. This is a great addition to an already excellent range.

On Software Disk 5, djb microtech has provided pre-programmed activities to measure the efficiency of a motor (figure 3) and determine the specific heat capacity of a liquid and a metal with the Joule and Watt Meter.

However, this same software provides the option to design activities with this device. This same disk has various other new activities: current in a bulb at switch-on, half-life thickness, SHM-force constant, an application for the ranger, force and motion, lift – force and motion,

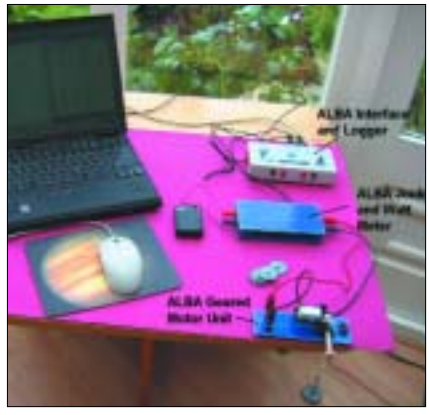


Figure 3. *Investigating the efficiency of a geared motor with the ALBA Joule and Watt Meter.*

WE RECOMMEND

Joule and Watt Meter

ALBA

Rating: ★★★★★ excellent

Price: ALBA Joule and Watt Meter A1-1075.00 £49.50; ALBA Input Extension Unit G1-1000.50 £13.50; ALBA Software Disk 5 single user £46, site-wide £101. All plus VAT, postage and packaging.

Supplier: djb microtech ltd., Delfie House, 1 Delfie Drive, Greenock, Scotland PA16 9EN. Tel: 01475 786540. E-mail: info@djb.co.uk. Web: www.djb.co.uk

weight component down a slope, and Wheatstone bridge – unbalanced.

Since my last reviews many enhancements have been made to the already excellent ALBA software. There are more than a hundred activities, and many new sensors and associated equipment have been produced. If you have not seen what is available recently then it is well worth taking a look at the website.

Chris A Butlin

BOOK: AMUSEMENT PARK PHYSICS

Making a day of it

Since the mid-eighties the interest in amusement-park physics has nearly exploded in the US. More widespread use followed the National Science Foundation grant to Carolyn Sumners at the University of Houston, who developed some activities and then spread the ideas around at various meetings.

From earlier modest events, where enthusiastic teachers brought their class to a nearby park, physics and science days have been arranged – such as at Six Flags Over Georgia, and at Paramount's Great America in California – and they are now offered in many parks around the US.

This handbook has its roots in a 1986 workshop organized by the American Association of Physics Teachers (AAPT). It has inspired hundreds of thousands of students and teachers to study physics in amusement-park locations.

It describes briefly the early developments and includes various reprints from the AAPT journal *The Physics Teacher*. It also includes a section about different types of accelerometers and a student workbook – this includes activities that are not only for at the amusement park, but for before the visit and on the bus.

Planning and testing

Many exercises are provided, including questions to prompt reasoning and understanding. The book starts out with a teachers' checklist, which is certainly helpful – taking a class to a science day requires considerable planning.

The reprint collection at the end of the handbook provides detailed mathematical analysis of several common rides [1,2], a description of how science-day activities may look for a class and how

the students took on various tasks (including Fermi questions) [3]. It also includes a presentation [4] on organizing a science day, including a competition, and a 1995 paper [5] describing the development of electronic accelerometer measurements in the rides. The reprints represent various traditions on whether to discuss centrifugal or centripetal forces.

The reprints illustrate the rapid development of electronic measurement techniques, but also reflect how rides have developed over the last few decades. However, since the book is essentially 11 years old, much of the technological development – in ride and measurement technology as well as data processing – remains unexplored.

The verdict

The AAPT *Amusement Park Physics* book certainly includes plenty of useful material, but is anything missing?

First, I think that in the current climate no resource on amusement-park physics can be considered complete without at least a limited collection of Web resources. However, the AAPT book is essentially a reprint of older material and the only Web address provided is to the source of the cover picture.

Much of the material in the book is actually available online. A short list of links that could be useful to a teacher wishing to use amusement-park examples in physics teaching is given below (see Further information). In addition, I would have liked to see more discussion of the potential for real-time teacher–student interaction close to the rides.

What is also missing is more consideration of safety issues. Having seen students (and sometimes teachers) trying to bring all sorts of unsuitable items onto rides, I think that this item cannot be stressed enough. (One of the pictures in the reprint collection might make a safety official somewhat concerned.)

Although a park may be prepared to relax some of its ordinary rules in connection with a science day, high elevations and speeds, strong forces and large energies are just as potentially dangerous as always – Newton's laws are non-negotiable.

References

[1] Escobar C 1990 *Phys. Teach.* **28** 446–54
[2] Roeder J L 1975 *Phys. Teach.* **13** 327–32
[3] Taylor G, Page J, Bentley M and Lossner D 1984 *Phys. Teach.* **22** 361–7
[4] McGehee J 1988 *Phys. Teach.* **26** 12–17
[5] Reno C and Speers R R 1995 *Phys. Teach.* **33** 382–4

Further information

- Clarence Bakken, Physics/Science/Math Days at Paramount's Great America: www.physicsday.org
- NASA, Amusement Park Physics Day Material: microgravity.grc.nasa.gov/physicsday
- Duane Marden, The Roller Coaster DataBase: www.rcdb.com
- David Burton, Ride Extravaganza: www.ride-extravaganza.com
- Coasters and More – updates and technical details of upcoming rides: www.coastersandmore.de
- Roller Coaster Giga Links: Physics and Technology: www.coastersaver.com/links/general/physics.html

Ann-Marie Pendrill

WORTH A LOOK

Amusement Park Physics

Carole Escobar (ed)

Rating: ★★ fair

Price: $34.

Details: Published 1994, AAPT, 112pp

ISBN: 0 917853 53 9

CDs: COPPER IN THE CURRICULUM

E-source provides the answers

A sample page from the AS/A2 disc.

These CDs are free from the Copper Development Association and cover aspects of Key Stages 3, 4 and 5. The CDs are cut-down versions of the school science website www.schoolscience.co.uk. CD 1 contains material for Key Stages 3 and 4, which covers motors and electromagnets. Aspects of biology and chemistry are also covered. CD2 is specific to AS/A2-level Physics and is split into five sections: using electricity, electric current, efficient motors, generating electricity, transformers and the grid.

Each section is text based with some interactive elements. Hot spots in the text allow limited interactivity with illustrations and tables. Diagrams are provided down the left-hand side of the page – these are often interactive, changing with hotspots in the main body of the text.

The content is comprehensive and is a great supplement to a traditional textbook. The information is graded, changing from GCSE standard and ending with true A2 standard. The content is suitable for all AS/A2 courses and is well set out.

At the end of each section is a summary that allows the student to test their understanding. The summary allows answers to be entered into text boxes, which are then checked by clicking on a link showing the correct answers. If you click on the answers without entering any data the disc prompts you to give some answers.

This 'e-source' is best used as revision material or for use as supplementary research. However, the disc could have included other items of multimedia – today's students expect a little more from their information and communications technology sessions than just text interspersed with diagrams.

An able and computer-literate student may rapidly become bored with the basic style of these CDs. I would like to have seen some video content and demonstrations of experiments, which would then make this CD a really useful revision resource.

These discs do offer further resources. I do not feel I would buy these if they were not free because the style is too basic, but as a free resource they are a useful addition to a resource bank. The content is available on the Internet, so having the discs is not essential, but for those times when the Internet is down – as it always is when you need to use it – having the content on CD is very useful. These discs will work easily over a network and so far have caused no problems, even when accessed by many machines.

John Kinchin

WORTH A LOOK

Copper in the Curriculum

Disc 1 KS3/GCSE Science
Disc 2 AS/A2 Physics

Rating: ★★★ good

Price: Free

Supplier: Copper Development Association (www.cda.org.uk) or CDA, 5 Grovelands Business Centre, Boundary Way, Hemel Hempstead, Herts HP2 7TE

BOOK: HURDLES AND STRATEGIES IN THE TEACHING OF ALGEBRA

Strategies for teaching algebra

A physics journal isn't really the right place to review a book like this. The problem is that the title may well tempt physics teachers to buy it.

My initial reaction on reading the title of this book was that I had stumbled on the main vein of mathematical education knowledge. But if you think this book will explain how to solve those tricky algebraic manipulations you encounter while teaching physics, then think again.

This book is a collation of maths teachers' tips. It has questions like 'How do people teach $-\times-=+$?' and then some comments from maths teachers on the methods they use. The answers are usually detailed and specific and I would not describe these as strategies. If your maths colleagues don't do things the same way as described in some answers you may be getting yourself in trouble.

There are some worksheets in the back that can be photocopied, but this is definitely a book for maths teachers rather than a physicist needing to bring pupils up to speed on their maths. At £9, though, it might make a nice Christmas present for the maths department.

Gary Williams

HANDLE WITH CARE

Hurdles and Strategies in the Teaching of Algebra

Tony Barnard

Rating: ★ poor

Price: £9

Details: Published 2005, The Mathematical Association

ISBN: 0 906588 54 5

EQUIPMENT: LAUNCHPAD

Educational ping-pong

This is a pack that contains enough components to make 25 'launchpads' that will fire a ping-pong ball quite a distance (7 m or more). The kit contains 50 motors, 50 ring fasteners, 50 wheels and tyres, 25 punched plates, battery boxes (but no AA cells), snaps and ping-pong balls.

I had 12 and 13-year-olds assembling these kits. Most had some difficulty in getting them working first time. After some tinkering at the end of the lesson I had 90% of them operational.

This pack offers various experiment possibilities – changing the angle of projection, mass of projectile and speed of the turning wheels if a potentiometer is added. At £40 for 20 working launchers this is good value for money as very few failed. The weak point in the design is the connecting tags on the motors.

While the students had fun shooting balls across the room, there was a lot of time wasted in a non-science sense. Using the assembled kits with other groups would reduce this, or the kits could be made up by a technician beforehand.

Sandra Hale

WORTH A LOOK

Launchpad

Middlesex University Teaching Resources

Rating: ★★★ good

Price: £40.28

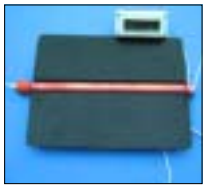
Supplier: Available from www.mutr.co.uk

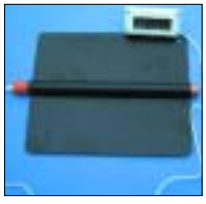
Reference code BIG 002

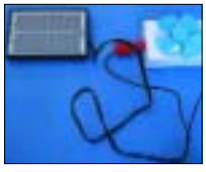
(Single set available as BIG 016 for £2.12)

EQUIPMENT: GREEN ENERGY

Powering up with sun and wind







Solar water-heating kit

This unit, which is neatly packaged, consists of a metal plate with a ridge designed to hold a short length of copper tubing into which water is added. A temperature probe is fitted into a bung and then inserted into one end of the tube, which is sealed at the other end. The temperature probe is connected to a digital display that shows the temperature of the water in the tube.

This simple design makes it very easy to set up and I had the unit operational in less than two minutes. The plate operates best in normal sunlight and within 15 minutes the water temperature had risen to 36 °C, even though this was a morning in late September with only a moderate amount of sun. On a hot sunny day the temperature will rise significantly higher than this.

In the laboratory good results were obtained with an infrared (IR) lamp. The unit is sturdy and is also customizable. By taking out the temperature probe I was able to fit a bung and temperature sensor to a datalogger, which allowed me to monitor the temperature over a day.

The supplied display unit has open connectors, allowing various connections to the outside world. This requires a limited amount of expertise with a soldering iron and may not be to everyone's taste.

The unit is supplied with sample worksheets that are very basic and suited to Key Stage 2 and 3 pupils, though using a datalogger and temperature sensor with a light and IR sensor means the unit can be used with A-level students.

The unit is available from the National Energy Foundation (www.nef.org.uk/powered/index.htm). At £45 it is a little expensive, but can be adapted to a number of levels. It is useful as part of an energy circus and is a good introduction to green energy for students.

Solar voltaic cell

This 3 V 80 mA solar cell comes with motor, light-emitting diode (LED) and buzzer module boxes. Measuring approximately 10 × 6 cm, the cell is easily connected to any of the three modules by 4 mm plugs.

The cell is not as responsive as I would have hoped. It certainly needs a sunny day or a reading lamp before it will power the motor and is very fussy about the light levels it needs before starting to operate. When it does burst into life then it can turn the motor very fast.

The LED and buzzer were less useful; the buzzer only indicated when the light levels were hard enough. Again the use of a datalogger, light and ammeter/voltmeter sensors were useful to indicate the power output with light intensity. Covering the photovoltaic cells with black card showed how the output varied with area.

Further investigations on the angle of the cell and wavelength could be made very easily. The cost of the unit is £45 plus VAT. At this price I feel it is a little expensive compared with buying cells direct from electronics catalogues. However, the unit is already wired up and works. It is ideal for Key Stages 1, 2 and 3, is well made and includes some basic worksheets. A little ingenuity allows it to be used with older students, extending its useful range and maybe justifying its cost.

Wind turbine kit

When this kit arrived the size of the box suggested something that could cause a buzz in the classroom. My initial impressions were of a flimsy toy that would not stand up to much wear and tear. However, this is not the case. While it is not designed for external use in all weathers, it certainly performed well on a windy day in the wide expanses of the Lincolnshire fens!

It comprises a central hub connected

to an interchangeable gearing system and then to an electric motor. The ration of the gears can be changed, allowing experiments into the optimum energy transfer.

The windmill can have up to six vanes, which are simply constructed of a plastic tube and clip into which paper sails are mounted. These can be adjusted to allow investigations into the number of vanes and the angle of the sails to be carried out. The windmill is connected to a motor, an LED and buzzer module boxes, or to a voltmeter. The tail is flimsy and care needs to be taken of this.

I found the motor etc were of little use and made the most of the voltmeter, which although cheap, was more than up to the task. The unit coped well on a gusty day and just managed to turn in a slight breeze. By varying the angle of the sails the efficiency of the wind turbine can be altered.

Using a better voltmeter and a windspeed meter (I used the one we have for checking the flow rate of our fume cupboards) it was easy to verify that the energy expelled was proportional to the cube of the velocity of the air and the area of the sails.

The whole unit is freely rotating on a pole that can be bench mounted. The instructions do indicate that this is ideal for use indoors, with a fan as the wind source. This works extremely well and would suit an AS/A2 investigation. Rain will damage it, so use outdoors should be carried out with care.

I was very impressed with the kit. The buzzer etc could have easily been omitted with little loss in quality. The cost is £99 plus VAT. While this may be a little expensive, especially if a number were to be purchased, the educational possibilities are wide and varied.

Of the three, I found this the most useful across the key stages. It certainly interested my neighbours who came to see the new addition to our garden. Do not expect to reduce your electricity bills with this unit, but do expect students to be enthusiastic at using it.

My only criticism would be the price. Remove the buzzer, voltmeter etc (most labs have these), and reduce the price to £80 and you have a winner. It is still good value at £99 and I will be using it with my year-10 class next week.

John Kinchin

WORTH A LOOK

Solar Water Heater Kit

Ecostyle

Rating: ★★★ good

Price: £45 plus VAT

Photovoltaic Kit

Ecostyle

Rating: ★★★ good

Price: £45 plus VAT

Wind Turbine Kit

Ecostyle

Rating: ★★★★ very good

Price: £99 plus VAT

Supplier for all products:

www.nef.org.uk/powered/index.htm

EQUIPMENT: WIRELESS DATALOGGER

Datalogging away from home

One of the benefits of modern dataloggers is that they can be used away from the host computer. The ability to obtain data remote from the laboratory makes them a powerful tool that schools cannot really afford to ignore.

There is a wide choice of loggers available, all with differing levels of usability and cost. This new datalogger from Sciencescope brings a new dimension to the fold, using Bluetooth as the means of downloading data from the unit to the host computer. Unless you are lucky enough to have a suite of computers in your lab or a computer suite close by, the hardest part has always been transferring the data to a computer for analysis.

The wireless way

The use of Bluetooth allows a wireless link between a number of loggers and one computer. The Bluetooth transmitter/receiver plugs into the USB port of the host computer and replaces the fixed link between the dataloggers and the computer.

It is possible to connect a number of loggers to one computer to download data and it is very easy to switch between dataloggers by selecting the relevant transmitting unit from a menu in the software. I have very quickly downloaded data from four operating loggers in succession with no interference or loss of data.

While remote, the datalogger will automatically read 500 points on four channels for a few weeks. The manufacturers claim that the unit will continue logging for up to 47 days, which is more than adequate for most applications. Unlike many of the other loggers in the Sciencescope stable this unit has no built-in sensors, but there is a fantastic range of sensors that you can connect, including many of the older ones sold by Philip Harris.

When connected to the host computer via the Bluetooth link the range of datalogging options increases dramatically. The unit is now effectively serving data for the host computer, allowing a data capture rate of 2000 or more readings at a minimum of 61 μs between readings. The manufacturers claim a maximum distance between host computer and datalogger of 3 m. I have found that there is still a reasonable connection up to 5 m, although this cannot be guaranteed.

The software allows a significant amount of control over the logging rate and the starting and stopping conditions. It is easy to use and can simply display the output of the sensors, making it ideal for use with an electronic whiteboard, or in traditional data-capture mode. The features for data analysis are wide ranging, allowing calculations on the data, gradients/areas under graphs, as well as statistical analysis and the ability to export to a spreadsheet.

The ability to demonstrate experiments without a fixed physical line between computer and logger is an immense improvement on previous loggers and is the way that data acquisition should be aiming. The lack of in-built sensors can be nuisance, but not one that is a major inconvenience. The unit will accept four external sensors – more than enough for most uses.

Each unit costs £250, which includes a power adapter and a single software licence for the Datadisc software suite.

John Kinchin

WE RECOMMEND

Wireless datalogger

Sciencescope

Rating: ★★★★ very good

Price: £250

Supplier: www.sciencescope.co.uk

WEB WATCH

A rollercoaster ride

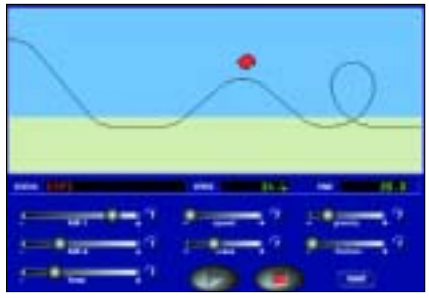


Figure 1. *Interactive funderstanding.*
Figure 2. *Build your own coaster.*

Theme parks have realized that they can extend their season by running specials for physics classes because they have a wealth of material to support thrill-seeking mechanics students.

Many of the parks have their own activity packs, designed to support visits to their park. I know this because we were supplied with worksheets when we booked our local theme park, and I have lots of anecdotal evidence from colleagues of 'useful but not fantastic' resources.

The UK's Thorpe Park has put its worksheets out on the web (www.thorpepark.co.uk/groups/schools/free_resources.asp). The main datalogging manufacturers have developed activities using some nifty bits of kit (if you can afford them). Vernier has a downloadable booklet at www2.vernier.com/booklets/data_park.pdf.

Do your research

Some great books on theme-park physics are available. There are two books entitled *Amusement Park Physics*. One is a compilation from the American Association of Physics Teachers (see p584), the other was written by Nathan Unterman.

If you have a big colour printer, NASA has some nice resources, which they developed for physics days at US theme parks. See exploration.grc.nasa.gov/physicsday.

The most frequently cited site, which explains the physics behind the rides, is www.learner.org/exhibits/parkphysics, but I have to confess that it all seems rather bland.

If you want to design a rollercoaster my favourite site is Funderstanding at www.funderstanding.com/k12/coaster (figure 1). I'm always thrilled when the car flies off the track going over the second hill, but I am a little mystified how it never falls off the loop. Discovery Channel (figure 2) also has a design circuit at dsc.discovery.com/convergence/coasters/interactive/interactive.html. This has nice graphics but there is less physics to think about in the design.

If you want to consider some of the more complicated rides, you might like to look at The Scrambler – animated in slow motion at homepage.mac.com/teast/scrambler.html. Or if you prefer something more simple, Walter Fendt has a carousel animated at www.walter-fendt.de/ph14e/carousel.htm.

Videos of rides can be downloaded from numerous sites (such as www.themeparkreview.com/videos/video.htm), although the best physics videos that I have seen are only available as part of Pasco's Videopoint package. Sadly the seriously fun stuff is not free; if you really want to design a coaster ride then you have to buy the games.

Kerry Parker