WEB WATCH

Exercising your mind: discover the physics of sport on the Web

Figure 1. *The Exploratorium baseball website contains the details of practical activities that students can try at home.*

Figure 2. *This cricket website models a diffraction grating on a line of fielders.*

At present I am resting between triathlons. Unfortunately this rest period is entering its second year. I should have used the time to write a physics-of-triathlon website because I haven't been able to find one – which is a surprise given the number of physicists that I've met that do triathlons. Anyway, this is what my web-search unearthed on the physics of sport.

San Francisco's Exploratorium has a good website on the science of several sports, including ice hockey (www.exploratorium.edu/sports/index.html). It covers friction, materials and pressure. It's a good place for pupils to start if they're doing some research.

Baseball

The Exploratorium site also has good pages on baseball (www.exploratorium.edu/baseball/), which includes a reaction-time online activity and another exercise that lets you change the bat speed, the angle at which the ball is hit and the type of pitch thrown. It also shows you the trajectory of, and distance travelled by, the ball after it has been hit (figure 1). The site contains the details of practical activities that students can try out, such as testing the bounce of a ball.

www.physics.usyd.edu.au/~cross/baseball.html is short and sweet. It has a good explanation and graphic describing the 'sweet spot' on a baseball bat. For more information on the vibration and acoustics of baseball and softball bats, and links to related sites, take a look at www.kettering.edu/~drussell/bats.html. This website is more suited to the 16+ age group.

Golf

Walking around a field hitting a ball with a stick doesn't appeal to everyone, but if you just can't get enough of it then kingfish.coastal.edu/physics/projects/2000_Spring/golf/ is the website for you.

On the site there are pictures showing how the golf ball has developed from having a smooth surface to a dimpled one, there's a movie of an ideal golf swing, and there are facts such as, the speed of the ball leaving a tee is 140 mph.

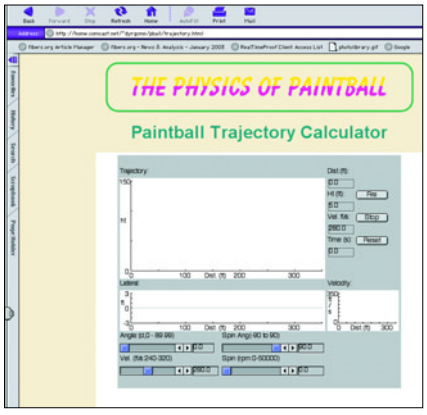


Figure 3. *On this paintball site you can model the effect that spin has on a ball.*

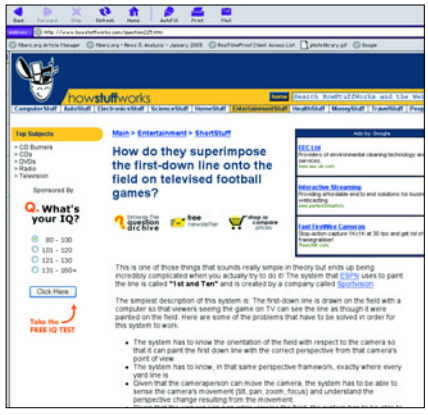


Figure 4. *There is lots of good physics and technology on* How Stuff Works.

Sports Illustrated has a physics of golf website at sportsillustrated.cnn.com/augusta/cool_stuff/physics/index.html with a simple idea for showing whether you've hit a ball straight, among other things. The physics covered is fairly low level but the information on the site would allow you to extend the ideas to the 16+ age group. There's an interesting parabolic golf applet at www.nationalsciencecenter.org/FortDiscovery/RiverFrontPlazaBalcony/demos/parabola/ParabolicGolfApplet.htm. It doesn't tell you much about golf but has a good way of showing the properties of parabolas.

Rugby

Rugby is almost a religion in Wales and New Zealand but I could find only a few websites. At www.npl.co.uk/time/msf.html I liked the idea of making your own clock to synchronize with the NPL's. The plans for the clock are available from links on the site. There's a rugby-kicker applet at www.citizenphil.co.uk/rugby/index.html where you pull a force vector back from the ball and take wind speed and direction into account before kicking.

There's a similar game at news.bbc.co.uk/sport1/hi/rugby_union/rugby_world_cup/kicking_kings/default.stm but the vector idea isn't so obvious. Both of these games are fun to play, especially with the encouraging sound effects turned up.

Cricket

Bouncing balls and wickets need careful scrutiny, and kinetic theory comes in handy according to www.scienceinafrica.co.za/2002/december/bounce.htm. The physics is of a low level and should be understood by most pupils in the 14–16 age group. Modelling a diffraction grating as a line of fielders (see figure 2) is a great idea and is dealt with at www.phys.unsw.edu.au/~jw/cricket.html.

There's a fairly comprehensive download on the maths and physics of swing bowling available at www.tickey.co.za/cricket/Maths%20and%20physics%20of%20cricket.pdf. It contains some interesting points about airflow and ball speed.

Paintball

If you are interested in investigating the effect of spin on trajectory then home.comcast.net/~dyrgcmn/pball/trajectory.html – a paintball site – has a great applet. You can change the angle, spin and velocity of the ball, get views of the trajectory, see the distance the ball travels and determine the time of flight (figure 3).

For a novel way to introduce the gas laws look at *CO2 Dynamics* at www.warpig.com/paintball/technical/gasses/co2dynamics.shtml. There's some quite

Figure 5. *This site allows you to evaluate bike performance.*

complicated material on the site as well as some basic ideas, and you can find links to lots more paintball pages with pictures of equipment. Unfortunately the units used are not SI, but I'm sure that someone of your intellect can work out the conversions in a flash.

Soccer

I liked the ideas described on the site at www.albertson.edu/physics/PHY271_F01/Projects-2002/whit,%20caleb,%20bill%20project/whit,%20caleb,%20bill%20project.htm and there is a good suggestion for a coursework experiment. The site has graphs and movies (although the files are about 3 Mbyte) that might be useful for someone repeating the experiment.

PhysicsWeb has an interesting article about soccer at physicsweb.org/article/world/11/6/8#world-11-6-8-1. While www.geocities.com/SiliconValley/Horizon/8596/ssoccer.html has a downloadable game called Starship Soccer that involves flying around in spaceships hitting balls. But are the laws of physics obeyed?

At www.oceansiderevolution.com/EINSTEIN.HTM there are some easy-to-read presentations of ideas to do with physics and soccer. The coverage is basic but it has plenty of scope. As the final whistle beckons, why not read a little about Niels Bohr and his soccer career at www.denmarkemb.org/bohr.html.

Football

This seems a great idea: 'Every Husker home game, Tim Gay attempts something as crazy as running against the NU defence: bringing physics to everyday life. In one-minute segments shown on the screens around the stadium, he talks about basic physics concepts that play an important role in the game of football.' You can download some of the clips (they are quite large files) from physics.unl.edu/outreach/football.html.

The answer to the question, 'How do they superimpose the first-down line onto the field on televised football games?' can be found at www.howstuffworks.com/question225.htm. However, the answer given is so complicated that you wonder why they bothered. There's lots of good physics and technology here to discuss with classes though (figure 4).

Cycling

To be honest I don't know where to start with this site: www.analyticcycling.com/. It has everything about analysing cycling, and more. You can input data on just about everything: crank length, wind speed and what looks to be at least 100 (no really) other parameters and you get an output on how performance is affected. This site (figure 5) is a must for anyone doing projects about cycling.

There's an interesting paper about the effectiveness of bicycle helmets at www.helmets.org/henderso.htm, and a page about aero wheels at www.canecreek.com/site/product/wheels/info/proof.html, which has a lot of physics on it.

A mine of information about aerodynamics and bicycles can be found at www.princeton.edu/~asmits/Bicycle_web/bicycle_aero.html (figure 6). This site has great graphics and covers pressure, Bernoulli's equation, turbulence and motion through fluids.

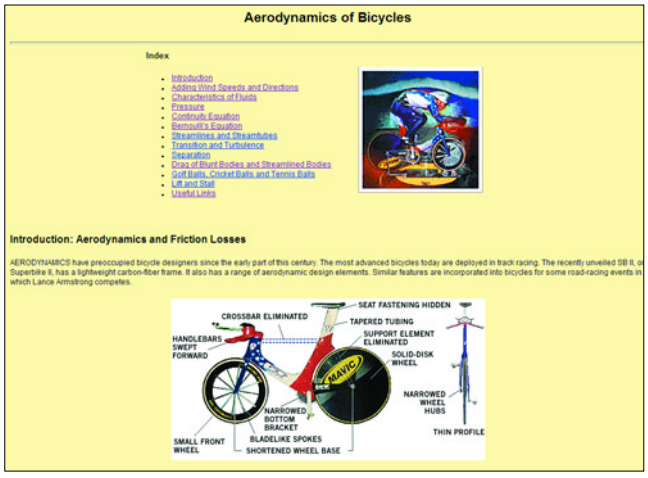


Figure 6. *Aerodynamics has an important role in bike design.*

At links.math.rpi.edu/devmodules/bicycle/index.html you'll find more interactive content concerned with forces and vectors as well as some experimental results from testing bike frames. The applets here are a little more animated, rather than giving just a numerical answer.

Surfing

A thesis by Michael Paine on the hydrodynamics of surf boards at www1.tpgi.com.au/users/mpaine/thesis.html is a good read. There's a physics of surfing page at www.blackmagic.com/ses/surf/papers/physicsgrm.html that describes experiments done on a board at sea and also in a wave tank. A description of how to make a model wave tank is at www.blackmagic.com/ses/surf/papers/mywaveproject.html. The tank can be used to investigate how the shape of the sea floor affects the way that waves break.

Tennis

'Anyone for tennis?' at www.physicscentral.com/news/news-01-10.html is a short article that explains the physics behind different court surfaces. There's more detail on this at users.wpi.edu/~tanguyen/tennis.html, as well as information about the sweet spot of a tennis racket and the power and coefficient of restitution. Kristina Pao has a page called *Technological Advances in Sports* (www.engin.swarthmore.edu/~kpao/first.html#tennis) that covers, among other things, how materials affect sport. She gives a number of examples, one of which is the tennis racket.

Weights

The Physics of Weight Training at www.bodybuilding.com/fun/becker2.htm has a manly feel to it and covers gravity, power, friction and mechanical advantage. The only problem with the site is that some of the units are a bit outdated.

The Physics of Strength is a similar site, but after the first page it starts getting into some big strong equations (see ffden-2.phys.uaf.edu/211_fall2002.web.dir/Peter_Broady/Pages/Homepage.htm).

The Physics Classroom at www.physicsclassroom.com/Class/energy/U5L1e.html has a summary of much of the mechanics that 14–16-year-olds are expected to know in the context of sport. There are also questions at the end and drop-down answers. Feel stronger by moving to another planet, *Your Weight on Other Worlds* is found at www.exploratorium.edu/ronh/weight/.

Kayaking

You can find very technical information about drag and kayak design at www.oneoceankayaks.com/kayakpro/kayakgrid.htm. While at www.seakayak.ws/kayak/kayak.nsf/NavigationList/NT0001DD22 there is an description of how to roll over and back again, and the role that your centre of gravity plays in this. This is a big site – 167 pages.

As well as having a movie of someone actually doing a roll in a kayak, home.messiah.edu/~barrett/mpg/mpg.html has lots of other physics movies, including some clear-ripple-tank mpegs.

Lastly on the kayaking theme, this native American has to get to the other side of the lake using his bow and arrow:

Figure 7. *Discover how to get a cannon ball into orbit.*

library.thinkquest.org/3042/java/linear_demo.html. You can change the mass of the man, the mass of the arrow and the speed at which the arrow travels and see how it affects his motion. Click on the 'visit site' button to get to the applet.

Skydiving

Is it really skydiving when you fall from above the sky? Have a look at www.canadianarrow.com/spacediving.htm to see what I mean. Being able to fall from space would be a good discussion topic with a class, and there are plenty of links to other high-altitude fall sites.

You can simulate a two-parachute drop and change the masses attached to the parachutes if you go to departments.weber.edu/physics/amiri/director/dcrfiles/airResistance/ChuteTwoS.dcr. At physics.k12albemarle.org/teacher/projectile/terminal/home.html there's a movie showing how forces change as you fall and an explanation of terminal velocity.

Basketball

Slam Dunk Science has lots of good ideas for basketball-based research (www.scire.com/sds/sdsmenu.html). Some of the activities require more complicated apparatus, but there's plenty of detail to help you set them up. There's also a list of web links. *Fear of Physics* lets you calculate how to make a jump shot every time (www.fearofphysics.com/Proj/proj.html). You can also view a jump shot as if you were sitting on the ball.

www.geocities.com/thesciencefiles/physicsof/basketball.html can fill you in on the physics behind a lay-up (especially if you have no idea what one is – like me).

Pole vaulting

The applet at www.aip.org/png/html/polevault.html lets you work out how high you could jump. While the sites at www.physics.carleton.ca/~watson/1000_level/ph14e/ph14e/mfbar2.htm and www.uvi.edu/Physics/SCI3xxWeb/Electrical/magnetism.html cover poles of a different kind. (OK, I'm stretching the pole idea a lot, but they are useful sites).

Mountains

Steve Giddings has an interesting leisure time (see www.physicscentral.com/people/people-02-9.html). While at *Motion Mountain* (motionmountain.dse.nl/welcome.html) you can download a free textbook. However, you may not want to point immature students in the direction of some of the chapters, for example 'Are particles like condoms?'.

The interactive movie at physics.k12albemarle.org/teacher/Planet/home.html lets you put a cannon on top of a mountain and change the speed of the shells that it fires. Whoever thought of this must be a genius (figure 7).

Snowboarding

This snowboard-design site (ffden-2.phys.uaf.edu/211_fall2002.web.dir/Marvin%20Casanova/design.htm) starts off using some very simple physics and then moves on to more complicated stuff.

At www.bomberonline.com/articles/physics.cfm you'll find the physics of a carved turn explained (although the text does seem to repeat itself). Finally, for a little light relief go to www.miniclip.com/

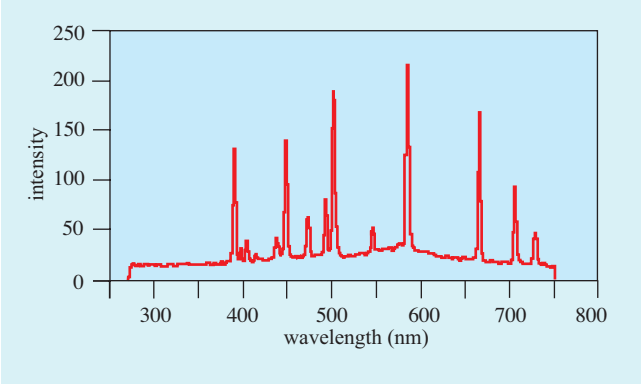
snowboardingxs.htm. There is no physics mentioned here but it might help you to work out what a carved turn is.

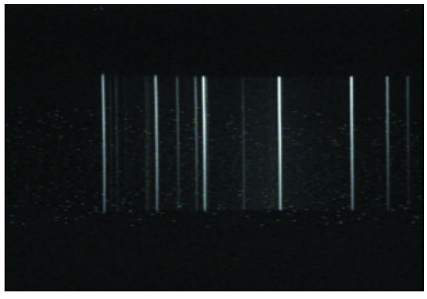
As you can see, the science behind sport makes a great topic for students to research. There's a huge amount of material out there and it covers just about every sport, even naked skydiving – modena.intergate.ca/business/kas/skydive/faq.htm. However, searches for 'physics and naked skydiving' didn't return any results, which somehow seemed comforting.

Gary Williams

EQUIPMENT

Spectrometer suits classroom use





Output from the spectrometer (left) and the corresponding spectrum from a helium lamp. Only a few seconds' work.

The TV Spectrometer is housed in an aluminium cylinder measuring 15 cm in length and 3 cm in diameter. Mounted on a small tripod it is easy to point it at any light source – room lights, a TV, a projector, spectral lamps or the sky. No further alignment is necessary.

A live spectrum is displayed on the PC, and it can be captured with a single mouse click. The spectrum can be saved and with just a few keystrokes, analysed to show a full intensity versus wavelength plot from 300 to 800 nm.

The software includes some simple analysis tools that can find the centroids of the peaks and display their wavelengths. It also allows a calibration curve to be built – for example, from a helium lamp.

The apparatus is simple to use and can do a number of jobs: running emission and absorption spectra; colour mixing; using Fraunhofer lines and infrared in a lamp; and testing the transmission of colour slides for the Planck's law apparatus.

The kit comes with all the necessary leads and software and is straightforward to set up. My colleagues in chemistry and biology also have a host of uses for it.

This is an excellent device that can be used as a demonstration tool for all ages. It is easy to use and has applications in all of the sciences. It could be even better if it had a colour output.

Ken Zetie

TV Spectrometer

Rating: ★★★★ very good

Price: £395 + VAT for the spectrometer, frame-grabber hardware and software including calibration. £15 for a tripod mount, £15 for optical bench mount and £10 post and packaging

Details: Available from Elliott Instruments 57 Church Rd, Northfield, Birmingham, B31 2LB. Tel: 0121 475 2868. Web: www.elliott-instruments.co.uk

EQUIPMENT

Igniting interest in the gas laws

This is an excellent device to use when you want to illustrate how diesel engines work and when talking about pressure–volume changes in a gas.

To show the effect of pressure change, a piece of cotton wool is placed at the bottom of the thick-walled Perspex cylinder. The piston is slammed downwards and the cotton wool bursts into flames.

Work is done in compressing the gas, its internal energy rises and there is a sudden temperature rise. This temperature change is clearly demonstrated and will fascinate students of all ages. I can thoroughly recommend this device.

Bernard Taylor

Compression ignition apparatus

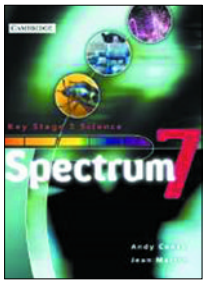
Rating: ★★★★★ excellent

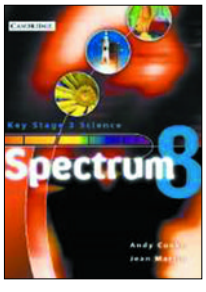
Price: £19.58

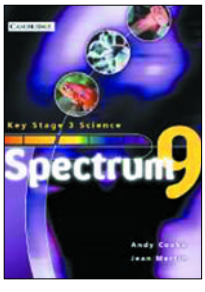
Details: Available from Philip Harris Education. Code: G95324

RESOURCE REVIEW

Spectrum delivers customizable science course for Key Stage 3







Based on the English Qualifications and Curriculum Authority (QCA) schemes of work for 11–14-year-olds, the *Spectrum* course consists of three pupils' texts, three CDs per year group and a ring-bound folder of technician's notes. Each trio of CDs (only year 7 was available for this review) consists of a teacher's CD, an activities CD (for checking progress and reviewing work) and a Testmaker CD to create paper-based or online tests.

The pupil books are split into the traditional themes of biology, chemistry and physics. They are set out in line with the QCA schemes of work, starting in year 7 (ages 11–12) and working through to year 9 (ages 13–14) work.

Each chapter starts with a list that relates to the QCA scheme of work and a list of key words, and is broken down into sections, which are accompanied by relevant diagrams and questions aimed at testing and research. At the end of each chapter there is a summary laid out as a spider diagram. Each book is in full colour with a glossary/index at the back.

The teacher's CD contains copies of the worksheets in PDF format and an editable format. This latter form I found most unhelpful as only a limited amount of editing could take place.

The Reviewing and Checking Progress CD has activities for each unit covered in the book. These multimedia exercises are well thought out and make pupils think about what they are doing. A printout of the work that a pupil covers can be obtained at the end of each exercise.

The Testmaker CD allows customized tests to be produced. These can be in SATs-exam or multiple-choice formats. and the tests can be printed out or com-

pleted online. This CD has a limited number of questions, but tests are fully customizable, allowing a school logo and class name to be added and relevant questions to be produced in a form to suit the type of assessment. The CD can be used to check knowledge from KS2 as a pretest or as an end-of-unit test.

The course has been designed to allow schools to integrate it into their own courses. For those schools that do not like a bought package, this is one of the most customizable ones available. It can support an existing course that the school has developed and, alongside the QCA materials, provides a powerful resource bank. However, I would have preferred the documents to be available in Word format.

The use of three books classed as biology, chemistry and physics may not please some, but it does allow flexibility to teach either with specialist teachers or with one teacher. It gives the option to teach a topic when it is suitable for the school, not the course editor.

As a head of science I would seriously consider this course to supplement our in-house course. It copes with all levels of ability and has sufficient material to allow pupils to be assessed at the start of each unit and at the end. It also allows a great degree of flexibility to pick modules and use them in whichever year is most appropriate. For the school that has already purchased a course or is still using one that is several years old, the books alone are an excellent support for non-specialist teachers or for new entrants to the profession. With a copy of the CD, any new science teacher will have sufficient material to prepare a range of lessons.

John Kinchin

Spectrum Science

Andy Cooke and *Jean Martin*

Rating: ★★★★ very good

Details: Full details of the *Spectrum* science course material are available at uk.cambridge.org/education/secondary/spectrum/

Book Review

Revealing the buried past

There is an increasing interest in the use of geophysics techniques in archaeology (see *Phys. Educ.* March 2004). So it is no surprise that the authors of this book are the geophysics consultants for the popular Channel 4 TV programme *Time Team*.

In *Revealing the Buried Past* the authors explain the science behind the main geophysics techniques; discuss the limitations of the instruments and the problems that arise in the field; describe surveying techniques; and give a brief overview of image processing. A number of very interesting case studies are accompanied by excellent images of instruments and survey results.

While a physicist might want more detail about some of the instruments, this is an accessible and comprehensive introduction to archaeological geophysics. This is a useful book for teachers and sixth-formers, and a place should be made for it in the school library.

Bernard Taylor

Revealing the Buried Past: Geophysics for Archaeologists

John Gator and *Chris Gaffney*

Rating: ★★★★ very good

Price: £17.99 (pbk)

Details: Published 2003, Tempus Publishing, 192pp

ISBN: 0 7524 2556 0

RESOURCE REVIEW

A framework for success

The *Catalyst* science course comprises three pairs of books classified by ability. The green books are aimed at lower-ability pupils and the red books at those with greater ability. The entire course consists of three books for students and an associated teacher's resource pack and file (one for each year group). An Interactive Assessment for Learning pack and an Interactive Presentations pack are also available as part of the science course.

The books are all full colour and follow the QCA schemes of work. Each topic is colour coded and split into subtopics covering different aspects of the curriculum. The course also follows the suggested QCA order of teaching and learning. Each chapter has a summary, questions and a formal question session at the end. There are no answers supplied in the pupils' books.

Where appropriate there is supplementary information on famous scientists and applications of the science covered. The books are well laid out and easy to follow. There is a comprehensive glossary and a detailed index at the end of each book. The difference between the red and green levels is not substantial. In reading any particular topic, the basic information provided is the same. The difference is in the presentation and the difficulty of the questions asked in the text. The two books can be used together in a mixed-ability class as both texts have the same chapters on the same page. As with all modern textbooks the covers are relatively thin and might require additional protection.

The sample Teacher Resource CD-ROM that was provided contained just a small taste of the material that is available on the course. Unfortunately this was not sufficient to provide a true review of the resources. The final pack consists of worksheets, skill sheets and – most useful – lesson plans. The samples of the latter are comprehensive and allow for differentiation within the same class, much in line with the idea of using two textbooks in the same class. Sadly the interactive presentations and interactive tests were not available in sufficient detail on the sample CD to make a fair assessment of their suitability.

The books are comprehensive and provide an ideal course for most secondary schools. The brightest pupils may find the going a little slow. Without the complete package it is not possible to deter-

mine what extension material is available to stretch the most able students.

Presenting the course in three books enables the course to be broken up into three years, with all the lessons/resources planned. For those schools that are accelerating KS3 into two years, this is not the best material available.

By working with the QCA scheme the books fit well into any homemade course and are a valuable resource, although £10.25 is a little expensive for each book. The use of two books per year group is a good idea; whether this increases the pressure on already stretched science budgets is a matter for debate. As the academic profile of a year group changes with new the intake into year 7, it will mean careful use of tracking/KS2 data to ensure that the right number of appropriate books are purchased to avoid expensive mistakes.

John Kinchin

Catalyst: A framework for success

Carol Chapman and *Moira Sheehan*

Rating: ★★★★ very good

Details: Published 2003, Heinemann

Catalyst 1 Green Student Book. ISBN: 0435760114. **Price:** £10.25

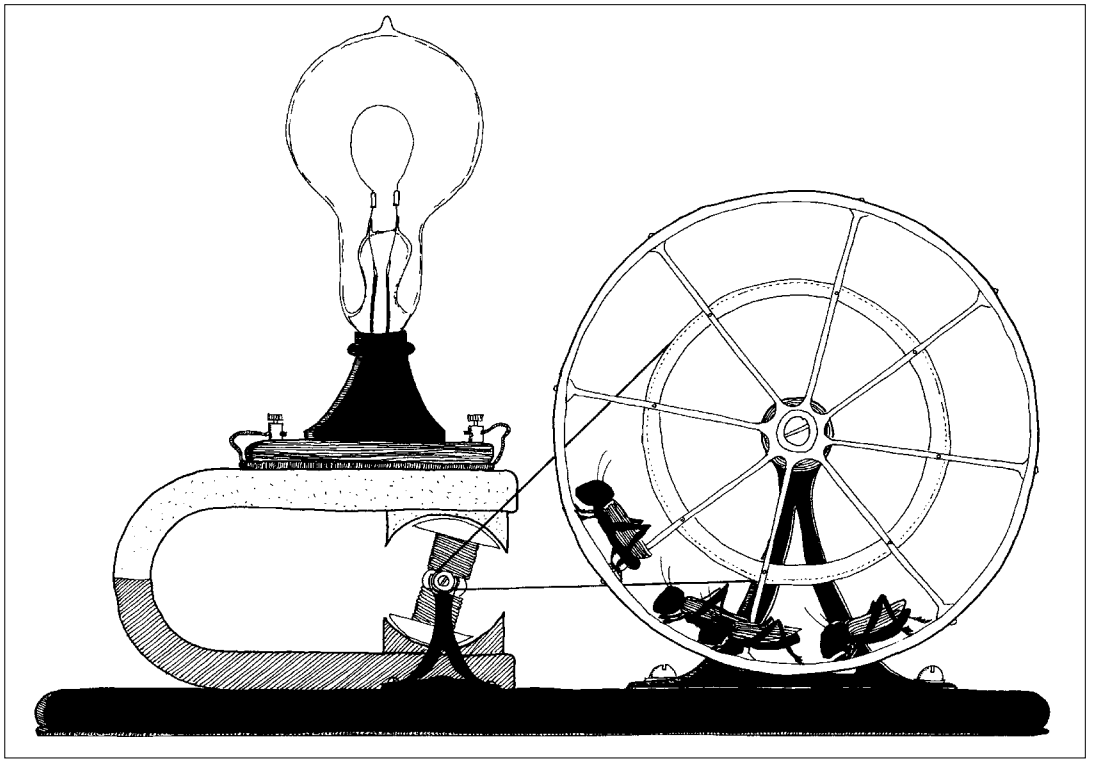
Catalyst 1 Red Student Book. ISBN: 0435760106. **Price:** £10.25

Catalyst 1 Teacher's Resource File and CD-ROM. ISBN: 0435760130. **Price:** £210.00

Catalyst Interactive Assessment for Learning 1: Core. ISBN: 0435760602. **Price:** £260.00

Catalyst Interactive Presentations 1. ISBN: 043576120X. **Price:** £260.00

Similar resources for years 8 and 9 are also available. For a list of all the resources available, please visit the Heinemann website at www.heinemann.co.uk



'We're just on light duty.' (Geoff Haggart). © Gorazd Planinšič.