

Classroomphysics

The newsletter for affiliated schools

March 2012 Issue 20

Stimulating Physics builds on success



Institute of Physics

Above and inset: teachers enjoy participating in workshops to explore new classroom activities run by the Stimulating Physics Network.

Thanks to the hard work of all involved in the project, it has been announced that the Stimulating Physics Network (SPN) will continue to support teachers of physics and their students until March 2014, with ongoing funding from the Department for Education. The further development of the SPN reflects the success that the programme has had in its work to improve the quality of pupils' physics experience in schools and to reinvigorate a culture of physics in science departments.

An interim report recently submitted by the SPN's external evaluators indicates that, in a sample of 52 Partner Schools, the uptake of AS-level physics has increased by 43% from 2009 to 2011. In Partner Schools that joined the project before 2011, the uptake of AS-level physics by girls increased by 119% between 2009 and 2011. The full report on Phase 2 of the project (2011–2012) is due at the end of March.

There are two main strands to SPN: "Global Support" offers workshops, an online support community and teaching resources available free to all teachers of physics. Feedback from recent workshop participants reflects the practical emphasis.



"Great ideas for delivering engaging physics."
"Wish I'd seen some of the demonstrations when I was a school student!"
"Provided scientific models, which I would never have considered and I will definitely use in the classroom."

The network has facilitated a total of 7671 teacher-hours of CPD since the end of October 2011, with 95.8% of participants reporting an increase in confidence after a support session.

In its second area of activity, SPN works with selected Partner Schools to build a close relationship with a whole science department through the dedicated support of a Teaching and Learning Coach (TLC). Over two years, the TLC creates tailored CPD sessions to increase the confidence and subject knowledge of non-specialist physics teachers within the department, as well as offering new approaches and ideas to established teachers of physics. Evaluation of the impact within SPN Partner Schools has shown that 94.8% of teachers thought that the CPD workshops had a positive effect on their teaching. The support of a TLC is free but is only available to selected schools; however, a new recruitment phase of SPN Partner Schools is underway and so schools that think they would benefit from working with a dedicated physics specialist should get in touch with the external liaison officer at one of the regional Science Learning Centres.

For more information: including further details about free events, explore the SPN's regional pages available at www.stimulatingphysics.org.

Editorial



Welcome to the 20th issue of *Classroom Physics* – the newsletter has been running in this form for five years! You will also have received a copy of our education brochure for 2012, *The Classroom and Beyond*, which details all the resources and support that the education department offers. Affiliated schools and colleges also have leaflets about Physics Update courses and the Rugby teachers' meeting.

Our lead story is an update on the Stimulating Physics Network and the extension to its funding. There is also a short report on the IOP at the ASE Annual Conference (p2) and the school experience programme for potential teachers (p2). We also have news of our revised teaching medical-physics resources and the film of last year's lecture (p3). The resource DVD should be in affiliated schools by end of spring.

Other IOP news includes an extension to our school grant scheme, with the IET joining our partnership with the STFC. This means that there is more money to apply for (p5). Our updated resource for post-16 students and a reminder about 16–19 membership are featured on p2.

The IOP Teachers Awards are once again open for nominations. We have received very few nominations in recent years but hope that, if you know a great teacher, you will spare the time to nominate them for one of our awards (p3). Nominations deadline is 31 May.

Other resources and news featured include the NPL's Open House (p5) and the Science Museum's Futurecade (p4). The Irish Science on Stage team has produced some videos (p4) and the ASE has new editions of its Science Practice guide: *Teaching Secondary Physics* (p5).

F1 in Schools successful programme has largely been promoted via DT departments but teachers of physics may also be interested in it too (p4).

Our teaching tips include more ideas for modelling steady states (p7) from the SEP resources and measuring the speed of sound outside, adapted from *practicalphysics.org* (p8).

If you would like further copies of our resources, new or old, as described in our brochure, contact us via education@iop.org. Comments and feedback are always appreciated.

Clare Thomson, editor (tel 020 7470 4981, e-mail clare.thomson@iop.org).

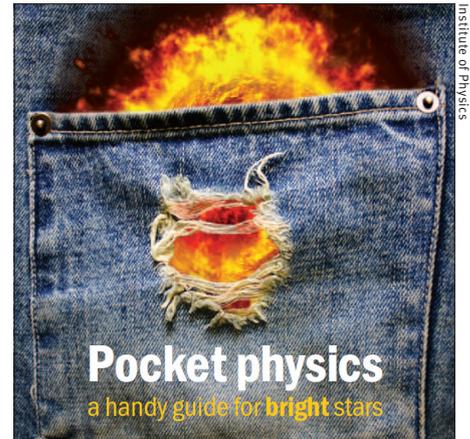
A handy guide for bright stars

The Best Pocket Physics Handbook has been a popular resource for post-16 students for a number of years. This has now been renamed and updated. After much discussion, we hope that the information included is detailed enough to be useful, but not overwhelming, for post-16 students of physics.

We are also using *Pocket Physics* as the vehicle for advertising the Institute's 16–19 membership scheme. This is completely free and allows those aged 16–19 and studying physics to become part of the physics community. The scheme has been running for two years and there are currently more than 4500 members. Registration via the IOP website is easy and, along with a copy of *Pocket Physics*, members receive:

- full access to *Physics World* online and physicsworld.com;
- exam and university guidance;
- the chance to interact with other young physicists.

Pocket Physics also promotes myphysicscourse.org, our comprehensive guide to undergraduate physics courses in the UK and Ireland. This searchable web resource will ultimately replace the print



publication *Physics on Course*.

Please do bring these important resources to the attention of your students and encourage them to sign up as 16–19 members.

For more information: to register for 16–19 membership, visit www.iop.org/16-19. To download a PDF of *Pocket Physics*, visit www.iop.org/publications and click on “2012”. To support students in finding the right physics degree, direct them to www.myphysicscourse.org.

Institute makes a stand at the ASE Conference

Once again, the Institute had a high profile at the Association for Science Education (ASE) Annual Conference. The stand in the exhibition marquee was kept very busy with people coming to collect our free resources.

The John Lewis Lecture was given by Dr Lucie Green of the Mullard Space Science Laboratory on “The highs and lows of solar activity and why we should care”. The talk provided an excellent insight into the physics of the Sun. At the reception we celebrated 10 years of the Physics Teacher Network, as well as the launch of the new Supporting Physics Teaching 14–16 materials.

The Stimulating Physics Network and the IOP education department ran 30 workshops over the three days, on a whole range of topics – from “Outdoor



The Institute stand at this year's ASE Conference.

physics” to “Building your own modulated laser pen”.

Next year the conference will be at the University of Reading on 3–5 January 2013.

For more information: visit www.ase.org.uk/conferences to find out more about all that is on offer at the ASE Conference.

Calling more schools!

Thank you to schools who have already volunteered to be a part of our School Experience Programme. We have had a great response and will be actively promoting this programme to university students and graduates who are considering a career in physics teaching.

The majority of training providers require an applicant to have at least three days of school-based observational experience

before submitting their application. At present, there is little help for individuals wishing to gain this experience prior to applying for teacher training.

Are you willing to help the physics teachers of the future take their first steps? We are still looking for schools to be a part of this programme, so if your department is able to assist, e-mail teach@iop.org with your school's name and postcode, a contact name and the time of year that you would be willing to host a prospective teacher.

Medical physics: the science of seeing inside the human body

The film of last year's Schools and Colleges Lecture is now available to view and download from the IOP website. Filmed at the Royal Institution and delivered by Michael Wilson, medical physicist at Birmingham University Hospital NHS Trust, the lecture explores how physicists build machines that help us to see inside the human body. This inspirational lecture explores how, over the last hundred years, physicists have developed increasingly sophisticated scanning techniques to diagnose and treat illnesses.

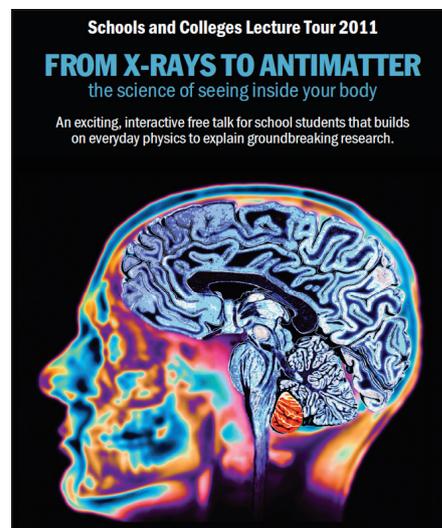
The lecture will shortly be available on DVD, along with a fully revised package of resources for the teaching of medical physics aimed at GCSE or standard grade. Drawing on a variety of sources – not least the school lecture itself – these teaching resources include 3D animations, interactive games, details of practical work, videos and suggested lesson plans that cover nine topics in medical physics: ultrasound;

electrocardiograms (ECGs); positron emission tomography (PET); magnetic resonance imaging (MRI); pulse oximetry; radiotherapy; X-rays; CT scans and the gamma camera. Medical physics provides a useful context for your physics teaching with imaging techniques spanning the full electromagnetic spectrum, from radio waves in MRI to gamma rays in PET.

Alternative teaching contexts for MRI and PET include electromagnets and the wide-ranging uses of radioactivity, while pulse oximetry and ECGs can be included in lessons on either electricity or the human circulatory system.

Careers in medical physics have broad appeal – both men and women are equally represented. To illustrate the benefits of continuing with physics post-16, the DVD will also include some medical-physics career information and profiles.

Affiliated schools will receive a copy of the DVD in a separate mailing in March.



For more information: the lecture can be found at www.iop.org/schoolslecture. Teaching materials will be available from www.teachingmedicalphysics.org.uk.

Nominate now for the 2012 Teacher Awards

Teachers contribute an immense amount to society and sometimes do not achieve the recognition they deserve. One of the ways that the Institute sets out to redress this is through the Teacher Awards scheme. Every year a group of outstanding individuals, from both primary-school science and secondary-school physics, are honoured alongside distinguished research scientists and industrialists at our annual awards dinner. In this way, we recognise that without dedicated teachers, our society would not have a physics-research community or a technological base.

Last year, more than 50% of those nominated went on to receive an award and there is no fixed number of awards given each year. If you nominate a teacher, we ask you to provide evidence of their achievements and contribution to the life of their school or college, both in and outside the classroom. We also expect that these teachers will have been involved with the wider teaching community in some way, such as providing professional development for local colleagues. Pupils' own opinions and support can provide important evidence for the nomination. The nomination process closes at the end of May.

It is easy to nominate a teacher; just download the forms from the Institute's website and return a completed version.



Dr Mark Whalley (left) receives his award from the IOP president, Prof. Sir Peter Knight.

For more information: visit www.iop.org/teachersawards.

F1 in Schools: physics drives into action

Finding projects that explore the applications of physics and that students find truly engaging is an ongoing task for schools up and down the country. F1 in Schools aims to address both of these issues and can be used in the physics classroom or as a science club competition.

Students model the same processes as a real Formula One team; from designing and building a car to managing a business and working collaboratively. Students must use their physics understanding to carry out the challenge and they are actively encouraged to “push the envelope” in the application of their physics knowledge to the design and development of their car. They must then be prepared to explain their decisions to professional engineers and judges.

F1 in Schools has produced a full set of resources to enable teachers to implement the project within their teaching, either as individual lessons or as part of a whole school project.



Getting into gear: students at work on their F1 in Schools project.

For more information: visit www.f1inschools.co.uk. To access the learning resources, visit www.pearsonpublishing.co.uk/fscr.

Playing games with the science of the future?

In recent weeks government ministers have been promoting greater use of technology in teaching, advocating that games are an effective teaching tool and not just for fun. Following this, the Science Museum has just launched Futurecade, a suite of four online games (Bacto-Lab, Space Junker, Cloud Control and Robo-Lobster), to engage students with current and future applications of science.

Designed to be thought-provoking, fun and relevant to teenagers’ interests, the games are based on simulations of scientific and technological processes. They aim to raise questions on how the underlying science and technology impact on humankind, and give students the confidence to find their own voice and have a say in how science plays out in their lives. Futurecade was created and tested with the help of both science experts and teenagers. The accompanying teaching notes provide



guidance for using the games to support classroom learning.

The Science Museum recognises that using the right tools to engage teenagers with science and technology is important. Karen Davies, head of learning resources at the Science Museum says: “We believe that games provide great opportunities for

learning in an increasingly digital society. As well as being motivating and rewarding, games can embrace different learning styles and reach those who don’t respond to conventional teaching methods.”

For more information: visit www.sciencemuseum.org.uk/futurecade.

Science on Stage teams deliver demonstration resources

Have you ever wondered how to make a camera obscura, or looked for a demonstration to illustrate Newton’s laws, or tried to defy gravity? New video resources from the Irish Physics on Stage and Science on Stage teams can now help you with these challenges. Forty-five science demonstrations have been produced (in both English and Irish format) and are

available from www.scienceonstage.ie/videos.html. Booklets of these demonstrations and teaching ideas can also be downloaded in PDF format from www.scienceonstage.ie/resources.html.

For more information: contact Dr Eilish McLoughlin and Paul Nugent (e-mail irelandsos@gmail.com).



School Grants Scheme has wider reach

The Institution of Engineering and Technology (IET) has recently joined the IOP and STFC School Grants Scheme as a partner. They will be providing an additional £21 000 of funding each year and will help to assess the applications. This is a great opportunity to work more closely with your design and technology colleagues and will provide funding for more engineering-based activities in areas such as design and production or the built environment.

Since the scheme was established in 2005 the STFC and IOP have awarded almost £250 000 to school-based projects that have benefited more than 94 000 pupils. Grants of up to £500 are available for projects and events linked to the teaching and promotion of physics

IET The Institution of
Engineering and Technology



Science & Technology
Facilities Council

(especially those based in astronomy, space or particle physics). Its popularity has continued to grow every year, with an average of 100 submissions in each round. As a result competition is fierce and the judges will only consider funding the very best applications. The IET's involvement will allow a wider range of projects to be funded.

There are three deadlines per academic year, corresponding to the school terms: 1 February for summer-term projects, 1 June for autumn-term projects and 1 November for spring-term projects. There is a fixed amount of money available per round to ensure that schools have a fair chance of receiving funding, regardless of the time of year that they apply. Schools must apply in the round that corresponds to the planned timing of their activity.

The next deadline for applying for a schools' grant is 1 June for activities that will occur in the autumn term 2012.

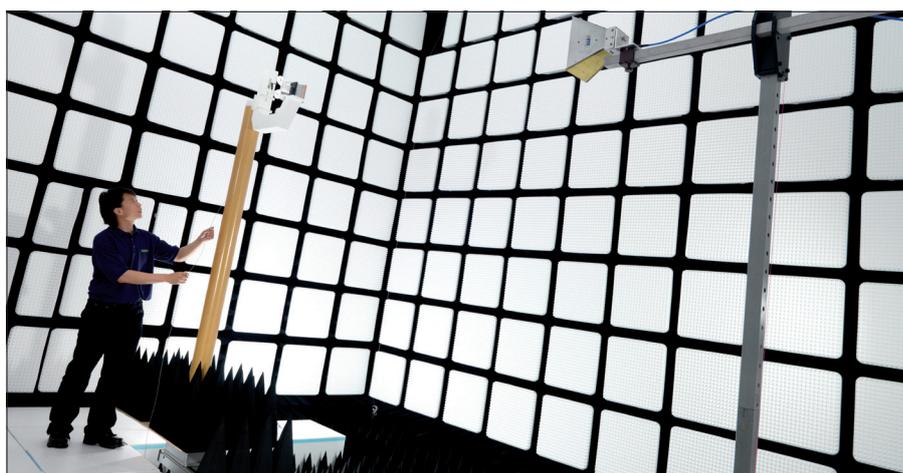
For more information: to download a School Grants Scheme application form, visit www.iop.org/schoolgrants.

The NPL opens its doors to physics students

Whether you have visited the National Physical Laboratory (NPL) on numerous occasions or not at all, have you ever wondered what goes on in their laboratories? Well, this is your opportunity to find out. Following on from the success of the 2010 open days, the NPL will again be holding open-house events.

As the UK's national measurement institute, the NPL develops and maintains the nation's primary measurement standards to ensure accuracy and consistency. The NPL is home to the metre, kilogram and second, and their scientists use the science of measurement in cancer treatment, Earth observation, farming, mobile-phone technology, GPS, electronics and countless other applications. Wherever measurement is needed, the NPL is there.

The NPL will be opening its doors to the general public on 14 March and the Schools' Open Day will be held on 15 March.



An NPL scientist applies the science of measurement in one of the NPL's laboratories.

Pre-registration is a must for both of these events. There will also be a programme of short talks and exhibits to showcase the NPL's scientific research.

For more information: visit www.npl.co.uk/openhouse for the Open House event and www.npl.co.uk/openhouse/schools for the Schools' Open Day.

'Teaching Secondary Physics' new edition is available now

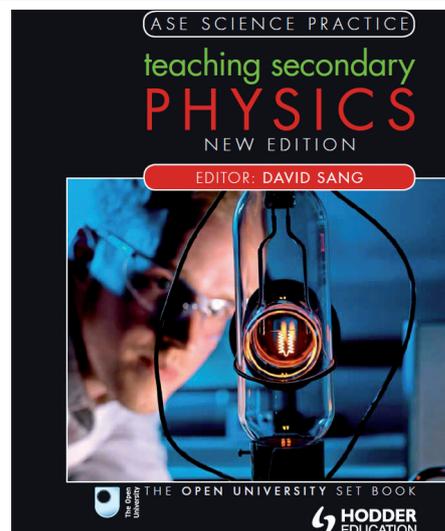
The ASE Science Practice series provides practical guides to teaching secondary biology, chemistry and physics, and "how science works". These books are appropriate for both specialist and non-specialist teachers who wish to stay at the forefront of their subject.

The new edition of the physics title *Teaching Secondary Physics* (edited by David Sang) is a resource for NQTs and non-specialists looking for support in the physics classroom, as well as experienced

teachers looking to extend the range of strategies and approaches that they use.

The publication includes: an outline teaching sequence showing how concepts can be developed throughout the 11–16 phase; an indication of the topics that students may have covered in their primary-science lessons; activities to cover the basic curriculum; details about likely student misconceptions; helpful information about practical work and apparatus; opportunities for investigative work and other aspects of "how science works"; enhancement ideas that relate science to everyday contexts; and extension material.

For more information: visit www.ase.org.uk/bookshop/new-books.



Events

EVENTS FOR TEACHERS

Astronomy in the Classroom

National Space Centre

7 March

This course supports teaching KS4 and 5 physics as well as GCSE astronomy. There will be resources to take away to use in the classroom.

Details and booking: visit

www.spacecentre.co.uk/page.aspx/205/TEACHER_PROGRAMMES.

Physics for Specialist Teachers of KS5 Physics

National Space Centre

23 March

A course to support teaching KS5 physics using the context of space science. With resources to take away, you will be able to implement these activities in the classroom.

Details and booking: visit

www.spacecentre.co.uk/page.aspx/205/TEACHER_PROGRAMMES.

Practical SHAP

University of York

27–28 March

This course is designed for teachers and technicians who use Salters Horners Advanced Physics. The main focus will be on activities and a selection from both AS and A2 years will be showcased.

Details and booking: contact Joanna Macdonald (e-mail joanna.macdonald@york.ac.uk).

Stimulating Physics: A Day of CPD for Teachers and Technicians

Highgate School, London, N6

29 March

This free day of CPD will include a choice of up to four different practical workshops.

Details and booking: visit www.slcs.ac.uk/go/lon/Inc11379.

Spring Physics Update

Royal Holloway, University of London

30 March – 1 April

This three-day residential course will be based at the university's physics department.

Details and booking: visit www.iop.org/update or contact Manchi Chung (e-mail manchi.chung@iop.org).

Extreme Physics: Teacher CPD Sessions

31 March – 5 April – Rugby School

9–14 April – Lancaster GS

10–12 April – Durham School

10–15 April – Stowe School

These free CPD sessions are for anyone who is teaching physics or supporting the Extreme Physics events.

Details and booking: contact Helen Pollard (e-mail h.pollard@sep.org.uk).

Stirling Meeting

University of Stirling

23 May

The 38th Annual Meeting organised by the IOP in Scotland will feature a day of lectures and workshops as well as an exhibition.

Details and booking: visit www.stirlingmeeting.org

or contact Lauren Stacy (e-mail lauren.stacy@iop.org).

Rugby Meeting

Rugby School, Rugby CV22 5DW

14 June

The 24th Annual Meeting for teachers of physics in schools and colleges will provide a mixture of information, stimulation and communication, as well as an exhibition.

Details and booking: visit www.iop.org/rugby or contact Manchi Chung (e-mail manchi.chung@iop.org).

Astrophysics

University of London Observatory, Mill Hill

12 June

This one-day course will focus on key theories of space science using the facilities at the observatory. The course fee is £150.

Details and booking: visit www.slcs.ac.uk/go/lon/Inc11001.

IOP Teacher Network for North Wales Conference

Bangor University

19 June

The main speaker will be Prof. Steven Cowley from UKAEA who will be giving a talk on fusion power. There will also be even more workshops this year.

Details and booking: contact Andrea Fesmer (e-mail andrea.fesmer@talk21.com).

A Day for Everyone Teaching Physics

Durham University

21 June

This free day for anyone teaching physics will include a keynote lecture given by Prof. Julie Mennell, which will link physics to the latest developments in forensic science. There will be workshops and an exhibition.

Details and booking: visit www.sciencelearningcentres.org.uk/centres/north-east.

South West Physics Teachers' Conference

St Luke's Campus, University of Exeter

22 June

This event will be for anyone involved in the teaching of physics – teachers and technicians. It will comprise a lively programme of lectures and workshops.

Details: contact Alison Alexander (e-mail alisonalexander@aol.com).

KS4 Science Teachers Conference

Manchester Metropolitan University

22 June, 10.00 a.m. – 16.00 p.m.

This day meeting has been organised by IOP and the Science Learning Centre Northwest. Details: contact Rachel Eppy (e-mail slc.northwest@mmu.ac.uk).

Summer Physics Update

University of Birmingham

6–8 July

This three-day residential course will be based at the university's physics department.

Details and booking: visit www.iop.org/update or contact Manchi Chung (e-mail manchi.chung@iop.org).

EVENTS FOR STUDENTS

Schools and Colleges Lecture – Physics and the Games: a winning formula

This free lecture for 14–16-year-olds, given by a team from Sheffield Hallam University's world-leading Centre for Sports Engineering Research, starts its UK tour.

Details and booking: visit www.iop.org/schoolslecture.

SEPnet's GCSE Physics Taster Events

14 March – University of Southampton

18 and 19 June; 8 and 9 November – Queen Mary, University of London

26 and 27 June – University of Sussex

27, 28 and 29 June – Royal Holloway, University of London

9, 10 and 11 July – University of Kent

9 and 10 July – University of Oxford

11 and 12 July – University of Surrey

These energy-related events are best suited to students who are just about to start or have just started their GCSEs.

Details and booking: visit www.sepnet.ac.uk/news_events/index.html (e-mail gcse@sepnet.ac.uk).

The Physics Paralympics

2 July – Northgate High School, Ipswich

10 July – Uppingham Community College, Rutland

These parallel competitions are for teams of four year-9 students – book early.

Details: East of England, contact Gerry Blake (e-mail g.blake@sep.org.uk); East Midlands, Helen Pollard (e-mail h.pollard@sep.org.uk).

Space School

University of Kent

4–5 and 11–12 August

The university is now recruiting 11–18-year-olds for this year's space school. It will be held on the first two weekends of August to coincide with the annual Perseid meteor shower.

Details and booking: visit <http://astro.kent.ac.uk/mds/Spaceschool/>.

More about steady states and climate change

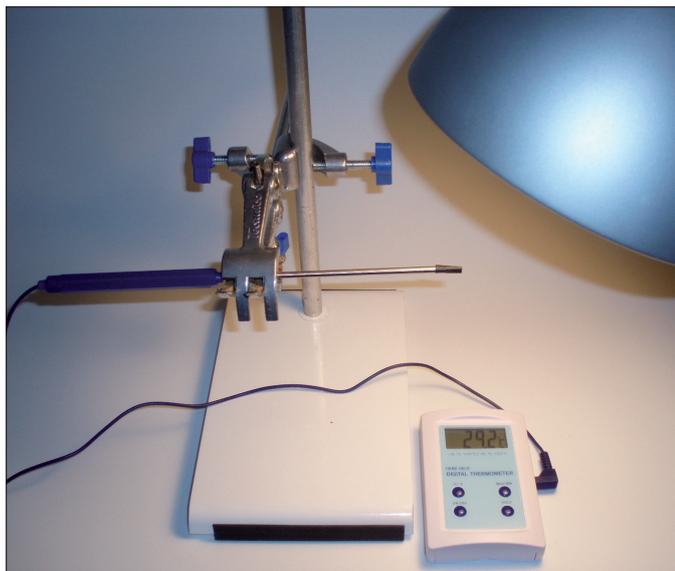


Figure 1. A steady-state system using a digital thermometer.

A previous edition of *Classroom Physics* had an article that looked at how the flow of water in and out of a bottle could be used as a model in the context of teaching about climate change (“Modelling climate change with a leaky bottle”, March 2010). The flows of water represent the energy input (radiation from the Sun) and energy output (radiation from the Earth), while the level of the water in the bottle represents the Earth’s temperature.

The average temperature of the Earth remains approximately constant because of the balance between the rate of energy flow from the Sun to the Earth and the rate of energy flow from the Earth into space. However, the temperature does not remain exactly the same because of changes to the rates of energy input and output.

One of the difficulties of modelling this directly, using thermal systems, is that they tend to be less responsive – for example, the relatively high thermal capacity of a beaker of water makes its response very sluggish. A simple solution is to use the thermometer itself as the steady-state system, thus reducing the thermal capacity to the absolute minimum. A digital thermometer is ideal for this. Wrapping a small piece of black tape around the tip of the probe, and then shining a desk lamp on it, creates a system that quickly reaches a steady-state temperature (figure 1). Effects of changing the energy input (e.g. altering the distance of the lamp) or the energy output (e.g. bringing a desk fan close to the probe) can then be explored. Using a temperature probe with a datalogger enables the results to be recorded (figure 2).

Another solution is to use a low-voltage lamp inside a cardboard box covered with thermocolour film – the colour of the film depends on the temperature and changes with the conditions. This is a striking visual way of exploring steady states qualitatively. (More information can be found in “Keeping moving to stay where you are: energy flows and temperature differences” R Boohan *Physics Education* vol 31 no 1 pp20–23.)

Monitoring the temperature of a room in a school or a house is a good way of exploring the idea of a steady state. A convenient piece of kit to do this is the Mindsets Mini Temperature Datalogger (just released with other sensors to follow). This is a portable datalogger with its own memory and power supply, with the data being directly imported into a computer via its USB connection (figure 4).

The graph (figure 3) shows the use of three of these dataloggers – one placed on a convector heater, one in the centre of a room and one by a window. Initially the thermostat of the convector heater is

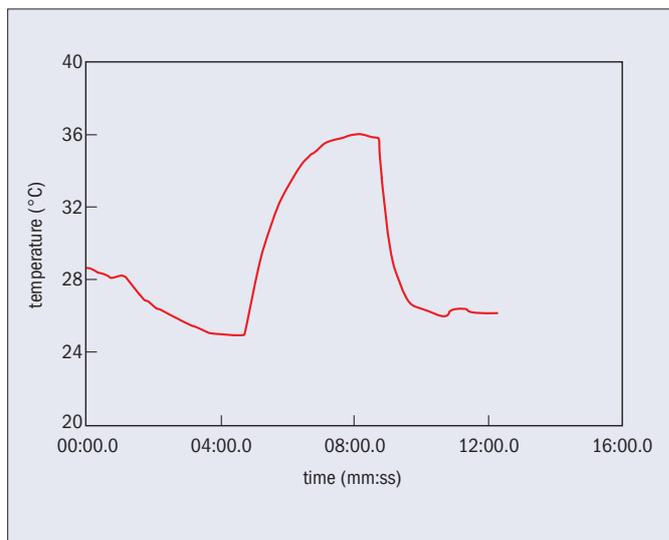


Figure 2. Initially, the lamp is moved further from the probe, then closer, and then a desk fan is switched on.

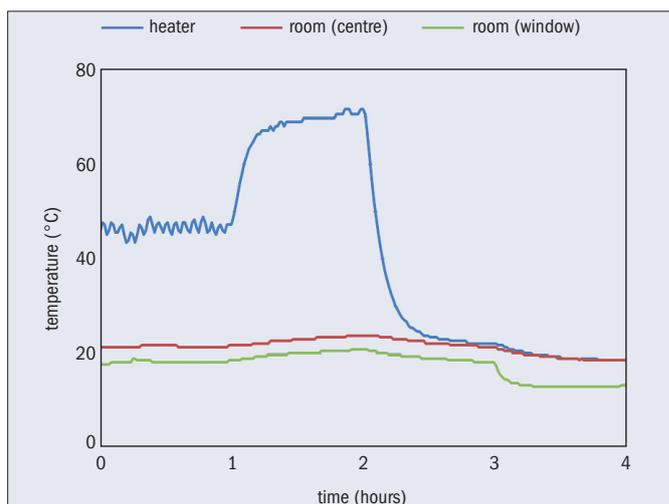


Figure 3. Using the datalogger to monitor room temperature.

switching the heater on and off to maintain a constant temperature in the room. After an hour the thermostat is turned up, then after another hour it is switched off and finally after another hour the window is opened. This kind of investigation can be extended over a longer period of time by monitoring a central-heating system, and seeing how the room temperature responds to changes in the radiator temperature and external temperature.

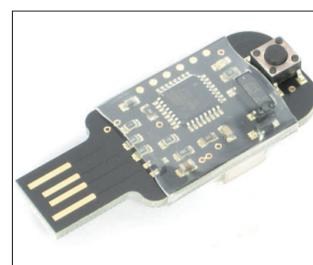


Figure 4. The Mindsets Mini Temperature Datalogger.

For more information: steady-state models are discussed in the SEP booklet *Modelling Climate Change* (www.nationalstemcentre.org.uk/sep). The Mini Temperature Datalogger is available for purchase (£9.95) from Mindsets (www.mindsetsonline.co.uk).

Richard Boohan was series editor for SEP’s Innovations in Practical Work publications and is now an independent consultant.

Knocking on Newton's door: measure the speed of sound using echoes



Cambridge 2000

The north cloister of Neville's Court, Trinity College, where Isaac Newton stamped his foot to time the echoes and determine the speed of sound.

This is a slightly amended version of an experiment on the *Practical Physics* website.

Class experiment

Echoes can be used outdoors to estimate the speed of sound. This is clearly more pleasant to do in better weather, but is a good opportunity to take your class outdoors.

Apparatus and materials

- stopwatch(es);
- calculator;
- two pieces of wooden dowel to bang together;
- large, flat reflecting surface, such as the wall of a gymnasium or hall.

Technical notes

Obviously, you want strong echoes from one reflecting surface and not several.

Procedure

A. The experimenter stands as far away as possible from a large reflecting wall and claps their hands or bangs the two pieces of dowel rapidly at a regular rate. Around 40 to 50 metres away from a wall works well.

B. This rate is adjusted until each clap just coincides with the return of an echo of its predecessor. When this happens the echo is no longer heard separately from the original sound. If you are able to stand much further away in an open space you can adjust the clap/bang rate until the clap and echo are heard as equally spaced.

C. Get students to use a stopwatch and count the number of claps/bangs in 10 seconds, N .

The time between claps is then $= 10/N$. Make a rough measurement of distance to the wall, s , in metres.

In time $10/N$ the sound has travelled to the wall and back; that is, a distance of $2s$.

Thus the speed of sound, $v = \frac{2s}{10/N} = \frac{s \times N}{5}$ m/s.

Teaching notes

1. Students are far more likely to grasp and to remember how to obtain the estimated speed of sound if you can arrange for them to work in small groups to undertake this experiment. This may be difficult to organise, depending on the geography of your school grounds, but well worth trying. One person is needed to make the noise, one to time 10 s, at least one to count the number of claps in 10 s and one with a calculator to do the calculation.

2. Newton used echoes to estimate the speed of sound in an outdoor corridor at Trinity College, Cambridge. Allegedly the sound was able to lift a door knocker at the far end of the corridor.

3. Discuss why a rough measurement of the distance is adequate.

4. The speed of sound in air is roughly 340 m/s at 20 °C and 330 m/s at 0 °C, but will vary depending on atmospheric pressure and temperature.

5. The discussion may lead on to comparing the speed of light and the speed of sound, and why we see lightning before we hear the associated crack of thunder.

For more information: visit www.nuffieldfoundation.org/practical-physics/measuring-speed-sound-using-echoes.