

Classroomphysics

The newsletter for affiliated schools

June 2008 Issue 5

Physics careers advice tops Institute's agenda

If you are reading this then you probably know that studying physics brings benefits that last a lifetime, including knowledge and skills that are valuable outside the subject. The career opportunities that stem from studying physics are as vast as the subject itself, due, in part, to the transferable skills gained while studying physics.

Unfortunately, while many of you may know this, it is likely that the majority of your students will not. The Institute has argued for some time that one reason why more students don't study physics is that not enough of them understand the role that it plays in modern society or how studying physics could benefit their careers.

I believe that the Institute should be able to do more to help you to show young people the advantages gained from studying physics. The main purpose of this article is to enlist your help in ensuring that we meet your needs and those of your students.

So, what do we know about young people and their perceptions of physics? One of the factors that may explain why students don't identify with science is that they don't see it playing a role in their lives beyond school. Some, perhaps many, students believe that choosing to study science means that they are embarking on a career path that has only one end point – a white coat and glasses.

While many physics graduates go on to work in scientific areas, research or teaching, many, possibly most, move into jobs where they are not working as "physicists" as such, but in which they are using the skills that they have developed through studying physics. There is no reason why someone with a physics degree can't pursue other careers.

So a key message for young people is that studying physics is a good way of keeping their options open.

We plan to revise our current literature to



Students consider their options at a careers fair.

produce two leaflets aimed at 14–16- and 16–18-year-olds, which will combine this message with information about physics qualifications and what physicists do.

The Institute is working with the Science Council on the *FutureMorph* careers website www.futuremorph.org to provide a single entry point for "Careers from Science" information. We will improve the careers information on www.physics.org and add short video clips of physicists at various stages in their careers, talking about how physics has helped them. We are also considering producing a guide for heads of physics, making suggestions about how to promote the subject in their schools.

A number of physicists volunteer to help schools with their careers events. I hope that we will be able to persuade more to do so, so that we can better meet the demand from schools for people rather than paper.

I would like to know what you think about our current resources, what you like and what you don't like, and what we could do to help you promote further study in physics. Please send your thoughts to Daniel Sandford Smith (e-mail daniel.sandfordsmith@iop.org).

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Editorial



This is the last issue of *Classroom Physics* for this school year. The second half of the summer term seems to be the

one chance to reflect on how things have gone this year and the opportunities and challenges that the next will offer. In both England and Scotland, curriculum review is a hot topic. Change can be hard to deal with, and for those who have been teaching for some time, there can often be a distinct sense of déjà vu. However, I hope that the Institute of Physics affiliation scheme can continue to support and inspire you and that you are finding *Classroom Physics* useful.

Our front-page story looks ahead to forthcoming developments in the careers advice and resources that we offer to teachers and students. This is an important area that we want to expand, and we hope to have new resources available towards the end of 2008.

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Editorial (continued)

You will have received a copy of the *Materials Interactive* CD-ROM with the newsletter, which is designed to highlight the importance of materials in everyday use and the career opportunities for post-16 materials-science students. The resources are also available online (p4).

There is the opportunity to receive free resources to support A2 units in GCE Applied Science specifications (p2). If you are an affiliated school and are teaching, or thinking about teaching, one of these courses, this is an offer that you can't refuse. Further support for A-level teaching is available from the Space Academy, including an intensive "Away-day to Mars" programme (p5).

The winners of the Planet SciCast competition have been announced (p3). This is the first year that SciCast Physics has been judged by the regional branches of the Institute. We hope that more of your students will be encouraged to submit an entry to next year's competition. You might also have students who are interested in the "Capturing Carbon" competition (p2).

Other featured activities include the Telescopes for Schools project and the International Year of Astronomy in 2009 (p4). The British Association Festival of Science in Liverpool in September has a full programme of activities for schools (p4) and there are also other events for students (p5). If you are thinking about outreach work with feeder primary schools, take a look at the innovative Science Action Centre (p3).

The events page has details of a vast range of support for teachers (p6). If you would like the chance to make an impact outside the classroom, you might be interested in the Institute's new fellowship scheme, supported by the Anthony Waterhouse Memorial Fund (p2).

See "Teaching tips" (p7) for an extract taken from *Science on Stage*, produced by the Institute of Physics in Ireland. This has a wealth of ideas for demonstrations and activities available online.

The worksheet on p8 can be used to test the understanding of some of the fundamental ideas in simple circuits.

If you have any comments or requests for future issues, do get in touch.

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

Institute initiative encourages teachers to develop curriculum

The Institute is introducing a new fellowship scheme to provide support for physics teachers early in their careers who would like to make an impact outside the classroom.

The Anthony Waterhouse Memorial Fund, generously endowed by a donation from Helen Parsons in memory of her brother, will fund two year-long fellowships to enable teachers to contribute to curriculum development. This could be through:

- developing teaching materials;
- carrying out action research;
- developing software.

To qualify, applicants need to:

- be currently teaching in a UK or Republic of Ireland school or college;
- have a degree in physics or physics PGCE.

Successful applicants will be given:

- an honorarium of £1000, which will be

paid in two instalments;

- access to a fund of £2500, which could be used to pay for:

- specific, relevant training courses;
- travel and accommodation;
- material and resources;
- consultancy (e.g. software production).

To apply, e-mail a covering letter and CV to Daniel Sandford Smith by 30 June. Your letter should provide evidence of your success as a classroom teacher and indicate the nature of the project that you would like to pursue using the fellowship funds. The final project will be developed in negotiation with staff from the Institute.

For more information: contact Daniel Sandford Smith (e-mail daniel.sandfordsmith@iop.org).

GCE Applied Science resources support A2

A new package of resources to support A2 units in GCE Applied Science specifications (AQA and OCR) will be published in June. It consists of 26 activities developed by the Nuffield Curriculum Centre and 4science in conjunction with a teacher network based on Science Learning Centres in Bristol, London and Manchester.

The activities target A2 topics for which, up till now, teachers have had to develop their own resources. Physics activities include "impact testing", "investigating X-rays", "thermography", "physics of performance effects" and "cells and batteries". Each has a brief for students, structured as a number of tasks, with teaching guidance.

The GCE Applied Science resource package consists of a ring binder containing

350 pages that may be photocopied, and a CD-ROM, from which the activities can also be printed. All materials are presented as Word documents so that they can be modified by teachers to suit local needs. For example, some of these activities could easily be adapted to suit A-level physics.

The project is funded by the Wellcome Trust, the Gatsby Charitable Foundation and the Institute. A single copy of the package is available free to Institute-affiliated schools and colleges, on request.

These A2 resources stand alongside AS materials, plus AS and A2 revision guides for externally assessed units, all available commercially from www.4science.org.uk. They will shortly be free to download from www.nuffieldcurriculumcentre.org.

For more information: or a free copy of the GCSE Applied Science A2 pack, contact Gita Taylor (e-mail gita.taylor@iop.org).

Competition calls for carbon-science pictures

The British Carbon Group (BCG) has announced details of the Capturing Carbon 2008 Carbon Image Competition. Entries are welcome from all organisations, including schools, colleges and individuals (of all ages). There are two categories: open competition and under-18s. The first prize in each category will be a certificate of merit awarded by the BCG and a cash prize of £150. The BCG reserves the right to award additional certificates and prizes if the judges feel that special acknowledgement is

deserved of individual entries.

Works can depict any aspect of the world of carbon science. Entries must be in electronic format, accompanied by a title and a 100-word (maximum) description of the picture. Entrants are asked to provide their full name, affiliation, address, e-mail address and age (if under 18).

For more information: visit www.britishcarbon.co.uk and click on "Capturing Carbon". The deadline is 31 October 2008.

Young directors celebrate at SciCast ceremony

Over the past year, teams across the country have been putting their creativity to the test by making short, entertaining physics films, and on 25 April their efforts were rewarded at a glittering awards ceremony in London.

SciCast Physics, part of Planet SciCast, is a short-film competition that challenges students of all ages to explain a principle of physics in less than two-and-a-half minutes. To reach the final in London, the young film-makers had already been judged the best in their region by members of the Institute's local branches.

After a nail-biting wait, Prof. Peter Main, director of science and education at the Institute, announced that the winners of the SciCast Physics award for best physics film were Dizzy with their film *Physics of Roundabouts*. Dizzy, a team of students from the Thomas Hardy School in Dorset, used a bucket of water, jam, pies and, of course, a roundabout to explain how enjoying the playground is dependent on physics.

Other winners included Vibrant Films, who won best entertainment film with *Refraction*; Go, who won best engineering film with *Magnets and Rollercoasters*; and Marshions,



Dr Laura Grant (left) and Starlink – the overall winners of the 2008 Planet SciCast competition.

who won best film by a team including primary students, with *Around the Universe in 2.5 Minutes*.

The ceremony culminated in the announcement of the winner of the Planet SciCast jurors' grand prize for the best film overall. Despite being open to all entries, not just the physics films, the prize went to Starlink for *Physics – Stronger than the People Who Study It?*

You can watch all of the 2008 films at

www.planet-sciCast.com, where you can also find the complete competition rules, guidance for first-time film-makers and all-important advice about how to make sure that you don't infringe copyright.

The 2009 SciCast Physics competition is open for entries. To stand a chance of being invited to next year's awards ceremony, your short film needs to explain an aspect of physics in an entertaining way. The closing date for entries is 9 January 2009.

Physics flies into action at school science centre with help from the Institute

When I was appointed head of science at Bishop's Stortford College, Hertfordshire, part of my brief was to promote science in the college and in the local community. An idea I had implemented at my previous school was to create an interactive science centre. Unfortunately, this had to be closed because the school needed the space for a classroom. Now I had an opportunity to recreate it but on a grander scale.

Our Science Action Centre was opened in July 2006 and houses 40 interactive displays and experiments using mirrors, light, sound, air and magnets. There is a Helios Planetarium, funded by a grant from the Institute of Physics, and another recent addition, ViewSpace, provides an amazing internet-fed, self-updating, permanent exhibit direct from NASA. We have invited local primary schools to use it free of charge, and they always have a brilliant time.

There has been much talk recently in government about how to halt the declining interest in science among young people. We have been working very hard for some time to ensure that children, both at the college and in local schools, get excited about the subject. In essence we make learning about science fun for pupils of all ages, in both



A student has fun creating the optical illusion of flight using a mirror at the Science Action Centre.

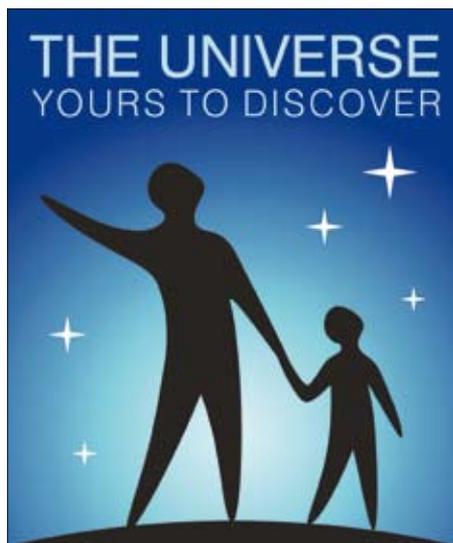
lessons and extracurricular activities. The centre allows us to build on this approach. The pupils who attend give us wonderful written feedback, but you only have to see their faces as they enjoy the fun to realise that there's something special happening. I'm sure it's not a coincidence that about 25% of our sixth form now take A-level physics.

If you want to give your science department

an extra buzz, why not give it a try? All you need to start with is a hallway where pupils pass through, then add some eye-catching interactive displays and see what happens. **John Williams**, Bishop's Stortford College

For more information: or to arrange a visit, contact the Science Action Centre (e-mail scienceaction@bsc.biblio.net).

SPA pledges free telescopes



Would your school like a small, but high-quality, free telescope to help you to celebrate the International Year of Astronomy (IYA 2009) next year? The Society for Popular Astronomy (SPA) is anticipating obtaining funding to supply 1000 secondary schools with a telescope (70 mm aperture), a DVD showing how to set it up and use it, and contact with a local astronomer who can help. The DVD addresses KS3 astronomy syllabus topics and contains interviews with astronomers of all ages. The SPA will have a website showing teachers and science-club leaders which planets might be visible that night and what else can be seen. There will be a Spring MoonWatch (28 March – 5 April) and an Autumn MoonWatch (19–29 November) when the first quarter Moon can be seen, and a competition to encourage children to draw or photograph the Moon or the night sky.

IYA 2009 will be a global celebration of astronomy, supported by UNESCO and the International Astronomical Union, and more than 100 countries have joined the initiative so far. It is intended to stimulate worldwide interest, not only in astronomy, but in science in general, with a particular focus on young people. The year will mark the monumental leap forward that followed Galileo Galilei's first use of the telescope for astronomical observations. It also celebrates our landing on the Moon 40 years ago.

Helen Walker, president of the SPA

For more information: or to register, contact the SPA (e-mail iya2009@popastro.com).

Resource demonstrates why materials matters

The UK Centre for Materials Education (UKCME) has launched a new website, www.whystudymaterials.ac.uk, designed to increase understanding and awareness of materials science. The site has been created both as an informal guide to the world of materials and, importantly, as a teaching aid for use in secondary-level education.

The site hosts interactive games, quizzes and films, ranging from virtual tours of cars, football boots and aeroplanes, to ships, CDs and stealth aircraft, and even one of Liverpool's Chinese restaurants. Each tour enables the viewer to find out more about the materials used in everyday applications.

The online resource hosts video interviews with university students, information about related university courses, open days and career opportunities to help younger students make informed choices about their future, and frequent competitions with the chance for students to win prizes. There is also the opportunity to "Ask a Question" on the website, preferably one relating to materials science. (Rest assured, questions obviously copied from GCSE homework will not be given model answers.)

The resource is frequently updated, with several new curriculum-based teaching resources currently in development, including packs on nanotechnology; smart, biomedical



A screenshot of the new materials science website launched by the UK Centre for Materials Education.

and sporting materials; and intelligent packaging, which will be available via the website in the near future.

In addition to the resources developed by the UKCME, a searchable database on the website highlights a large number of individually selected and annotated third-party learning materials, on all topics relating to materials science.

For more information: visit www.whystudymaterials.ac.uk to explore the new site, or follow the "Visit our new website for schools" link from the UKCME homepage at www.materials.ac.uk and register to keep up to date with new developments.

Outreach event hits north west this autumn

In September, science and culture will collide as Liverpool (European Capital of Culture 2008) experiences an explosion of science. With more than 150 events being planned, including hands-on family days, debates about current hot topics, trips to places of interest and unique opportunities to question the UK's top scientists, the British Association Festival of Science offers something for everyone. The outreach event is Europe's largest celebration of science, technology and engineering.

The extensive programme for schools includes workshops, science shows, hands-on activities, debates and opportunities for pupils to meet and question scientists and engineers from all over the country. The festival offers a rare opportunity for students in Liverpool, Merseyside and



from across the north west to experience the excitement and pleasure of discovering science, technology and engineering.

For more information: To download the programme, visit www.the-ba.net/festivalofscience, or call SETPOINT Merseyside (tel 0151 231 2400) for further details and to make a booking.

EVENTS FOR STUDENTS

Institute of Physics 2008 Schools and Colleges Lecture: Rock in 11 Dimensions – Where Physics and Guitars Collide!

This free lecture for 14–16-year-olds, given by Dr Mark Lewney, continues its UK tour. It will be in the south east and London in July, and in Scotland in early September. Details and booking: visit www.iop.org and click on “Events” under “Schools and Colleges” or contact Joanne Page (e-mail joanne.page@iop.org).

Large Hadron Collider Masterclass

Department of Physics, Queen Mary, University of London, Mile End Campus
30 June, 10.00 a.m. – 4.00 p.m. (TBC)

Year-10 GCSE physics students will learn about the workings of the LHC and the massive computer grid, which will be used to analyse the data, as well as having the chance to build a particle accelerator and search for particles.

Details and booking: contact Laura Jackson (e-mail l.f.jackson@qmul.ac.uk, tel 0207 882 3020).

Year-9 Gifted and Talented East Anglia Inter-School Physics Competition 2008

County Upper School Sports Centre, Bury St Edmunds

7 July, 10.00 a.m. – 3.00 p.m.

Sponsored by the Institute of Physics and Hawkin's Bazaar.

Details and booking: contact Gerry Blake, Cambridgeshire Teacher Network coordinator (e-mail gerryblake@2hollygrove.freeserve.co.uk). Confirmation of entry must be made by Monday 16 June at the latest.

Trust Physics!

Penrhyn Castle, Bangor, Gwynedd

24 September

A day of physics activities at the National Trust's Penrhyn Castle. Year-5–7 pupils can find out the answers to some interesting science-related questions, such as:

- How was ice made without freezers?
- How was the castle built without the machines we have today?
- Why was the slave trade important to the castle?

The event will include physics workshops, talks, tours and a chance to make a display. Details and booking: contact Andrea Fesmer, North Wales Teacher Network coordinator (e-mail andrea.fesmer@talk21.com).

Let us know if there are other events that we should publicise.

Space Academy boosts pupils' core understanding of physics



Anu Ojha uses the Orlan spacesuit to teach Moulton Science College students about gas pressure.

The National Space Centre (NSC) in collaboration with the universities of Leicester and Nottingham and the regional Science Learning Centre represent a powerful resource for science education and public engagement. With £990 000 of new funding from the East Midlands Development Agency, this group has set up the country's first Space Academy, which aims to boost support for science, technology, engineering and mathematics teaching using space and climate change as inspirational contexts for curriculum studies. These programmes are being developed in conjunction with international leaders in the fields of space science, environmental monitoring and satellite navigation, and they will be delivered by some of the best teachers in the UK who have been assessed nationally for excellence in their field.

As part of the Space Academy programme, the NSC has used the challenges of Martian exploration as the basis for an intensive day-long course designed to support AS and A2 physics students in their curriculum study. The mission challenges – including launch, flight through interplanetary space, landing and human survival on Mars – are used as contexts for curriculum topics, including Newtonian mechanics, ideal gas behaviour, electrical power systems, gravitational theory, the photoelectric effect and applications of inverse-square and exponential-decay laws.

Called “Away-day to Mars”, the course

has been piloted with several school groups during 2007–2008 and participants have praised the scheme, not only for the inherent interest provoked by the subject but, more important, for boosting pupils' core understanding of physics – especially the synoptic element of the syllabus. During the day a mixture of theory, practicals and mathematical modelling is utilised, with students using items that normally would be inaccessible to school groups, such as a genuine Russian spacesuit and a sample of a Martian meteorite.

Sessions are led by the director of education and space communications at the NSC, Anu Ojha – an advanced-skills physics teacher who has worked in collaboration with NASA for several years to develop resources for use in A-level science teaching.

Past sessions have included input from visiting space scientists at the NSC, including Prof. Paul Delaney from York Observatory, Canada; and Dr James Carpenter, a space scientist working with the European Space Agency on solar-system exploration. Carpenter praised the programme as being “A fantastic way for A-level physics students to develop and stretch their skills in the inspirational context of Martian exploration.”

For more information: For 2008–2009 programme dates, visit the NSC website at www.spacecentre.co.uk or contact the education manager, Chris Darby (e-mail chrisd@spacecentre.co.uk).

Events

EVENTS FOR TEACHERS

North-West Midlands Institute of Physics Teachers Network Day

West Midlands Science Learning Centre,
Keele University, Staffordshire

16 June

This year will feature a talk by Prof. Nye Evans entitled “The universe – our biggest laboratory”, workshops about the Van de Graaff generator, the Virtual Physical Laboratory and datalogging, as well as the Institute’s new workshop about using games to stimulate and enhance learning.

Details and booking: contact Mike Melling (e-mail m.j.melling@talk21.com, tel 01782 615 636).

Physics Can Be Easy!

Chadwick Laboratory, University of Liverpool
18 June, 9.30 a.m. – 3.45 p.m.

The Institute’s Merseyside Teachers Network and ASE present a free one-day conference for science teachers with an emphasis on physics at KS3 and KS4. Activities include talks, workshops and resources to take away. Details and booking: contact Lucas Hayhurst (e-mail lht@blueyonder.co.uk).

Is Physics Teaching and Learning a Priority for You?

School of Physics and Astronomy, University of Leeds

18–19 June

Aimed at teachers of GCSE/A-level physics and year-12 students, this two-day conference will include opportunities for teachers to talk about new materials, while students get a taste of university life.

Details and booking: visit <http://www.triplescience.org.uk/news/article-5203.aspx> or contact Vanessa Owen (e-mail vowen@saintolaves.net).

Scottish Physics Summer School

Department of Physics, University of Glasgow
23–27 June

A week-long event, with en suite accommodation in university halls. Fee: £180. The programme will include keynote speakers, discussion with researchers, practical laboratory work and optoelectronics for schools.

Details and booking: visit www.iopscotland.org or contact Gregor Steele (e-mail gregor.steele@sserc.org.uk).

Annual Liverpool Physics Teachers Conference

University of Liverpool, Chadwick Laboratory
26 June

This free event is jointly organised by the University of Liverpool and the Institute’s Merseyside Branch. It will include lectures, workshops and discussions.

Details and booking: visit <http://www.liv.ac.uk/physics/schools/index.html> or contact Ann Marks (e-mail liviop@amarks.co.uk).

IOP Teacher Network in London: A-level Physics Day

University College London
30 June

A great day out for A-level physics teachers in the London area, with something for everyone, including talks from scientists; a hands-on workshop, with some experiments to take back to school; short talks about physics education and university applications; plus opportunities to mingle and chat with other teachers.

Details and registration: visit http://www.iop.org/activity/education/Teacher_Support/Teachers_Network/page_2574.html and click on “London”.

Advancing Physics Teachers and Technicians Courses

Department of Physics and Astronomy,
University of Birmingham

1 July: Introduction to AS

2 July: Introduction to A2

3 July: Technicians course

These courses, run jointly with OCR, will cover all aspects of teaching and learning, including a session on coursework and an introductory CD session, reflecting the revisions made to the specification for September 2008. Special rates are available for affiliated schools.

Details: visit <http://advancingphysics.iop.org/teacher/index.html>.

Salters Horners Advanced Physics Residential Course

University of York

2–4 July: AS preparation, teachers course

This course will be particularly valuable for teachers and technicians preparing to teach the new Edexcel GCE physics from September 2008 and who are intending to adopt a context-led teaching approach. Details and booking: visit www.york.ac.uk/org/seg/salters/physics or contact Sandra Wilmott (e-mail slw5@york.ac.uk, tel 01904 432 601).

IOP Teacher Network in London – Non-specialist Teachers of Physics at KS3/4

1 July – St Gregory’s School, Kenton,
Middlesex HA3 ONB

4 July – Chaucer Centre, Morden SM4 6PX

7 July – Lewisham Professional Development Centre, Lewisham SE23 2SP

9 July – Trinity Catholic School, Woodford Green, Essex IG8 OTP

A full day of practical workshops and discussion, focusing on the new curriculum at KS3 and triple science.

Details and registration: visit http://www.iop.org/activity/education/Teacher_Support/Teachers_Network/page_2574.html and click on “London”.

Physics Update: a Course for Practising Teachers of Physics

Department of Physics and Astronomy,
University of Leicester

11–13 July, Friday 12.30 p.m. – Sunday 1.00 p.m.

A half-day visit to the National Space Centre, the UK’s largest attraction dedicated to space, plus many interesting and exciting talks and workshops.

Booking: contact Leila Solomon (e-mail leila.solomon@iop.org, tel 020 7470 4821).

East Midlands Teacher Network Day

Ockbrook School, Derby

20 September

Receive up-to-date information, share ideas, collect free resources and view Lab in a Lorry. Dr Hunt’s keynote lecture entitled “Boomerangs, bouncing balls and other spinning things” will appeal to everyone. Details: contact Neal Gupta (e-mail neal@ngupta.wanadoo.co.uk) or Helen Pollard (e-mail hjp@oakham.rutland.sch.uk).

Frontiers of Physics 2008: IOP in Ireland Teachers of Physics Annual Conference

The School of Physics, University College Dublin, Belfield, Dublin 4

27 September: 9.30 a.m. – 4.00 p.m.

A day of lectures, demonstrations and workshops for post-primary physics teachers. Details: contact Paul Nugent (e-mail paulnugent@eircom.net)

Welsh Physics Teachers Annual Conference

Christ College, Brecon

8 October

A day of workshops, lectures and discussion for teachers organised by the IOP in Wales. Details and registration: visit http://www.iop.org/activity/education/Teacher_Support/Teachers_Network/page_2574.html and click on “South Wales”.

Classroom activities – amazing lasers

Here are a couple of lesson ideas that use a laser. They are taken from the booklet *Science on Stage 1 & 2*, selected by the Institute of Physics in Ireland. This teaching resource is available for download at <http://www.scienceonstage.ie/resources.html>. You should do your own risk assessment before using these classroom demonstrations.

Twinkle, twinkle, little laser

Recreate the shimmering light from distant stars and galaxies, in the laboratory.

You will need:

- a laser
- a candle
- a screen

Background:

A laser beam passes over a lighted candle and produces a twinkling spot on a distant screen.

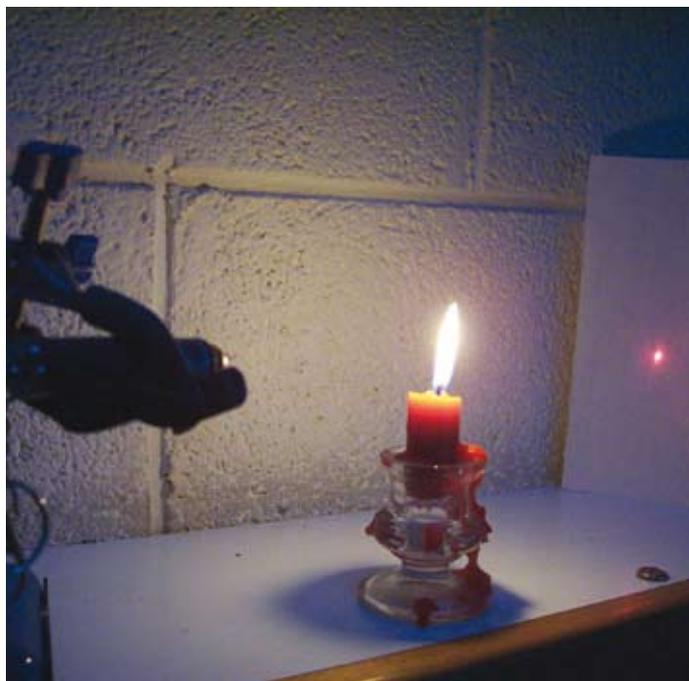
Follow these steps:

1. Set up the laser so that the beam passes over the candle flame.
2. Observe the spot on the distant screen.
3. Gently blow the flame.
4. The spot will visibly move.

So what happened?

Why should laser light and candlelight seem to interfere?

Laser light travels in a straight line when travelling through a medium of uniform refractive index. The heat from the flickering flame causes the density and the refractive index of the air to change, so the laser spot dances on the screen.



What next?

The demonstration describes clearly why stars twinkle. When you look at a star you are viewing it through the layers of the Earth's atmosphere. These layers have different densities and are not stationary. This causes the starlight to fluctuate.

Your very own piece of a black hole

Explore the refractive index of liquids.

You will need:

- a small, transparent tank
- a laser
- salt
- water
- a funnel and tubing
- a suitable exotic object

Background:

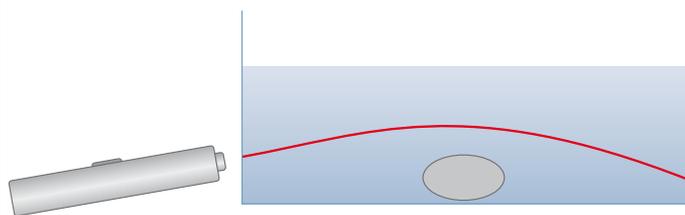
The speed of light varies with the density of materials.

Follow these steps:

1. Place the object at the bottom of the tank.
2. Half-fill the tank with water.
3. Make up a saturated salt solution by adding salt to water until no more dissolves. (The salt dissolves more rapidly in warm water.)
4. Using the funnel and tubing, carefully add the brine underneath the water already in the tank.
5. Position the laser to produce the desired curving of light.

So what happened?

The steady change in the concentration of the salt solution results in the gradual variation in the refractive index of the solution. The laser beam is slowly refracted and the light is curved downwards, giving the impression that the piece of black hole is bending the light.



Top and bottom: photographic and schematic representations of refraction.

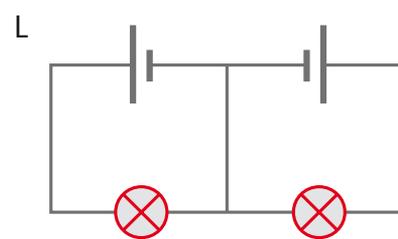
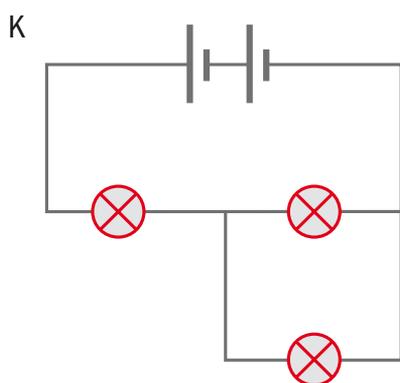
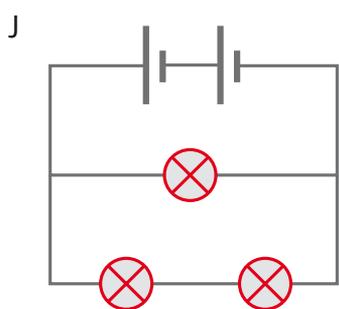
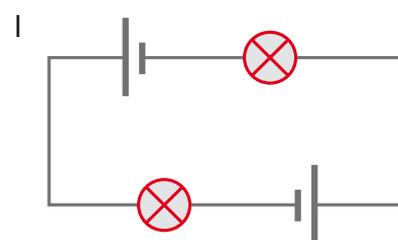
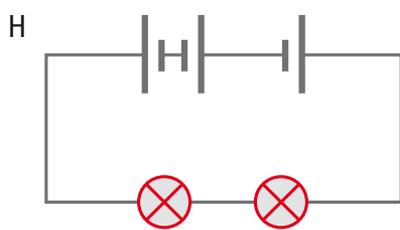
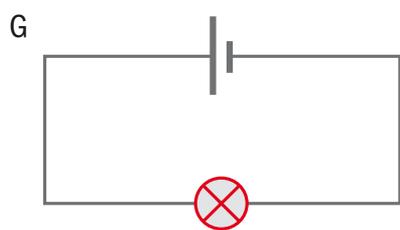
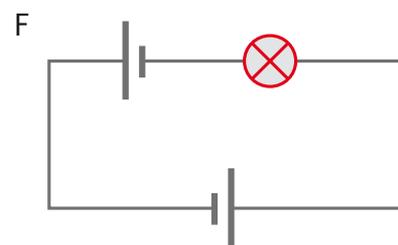
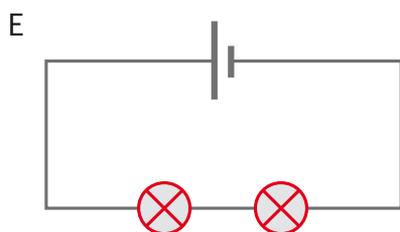
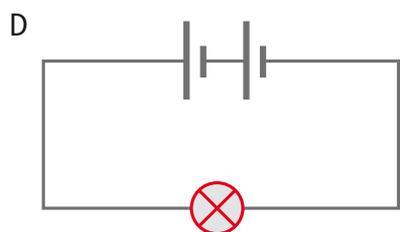
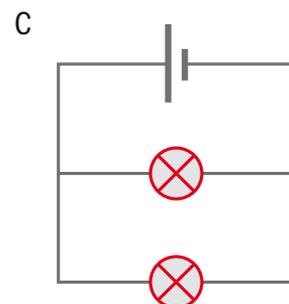
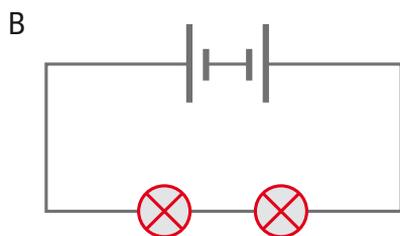
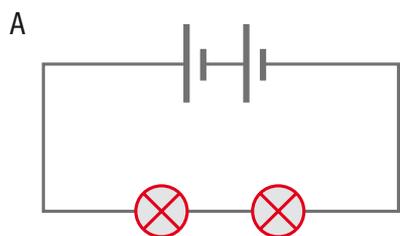
What next?

This demonstration can be used to explain:

- gravitational lensing;
- total internal reflection;
- the principle of the mirage (inverted).

Circuits quiz

Assume that all of the cells are the same and the lamps are identical.



If one cell lights one lamp to normal brightness:

1. Write next to each lamp whether it will be bright, normal, dim or won't work.
2. Highlight the circuits where the lamps are lit to the same brightness as in circuit A.

Note: circuits J, K and L are more difficult.