IOP | Institute of Physics
Education *Supporting Teachers*

Classroomphysics

The newsletter for affiliated schools

March 2014 Issue 28

Women in science

International Women's Day celebrates success and aims to inspire change

The theme for this year's International Women's Day is inspiring change, with attention given to celebrating the achievements of women and supporting more women into science, engineering and technology.

Last year, the Grant Thornton International Business Report revealed that globally more women were making it into senior positions of responsibility than at any time since 2010. Although female scientists are still under-represented in many fields, this year we can celebrate having four leading female scientists holding the role of president at the three scientific learned societies – Institute of Physics, Royal Society of Chemistry and Society of Biology – as well as at the Association of Science Education. Here is a brief introduction to each of these women.

Frances Saunders, Institute of Physics

Dr Frances Saunders started her career as an electronic engineer in the motor industry before joining the Royal Signals and Radar Establishment as a research scientist in liquid crystal devices.

In 2006, Frances became the first female chief executive of the Defence Science and Technology Laboratory (Dstl). Heading an organisation of 3500 scientists, she grew the Dstl's turnover from £360 m to more than £600 m.

Since leaving Dstl in 2012, Frances has focused on building a portfolio of activities promoting science, engineering and leadership, in particular for young people.

She has an adventurous streak, having flown a Harrier and abseiled into a frozen crevasse in Antarctica.

Lesley Yellowlees, Royal Society of Chemistry

Prof. Lesley Yellowlees completed both her BSc in chemical physics and her PhD in inorganic electrochemistry at the University of Edinburgh. After completing research positions in Brisbane, Australia, and Glasgow she returned to Edinburgh in 1986.

She is currently professor of inorganic electrochemistry, vice-principal and head of the College of Science and Engineering. She is a leading figure in the fields of spectro-electrochemistry and solar-energy research. Her other interests include the public engagement of science and the promotion of women in science.

Globally more women are making it into senior positions of responsibility

Nancy Rothwell, Society of Biology

Dame Prof. Nancy Rothwell trained in London as a physiologist and her current research aims to understand the mechanisms of brain disorders such as stroke and haemorrhage, and to develop new treatments.

She is president and the first female vice-chancellor of the University of Manchester, and professor of physiology. She has a strong interest and involvement in public engagement and education, and in government policy.

Alice Roberts, Association of Science Education

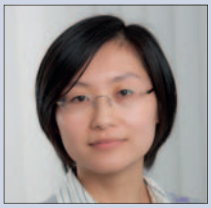
Prof. Alice Roberts is a clinical anatomist, author, broadcaster and professor of public engagement in science at the University of Birmingham.

She originally trained as a medical doctor, before becoming a university lecturer. She has a PhD in paleopathology (the study of disease in ancient human remains), and is a regular presenter on TV and radio programmes including *Horizon* and *Inside Science*.

The latest physics education news, resources and classroom ideas – from the IOP education team

In this issue

Editorial



Welcome to the spring edition of the newsletter. Affiliated schools will receive a copy of last year's schools and colleges lecture, "Defying Gravity: make physics your launch pad" and a promotional flyer for the Mission Discovery programme. This issue's p8 teaching tip links to the content in the talk.

We gave out hundreds of resources from our stand at the January ASE conference and led various workshop sessions throughout the three days, including a seminar on the Institute's *It's Different for Girls* report and hands-on workshops ranging from using football to explain physics concepts, to making the teaching of forces engaging through the use of toys.

If you weren't able to make it to the ASE conference, there will be plenty of opportunities to catch up with the Institute's education team at the many meetings that will be occurring in the summer term. Some of the largest day meetings organised for the physics teaching community are now open for bookings, including the Rugby Meeting (5 June) and the Sterling Meeting (21 May). For more details of these, see the events section on p7.

We have mentioned the Institute's work around encouraging more girls into physics in past newsletters, but in this edition we delve deeper highlighting the new *Closing Doors* report from the Institute (p3) and various events that are happening around the UK.

Our front-page article features an introduction to the current female presidents of the four scientific professional bodies. Dame Jocelyn Bell Burnell (who was the Institute's first female president from 2008 to 2011) has also recently been named as the first female president of the Royal Society of Edinburgh and will be taking up the post in October.

If you would like further copies of any of our resources, please e-mail education@iop.org.

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Breaking news

New project on improving gender balance

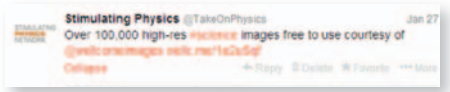
The Institute of Physics is due to announce two major projects to find ways of improving gender balance in the uptake of A-levels (in physics and across all subjects). We have developed a series of evidence-based pilot projects that we will be running in schools over the next two years. There will be a total of four strands of activity: working with students, working with teachers of physics, working with the whole school and a strand that is a combination of the first three. Having identified the problems and some of their causes in the two recent reports, we hope to find truly effective ways of tackling those problems, and take the influence of gender and gender identity out of students' decisions about their A-level subjects.

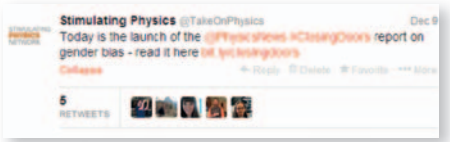
If you are interested in being a part of these projects (either individually or as a school), please contact Natasha Plaister (e-mail natasha.plaister@iop.org).

Social media

@TakeOnPhysics top tweets

The best of Stimulating Physics from December to January – sharing advice, events and ideas for teachers of physics.





Student event

Inaugural Women in Physics Day in Ireland

On 19 March, Queen's University Belfast and the Institute of Physics Ireland will be holding their first "Women in Physics Day". The event is focused on promoting physics among young women in Ireland. Women at various stages of their physics career (both from academia and industry) have been invited to participate in this event, offering a friendly atmosphere for all participants to share experiences.

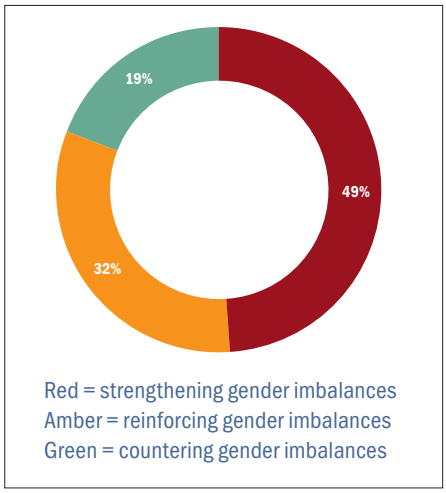
The event will be open to A-level, undergraduate, master and PhD students. It will start with registration at 9.30 a.m. in Whitla Hall, Queen's University Belfast, and will finish by 4.30 p.m. (or you can leave at 2.30 p.m.). The day will include talks, a poster session with prizes, a science fair sponsored by Seagate, as well as demonstrations and hands-on experiments for everyone to enjoy. Prof. Jocelyn Bell Burnell, discoverer of the first radio pulsars, will also be speaking.

For more information: and to book places at the event, contact Miryam Arredondo (e-mail mp.outreach@qub.ac.uk).

Girls in Physics

IOP report explores gender and subject choice

The *Closing Doors* report used the National Pupil Database to look at progression to A-level in six gendered subjects and unearthed a range of worrying findings. The report found that 81% of co-educational, state-funded schools across England are strengthening or reinforcing gender imbalances in terms of subject choice, while fewer than one in five (19%) are countering them.

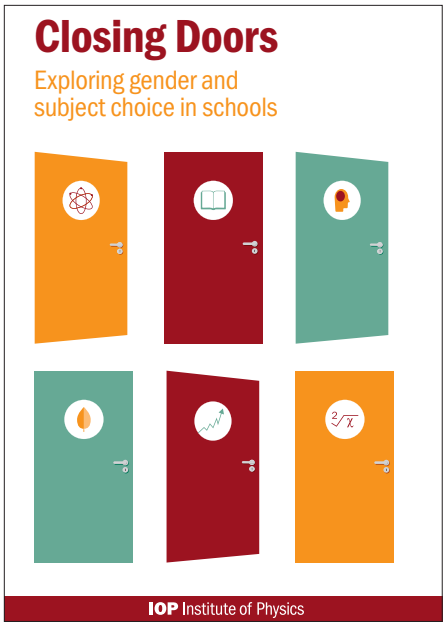


Closing Doors investigates six subjects – physics, maths and economics as three that show a male bias; and biology, English and psychology as three that show a female bias. Although individual teachers are clearly important, the evidence strongly suggests that it is the school culture that determines whether the damaging effects of gender imbalances are overcome or at least reduced.

Earlier research, undertaken for IOP's *It's Different for Girls* report, showed that single-sex schools are significantly better than co-educational ones at countering gender imbalances. This report corroborates that finding and shows that both co-ed schools with sixth forms and independent co-ed schools also fare better at overcoming gender stereotyping.

Prof. Peter Main, Director of Education and Science at IOP, said: "We are highlighting these findings to encourage schools to think seriously about gender balance. Leaving gender stereotypes unchallenged creates unfair and unnecessary barriers, and stops students achieving their full potential.

"We found that where a school is good at overcoming an imbalance in one subject, they are usually good at doing so in all of the other five subjects. And, although the national picture is dismal, there is a silver lining in that some schools have demonstrated that they have been able to overcome these barriers. Other schools need to learn from these examples."



The report recommends that schools reflect on their own statistics and put in place whole-school measures to counter gender stereotyping.

For more information: and to download copies of the report, go to www.iop.org/closingdoors. To request a print copy of the report, e-mail education@iop.org.

Resources

IOP launches new quantum physics site

At the end of December 2013, the Institute launched its newest curriculum project for higher education: quantumphysics.iop.org. Although the site is aimed at undergraduate tutors and students, this free learning resource can also be used to interest and develop more-able sixth-form students, and also help teachers at secondary level to refresh their familiarity with the topic.

To allow multiple routes through the site, information has been presented as ~80 short articles, all introduced as a question, e.g. What is a photon?, How do atomic clocks work? What is quantum cryptography? These articles are complemented by 17 interactive simulations, a commissioned glossary, further-reading suggestions and a set of problems (with solutions available to tutors).

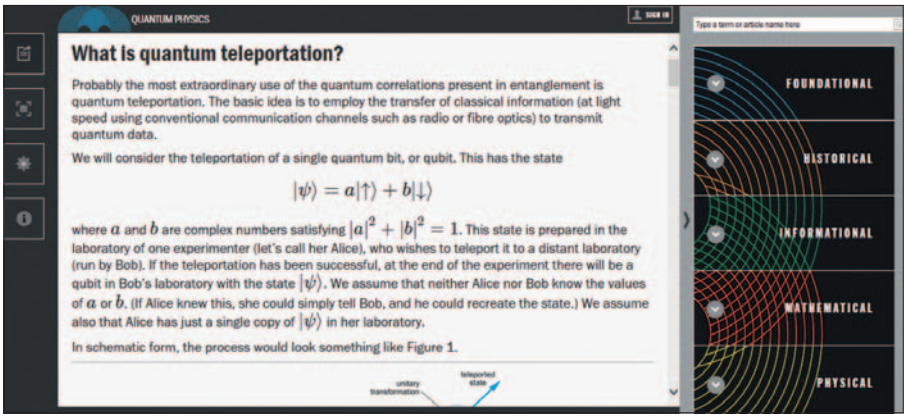
"I think I can safely say that nobody understands quantum mechanics," Richard Feynman *The Character of Physical Law* 1965.

This resource acknowledges the difficulty of this topic. By encouraging users to rate their understanding of articles (on a nine-point scale) as they move around the site, this rating then provides a useful navigation and learning aid – helping users to visualise the areas that they are finding most difficult, and encouraging revisits and wider reading around the articles.

The site is also unique because it allows users to choose their own path through the material. It offers five themes: foundational, historical, informational, mathematical and physical. These are a reordering of the same content – encouraging users to select the route that feels most accessible to them.

All material on the site is free to access once you have completed a short registration, and all material is licensed to encourage sharing and distribution of the materials, with the requirement that the original source is cited as quantumphysics.iop.org.

For more information: please contact Christina Walker in the IOP Higher Education team (e-mail quantumphysics@iop.org).



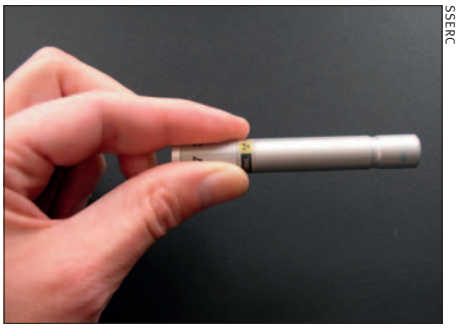
A sample page from the quantumphysics.iop.org website.

Health and safety

Scottish Radiation Protection Adviser services

In the last issue of this newsletter there was an article on the Radiation Protection Adviser (RPA) services offered by CLEAPSS. What some readers may not realise is that in Scotland these services are supplied by SSERC, the Scottish Schools Education Research Centre. All local authority schools in Scotland are SSERC members, as are the majority of independent schools and a number of FE colleges.

SSERC gives advice on all aspects of engaging, effective, safe practical science and technology in schools. The RPA service is included as part of membership. It is worth noting that while the laws governing the use of radioactive material in schools



SSERC

SSERC advises on the safe and effective use of radioactive sources in Scottish schools.

are similar throughout the UK, there are some differences. For example, a letter of approval from the Scottish government is still required if a school decides to purchase a source.

As well as providing an RPA service, SSERC supports the use of radioactive sources in schools by running training courses. Details can be found on the website at www.sserc.org.uk. Two courses are scheduled per year and members can request tailor-made events for their schools.

For more information: visit www.sserc.org.uk. The current RPA for Scottish schools is Jim Jamieson, but enquiries should be made to Gregor Steele (call 01383 626070 or e-mail gregor.steele@sserc.org.uk).

Student awards

Have your students done some amazing work?

Are you planning on developing project work in your school? If so, make sure that you and your students get the credit you deserve by registering their projects with the British Science Association's CREST Awards Scheme. UK-wide and endorsed by UCAS for inclusion in students' personal statements, CREST Awards are well regarded, high quality and a tangible recognition of success.

There are four different levels of CREST Award – Discovery, Bronze, Silver and Gold – which involve anything from five to 70+ hours of project work. They can involve designing, investigating or communicating, and cover any area of science, technology, engineering or maths.

CREST can also link into work-experience placements, after-school clubs or numerous other accredited schemes. Last year, more than 30,000 students embarked on a CREST Award and many CREST students go on to enter their projects into the National Science & Engineering Competition.

For more information: on CREST-linked schemes and how to register visit www.britishscienceassociation.org/CREST. You can also read one student's inspiring story at www.britishscienceassociation.org/blog/discovering-my-passion-science.

British Science Association

Holly, CREST Gold Award student, with her project "Cosmic Rain: Investigating Particles from Space".

Resources

Isaac Newton's life comes to the radio

We all know about Newton's work on motion, gravity, mathematics, astronomy and optics. His ideas and their applications pervade modern life as well as the school science curriculum. But what about his personal struggles, inner feelings, dilemmas, eccentricities and conflicts with other scientists?

Isaac Newton: A Life Scientific is a series of four "radio plays", written by an IOP member of the Lancashire and Cumbria Branch with support from award-winning writer Kevin Dyer, and performed and recorded with IOP funding by members of the Duke's Theatre, Lancaster. The plays address his life and work in an educational and entertaining way.

The stories, "Inertia", "Force", "Reaction" and "Gravity" feature Newton's four laws, as well as his life as a boy in Woolsthorpe in Cambridge and as a Fellow of the Royal Society, against a backdrop of late 17th-century society and prejudice against women.

Wellcome Library, London

Oil painting of Sir Isaac Newton (1642–1727).

Initial reactions from IOP members, teachers and students have been positive: "The stories paint an evocative pastiche of Newton's work and the supporting characters do an excellent job of illuminating the various aspects of his personality. The voice acting was good and the ambient sound creates a nice sense of location and atmosphere."

The target audience is 13+ years old and each story will fit into a typical science lesson. They may also be of interest to drama teachers and the full scripts are available on request.

For more information: and to listen to the stories visit www.iop.org/resources/videos/education/newton/page_62377.html and to give feedback on the resource contact Bob Jones (e-mail jonesr1522@gmail.com).

Practical work

Ensure practical science remains a priority

UK schools carry out some of the best science practical work in the world, but this needs appropriate space, equipment and technical staff. As either a teacher or technician you will be facing increasingly difficult decisions about how to spend your budget. To help you make the most of your money, SCORE (a policy partnership of the Association for Science Education, Society of Biology, Royal Society of Chemistry, the Institute of Physics and Royal Society) has produced a series of tools for science departments.

These tools were the result of a significant research project into Resourcing School Science and include:

Royal Society

SCORE offers a tool kit for science departments.

- an equipment and consumables checklist organised by key stage and class size;
- a means for reviewing access to outside space for science teaching;
- guidance on the number, type and specification of the laboratories you need;
- a tool to review levels of technician staffing.

These tools can be used in a number of ways: to create an inventory and review current stock; to plan a rolling programme of replacement; to help with budget forecasting and procurement planning; to assist with planning new laboratories; and to engage senior leadership in recognising the needs of your science department.

For more information: visit http://score-education.org/publications/publications-resourcing-benchmarks.

Resources

Coronas, cupcakes and communication

Students from Eastlea Community School in Newham have written the science book *A Big Ball of Fire*, which is now available to download for free from the iTunes store (bit.ly/1iLC66F).

The young science communicators aged 12 and 13 started the project last March; they identified readers' interests and researched the solar-physics questions that they would pose within the book. Dr Helen Mason and Prof. Carolin Crawford from the University of Cambridge, and Dr Lucie Green from UCL's Mullard Space Science Laboratory provided expert input into their project.

The result is an interactive book filled with illustrations, images, videos, quizzes and fun craft activities (such as baking Sun-themed cupcakes to inspire interest in the topic).

Students were given the opportunity to visit the Institute of Astronomy at the University of Cambridge to research the topic, and interview astronomy and astrophysics students. The young authors took part in the creation of solar flares, as well as Sun and sunspot observations.

NASA

The Sun in the ultraviolet (in helium emission) taken by SDO/AIA.

Heather MacRae from Venture Thinking, who helped the students to develop the project, said: "*A Big Ball of Fire* has been a terrific learning experience. Helen, Lucie and Carolin have shared ideas and content, but the students have been the authors and editors. They have made solar physics accessible and engaging through hands-on activities, exciting images, and informal interviews and quizzes."

The book will be launched on 7 March 2014 as part of National Astronomy Week at the Technopop exhibition held at Queen Elizabeth Park, London.

For more information: visit bit.ly/1iLC66F to download a copy of the book and visit www.technopop.co.uk for details of the exhibition. Tickets for the launch event can be obtained by contacting Heather MacRae, Venture Thinking (e-mail heather@venturethinking.com).

Resources

Advising the engineers of the future

Tomorrow's Engineers is a careers programme that aims to engage young people, aged primarily between 11 and 14, in engineering. With input from professional engineering institutions, Tomorrow's Engineers produces a range of inspiring careers materials to inform students about the routes into engineering and the subjects that are needed, particularly maths and physics.

The resources include a "What is Engineering?" presentation, career route maps, postcards and leaflets for students, information for parents, and a resource pack for teachers. All of these resources can be downloaded via the Tomorrow's Engineers website. A hard copy of the publications can also be requested and sent to teachers free.

Tomorrow's Engineers produces a range of inspiring careers materials to inform students about the routes into engineering

For more information: visit www.tomorrowsengineers.org.uk/Careers_resources/.

Tomorrow's Engineers

Career resources available from the Tomorrow's Engineers programme.

Student event

Girls' engineering discovery workshop

The UK will need 87,000 engineers qualified at level 4+ and 69,000 qualified at level 3 in each year between now and 2020 to meet demand in the industry. An engineering technician apprenticeship is an increasingly popular entry route into the profession because young people can earn while they learn, acquiring highly sought-after work experience before going on to study for a degree at a later stage if they choose to.

How much do you know about the wealth of exciting opportunities open to young people to work as technician engineers in the built environment? Too many people – especially girls – dismiss engineering and construction as dirty, boring or not for them. WISE has organised a special event for girls, parents and teachers to meet young women who have chosen a career in engineering, to find out what they actually do and why they love their jobs. The next Building Your Future morning will be held on Saturday 15 March from 10.30 a.m. to 1.00 p.m. at the First Direct Arena in Leeds.

This event is targeted at girls aged 15–22 who have or are likely to achieve at least five GCSEs at grade A*–C, including English, maths and at least one science subject. Girls who like finding out how things work, enjoy solving problems, and are creative, great communicators and team players would do well in engineering and the built environment.

WISE

Students attending a WISE Building your Future event in London.

For more information: and to book a place at the event, visit www.wisecampaign.org.uk/events.

Teacher event

Science on Stage comes to London in 2015

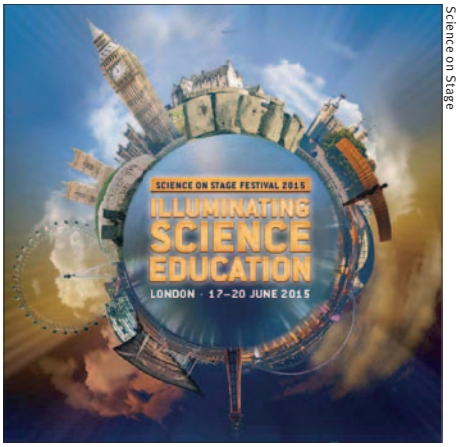
Since 2000, teachers from Europe and Canada have met every other year to participate in the international Science on Stage festivals to showcase innovative and inspirational teaching methods.

The next festival will take place in June 2015 at Queen Mary University of London and the organising committee is looking for innovative teaching ideas in science and mathematics. Good practice will be highlighted through workshops, seminars and some on-stage performances by keynote speakers and teachers.

Places are available for teachers in any STEM subject, primary or secondary – both newly qualified or experienced teachers. Applications can be made via the website: www.qmul.ac.uk/scienceonstage/apply.

More and more participants every year appreciate the opportunity to exchange experiences with colleagues: "I was absolutely overwhelmed by the presenters' and participants' love and enthusiasm for a wide variety of subject areas in science. I picked up so many different teaching and learning ideas at the festival that I am now implementing in my teaching of science... not to mention all of my new science friends I made along the way." (Maeve Liston, Irish teacher)

For more information: visit http://science-on-stage.eu.



Science on Stage

350 teachers from all over Europe will present their most innovative teaching ideas.

Student event

Programme inspires girls who love STEM

The Engineering Development Trust organises Inspire courses for Year 11/S4 girls who are passionate about STEM, supporting them in the transition from secondary to sixth-form. Each three-day, university-based course consists of a hands-on engineering project and a programme of "essential skills" development in: being organised; managing time effectively and efficiently; enhancing research and revision techniques; developing presentation techniques; writing class reports; taking useful notes; running successful projects; and being an invaluable member of a team.

There is a modest charge for the course, but Inspire students are given priority when applying in Year 12 for a place on the Headstart scheme, where they gain training in how to refine their UCAS application.

For more information: visit www.etrust.org.uk/headstart/inspire_year_11_girls_courses.cfm.

EVENTS FOR TEACHERS

Talk Science teachers' course
National Railway Museum, York
13 March
A free, one-day CPD workshop giving tools and techniques for classroom discussion about science. Details and booking: www.sciencemuseum.org.uk/talkscienceteachercourse.

Teacher Zone at Science Museum Lates
Science Museum London
26 March
VIP area exclusively for teachers with activities, drinks and nibbles. Details: www.sciencemuseum.org.uk/teacherzone.

A Day of CPD for Teachers and Technicians
Highgate School, London
29 March
Free event where you can choose four workshops, network with other teachers/technicians, and take away resources. Details and booking: contact Louise Tulip (e-mail louise.tulip@ioe.ac.uk).

Talk Science teachers' course
National Media Museum, Bradford
8 May
A free, one-day CPD workshop giving tools and techniques for classroom discussion about science. Details and booking: www.sciencemuseum.org.uk/talkscienceteachercourse.

40th Stirling Physics Meeting
University of Stirling
21 May
A meeting that will bring you into contact with the latest thinking in physics and physics education, and with colleagues from throughout Scotland. Details and booking: visit www.stirlingmeeting.org.

Rugby Meeting
Rugby School, Warwickshire
5 June
The 26th annual meeting for teachers of physics in schools and colleges will feature lectures given by leading research physicists and physics education experts, hands-on workshops and an extensive exhibition area. Details and booking: visit www.iop.org/rugby.

Space as a Context for Teaching Science
Rutherford Appleton Laboratory, Oxford, and National Science Learning Centre, York
8–10 June and 21 October
Learn from the scientists and engineers involved in one of the most important space missions to be launched this decade: the Gaia spacecraft mission to map the Milky Way. Details and booking: http://tinyurl.com/oox3qzd.

PHYSICS TEACHER NETWORK
England • Ireland • Scotland • Wales

As well as the national events detailed here, don't forget that the Institute's Teacher Network also runs local workshops for teachers all around the UK and Ireland. These twilight sessions are a great chance to get new ideas, pick up free resources and meet up with other local teachers. The network runs workshops on a variety of different themes, some focusing on new ideas for teaching a specific topic, and some "make-and-take" workshops that allow you to put together and take away a fantastic bit of kit – including homemade rocket launchers and cloud chambers. To find out what's on in your area, visit the education calendar on the IOP website at www.iop.org/events/education.

Teacher Network for North Wales Conference
Bangor University
18 June
Dr Jonathan Hare from BBC/OU Rough Science will be giving a talk on "Hollywood Science". Other workshop topics include "make-and-take", wind turbines, WJEC and lots more. Details and booking: contact Andrea Fesmer (e-mail andrea.fesmer@talk21.com).

The Day for Everyone Teaching Physics
Durham University
19 June
A free day of workshops and lectures (subsidised by IOP), including trebuchets and the best of *Physics Education*. Details and booking: contact Alex Brabbs (e-mail alex.brabbs@iop.org).

Talk Science teachers' course
Science Museum, London
3 July
A free, one-day CPD workshop giving tools and techniques for classroom discussion about science. Details and booking: www.sciencemuseum.org.uk/talkscienceteachercourse.

Physics CPD for Specialists
National Space Centre, Leicester
11 July
This course will cover a range of strategies, tools and resources focusing on planetary exploration and Earth-observation platforms. Details and booking: contact the National Space Academy administrator (e-mail nsa@spacecentre.co.uk or call 0116 2582147).

Summer Physics Update
University of Kent
18–20 July
This three-day residential course will feature a mixture of talks and practical workshops with ample opportunity to share classroom experiences with fellow physics teachers. Details and booking: www.iop.org/update.

EVENTS FOR STUDENTS

National Astronomy Week
Nationwide
1–8 March
This is a great opportunity to promote astronomy and the night sky to young minds. Information packs, guides for organising events, lesson plans and further details are available. Details: visit www.astronomyweek.org.uk or contact the NAW co-ordinator (e-mail naw214@the-observatory.org).

Big Bang Fair
The NEC, Birmingham
13–16 March
Organisers aim to welcome around 75,000 people to this free science and engineering fair. The event hosts an array of activities and live performances, with the first two days open to school groups and the weekend open to families. Details and booking: visit www.thebigbangfair.co.uk.

National Science & Engineering Week
Nationwide
14–23 March
National Science & Engineering Week highlights how the sciences, technology, engineering and maths relate to our everyday lives, and helps to inspire the next generation of scientists and engineers. Details: visit www.britishscienceassociation.org/national-science-engineering-week.

Collider: Step inside the world's greatest experiment
Science Museum, London
Until 30 April
Transporting visitors into the heart of one of the greatest scientific experiments of our times, Collider will provide a behind-the-scenes look at the famous CERN particle-physics laboratory. Details and booking: visit www.sciencemuseum.org.uk or call 020 7942 4777.

Year 10 Careers Event Day
National Space Centre, Leicester
16 and 30 June
This free event is aimed at students who are interested in taking up the sciences at A-level, and aims to broaden their view of what scientists and engineers do. Details and booking: contact the National Space Academy administrator (e-mail nsa@spacecentre.co.uk or call 0116 2582147).

Defying gravity: A demonstration of apparent weightlessness

Included with this issue of *Classroom Physics* is a DVD of the Institute's 2013 Schools and College Lecture "Defying Gravity", presented by Laura Thomas, an independent science communicator with a background in astrophysics. As well as covering the history and future of space flight it also explores why objects on the International Space Station appear to have no weight. The experiment below helps students develop a better understanding of this difficult concept.

Overview

This demonstration shows that it is not possible to measure the weight of a body in free-fall using a forcemeter.

Apparatus and materials

- Forcemeter, reading at least 10 N
- Mass, 1 kg
- Digital camera or video camera
- Lamp

Health and safety, and technical notes

If it is necessary for the student dropping the forcemeter to stand on something, a "kick-stool" as used in libraries or store rooms would be safest. Do not allow other students to stand close to the stool.

It is a good idea to highlight the pointer so that it shows brightly in photographs. Paint it white or cover it in foil.

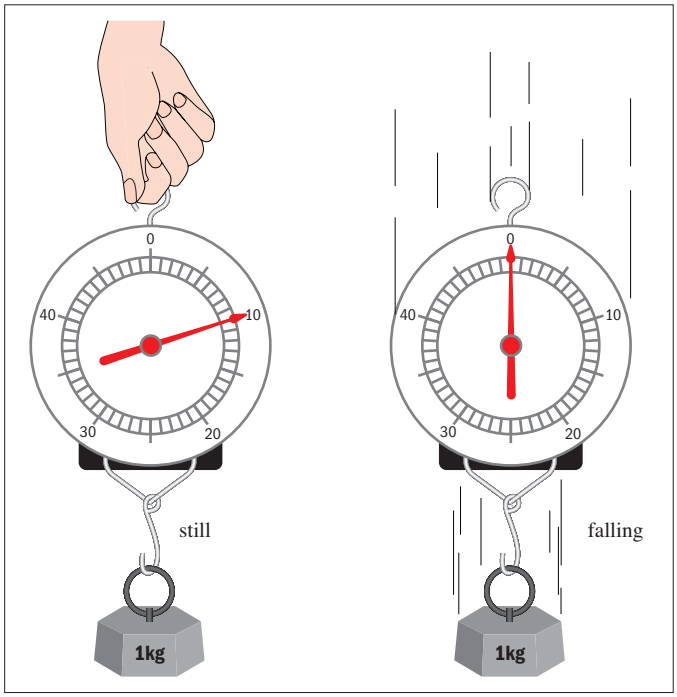
This activity is suitable for multi-flash treatment. Or you could make a video and play it back frame by frame.

Procedure

- Hang the kilogram mass from the forcemeter and get a student to drop it onto a cushion or a blanket held by other students.
- Take a photograph of the falling apparatus. Also, ask students whether they can see what the balance reads while dropping. Repeat this several times, so that students can look again and so that you have a collection of photographs.
- Use the forcemeter readings in the photographs as the starting point for discussion.

Teaching notes

1. The forcemeter shows a reading equal to the weight of the mass when the mass simply hangs from it. The extended spring exerts an upwards force, which balances the downwards weight.



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The forcemeter reads zero during the fall (ignoring oscillations of the spring due to disturbance on release). Gravity has not been switched off, however, and the mass is still subject to a downwards force. It still has weight, we just can't measure the weight using the forcemeter.

2. When you release the system, oscillation of the spring can produce unwanted motion of the pointer. Try to take photographs during the latter part of the fall, and take photographs of several falls. This will show that there is little pattern to these motions.

Extra features

The School Lecture DVD includes a number of short clips as part of the extra features menu, which can be used to build on the concepts explored in the above demonstration. For example:

- Start with one of clips 1–4 made onboard the International Space Station to illustrate weightless conditions in orbit.
- Show clip 5 to promote discussion about how our perception of weight depends on our viewpoint.
- Finish with clip 6 to link orbital motion and apparent weightlessness.

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