IOP | Institute of Physics
Education *Supporting Teachers*

Classroomphysics

The newsletter for affiliated schools

March 2013 Issue 24

Policy

IOP responds to curriculum changes

Major changes are coming to all levels of the school curriculum in England with knock-on effects in Wales and Northern Ireland. Things are changing rapidly, with the education secretary Michael Gove announcing the introduction of new A-levels on 23 January and the launch of consultations on the National Curriculum (KS1–3) and school performance measures on 7 February. The Institute responds to consultations and requests for evidence, largely through the policy partnership SCORE (Science Community Representing Education). We want to respond in ways that support a healthy future for physics and take account of the views of practising teachers.

A-levels

Last year Ofqual ran a consultation about A-levels and the Institute responded through SCORE. The proposals are radical: not only are A-levels going to be revised, the process itself is being changed. The Qualifications and Curriculum Development Agency (who previously produced the subject criteria) no longer exists and the government would like higher education to have more input into A-levels. Our concern is that specifications will diverge and we are proposing that there should be national subject committees that oversee core content. We are also worried about the timing. The government's intention was to phase in the new A-levels from 2014 – with physics in the first phase. We expressed serious reservations about the haste and the damaging effect that phasing could have on the uptake and reputation of physics. The introduction of new A-levels has now been announced for 2015, with Russell Group universities helping to devise the academic content. AS levels are to be

IOP

The schools' curriculum is set to change.

an exam worth half an A-level but will not be a stepping stone to A-level. The new A-levels are now likely to coincide with the introduction of the new GCSEs in England.

Reform of GCSEs

Major changes are also planned for assessment at the end of KS4. Some subjects (including the sciences) are to become part of a new portfolio qualification: the English Baccalaureate (EBacc). The EBacc subjects nearly became part of a new qualification – the EBC. However, there was strong opposition expressed in response to the consultation, by Ofqual and by the Education Select Committee. So the secretary of state has proposed the retention of GCSEs for all subjects – including the EBacc ones. However, GCSEs will be revised so as to be more challenging and there will be only one tier (although it is possible that there will be extension papers in the terminal assessments). The new GCSEs will be taught from 2015.

We want to respond in ways that support a healthy future for physics and take account of the views of practising teachers.

Be heard

The proposals are part of a consultation on school performance measures that will run until the 1 May. There is also a live consultation on the new National Curriculum up to KS3 running until 16 April. These consultations provide an opportunity for you to make your views known. There are two ways that you can do this: you can respond directly to the government's consultation and/or you can join and contribute to the Institute's Education Forum. The Forum is our link with teachers through which we exchange, develop and collect views about policy changes. Much of the discussion takes place remotely on *talkphysics.org*. We also get together periodically to deepen the discussions and to get to know each other. Now would be a good time to get involved.

Charles Tracy,
head of education, pre-19

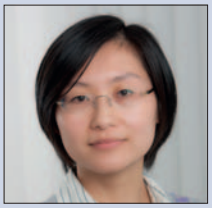
For more information: contact Manchi Chung (e-mail manchi.chung@iop.org).

- For SCORE's response to the Ofqual A-level consultation, see bit.ly/scorealevelresponse.
- For SCORE's response to the DfE KS4 qualifications consultation, see bit.ly/scoreks4response.
- For more details on the Institute's Education Forum, see iop.org/educationforum.

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

In this issue

Editorial



Welcome to the first edition of *Classroom Physics* for 2013. The lead article outlines how the Institute responds to government consultations and where your opinions could fit into those responses. If you are in an affiliated school or an individual member, join our Education Forum if you want your opinions to count. There is also a copy of our 2013 education brochure accompanying this edition of the newsletter. *The Classroom and Beyond* details all the resources and support the education department offers.

As ever, there is plenty of news of new resources and projects to support your teaching. Affiliated schools will receive a DVD of last year's Schools and Colleges Lecture, "Physics and the Games: a winning formula". Our teaching tips also have a sports theme. We have had our popular stickers redesigned to feature Marvin and Milo and link more directly to our reward postcards – we hope you find them entertaining and useful. We are also promoting the *Voicebox* resources again and would welcome feedback if you have found them useful.

The cost of our affiliation scheme has not risen for three years, but reluctantly we have decided to raise it slightly in 2013 – from £45 to £48 (€58 to €60 in the Republic of Ireland) – to be able to offer the same level of support and free resources to affiliated institutions.

We had a successful presence at the ASE Annual Conference in Reading in January and it was nice to meet and chat with many of you on our exhibition stand. Our seven sessions at the conference were all well attended and received. We look forward to meeting many more of you at the one-day IOP conferences being held around the country. For more details of these, see the events page, or the education calendar on the IOP website.

If you would like further copies of the resources described in our brochure, e-mail education@iop.org. Comments and feedback are always appreciated.

Clare Thomson, editor (tel (0)20 7470 4981, e-mail clare.thomson@iop.org)

Manchi Chung, assistant editor (e-mail manchi.chung@iop.org)

George Watson's College

Girls are encouraged to explore physics and engineering careers.

News

Buzz at girls-in-physics event

On 31 October 2012, the fourth annual event to promote the uptake of physics and engineering by girls was held at George Watson's College, Edinburgh. Starting from small beginnings, the event has grown steadily over the years with around 160 girls from across the Scottish Central Belt in attendance last year.

The programme included a short talk by guest speaker Dr Moira Jardine, St Andrews University, explaining why she had chosen physics – in particular astronomy – and workshops were provided by St Andrews, Strathclyde, Edinburgh and Heriot-Watt universities, SSERC, IET, ICE, Selex, The Hydrogen Office, and the Territorial Army.

The girls, working in groups, attended seven workshops. Activities included working with liquid nitrogen, constructing model bridges and testing their strength, building and using small hydrogen fuel cells to run model cars, investigating the properties of light, using physics in health monitoring, and learning to work as a team.

The day closed with a panel session where some of the workshop presenters answered questions about their career choices and current roles. It was obvious from the buzz in the hall and the questions and feedback from both staff and girls that this event was very worthwhile and encouraged girls to consider physics for their career path.

For more information: for details of the 2013 event contact Gail Millar (e-mail gailemillar@gmail.com).

Resources

Teaching approaches

The Nuffield Foundation has published a new set of resources to support the teaching of practical science as part of their *Practical Work for Learning* project. They cover topics from physics, chemistry and biology and are suitable for KS3 to KS5.

Most teachers would agree that practical work is an essential part of effective science education. However, practical work does not in itself necessarily improve learning. The effectiveness of practical lessons depends on the teaching approaches employed.

This project explores how effective teaching and learning approaches in science education can be applied to practical work.

Three approaches are exemplified:

- Argumentation – the process of developing, discussing and evaluating scientific arguments. Small-group discussion activities encourage the development and evaluation of arguments.
- Model-based inquiry – based on the generating, testing and revising of scientific models. Various ways of structuring model-based inquiry lessons are outlined.
- Science in the workplace – developing students' understanding by integrating careers information into science lessons. Clear links are made between what students do in the classroom and the activities of scientists and those who use science in their work.

For each approach there is an introduction, links to the research base and a collection of ready-to-use lesson plans and resources.

For more information: visit www.nuffieldfoundation.org/practicalscience.

Online project

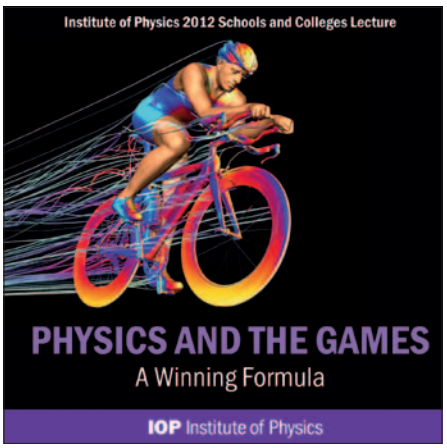
Looking for enrichment?

Sign up for the UK's largest online engagement project – *I'm a Scientist, Get me out of here!* enables school students to talk directly with practising scientists. Details on how to register are on the two postcards included with this issue of *Classroom Physics*. Post-16 students can take part independently in the IOP-sponsored medical physics or space zones by joining the Institute for free via www.iop.org/16-19.

Lecture

IOP's demonstration-packed schools' lecture

Affiliated schools will receive a DVD of the 2012 Schools and Colleges Lecture "Physics and the Games: a winning formula" with this issue of *Classroom Physics*. The lecture looks at how sports scientists and athletes use physics when analysing performance, designing equipment and developing tactics. It is presented by Dr David James and a team of sports engineers from Sheffield Hallam University's Centre for Sports Engineering Research. The centre is a world-leader in the field of sports engineering. In the build-up to the London 2012 Olympic Games, it provided technological support across many sports, such as swimming, diving, boxing and gymnastics.



From athletic performances...

Dr James covers a range of topics, focusing on athletics and cycling. He puts together an equation that shows how Usain Bolt, the fastest sprinter in the world, could also break records in the long jump if he were so inclined (see pp7&8 for some teaching tips based on this). He also explores how an understanding of aerodynamics has led cyclists to adopt the tactic of "drafting" during races.

The lecture ends by looking at the controversy over whether the athlete Oscar Pistorius, a double amputee who runs on prosthetic legs, has an unfair advantage over able-bodied athletes. Pistorius has been ruled eligible to compete, but Dr James suggests that sports engineers may soon be able to develop powered prosthetic limbs that allow amputees to run faster than any able-bodied athlete.

Also included on the DVD are several short films made by *Physics World*. The films feature Professor Steve Haake, director of the Centre for Sports Engineering Research, discussing the physics involved in cycling, running and swimming.

...to defying gravity

This year's Schools and Colleges Lecture, "Defying gravity: make physics your launchpad", will reveal how physics has allowed us to travel into space and how entrepreneurs are opening up space to new generations through space tourism.

For more information: on this year's schools-lecture tour dates and venues, visit www.iop.org/schoolslecture. The lecture is free but there are limited places available at each venue, so booking ahead is essential.

Resources

Voice your opinions on a sound resource

Two years ago your school or college may have received a copy of the SEP resource pack *Voicebox: The Physics and Evolution of Speech*. We are now looking to gather feedback on how it has been received by teachers. If you have incorporated any aspect of the resource into your lessons we would be very interested in your views, so take a few minutes to fill in our online survey available at bit.ly/iopvoicebox.

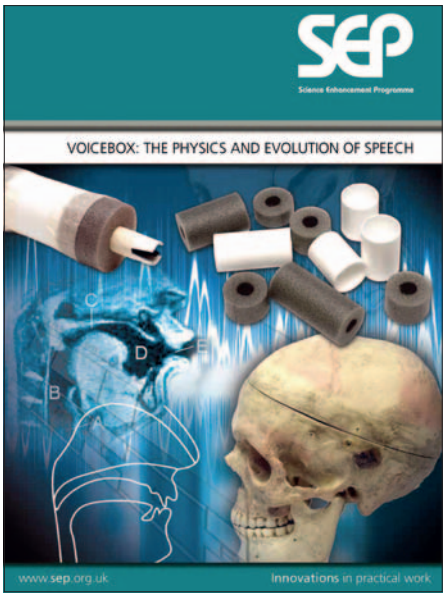
At the end of the online survey you will have the opportunity to volunteer to take part in a telephone interview. As a "thank you" we will be sending out £10 gift vouchers to teachers who participate in the telephone interview.

If you are unfamiliar with the *Voicebox* resource, it outlines a set of practical activities that have been designed to encourage students to understand human speech at a basic level.

Human vocalisation is unique in the animal world. Scientists study the anatomy and physiology of human speech, as well as how it evolved historically to make humans so different from all other animals.

The practical activities and interactive software can be used flexibly, as a circus or as a mix of student practical activities and teacher demonstrations, to provide students with an interesting context for sound lessons.

For more information: to order additional copies of the *Voicebox* publication for your school or college, e-mail education@iop.org, or visit www.iop.org/voicebox to download the resources.



Have you found the Voicebox: The Physics and Evolution of Speech resource pack useful?

Competition

Get set and demonstrate

The National Science & Engineering Week team are on the hunt for the best science demonstration ideas. Simply submit your idea as a video clip via the "Get set demonstrate" website.

The focus will be on the quality of the idea – not the video – and the very best will be transformed into a high-quality, free resource to be used by the science teaching community.

Get set... demonstrate
Running inspiring science demos

Every teacher or technician who submits a demonstration idea will be entered into two prize draws to win great science prizes for their school, including free access to Twig World resources and renewable energy kits from Timstar Laboratory Supplies. The competition closes on 1 April 2013 and the prize draws will take place on 15 February and 1 April 2013.

This initiative is funded by The Gatsby Charitable Foundation and supported by the Society of Biology, the Royal Society of Chemistry and the Institute of Physics, who along with experienced teachers, technicians and science demonstrators will be picking the best demonstrations.

For more information: visit www.britishscienceassociation.org/get-set.

Awareness days

Study physics? First Edition does 1st-class job

Education charity EDT (the Engineering Development Trust) has established First Edition days, which are designed to make young people aged 11–16 aware that STEM careers are an option, and inspire them with practical challenges that link the science classroom to the world around them.

A typical experience is that of Mike Hancock, teacher at Hinchingbrooke School in Huntingdon: "The EDT day at Essex University allowed pupils to look at the range of careers in science and engineering while trying some inspiring hands-on activities, at a time when they were making important decisions about their subject options and potential careers. The main focus was researching our carbon footprint and looking at alternative sources of energy – in this case solar power and renewable energy. We discussed ways of harnessing the Sun's power and then the pupils had to design their own solar oven and test it by trying to heat a mug of water. I have taken three classes to First Edition days and they have changed the perspectives of many pupils, possibly setting them on a path towards a STEM career and making them consider university."

EDT

Students taking part in an EDT Celebration and Assessment Day (CAD).

First Edition days are being held in Cheltenham, Newcastle upon Tyne, Shropshire, Leicester, Bradford and Guildford between March and June 2013.

For more information: visit www.etrust.org.uk or tel (0)1707 871 504.

Funding

Grants for schools to work with physicists

The Royal Society's Partnership Grants scheme is now open. Schools can apply for up to £3,000 to work with scientists and engineers on creative investigations. Funds are available for projects that engage with students aged 5–18 years old, as long as the project involves a UK school or college, and a practising scientist or engineer.

What are the benefits?

A Partnership Grants project offers students the chance to get hands-on with science or engineering and develop their practical and critical thinking skills while enhancing their scientific knowledge. Bringing a scientist or engineer into school can be a fantastic source of careers inspiration, and long-lasting partnerships such as these can benefit schools for years to come. Partnership Grant projects allow teachers to go beyond the curriculum, engage with cutting-edge research and access new equipment and skills.

What can schools apply for?

Teachers, schools and their partner scientists and engineers from across the country have come up with a range of different projects that have captured the imagination of students. A Partnership Grant project is an opportunity to exercise your creativity. If you have a great idea for a project but need help finding a partner scientist or engineer, then get in touch with the Royal Society team.

For more information: to find out about eligibility criteria and how to apply via our online application system, go to www.royalsociety.org/education/partnership/. Royal Society staff are happy to discuss ideas for projects and can be contacted by e-mailing education@royalsociety.org or tel (0)207 451 2571.

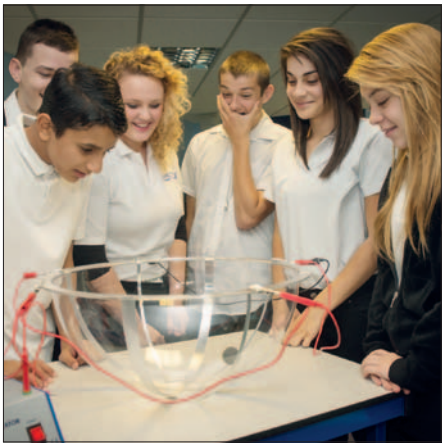
Student events

Hands-on with meteorites and LHC parts

Ten science centres have been given a set of equipment that includes a thermal imaging camera, meteorites, an optics kit and part of the CMS experiment at CERN's Large Hadron Collider (LHC), one of two experiments involved in the discovery of a Higgs-like particle last summer. The kits are part of a project to inspire 10–16-year-olds and link the centres with scientists and engineers so that they can share stories from the front lines of research. The project *Explore Your Universe: Atoms to Astrophysics* is designed to provide opportunities for school students to experience the physical sciences in a hands-on and inspirational way.

Each centre will be offering school workshops for 10–13-year-olds and a master class for 14–16-year-olds covering topics such as light and radiation. They are all tied to real-world examples of research and applications of technologies, such as how particle accelerators and detectors, like those at the heart of the LHC, are now being adapted for diagnosing and treating cancer.

For more information: each science centre will be organising their own series of events. For details contact their learning and education teams: At-Bristol www.at-bristol.org.uk; Catalyst in Cheshire www.catalyst.org.uk; Dundee Science Centre www.sensation.org.uk; Glasgow Science Centre www.glasgowsciencecentre.org; INTECH near Winchester www.intech-uk.com; Observatory Science Centre in East Sussex www.the-observatory.org; Our Dynamic Earth in Edinburgh www.dynamicearth.co.uk; Royal Museums Greenwich in South London www.rmg.co.uk/royal-observatory; Satrosphere in Aberdeen www.satrosphere.net; Science Oxford www.scienceoxford.com.



STFC

Students learn about research through hands-on activities such as the "salad bowl particle accelerator".

Resources

New Sun|trek resources delve into real data

Sun|trek (www.suntrek.org) and its sister website iSun|trek (www.suntrek.org/blog) present the science of the Sun to 11–16-year-olds. These websites are packed with images, movies, ideas for lessons and the latest information and resources, which can all be downloaded.

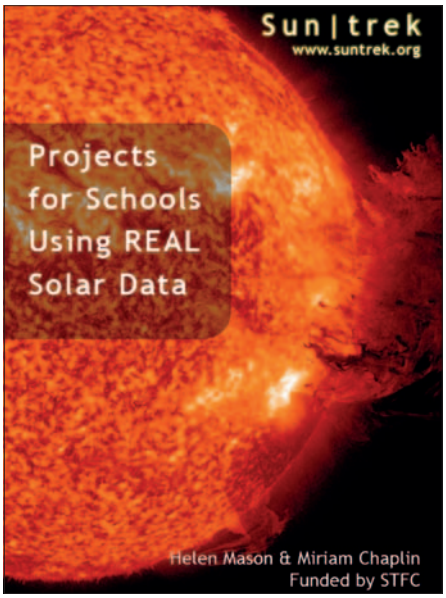
Topics covered include solar spacecraft (SoHO, SDO, Hinode), sunspots, solar activity and flares together with their impact on the Earth's environment (space weather), the solar system and Earth's energy resources. Many of these topics can be linked directly to key areas of the science curriculum (including magnetism, electromagnetic radiation, energy transfer, atoms and spectra, satellite orbits and historic figures in astronomy). There are also profiles of young solar researchers.

New for 2013 is a set of Sun|trek projects that have been produced for UK schools using real solar space data (www.suntrek.org/classroom-projects/classroom-projects).

These new Sun|trek projects

- are intended to support 14–16-year-olds;
- provide a context for teaching certain aspects of "how science works", such as data handling, calibration and resolution, and
- each project consists of two or more student activities, with supporting notes for teachers.

For more information: to find out more about this resource, visit www.suntrek.org. Feedback from teachers on any aspect of Sun|trek is welcome. Contact Dr Helen Mason (e-mail h.e.mason@damtp.cam.ac.uk).



Science fair

The Big Bang explodes into life – all are invited!

The UK's biggest celebration of science and engineering for young people will take place at London ExCeL on 14–17 March 2013 (the 14 and 15 March will be for school groups). Giving young people a taste for where their classroom studies and out-of-school interests could lead, the large-scale event will host over 100 hands-on activities, exhibitions and live theatre shows, as well as the finals of the National Science + Engineering Competition. Activities include everything from robot challenges and seeing how chocolate bars are made, to exploring nuclear power and understanding green energy by making wind turbines.

Fancy being a world-record holder? For the first time ever, Guinness World Records: Science Live! is at The Big Bang Fair, and visitors will be able to participate in a number of world-record attempts. Some of the country's leading scientists and engineers will also be on hand to showcase some of the great career options out there, and youngsters can ask their burning questions in the careers resources area.

If you are unable to make it to the national fair, book a place at a Big Bang Near Me event. These are local events taking place in June and July across 12 regions.

The Big Bang Fair

Action-packed events give budding young scientists and engineers a taste of the future.

For more information: register now for The Big Bang Fair at London ExCeL by visiting www.thebigbangfair.co.uk. To register for the regional Big Bang Near Me events, visit www.thebigbangfair.co.uk/nearme.

Resources

Free ebooks explore NASA telescopes

NASA's Hubble Space Telescope has been providing astounding images of the universe since April 1990. The next-generation James Webb Space Telescope will peer even deeper into space and unveil even more mysteries. Both of these telescopes are now the topics of two free ebooks.

Hubble Space Telescope: Discoveries takes the reader on a tour of some of Hubble's most significant successes, combined with some of the telescope's technology and history. Interactive elements include a gallery of images taken by Hubble's instruments and a short movie on the discovery of planet Fomalhaut b.

James Webb Space Telescope: Science Guide explains the innovative technology and design making the Webb a reality. Among the interactive elements are images that transform as they are seen in different wavelengths of light, a simulation of the formation of the "cosmic web" in the early universe and an animation of the telescope unfolding in space.

NASA and STScI

NASA's space-telescope ebooks.

For more information: download both ebooks from www.hubblesite.org/ibooks.

Events

EVENTS FOR TEACHERS

Spring Physics Update
University of Sussex, Brighton
22–24 March
This three-day course will be hosted by the physics department and will feature talks and practical workshops with opportunity to share classroom experiences.
Details: visit www.iop.org/update.

Practical SHAP Residential CPD for Teachers and Technicians
University of York
26–27 March
The programme will focus on practical and ICT activities in both AS and A2. Experienced SHAP technicians and teachers will be involved in running the course.
Details and booking: visit www.york.ac.uk/org/seg/salters/physics/support/inset_courses.html or contact Joanna MacDonald (e-mail joanna.macdonald@york.ac.uk).

Stirling Physics Meeting
University of Stirling
22 May
The 39th meeting organised by the IOP in Scotland will put you in contact with the latest thinking in physics and physics education, and with colleagues from throughout Scotland.
Details: visit www.stirlingmeeting.org.

BGS Geophysics and Seismology Update
British Geological Survey, Keyworth
31 May–2 June
The British Geological Survey (with support from the IOP and British Geophysical Association) will be holding a three-day teachers course based at their headquarters in Nottingham. The programme will feature a mixture of talks and practical workshops on the theme of seismology and geophysics.
Details: visit www.iop.org/update.

Rugby Meeting
Rugby School, Warwickshire
6 June
The 25th 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 opportunity to browse the extensive exhibition area.
Details: visit www.iop.org/rugby.

Space as a Context for Teaching Science
The Royal Observatory, Edinburgh & National Science Learning Centre, York
9–11 June and 7 October
Teachers can see the observatory facilities and meet scientists and engineers working on the James Webb Telescope.
Details: visit www.slcs.ac.uk/go/nat/dnac12159.

Teacher Network for North Wales Conference
Bangor University
11 June
This conference is for all who teach physics, with an exciting programme of talks and workshops. The guest speaker will be Professor Lyn Evans.
Details and booking: contact Andrea Fesmer (e-mail andrea.fesmer@talk21.com).

A Day for Everyone Teaching Physics in the North East
Durham University
20 June
This free conference provides the opportunity to explore new resources for teaching physics and some of the latest developments in physics itself. Places must be pre-booked (failure to attend without notice will incur a £25 administration fee).
Details and booking: visit www.sciencelearningcentres.org.uk/northeast or contact Nicola Hall (e-mail n.l.hall@durham.ac.uk or tel (0)1913 706 200).

South West Physics Teachers' Conference
St Luke's Campus, Exeter
21 June
This popular free event will be the usual mix of practical workshops, inspiring talks and congenial networking – all teachers, technicians and trainees are welcome.
Details: visit www.sciencelearningcentres.org.uk/centres/south-west/courses-and-events/ 45545-60335.

Summer Physics Update
University of Leicester
12–14 July
This three-day course will be hosted by the physics department and will feature talks and practical workshops with opportunity to share classroom experiences.
Details: visit www.iop.org/update.

National Space Academy Physics & Astronomy CPD Sessions
National Space Centre, Leicester/Rutherford Appleton Laboratories, Oxfordshire
Various dates
These CPD sessions will take you through activities, demonstrations and other resources needed to bring space science and astronomy alive in the classroom.
Details: visit www.nationalspaceacademy.org or contact Lisa Colford (e-mail lisac@spacecentre.co.uk).

EVENTS FOR STUDENTS

2013 IOP Schools and Colleges' Lecture – Defying Gravity: Make Physics Your Launchpad
This free lecture for 14–16-year-olds, given by Laura Thomas, will explore how scientists and engineers have used physics to make the dream of space exploration a reality.
Details: visit www.iop.org/schoolslecture.

SEPnet GCSE Physics Taster Events
Various universities/dates
Half-day physics taster course; these energy-related events are best suited to students who are just about to start or are just starting their GCSEs.
Details: contact SEPnet (e-mail gcse@sepnet.ac.uk) or visit www.sepnet.ac.uk.

The Big Bang Fair
ExCeL, London
14–17 March
Booking is now open for The Big Bang Fair, the largest celebration of science and engineering for young people in the UK.
Details: visit www.thebigbangfair.co.uk.

Forensic Science Weekend
University of Kent
13–14 April
Forensic science for 15–18-year-olds. Explore ballistics and crime-scene analysis.
Details: e-mail science@kent.ac.uk.

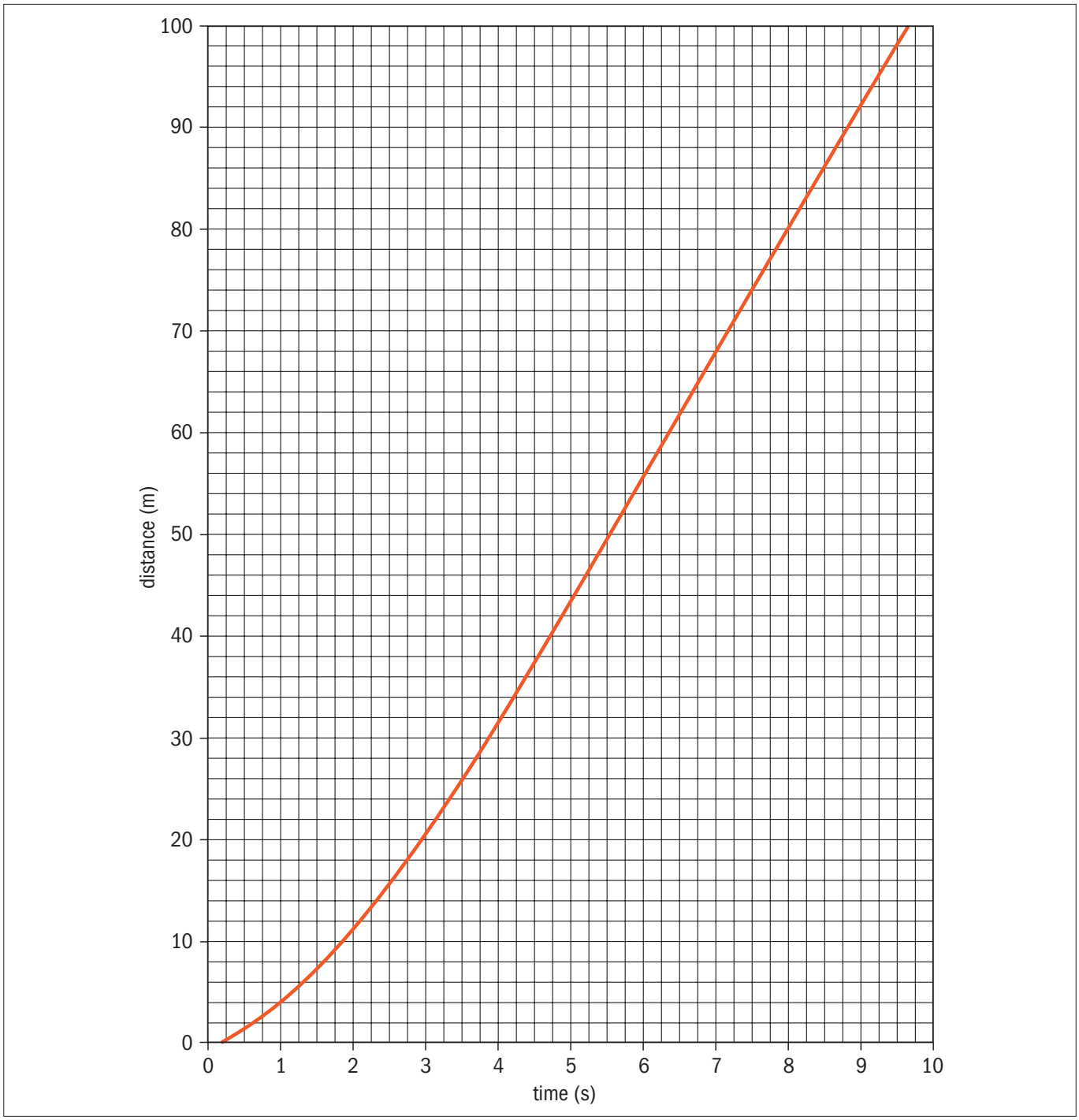
UK Space Industry Careers Events
National Space Centre, Leicester
24 June, 1 and 8 July
Aimed at high-ability Year-10 students. Researchers working on space missions and earth observing platforms provide talks.
Details: contact Lisa Colford (e-mail lisac@spacecentre.co.uk).

'It's Not Unlucky 2013' Year-9 Physics Competition
2 July – King Edward VI School, Bury St Edmunds
5 July – Uppingham Community College, Rutland
Open to teams of four year-9 students, book early to secure a place for your school.
Details: contact Gerry Blake (e-mail gerry.blake@iop.org) for the East of England and Helen Pollard (e-mail helen.pollard@iop.org) for the East Midlands competition.

Space School
University of Kent
3–4 and 10–11 August
The programme will include rocket building and using the university's telescopes.
Details: visit www.kent.ac.uk/physical-sciences/spaceschool or contact Sharon Humm (e-mail spaceschool@kent.ac.uk).

How fast was Usain Bolt at the 2012 Olympics?

The graph is plotted using data for Usain Bolt's 100-metre race at the London 2012 Olympics.



Use the graph to

1. work out how long it took Bolt to finish the race;

2. describe Bolt's motion in the first 3 seconds of the race;

3. describe Bolt's motion after the first 3 seconds of the race;

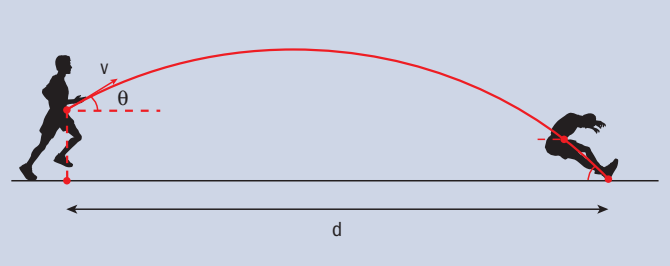
4. work out Bolt's maximum speed;

5. estimate Bolt's reaction time, and

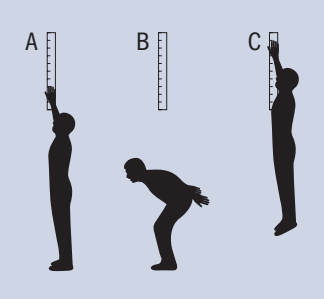
6. work out Bolt's average speed.

Physics and the Games – jumping

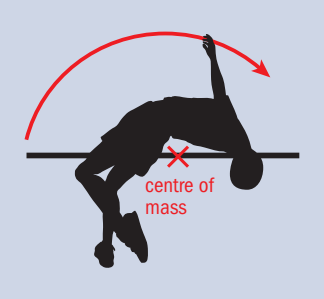
Included with this issue of *Classroom Physics* is a DVD of the Institute's 2012 Schools and Colleges Lecture "Physics and the Games: a winning formula", presented by Dr David James and colleagues from Sheffield Hallam University's Centre for Sports Engineering Research. The lecture covers the physics of the long jump, cycling and running, and has been divided into chapters for ease of use. The following teaching tips accompany chapter 3.



Projectile motion in the long jump.



Determining height for a vertical jump.



The centre of mass in the high jump.

Long-jump lesson

Historically, increases in the top speed of 100-metre athletes have corresponded to increases in long-jump records. Chapter 3 examines the question of how far Usain Bolt could have jumped if he had also competed in the long jump.

- Depending on available time, play some or all of the first 11 minutes of chapter 3 (from 6.10 to 17.10) as an introduction.
- Students complete the worksheet (see previous page) to practice using distance–time graphs and to determine Usain Bolt's top speed in the London 2012 Olympics (around 12 m/s).
- Provide students with the projectile motion formula for solving a theoretical long-jump distance, d:

$$d = \frac{v^2}{g} \sin(2\theta).$$

- Ask students to calculate d for Usain Bolt by first calculating Bolt's speed after take-off (v) by assuming that it will be 85% of his top speed reached in the London 2012 100-metre final (i.e. v is around 10 m/s) and by using a take-off angle, θ, of 33°.
- Play the remaining three and a half minutes of chapter 3 (from 17.10 to 20.40) to finish.

The students should obtain a value for d between 9 m and 10 m. Remind them that their answer may be different to the answer given in the lecture (9.9 m) because they are estimating gradients and using a different data set. The data used in the lecture were from the 2009 World Championships in Berlin.

High-jump lesson

Students can determine their take-off speed for a vertical jump by considering kinetic and gravitational potential energy.

- Working in pairs, one student reaches up with their hands. Their partner attaches a metre rule to the wall, with the bottom of the rule just below the point on the wall that the student can reach and records the starting point (A). The student then bends their knees (B), jumps as high as they can and at the top of their jump reaches up to touch the metre stick (C). Their partner records the reading on the metre rule. Subtracting the two readings gives the height (h) of the jump.
- The take-off speed (v) can then be calculated by assuming that air resistance is negligible using

$$\frac{1}{2}mv^2 = mgh.$$

- After discussing why they do not need to know their mass (m) to use the above expression, ask students to calculate v.

Follow-up activities

- As a class, discuss whether physical attributes (such as leg length) make a difference to how high students in the class can jump.
- Watch a historical clip of the high jump, such as that from the 1928 Olympics (www.olympic.org/videos/king-crowned-high-jump-champion) and discuss how the technique used by athletes in the high jump in the London Olympics differs, and the advantage this offers (i.e. arching over the bar in order to clear it with their centre of mass just passing over the bar).

Taj Bhutta, careers and student officer, pre-19

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