IOP | Institute of Physics
Education *Supporting Teachers*

Classroomphysics

The newsletter for affiliated schools

September 2015 Issue 34

Practical work

Using log books to support new A-levels

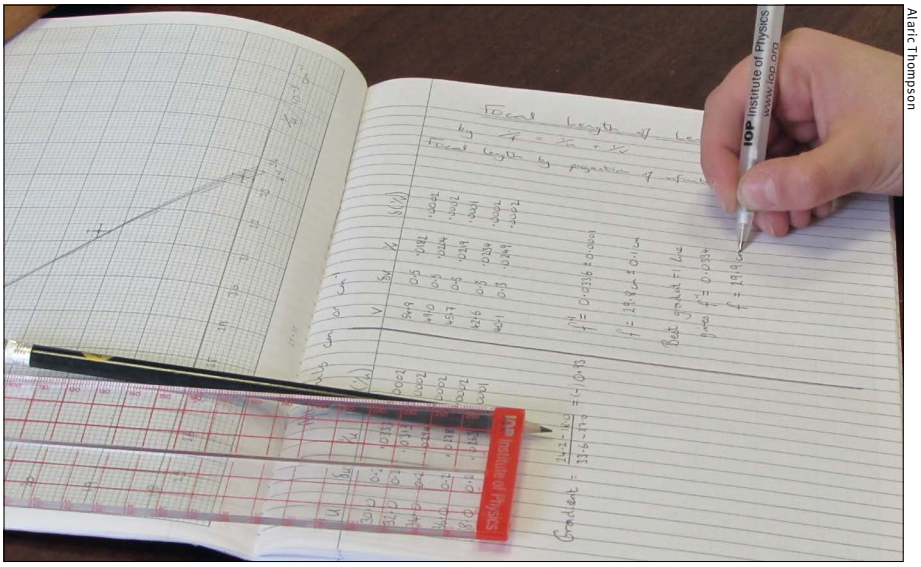
In schools and colleges where laboratory log books are not already in use, September is the ideal time to introduce them to A-level students. Log books are an essential part of practical science and engineering. For students to be competent in their use before they enter industry or undergraduate labs is a great advantage both to the student and the institution.

The new A-level regulations requiring students to complete at least 12 practical activities *do not* require that the students employ a log book, and in a way this is good. Should the awarding organisations have decided to use log books as an assessment tool then it could have led to artificially pristine entries with students 'working in rough' and 'copying up' later that would defeat the objective of the log book being a live document.

The discipline required to keep an up-to-date record of the practical activity without resorting to drafting, using correction fluid or ripping pages out of the book can be instilled in students during their A-level course. Similarly, encouraging students to plot their graphs as they go through the practical encourages them to identify early on when something starts to go wrong.

The log book "should contain sufficient information to allow a third party, together with the script, to understand what you did on the day" (Lancaster University Lab Manual 2012, Dr R P Haley).

The script might be included in a lab manual that contains the theory and experimental procedure so that students need not write up lengthy methods (though doing so for an independent enquiry-based project would be essential). Of course, students will need instruction and they will need to practise working with a log book. It is through making mistakes and learning from them that students will become proficient in recording practical work.



Alaric Thompson

Student log book with alternating graph and lined pages.

Guidance on using log books can be easily found by searching for university lab guides online, but provided the log book contains titles, dates, diagrams, neat data tables, graphs, some consideration of uncertainties and a conclusion then they will not go far wrong.

The nature of the book itself is not of key importance though it should not be loosely bound. It should be relatively hardy to resist wear and tear and alternating graph/lined pages are an advantage.

There may well be some degree of grumbling at first but you will be thanked for your perseverance later on.

Win an iPad mini

Complete our 3 minute survey today

Affiliated schools and colleges are invited to comment on this newsletter and the affiliation scheme. Your feedback will help us to improve the support that we provide.

To complete the survey, visit:

iop.org/affiliation

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

In this issue

Editorial

Welcome back after a restful summer break.

We are seeking important feedback from all our schools and colleges signed up to the IOP's affiliation scheme. To ensure we are sending out news and resources that are meeting your needs in the classroom, complete our short survey: iop.org/affiliation.

2015 is not only the International Year of Light, but (fingers-crossed) the year that Tim Peake embarks on a mission to the International Space Station.

To highlight both these events, we have sent out to our affiliated schools and colleges a light-themed resource, *SEP's Mixing Colour* booklet, and information on various education activities that coincide with Tim's mission (details on p7 and teaching tip on p8).

IOP staff will be leading on a range of free physics CPD workshops (details on p5) at the ASE Annual Conference early next year (University of Birmingham, 7–9 January 2016). Book your place at the conference now via ase.org.uk/annual-conference.

Affiliated schools and colleges will have received a postcard about our Schools Experience Programme. Every year we match more than 200 prospective physics teachers with schools willing to provide observational experience. To register your support visit iop.org/sepschools.

As always, we appreciate any feedback e-mailed directly to us. But let me take this opportunity to once again remind you to feedback your thoughts on the support you receive via the IOP's affiliation scheme. Simply visit iop.org/affiliation today; you never know you might win yourself a nice little treat in the form of an iPad mini.

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Resource

Supporting students entering university in 2016 and beyond

myPhysicscourse.org — Finding the right degree

There are a growing number of degree comparison websites. For those students who are unsure of which subject they want to study or where to study *Which? University* (university.which.co.uk) is the best place to start. The site draws on data from a number of sources, including UCAS and the National Student Survey, and displays the information using an easy-to-understand and easy-to-navigate website.

For those students who know that they want to study physics at university the most appropriate place to start their search is the Institute's own degree-listing website myPhysicsCourse.org. This has now been updated for 2016 entry. It remains the only site that provides a definitive list of degrees accredited or recognised by the Institute and allows students to filter results by location, entry requirements or subject combination (e.g. physics with astrophysics). The individual university pages also contain links to further information on scholarship and bursary information.

For more information: visit myPhysicsCourse.org. If you would like to provide any feedback on the use of this site, please e-mail myphysicscourse@iop.org.

Student events

Lab in a Lorry to tour Welsh schools

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Lab in a Lorry visiting school students in Somerset.

A new partnership between the IOP's Lab in a Lorry (LIAL) and the National Science Academy means that the mobile lab will be returning to Wales from September 2015 to March 2017. Touring for five terms, this will be the longest period that LIAL has spent in Wales and they are aiming to visit over 60 schools. Their most recent tour visited over 11,500 school students at 65 locations around the country and relied on hundreds of volunteers from the local community.

LIAL allows school students to explore the world of physics by getting them to try out hands-on science experiments and gives them an opportunity to speak to scientists and engineers.

For more information: or to request an event at your school free of charge, please visit www.labinalorry.org.uk. You can also register there as a potential volunteer.

Teacher CPD

Educators honoured with fellowship awards

Alan McKeegan and Lewis Matheson have been named as the recipients of the prestigious Anthony Waterhouse Fellowships for 2015. This annual award recognises the need for school-based research by providing teachers with the opportunity to independently develop an educational idea. The fellowship covers research expenses of up to £2,000 and offers support via the Institute's links with practitioners, policymakers and educational researchers.

In order to maximise children's learning and attainment, both educators realise the value of researching into alternative teaching methods. Alan McKeegan, assistant Vice-Principal at Wade Deacon High School,

Alan Mckeegan / Lewis Matheson

2015 Fellowship recipients, Alan McKeegan (left) and Lewis Matheson (right).

is dedicating the funds to exploring how peer mentoring affects the uptake of physics at A-level and beyond. His goal, he said, was to "increase the number of pupil premium pupils who go on to study physics" and he hopes that the research will be transferrable and easily-replicable at other schools.

Having already produced a number of popular videos (www.alevelphysicsonline.com) for supporting physics lessons, Lewis Matheson, head of physics at Beechen Cliff School, seeks to research the impact of filmed teaching content on student learning.

Both teachers are based in schools that are part of the Institute's Stimulating Physics Network (stimulatingphysics.org).

For more information: about the fellowships, how to apply and details of previous award recipients, visit iop.org/waterhousefellowship.

Resource

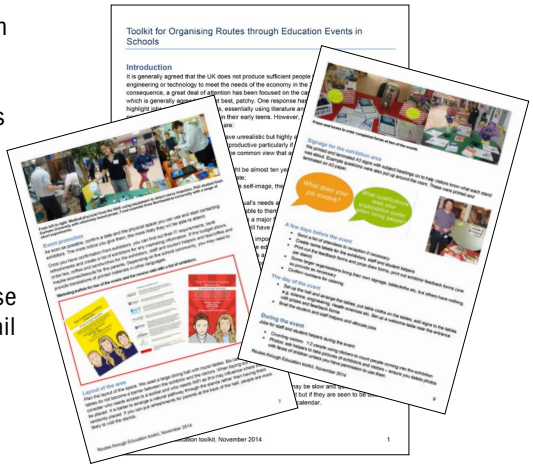
New toolkit for Routes through Education events

People rarely have a career for life now, so the information about subject choice and future jobs needs to reflect this. Over the last few years, the Institute of Physics has led a number of projects investigating the barriers that prevent young people from choosing to study physics.

Our research has shown that: parental influence is strong; there is a limited knowledge of the range of jobs available (particularly in the STEM field); and, young people need to know that the subject choices they make at school will impact their future career.

The Institute worked with partner schools to offer Routes through Education events for students and their parents. Feedback was very positive so a toolkit has been developed to help other schools organise similar events. The toolkit contains lots of information and tips to make organising an event easier; it contains an action plan and template letters that you can use and adapt as you wish. The IOP are keen to hear how you use the toolkit and how your event went (e-mail education@iop.org).

For more information: and to download the toolkit visit iop.org/toolkit.



Teacher recruitment

Recruiting prospective physics teachers

Ensuring a flourishing future for physics is a top priority for the IOP. As teacher recruitment plays such an important role in this, we have established some initiatives to help schools recruit more trainee physics teachers.

If your school is involved in teacher-training recruitment, we urge you to register for our free School Direct Registration Programme. The programme provides tailored marketing and recruitment support to help schools fill their school direct training places. Register your school online to receive:

- A marketing action plan with tips on how to recruit physics teachers and how to run successful recruitment events;
- eNewsletters with further marketing advice;

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The IOP can help you recruit the best physics teacher possible.

- Space to advertise your recruitment events on the IOP website.

For more information: and to register, visit iop.org/schooldirect.

We are also looking for more schools to sign-up to our School Experience Programme to host prospective physics teachers for observational classroom experience. School experience is not just a vital part of the teacher-training application process; it also enables candidates to meet prospective future employers and for schools to meet prospective employees!

If you would like to get involved in the School Experience Programme, simply register your details on our website and we will add you to our database. We will only contact you when a prospective teacher in your local area is looking for school experience.

For more information: and to register, visit iop.org/sepschools.

Funding

Funding for inspirational photonics

The UK School Photonics Competition (SPC) is offering all schools and similar organisations the opportunity to win up to £1,000 to support the promotion of photonics in their school or college. This award could be used to take a class to one of the many International Year of Light events around the country. It could also be used to organise a school visit to an observatory, science museum, or photonics company. If you would like to acquire a new set of photonics education kit for your school, then consider entering this competition.

United Nations Educational, Scientific and Cultural Organization

INTERNATIONAL YEAR OF LIGHT 2015

To enter the SPC state in 200 words how your school would inspire the next generation to look at light differently and the funding (up to £1,000) needed for the event/activity. Send your entry to richard.mosses@optoelectronics.org.uk. The deadline for this competition is 31 October 2015.

This competition is being run by the Scottish Optoelectronics Association, on behalf of the UKCPO, as part of the International Year of Light 2015.

For more information: including competition rules, visit bit.ly/1HGgHTQ or contact Richard Mosses (e-mail richard.mosses@optoelectronics.org.uk). International Year of Light events in the UK can be found via light2015.org.uk.

Teacher training

Upskilling the workforce with specialist training

At the end of 2014, the Prime Minister announced a £67m package of new initiatives to transform STEM teaching in England.

One of these initiatives was Teacher Subject Specialism Training (TSST); bespoke training for current teachers that will provide up to 3000 extra maths and physics teachers each year for the next five years.

TSST is designed to upskill non-specialist teachers who could potentially teach physics in addition to their main subject, and teachers who want to retrain as physics teachers. More than 100 schools in England will be running TSST courses from September 2015.

Training is designed and delivered by schools, which means the delivery mode of each course will vary. Some long courses will run from September to June with just one intake in September, whereas others will be shorter and allow for multiple intakes. Courses are available to participants at no charge.

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Training available to upskill biology and chemistry teachers to teach physics.

For more information: about TSST, including a directory of schools that are running courses, will be added to the IOP website in the coming months. In the meantime, please pass this information on to any colleagues who might be interested and encourage them to e-mail teach@iop.org for further details.

Girls in Physics

'People like me' Resource Pack and App

WISE is a campaign dedicated to promoting women in science, technology and engineering (STEM). It works to ensure that more girls are encouraged to do STEM subjects and their latest resource has been developed to educate and inspire the women of the future.

The pack comprises a set of training and teaching resources as well as an interactive app for girls in KS3. It was launched during the British Science Festival and takes a fresh approach to tackling the under-representation of girls in science.

PEOPLE LIKE me

The resource is based on research conducted by WISE in the *Not for people like me* report that found that talking about the day-to-day life of a scientist often did not attract girls to STEM. Instead, the report concluded that emphasising the sort of people that are successful in STEM careers and highlighting the attributes that scientists use in their scientific careers did work. The pack shows how personal attributes such as creativity and communication can open doors to STEM opportunities suited to a wide range of personality types.

The programme is targeted at teachers teaching Key Stage 3 girls, an essential time for allowing students to develop the confidence to progress beyond GCSE.

For more information: about the resource pack, visit www.wisecampaign.org.uk.

Teacher event

Join us at ASE next year

The ASE's Annual Conference comprises of more than 300 science education sessions led by teachers, technicians, and teacher trainers – and the IOP's Stimulating Physics Network and Physics Teacher Network will be out in force.

We will be at the University of Birmingham from 7–9 January with 16 different workshops, three pupil activity showcases, and two panel discussions, including:

- **Illustrating the Electromagnetic Spectrum** Innovative and affordable demonstrations to illustrate each band of the EM spectrum.
- **Fruit & Sweet Physics** Practical activities that engage students with physics – all using easily available fruits and sweets.
- **The Electromagnetic Spear** Make-and-Take an EM wave model showing E and B components in full colour.
- **Lights, Cameras, Images** Explore activities for use in the classroom when teaching light, colour and spectra.
- **A-level Physics Practicals** A tour of A-level experiments: valuable tips, resources and new ideas.
- **The Trials and Trails of Particle Physics** Novel ways to use the CERN@school Mx-10 detector to show characteristics of ionising radiation.
- **Using Models to Teach Electricity** Use different models to teach electricity, address misconceptions and establish a sound basis of understanding.
- **Exoplanets** Use far-off planets to inspire students with physics in the classroom.
- **Lighting the Way: Engaging Girls With Physics** Use low-cost resources to engage girls (and boys) with light, and take a wider look at gender issues in science.
- **Going Round in Circles with Energy?** Reflect on energy and consider whether the much-loved activities of the traditional energy circus are of real educational value.
- **Thinking on Your Feet: Resources and Ideas for Teaching Physics through Football** Take a look at the IOP's football and physics resource, developed with Arsenal FC.

We will also be hosting an informal drop-in area, and live-tweeting from @TakeOnPhysics throughout the conference.

For more information: and to book, visit ase.org.uk/annual-conference.

Teacher event

Powerful physics at the Langage Energy Centre

What is the ballpark efficiency of a fossil-fuel power station? Physics teachers might answer 40% but the modern Combined Cycle Gas Turbine (CCGT) can achieve an unparalleled 60% efficiency. This is what 75 physics teachers and technicians discovered at our South West Physics Day; held this year at Langage Energy Centre in Plymouth.

The South West Physics Day is one of 10 annual conferences held by the Stimulating Physics Network at no cost to participants. Workshops are run by expert coaches from the IOP and partner organisations – and complemented by inspiring guest speakers and regional networking opportunities.

At Langage, sessions included *The Last Spinning Jelly in Devon*, with *The New Resourceful Physics Teacher* author Keith Gibbs, and *Enthusiastically Energetic*, a circus of mini-sessions that included both siphoning beads and a plasma ball. In *Extending Your Vision*, perceptual artist Terry Pope demonstrated some 'imagic' ideas for engaging students in optics, including his vision-extending Hyperscope.

Participants took full advantage of their unique surroundings, with a tour of

Teachers take a tour of the Centre's facilities.

Langage's facilities and presentations from Langage scientists. Alastair Cuthbertson, IOP Physics Network Coordinator, said: "*Physics is brought to life here – not only in terms of turbines and generators but also with comparative energy sources, baseload power versus top-up in the National Grid, transformers and distribution*".

For more information: visit stimulatingphysics.org/regions. Upcoming regional conferences include the East Midlands Network Day (26 September) and SPEED 2015 (3 October). To book a student trip to Langage Energy Centre, contact Jo.McCaren@centrica.com.

Signal boost

STIMULATING PHYSICS NETWORK

What Happens Next?

Teachers will be inspired at this free workshop at Tunbridge Wells Grammar School for Boys on 12 October. Simple demonstrations with unexpected outcomes will be showcased, designed to get pupils thinking and debating physics. Book your place, e-mail dahp.twggs@gmail.com.

Find more local workshops at stimulatingphysics.org/regions.

Salad Bowl or Particle Accelerator?

Bring Geneva to your kitchen table via our Salad Bowl Accelerator workshop at talkphysics.org/groups/5921. Physics teacher Dan Cottle provides a step-by-step guide to transforming the humble salad bowl into a CERN-worthy particle accelerator.

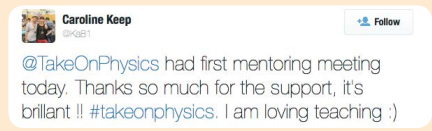
Visit home.web.cern.sch for related teaching resources.

Activities this Autumn across the regions

- More than 150 teachers across England attended SPN Summer Schools in Cambridge, Oxford and York; with talks from Andrew Casey, Marek Kukula and Pete Edwards.
- London and the South East gained a new early career mentor, Rozanna Poole.
- Mark Teale (North East Physics Network Coordinator) ran a Rockets Make-and-Take workshop for teachers at Churchill Community College, Tyne and Wear.
- More than 40 teachers joined us live on TalkPhysics.org to create DIY Salad Bowl Accelerators.
- Rodborough School became our latest Partner School in Surrey.

Twitter

Follow us **@TakeOnPhysics**



Student event

Try before you apply: physics at university

Ensuring students choose the right subject for them is a crucial decision for pupils thinking about university. Headstart courses have been developed to offer year 12 students a taste of what studying physics at university is like.

This four to five-day-long course can be invaluable to students in the months before they have to make their UCAS choices as they will gain an insight into what being a physics undergraduate entails and also appreciate the diverse options that a degree in physics or a physics-related subject can lead to.

Students can choose from more than 60 STEM-related courses at 39 universities around the UK. Courses range from nuclear physics to applied physics, as well as courses such as geophysics.

Applications for summer 2016 courses are accepted from 14 September onwards, so please pass this information on to any students who might be interested.

For more information: on how to apply visit www.etrust.org.uk/headstart.

A Headstart Physics Course in 2013.

Student activities

Use Tim Peake's Principia mission to inspire students

Tim Peake, the first British European Space Agency astronaut, is heading into space late 2015 on his Principia mission. There will be lots of opportunities to link your physics teaching to Tim's mission, including the Odysseus Contest and Mission X programme.

Budding scientists are invited to compete in the Odysseus competition to explore the mysteries and challenges of space. The contest offers young people a chance to demonstrate their ingenuity and deepen their understanding of everything from satellites and space probes to astrobiology and interplanetary travel.

High-value prizes will be awarded including internships, computerised telescopes and iPads. Finalists at international level will travel to Brussels or Toulouse. The top winners will be flown to the Guiana Space Centre in South America. Competition information including detailed instructions on how to submit an entry is available at www.odysseus-contest.eu.

Schools are also invited to take part in the Mission X international challenge taking place between January and April 2016. Registration closes on 1 December.

Mission X is a free educational programme developed by NASA scientists and fitness professionals working with astronauts and space agencies across the world. It uses the excitement of space exploration to inspire students to learn about nutrition, exercise and science. To register your school, visit www.trainlikeanastronaut.org.

For more information: including other ways for schools to get involved in Tim's mission visit www.esero.org.uk/timpeake.

Student event

Go4Set with EDT

Go4SET offers students in years 8 and 9 the opportunity to pursue their interest in science, technology, engineering and mathematics (STEM) education. The campaign led by Engineering Development Trust (EDT) entails a 10-week project that allows students the chance to collaborate with the scientific community and thus making connections between science in school and science in the workplace.

At this year's Go4SET launch event, student teams were asked to complete a couple of short engineering challenges. This was also a chance for teams to meet their mentors from companies involved in the campaign. The industry link enhanced the challenge and supported student understanding of real-world applications of science.

Through each of the project stages (research, design, modelling and evaluation) the experience sees students take ownership of the project and assume roles such as project manager, accountant and engineer.

Skills such as team work and communication are developed and their achievements commended in a Celebration and Presentation Day (CAD), where the students taking part in the programme are asked to do a short presentation and prepare a display model to accompany their report.

For more information: visit www.etrust.org.uk/go4set.

John Crane Ltd.

Withington Girls' School visiting their link company, John Crane.

EVENTS FOR TEACHERS

STEM in Education Evening
Bradford College, Yorkshire
8 September
An opportunity to meet teachers, activity providers and STEM Ambassadors during the British Science Festival (www.britishscienceassociation.org/bradford-2015). Pick up free educational resources and peruse displays celebrating new ways of approaching STEM in Education. Wine, non-alcoholic drinks and canapés will be served. Details and booking: bit.ly/1IeQkr2.

Teaching Electricity with Confidence
Sir Christopher Hatton Academy, Wellingborough
18 September
A programme of free physics CPD focussed on the topic of electricity to improve your subject knowledge and to try out a range of practical teaching strategies. Details and booking: contact Vanessa Forbes (e-mail forbesv@hattonacademyorg.uk).

East Midlands Network Day
Sir Jonathan North Community College, Leicester
26 September
A day of lectures, updates and KS3/4 workshops – for those new to physics teaching as well as experienced teachers – including (new for 2015) a strand of three workshops specifically designed for A-level teachers. Details and booking: Helen Pollard (e-mail helen.pollard@iop.org).

Stimulating Physics East of England Day (SPEED)
Netherhall School, Cambridge
3 October
A day of training and workshops for teachers and technicians of physics/science; it is free to serving teachers and technicians (or those enrolled on a training course to become a teacher or technician). Details and booking: visit bit.ly/1OpWkPg.

14th Annual Welsh Physics Teachers Conference
Christ College, Brecon
7 October
During the day, Professor Peter Vukusic will give a presentation and there will be an opportunity to attend hands-on practical workshops exploring a diverse range of physics topics. Details and booking: contact Cerian Angharad (e-mail cerianangharad@gmail.com).

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.

ASE Annual Conference
University of Birmingham
7–9 January 2016
The IOP will be leading more than 20 free physics-focussed sessions at this annual conference. Throughout the event there are lots of valuable CPD opportunities including an extensive exhibition area and drop-in activities. Book your place today and refresh your physics teaching. Details and booking: ase.org.uk/annual-conference.

Teaching Radioactivity with Confidence
Sir Christopher Hatton Academy, Wellingborough
13 January 2016
A programme of free physics CPD focussed on the topic of radioactivity to improve your subject knowledge and to try out a range of practical teaching strategies. Details and booking: contact Vanessa Forbes (e-mail forbesv@hattonacademyorg.uk).

EVENTS FOR STUDENTS

Greenlight4Girls
Imperial College London
26 September
Open to girls aged between 12 to 16 years-old, this event will include different activities – from deconstructing an Aston Martin engine to career advice in photonics, and coding an LED. Girls can apply for free places online and teachers can bring up to 10 students from their schools. Details and booking: e-mail projects@greenlightforgirls.org.

Beautiful Brains and Amazing Lasers
28 September, Exeter
29 September, Dorchester
30 September, Launceston
1 October, Truro and Pool
2 October, Plymouth
Dr Natalie Garrett will talk to students aged 12–18 about her research in biophotonics and life as a university researcher. If you would like to bring your students to a host school, please contact Miranda Addey (e-mail miranda.addey@iop.org) for full details and timings.

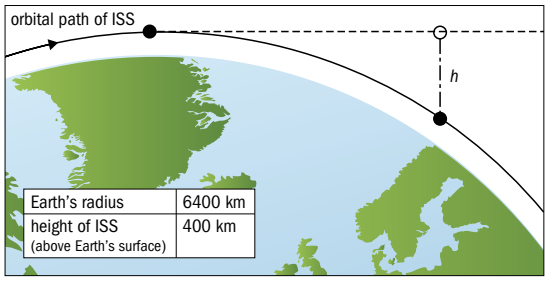
LIGHTtalks: Brighten Up Your World
Ricoh Arena, Coventry
15 October
The aim of this afternoon event is to create awareness amongst students – at a time when decisions are being made i.e. at AS-level – about the potential of photonics thereby encouraging them to consider photonics as a career choice. Details and booking: contact Brenda Hargreaves (call 01372 750 555 or e-mail brenda@photonex.org).

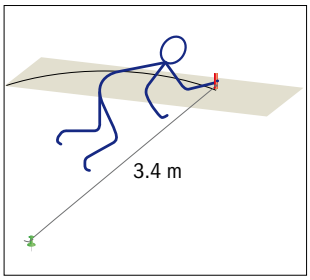
Year 12 Careers Conference
National Space Centre, Leicester
16 November
This event aims to raise the profile of the space sector by providing a forum for industry-based staff to meet students. Students will be made aware of the exciting and unusual space-related careers available. Details and booking: visit nationalspaceacademy.org/careers or e-mail nsa@spacecentre.co.uk.

STEM Clubs Week
Nationwide
1–5 February 2016
Find out more about STEM Clubs Week and see what schools did in 2015 by visiting www.stemclubs.net/stem-clubs-week-2015.

Tim Peake: Around the world in 90 minutes

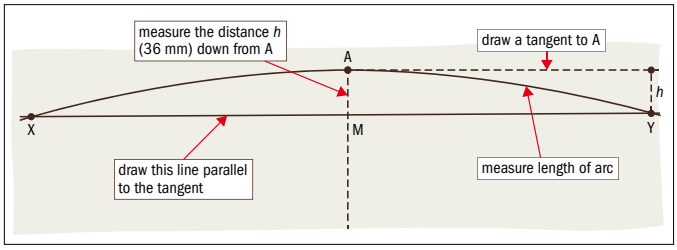

Tim Peake





In December this year, Britain's first European Space Agency astronaut, Tim Peake, will start his mission to the International Space Station (ISS). His six-month mission, called Principia, will use the unique environment of space to run experiments as well as trialling new technologies for future human exploration missions.

The following demonstration can be used to estimate how long it will take Tim to go around the Earth once he is on board the ISS. Students may be surprised by the result: the ISS's orbital period is around 90 minutes.



Top left: Tim Peake, the UK's first official astronaut. Figure 1 (top centre): orbital data of the International Space Station. Figure 2 (top right): drawing an arc with a radius of 3.4 m. Figure 3 (bottom): estimating the distance travelled by the ISS using a scale drawing.

Materials needed

- Paper sheet – 1.5 m long and 20 cm wide
- Thin, strong wire – 3.5 m
- Large mass or hook to anchor one end of the wire on the floor
- Metre rule (with cm and mm markings)
- String – 1 m

Introducing the demonstration

The demonstration works best on the floor or the side bench of a laboratory, with small groups of students. A common misconception is that there is no gravity in space. Ask the students what path they would expect an object to follow if no forces act upon it. They may need a little prompting, but they should conclude that if gravity did not act on a satellite it would move in straight line. Refer to figure 1 and explain that they can use the relationship $h = ½ gt^2$ to calculate h, the vertical distance the ISS drops in a time, t. The ISS orbits relatively close to the Earth's surface and so, for the purposes of this exercise, g can be taken to be 10 m/s^2.

Demonstration

Provide students with the data shown in the table on figure 1. Explain that you will be using a scale of 0.5 mm to 1 km and ask the students to calculate the scaled radius of the ISS orbit. Using data from the table, the orbital radius is 6400 + 400 = 6800 km, which corresponds to a scaled radius of 0.5 × 6800 = 3400 mm = 3.4 m.

Draw an arc with a radius of 3.4 m using the thin wire anchored on the floor at one end and held taut with a pencil at the other end (figure 2). The length of the arc, **XAY**, illustrated in figure 3, should be around 1.3 m.

Mark the midpoint of the arc, **A**, and draw a tangent at this point. On this scale, a travel time of two minutes provides a measurable value of h. Ask students to work out how far the ISS drops away from the straight line in this time, 120 seconds, and the distance this corresponds to on the scale diagram. Using $h = ½ gt^2 = ½ 10 (120)^2$ they should get an answer of 72 km, which corresponds to a distance of 0.5 × 72 = 36 mm.

From the point **A**, measure 36 mm down the radius and mark this position **M**. Draw a straight line, **XMY**, parallel to the tangent with a midpoint at **M**. Mark the position **Y** where this line intersects with the arc.

Place the string along the arc and mark the positions of **A** and **Y** on the string. Measure this length of string to determine the length **AY**. This should be about 0.5 m that corresponds to a distance of 1000 km once converted.

Finally, estimate how long it would take ISS to complete an orbit. The circumference of the orbit is 2π x 6800 km and so the distance **AY** represents 1000/(2π × 6800) = 1/43 of the circumference. Multiplying the 2 minutes it takes to travel this distance by 43 gives an estimate of 86 minutes for the time to complete the orbit.

For more information: on Tim's mission, sign up for the Principia newsletter via the UK Space Agency website at gov.uk/ukspaceagency. Find out about Tim and follow his amazing journey at twitter.com/astro_timpeake and facebook.com/ESATimPeake.

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