

# Classroomphysics

The newsletter for affiliated schools

September 2016 Issue 38

## Gender balance

# Girls in physics – a school-wide issue

The Improving Gender Balance (IGB) and Drayson pilot projects run by the IOP over the last two years have seen a notable increase in the proportion of girls doing physics AS-level.

IGB, funded by the Department for Education as part of the Stimulating Physics Network, worked with 20 schools with each school trialling one of three separate approaches:

- A** – working with girls to improve their confidence and resilience (eight schools)
- B** – working with science teachers on inclusive teaching techniques (eight schools)
- C** – working across the whole school on gender equality (four schools).

The Drayson project, funded by a private charity, blended all three strands and worked with six Thames Valley schools with low progression for girls post-16.

All strands had a positive impact, but the best results were seen in schools that used the combined approach. The cumulative impact was impressive: AS physics numbers increased from a total of 16 girls across the six schools (10% of the total AS-level cohort) in 2014, to 52 girls (27%) in 2016.

“The gender balance of your physics class is not a foregone conclusion,” said IGB project manager Jessica Rowson. “There are positive actions that teachers and school leaders can take to remove the barriers that prevent girls from taking physics. Our work suggests that working with the whole school may be the key to opening this door.”

The proportion of girls sitting AS-level physics nationally is just under 24%, with no significant changes in the last 20 years. The work of IGB and Drayson forms part of the growing evidence that whole-school issues play a role in perpetuating the gender imbalance in physics.



Working across the whole school on gender equality has a positive impact on girls in physics.

### Gender balance across your school – suggestions from IGB and Drayson

- **Monitor gender disaggregated data on post-16 progression and the gender balance of sets and extracurricular activities both in science and throughout the school**  
Data can reveal whether your school or department has issues and provides evidence to engage your senior leadership team with the problem.
- **Training for the whole school staff about bias and equality issues**  
Many people unconsciously associate science with men and arts subjects with women. This can affect the way that we behave and how we react to others, including the language we use. If teachers are better informed, this can lead to a better experience for all in the classroom.
- **Create opportunities for girls to explore science outside the classroom**  
Look at the gender balance in your extra-curricular science activities and clubs. Taking part in these activities helps to boost students' self-confidence and encourages them to identify with science, which can be particularly beneficial to girls.

**For more information:** visit [iop.org/genderresources](http://iop.org/genderresources) for ideas and guidance and also to sign up for our monthly newsletter. The external evaluation of IGB is at [stimulatingphysics.org/girls-in-physics](http://stimulatingphysics.org/girls-in-physics). For more information about IOP improving

gender balance projects, visit [iop.org/genderbalance](http://iop.org/genderbalance).

**Free staffroom poster with this issue**  
10 tips to promote inclusive teaching

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

## In this issue



### IOP advice to Parliament 2

Better physics CPD is vital to teacher recruitment and retention.



### Physics in space 4

Resources for the classroom fresh from Tim Peake's space trip.



### Teaching tip 8

Laser DJ – a simple optical communication demo using a laser pointer.

Editorial



Welcome to the new academic year.

This issue of *Classroom Physics* celebrates our Improving Gender Balance project. This grew out of our Girls in Physics project, but it has become clear that if we want to increase the number of girls progressing to physics A-level, we need to look at what is going on in schools more widely.

We've sent each Affiliated School a poster with some simple suggestions to promote inclusive teaching. Although these ideas are directed at science teachers, it may be interesting to discuss them with colleagues in other departments. We have also printed a checklist to help teachers of physics record and extend their own gender-inclusive practice (p7).

This term, many readers will begin teaching the new GCSE syllabus, which brings significant change.

Students will face increased mathematical demands and be expected to learn 23 equations by heart. Wider content and the linearity of the exams means that they will need to memorise more and the first exam that they will sit is at the end of two years (or even three years as many schools start GCSE science in year 9).

To ease the transition, teachers have been sharing ideas and tips on our TalkPhysics online discussion forum – in particular, there has been a memorable discussion on mnemonics for equations (see p3).

Finally, we have included another SEP booklet, this time on teaching sound. It provides an overview of the sources of sounds, how sounds interact with materials, and how sounds and vibrations are detected, plus discussions on the use of ultrasound waves to detect masses and movement under water and the range and characteristics of human hearing.

Have a great new year!

**Caroline Davis**, editor  
[caroline.davis@iop.org](mailto:caroline.davis@iop.org)

**Ellen Phillips**, assistant editor  
[ellen.phillips@iop.org](mailto:ellen.phillips@iop.org)

Photography by **Daniel Josman**

Policy

# CPD and its relationship to recruitment and retention

There should be a culture of continuing professional development (CPD) in schools and anyone offering physics CPD should be a chartered physicist, the IOP's Head of Education, Charles Tracy, told MPs in June.

He called for a national framework, or core curriculum, for CPD, saying initial teacher education should be seen as just the start of teachers' professional learning and that new teachers should have a lifetime of professional development ahead of them.

The IOP estimates that there should be about 10,000 physics teachers, but we are about 3,500 short. This means that a third of physics lessons could be taught by non-specialists – but there is no way of knowing because Qualified Teacher Status has no subject or level attached.

Charles told the committee: "If your headteacher wants to deploy you to teach physics to KS4, then you should be trained to teach physics to KS4. Headteachers should report on how many of their staff are teaching lessons that they are qualified to teach; that would be another driver for improving quality."

Speaking afterwards, Charles said: "The panel were agreed about the broad principle and in the detail for CPD. We have a role as the Institute because we are a professional body. Ultimately, we would like to encourage physics teachers to become chartered



Charles Tracy gave evidence to the House of Commons Education Select Committee.

physicists, which is the highest professional qualification."

Charles was invited by the House of Commons Education Committee to give evidence in its inquiry into the supply of teachers. He answered questions on CPD and its relationship to recruitment and retention on behalf of a policy alliance between the IOP, the Association for Science Education, Royal Society of Biology, Royal Society of Chemistry and the Royal Society.

**For more information:** visit [bit.ly/IOPevidence](http://bit.ly/IOPevidence) to read more about the inquiry.

Teacher recruitment

## Could prospective physics teachers observe your lessons?

Last year we matched more than 350 prospective and returning physics teachers with schools taking part in the IOP School Experience Programme (SEP).

This helped prospective teachers gain vital experience needed for their teacher-training application, and enabled returning teachers to re-familiarise themselves with the classroom and understand changes to the curriculum.

Ongoing high demand for SEP means that we need to expand the programme in 2016/17. So we're looking for more schools to take part across the UK.

By signing up, your school will benefit by making links with new and returning physics teachers. We will add your school to our database and, when a participant registers,



SEP matches prospective teachers to schools for observing lessons.

we match them to the schools closest to their postcode. If at any time you are unable to commit to a participant visit then we would simply find them another school to attend.

**For more information:** If your school is able to offer observational experience, please register your details at [www.iop.org/sepschools](http://www.iop.org/sepschools).

## Teaching resources

# Physics with the Baggies

We kicked off the summer by experimenting with a day of football and physics with West Bromwich Albion Football Club (Baggies).

Lawrence Cattermole, a Stimulating Physics Network Teaching and Learning Coach, delivered a training session to local physics teachers and educational staff from The Albion Foundation (the club's charitable trust that uses the context of football to provide sporting and educational opportunities to the most disadvantaged members of their local community).

The workshop explored eight activities linked to the beautiful game to help students understand the relevance of physics to sport. It was based on our "Thinking on Your Feet: Football and Physics" resources, developed with Arsenal Football Club. Participants modelled various football situations, from the effects of spin on free kicks to the physics of safe tackling.

Integrating the resource into the Foundation's outreach programme provided



Teaching and Learning Coach Lawrence Cattermole with Albion Foundation staff.

a great opportunity to collaborate and explore whether football can be used to engage students from disadvantaged backgrounds.

This new approach of providing joint workshops for physics teachers and football coaching staff proved promising, with both groups able to share their expertise

and experience to enhance the activities. Building on this success, we plan to establish more partnerships with football clubs and local teachers across the country.

**For more information:** download the resource at [iop.org/football](http://iop.org/football) or contact [mariana.salgueiro@iop.org](mailto:mariana.salgueiro@iop.org) for more details.

## Grants

## Apply for funding for micro:bit projects

Your year 7 students should each have received a BBC micro:bit pocket-sized programmable computer last year through your computer-science department. We included some resources suggesting ways to use it with the June edition of *Classroom Physics*.

Now we are inviting you to apply for an IOP School Grant of up to £600 to fund a project using this mini-computer.

For inspiration, look at the micro:bit resources from the Institution of Engineering and Technology. They cover 13 topics to help teachers incorporate the micro:bit into lessons. Examples include systems to manage tube-travel information or flood warnings.



How could you use your micro:bits?

Or you could develop your own ideas. Our school grants are available for projects

linked to the teaching or promotion of physics or engineering that fall outside of normal department spending.

Recent successful applications included a playground coding game aimed at introducing the language of coding to children, and the design and development of an unmanned airborne vehicle powered by a Raspberry Pi board.

**For more information:** the next deadline for the IOP School Grants is 1 November 2016. To apply and to view the application guidelines visit: [iop.org/schoolgrants](http://iop.org/schoolgrants). Download the IET micro:bit resources at [ietfaraday.org/microbit](http://ietfaraday.org/microbit).

## New GCSE

## Very Important Rule\*

A significant change to the GCSE requirements from this September is that students will need to be able to recall more than 20 equations for their exams.

Helping students to learn, rather than simply apply, equations isn't easy. Fortunately, the physics teaching community is here to help – a discussion on TalkPhysics, our digital forum for teachers of physics and their supporters, offers tips and ideas.

Suggested mnemonics range from simple rhymes to flashcards and internet-based association games. Despite many teachers relying on them, TalkPhysics users generally prefer to avoid teaching equations through triangles.

Alessio Bernadelli, TalkPhysics Editor and IOP Teaching and Learning Coach commented: "The best way to get students to remember equations is to do lots of practice questions and building revision of equations in your teaching. Something you might want to try is to make laminated cards with the terms for each equation. Cards are

good for quick recalling games, but also for rearranging."

\*Very Important Rule is one of many mnemonics for  $V=IR$ .

**talkphysics**

**For more information:** if you are already a member of TalkPhysics, follow the discussion (and add your own suggestions) at [bit.ly/TPequations](http://bit.ly/TPequations). If not, it is easy to register at [talkphysics.org/register](http://talkphysics.org/register).

Teaching resources



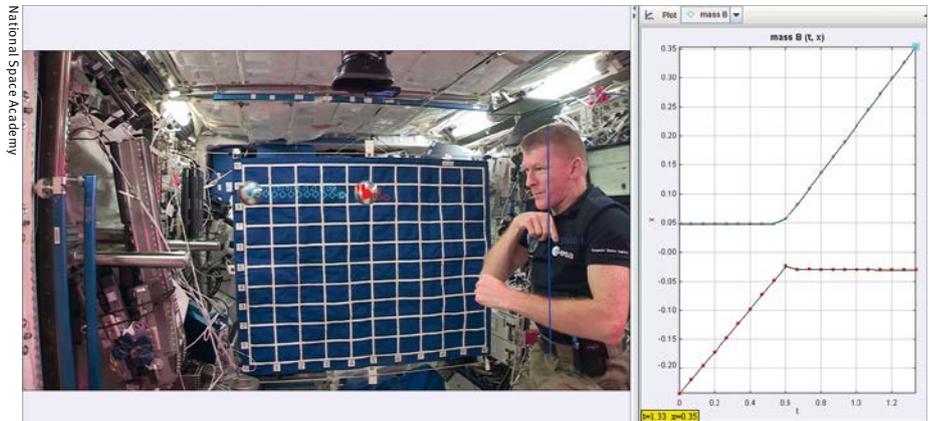
# Demos that are out of this world

Tim Peake's recent space mission has produced a remarkable set of videos and resources for teachers showing physics demonstrations carried out in free-fall.

The National Space Academy (NSA) designed, constructed and flight-qualified a teaching kit and set of procedures that were used onboard the International Space Station by European Space Agency (ESA) astronaut Tim Peake during Expedition 46/47 earlier this year.

The resulting videos, teacher guides and extension material, known as Astro Academy: Principia, are ideal for students in KS3–5 and link directly with the curriculum.

Getting the kit to the ISS was not trivial. It had to pass tests in 17 critical areas including surviving the acoustic environment during launch, shatterability potential during launch, flammability and materials off-gassing. It was sent up in June 2015 on a re-supply mission from Cape Canaveral, but the rocket disintegrated just after launch. Fortunately, the back-up flight spare kit was successfully delivered via a Soyuz flight in September, in good time for Tim's arrival in December.



Students can watch Tim Peake carry out demos in free-fall.

**Astro Academy: Principia contains**

- more than 30 film clips of Tim doing demonstrations illustrating aspects of momentum modelling, kinetic theory of gases, circular motion and centripetal forces and the harmonic oscillator behaviour of gas molecules
- five narrated teaching films showing Tim performing the demonstrations alongside further practical examples, explanations and ground-based experiments
- teacher guides to the films giving further advice and space-related applications
- related stretch and challenge questions for very able pre-university students
- more than 40 films and video capture files showing the use of Tracker software analysing dynamics in multiple planes.

**For more information:** the resources are available at [principia.org.uk/activity/astro-academy](http://principia.org.uk/activity/astro-academy).

**If Tim Peake's mission has inspired your students, enter them for one – or both – of these competitions...**

**UK Space Design Competition**



Teams are given a list of requirements for a space settlement and have a day to come up with a detailed design, which they present to a panel of judges who include experts in the field and representatives of the UK Space Agency. Students enter via video ([uksdc.org/compete/video-entries](http://uksdc.org/compete/video-entries)) or at regional events ([uksdc.org/compete/regionals](http://uksdc.org/compete/regionals)) taking place in October and November. Successful teams go to a residential competition weekend at Imperial College London and then to the international final at a NASA space centre. UKSDC is open to years 10–13 in the UK. There are Micro-Competitions ([uksdc.org/compete/micros/](http://uksdc.org/compete/micros/)) for years 7–9.

**European Youth Space Contest**



Also supported by the UK Space Agency, this competition has four themes: the Solar System and Space Science; Europe in Space; human beings on Mars; and Astrobiology – the search for life in the universe. Years 3–8 (Skywalkers) are asked to create a picture relating to one of the themes. Years 9–13 (Pioneers) are invited to work as a small team on a project based on a competition theme. Examples include: how rockets fly, why is space a good place to observe the night sky, why are space missions useful for humanity and what are the scientific benefits of landing a comet on Titan? Register at [odysseus-contest.eu](http://odysseus-contest.eu).

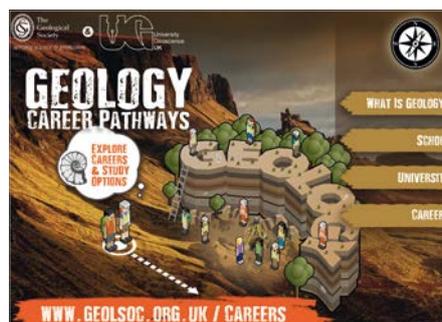
Careers resources

## Physics for geology

New careers resources will help students who are interested in geology to make subject decisions at GCSE, A-level and when applying to university – and highlight the importance of physics in making these choices.

The Geology Career Pathways website, created by the Royal Geological Society (RGS), is designed to show students the opportunities that are available and how to get there.

Physics A-level is highlighted as one of the preferred subjects for students who are applying for university geology courses.



Physics is a preferred A-level for university geology courses.

The website explains that an understanding of physics helps geoscientists study how rocks and

materials behave under stress, which is vital in planning construction projects and designing buildings that will limit the dangers of tremors in earthquake zones.

It goes on to describe a wide range of industries that employ geophysicists to investigate the physics of the Earth and its internal structure. This includes understanding earthquakes, gravity and geomagnetism.

**For more information:** visit [geolsoc.org.uk/careers](http://geolsoc.org.uk/careers). Students can see current vacancies for geophysicists at [jobs.geolsoc.org.uk](http://jobs.geolsoc.org.uk). Online teaching resources that support science in schools are available at [geolsoc.org.uk/Education-and-Careers](http://geolsoc.org.uk/Education-and-Careers).

## Student resources

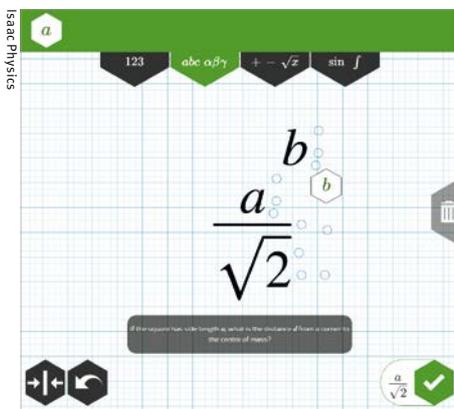
# New Isaac Physics resources aim to halve your workload

New online tools from Isaac Physics allow teachers to set complex problems and have them marked plus feedback given to the student automatically.

Lisa Jardine-Wright, co-director of Isaac Physics, explained that a central aim of the project is to halve a teacher's workload and the website now includes a drag-and-drop equation-entry system for students to submit algebraic answers to questions. She added that the data that is collected for each question allows the Isaac team to research common misconceptions and mistakes, and then provide specific feedback if the students make this mistake in their solution.

The team has also launched a pilot mentoring scheme for students who do not have a specialist physics teacher. Students will be set weekly work (less than one hour) appropriate to their current level and experience. Every two weeks they can join an online video tutorial where Lisa goes through the questions that students found difficult. This is anonymous between students and only Lisa is able to see the questions that they ask.

Isaac Physics is funded by the Department for Education, England and



Students can now submit algebraic answers to online questions.

is based at the University of Cambridge. It seeks to widen participation in STEM courses at university for students aged 16 to 19, offering resources categorised in six levels of difficulty.

**For more information:** visit [isaacphysics.org](http://isaacphysics.org) or the Isaac Physics forum on TalkPhysics [talkphysics.org/groups/isaac-physics](http://talkphysics.org/groups/isaac-physics). Look out for an Isaac Physics webinar on TalkPhysics later this year.

## Teaching resources

## Smartphones in physics experiments

"Kids often leave their books home, but never their smartphones," Italian physics teacher supporter Giovanni Pezzi told delegates at the IOP Stimulating Physics day at the University of Exeter in June.

His workshop, Smartphones in Physics Experiments, demonstrated ways to use smartphones to enhance learning with ideas for practical experiments from mechanics to optics, acoustics and thermography.

The free app Sensor Kinetic, which allows teachers to access the raw data from the sensors on their device, proved a great hit. This could be used for activities such as measuring  $g$  by dropping a phone in a polystyrene beans box or Simple Harmonic Motion experiments with the phone hung on a spring.

Giovanni also demonstrated an infrared camera that connects easily to a phone and can be used to help learners understand thermographs. (See right for our TalkPhysics webinar on infrared.)

Giovanni first presented his workshop at



*Kids never forget their smartphones – use them to enhance learning.*

the London Science on Stage International Festival in 2015. His talk was made possible by Science on Stage EU and Science on Stage UK via the programme "Take a Workshop to my country".

**For more information:** "Smartphones in Science Teaching" can be found at [bit.ly/PhysicsPhones](http://bit.ly/PhysicsPhones). If you'd like to join this international exchange, apply for the 2017 Science on Stage UK by 12 October at [bit.ly/ScienceOnStage](http://bit.ly/ScienceOnStage).



### Medical Physics – a Context for Teaching Waves

Sir Christopher Hatton Academy, Central England, 9 November

The second in a series of free CPD workshops for anyone teaching physics outside their specialism. We'll explore a range of teaching strategies to improve confidence and subject knowledge. Included in the programme are two practical elements on medical physics, a dedicated maths session...and lunch! Book your place at [bit.ly/CEregion](http://bit.ly/CEregion), or find more free CPD workshops in England and Wales at [stimulatingphysics.org/regions](http://stimulatingphysics.org/regions).

### Webinars on TalkPhysics

This term's digital highlight: our new series of TalkPhysics webinars. Physics Network Co-ordinators from across the UK share teaching tips and favourite demos – and each commenter receives a free, related paper from *Physics Education*. First up: Alessio Bernardelli on infrared ([bit.ly/TPinfrared](http://bit.ly/TPinfrared)), followed by Dan Cottle on electricity. September's webinar launches at the end of this month – don't miss it at [bit.ly/PhysicsWebinars](http://bit.ly/PhysicsWebinars).

### Activities this summer across the regions

- Grace Academy Coventry became our latest Partner School in the Midlands.
- SPN Mentors Niloufar Wijetunge, Rozanna Poole and Liz Hutchins ran a mentoring session on the endorsed practicals at A-level at Kings' College London.
- More than 70 teachers from the South, East and London areas attended an SPN regional day at Charterhouse School.
- 160 pupils and their teachers attended a lecture on gravitational waves at SPN link school Notre Dame in Sheffield, delivered by LIGO collaborator and physicist Dr Ed Daw.
- Physics Network Co-ordinator Mike Shovlin ran a Make and Take CPD session at All Saints Academy in Northamptonshire, on ultrasound transducers and receivers.



### Community

Follow us @TakeOnPhysics for advice, ideas and events for teachers of physics.

Here's how to start a fire with a lemon, or exploring potential difference [bit.ly/1UCOI30](http://bit.ly/1UCOI30) HT @asober



# Events

## EVENTS FOR TEACHERS

### Please Don't Buy an Electric Car!

Schools within two hours drive of Southampton

September onwards

A free 45-minute talk aimed at year 11–13 students. Providing an introduction on the debates and challenges facing the UK in satisfying its energy needs. Details and booking: Prof. Averil Macdonald [amm4@soton.ac.uk](mailto:amm4@soton.ac.uk).

### East Midlands Network Day

The Deepings School, Peterborough

24 September

Dr Rob Morris will present “MRI – Some Unexpected Applications” attendees will then have a choice of three workshops from seven on offer. Details and booking: [bit.ly/NetworkDay](http://bit.ly/NetworkDay).

### Frontiers of Physics Teachers Conference

School of Physics, Dublin Institute of Technology

24 September

A day of lectures, demonstrations and workshops, resources and networking for all teachers of physics including Junior Science Teachers. Details and booking: [paul.nugent@gmail.com](mailto:paul.nugent@gmail.com).

### Welsh Physics Teachers Conference

Christ College, Brecon

5 October

This event includes opportunities for networking, practical workshops and the chance to try out new equipment, including practical demos for all levels. Details and booking: [cerianangharad@gmail.com](mailto:cerianangharad@gmail.com).

### New to A-level physics

National STEM Learning Centre, University of York

6 October

A four-day course exploring different ICT activities, how to tackle common misconceptions and building cutting-edge research into your lessons to enable students to make maximum progression. Details and booking: [bit.ly/newtophysics](http://bit.ly/newtophysics).

### Physics for non-specialists: learning the language of physics, energy and electricity

Simon Langton Girl's Grammar School, Canterbury

13 October

A session exploring energy and electricity, and the language used in physics. Details and booking: [bit.ly/languageofphysics](http://bit.ly/languageofphysics).

### Physics for non-specialists

Simon Langton Girl's Grammar School, Canterbury

14 October

A day course looking at forces and motions. Details and booking: [bit.ly/nonspecialist](http://bit.ly/nonspecialist).

### Technicians supporting physics: 11–16

National STEM Learning Centre, University of York

7 November

This three-day course has been developed to be relevant to technicians with five strands, including where to source equipment, how to set it up, how practicals run in the classroom, scientific background to practicals, and health and safety. Details and booking: [bit.ly/technicians11-16](http://bit.ly/technicians11-16).

### Making Science Real in Schools (MARCH project) 3rd International Education Conference

Burlington House, London

15 November

A day conference bringing together educators and institutions promoting best practice in science education. Includes sessions on best practice both inside and out of the classroom, and the future of science education plus experts in education from around the world. A second evening event held on Tattershall Castle river-boat will celebrate the MARCH's achievements. Details and booking: [bit.ly/MARCHconference](http://bit.ly/MARCHconference).

### Physics Booster Courses: Motion, Forces and Energy

Charterhouse School, Surrey

5, 12, 26 November and 3 December

Saturday-morning sessions concentrating on enhancing subject knowledge and developing insight and understanding, using the SPT 11–14 resources from the IOP. Details and booking: Katherine Wilkinson [science@charterhouse.org.uk](mailto:science@charterhouse.org.uk) or visit [bit.ly/CharterhouseCPD2016](http://bit.ly/CharterhouseCPD2016).

## EVENTS FOR STUDENTS

### British Science Festival

Swansea University

6–9 September

Featuring a programme of talks, debates and performance across the university and city. Followed by a family weekend (10–11 September) hosted by Swansea's Waterfront Museum. Full programme details and booking information at: [britishsciencefestival.org](http://britishsciencefestival.org).

### IOP South West Schools Lecture Series

Various schools in Devon and Cornwall

26–30 September

The talk, suitable for ages 12–18, is presented by PhD student Jodi Walsh, of University of Bath and University of Exeter, and is entitled “Listening to machines underwater: how acoustics can help renewable energy”. Details and booking: [miranda.addey@iop.org](mailto:miranda.addey@iop.org).

### Physics Review 25th anniversary

University of York

19 October

Free event for year 12–13 physics students and their teachers to mark 25 years of the magazine: hands-on workshops; reception and exhibition; lecture on the future of mobile technology. Details and booking: [physrev25.eventbrite.co.uk](http://physrev25.eventbrite.co.uk).

## SAVE THE DATE

### IOP Rugby Meeting

The 29th Annual Meeting for Teachers of Physics in Schools & Colleges Rugby School

8 June 2017

Our one-day meeting at Rugby School for teachers of physics in schools and colleges, and teachers in training. Details, booking and presentations from this year's meeting: [iop.org/rugby](http://iop.org/rugby) or join our TalkPhysics group [bit.ly/Rugby2016](http://bit.ly/Rugby2016).



### Association for Science Education Annual Conference

University of Reading

4–7 January 2017

Registration fees start from £85 and trainee teachers can attend one day for free. Early-bird bookings close on Friday 28 October. Details and booking: [ase.org.uk/conferences/annual-conference/](http://ase.org.uk/conferences/annual-conference/).



**Congratulations to Stuart Farmer**, IOP Teacher Network Co-ordinator for Grampian and Northern Isles, on being awarded the 2016 Bragg Medal and prize of the Institute of Physics for outstanding contributions to enhance both the teaching and the public image of physics. Stuart is a Steering Group member of the Optoelectronics College.

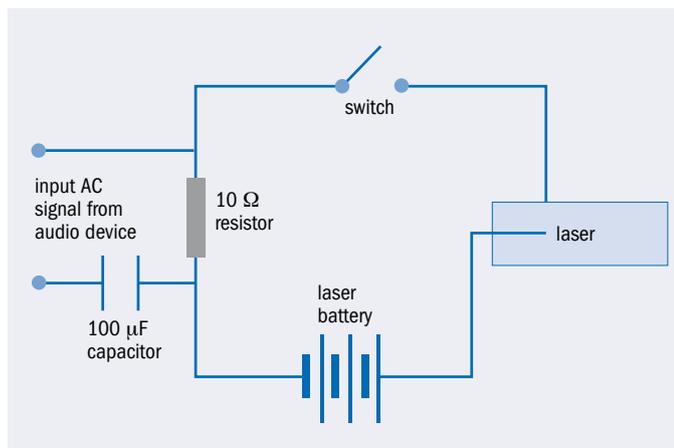
# Inclusive learning in the physics classroom – a checklist for teachers of physics

## Background

This checklist is a set of questions designed to help teachers of physics to record and extend their own gender-inclusive practice. It may also be helpful for use in appraisals by line managers, as well as for use by teacher trainers and inspectors. The list is based on the IOP's Engaging with Girls report (2009) and more recent work from the Improving Gender Balance project. More information on the project and copies of the full report can be found at [iop.org/genderbalance](http://iop.org/genderbalance)

Check your gender-inclusive practice in schemes of work and individual lessons	I do this routinely	Needs further development
Have you asked your classes what they think physics is, and why physics is useful to study? Did you monitor the answers from the girls and boys?		
Have you got “real-world” examples to use to introduce each new topic?		
Do you select analogies, examples and themes for assignments that both genders are equally likely to be able to relate to (e.g. tennis and cycling in addition to football and cars)?		
So that work has a clear rationale, do you make a point of following the sequence: applications – principles – applications?		
Do you give examples of careers that use the knowledge and skills developed in the topic?		
Do you expose your students to a diverse range of scientists?		
Do you use a variety of questioning techniques?		
Do you adopt styles of questioning that take account of some girls' stated preferences for time for reflection and discussion?		
In group and project work, do you ensure that roles are rotated so that all students have equal access to equipment, and take a turn doing note-taking and clerical activities?		
Do you monitor the proportion of time that you spend interacting with boys in comparison with the time spent interacting with girls?		

# Laser DJ: A simple optical communication demo



Above: laser circuit diagram. Top right: completed set-up.  
Bottom right: step-by-step guide to building the kit.

This cheap and simple demonstration can be built at low cost (£20–£30) and will help your students understand how information can be sent using light signals. Budding DJs can stream music from their smartphones to a music system and demonstrate their skills by “scratching” the laser beam.

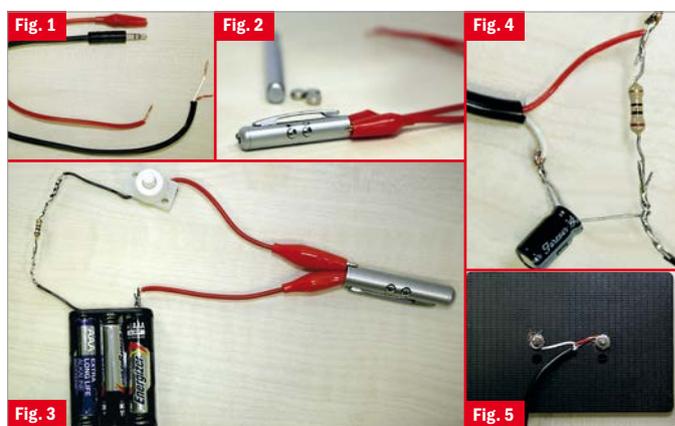
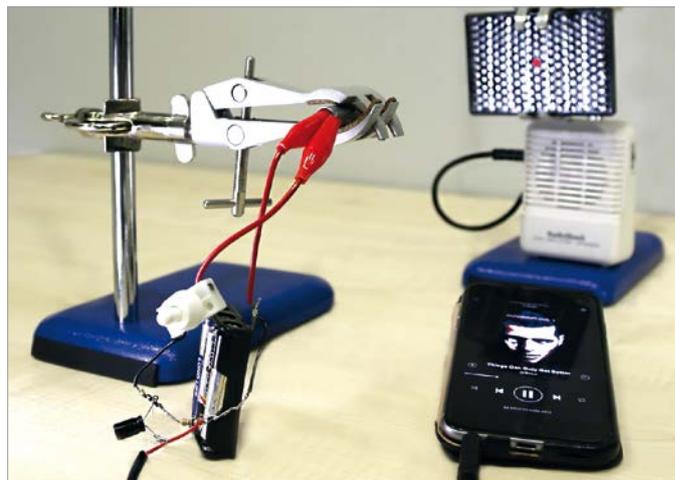
Refer to CLEAPS leaflet PS52 for additional guidance on use of lasers in the classroom.

### Equipment needed

- Laser pointer/pen (class 2)
- 3.5 mm mono jack lead (male to male)
- Lead with a small crocodile clip at each end
- 3 AAA batteries plus battery holder
- Push locking switch (e.g. Maplin code: FH94C)
- Solder and wire
- 100 μF capacitor
- 10 Ω resistor
- Any audio device that outputs to a standard headphone 3.5 mm jack lead (e.g. mp3 player or smartphone)
- Two stands and clamps
- Light sensor (e.g. Rapid Electronics order code: 37-0436)
- A music system with standard 3.5 mm microphone socket or mini audio amplifier (e.g. RadioShack Mini Audio Amplifier)
- Hair comb (optional, if your students want to laser DJ)

### Building the kit

- Figure 1: cut both the 3.5 mm mono jack lead and crocodile clip lead in half. For the jack lead also separate the two internal wires.
- Figure 2: open the laser pointer and dispose of the button cells (the laser will be powered by the 3 AAA batteries when connected to the circuit). Clip one half of the crocodile clip lead to the battery spring and the other crocodile clip to the body of the laser.
- Figure 3: solder the resistor, switch and battery pack in series with the laser.
- Figure 4: take one half of the 3.5 mm jack lead, attach a capacitor to one of the internal wires and attach it in parallel across the resistor.
- Figure 5: build a separate receiver by connecting the light sensor to the other half of the 3.5 mm jack.



### Setting up the demonstration

- Mount the laser horizontal to the bench using the clamp and stand. The laser pen is likely to have an in-built switch – switch this permanently on by taping or clamping as necessary.
- Use the other clamp and stand to mount the light sensor in front of the laser. Switch on the laser circuit and align the light sensor by ensuring that the laser strikes its centre.
- Plug the 3.5 mm jack from the light sensor into the music system/speaker and plug the corresponding lead from the laser into a smartphone/mp3 player. Press play and the signal from the music player should now be audible from the stereo/speaker.
- To laser DJ, move the hair comb back and forth across the laser beam to “scratch” the music.

### Additional notes

If you have trouble sourcing a mono 3.5 mm jack lead you can use a stereo version. Stereo 3.5 mm jack leads have three internal wires (two wires for the left and right channels and a central common ground wire). If using a stereo lead, wrap the ground wire around either of the other wires before connecting to the laser circuit.

**For more information:** more detailed information on how to build the kit and how it works is available at [bit.ly/laserDJ](http://bit.ly/laserDJ).

**Taj Bhutta** is the School Support Manager at the Institute and **Alessio Bernardelli** is a Teaching and Learning Coach for the Institute’s Stimulating Physics Network.