

# Classroom physics

The magazine for affiliated schools

June 2019 Issue 49

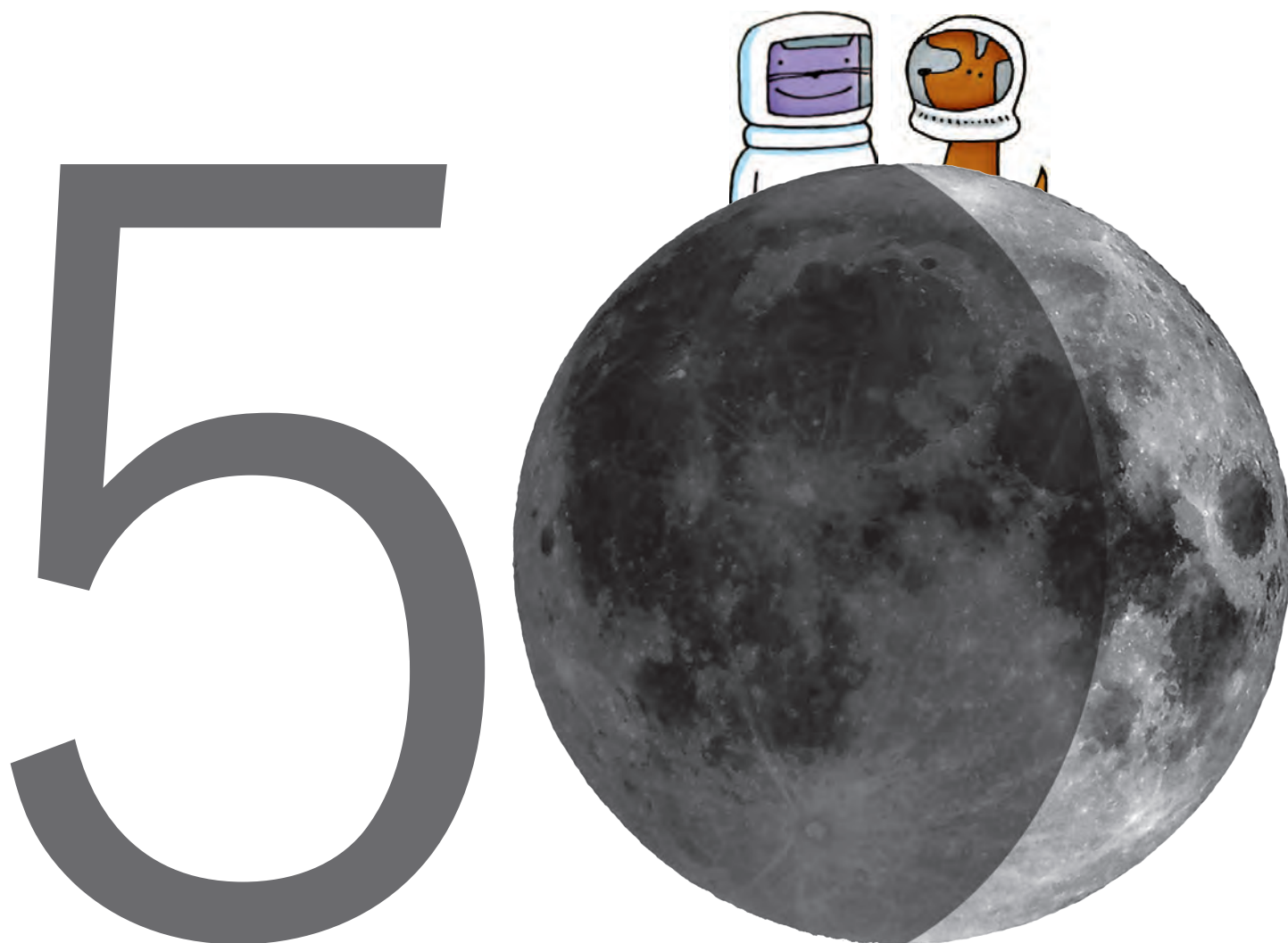
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Celebrating the 1969 Apollo 11 Moon landing:  
student activities and more inside

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**IOP** Institute of Physics

[www.iop.org](http://www.iop.org)



IOP

*The IOP Education Team – Robin is the bloke in glasses, second from left on the back row.*

# IOP Education moves into a new era

Was there ever a time when change was not the prime feature in education? Government-led initiatives may have reduced, but IOP is busier than ever with many new and updated projects.

Foremost, we are committed to improving our support to you. We have simplified and beefed up our offer to teachers to be more regionally-focused. IOP Physics Coaches will work directly with teachers of physics whilst our new Professional Practice Group will support leaders of physics CPD (see page 5).

Our major new education website IOPSpark is close to launch. Focused on helping you teach physics, it includes tried and tested resources plus new content such as common classroom misconceptions.

Policy-wise, in England we have been consulting with the DfE and fellow subject associations on the Early Career Framework, promoting subject-specific development for

early-career teachers. Similarly, we are collaborating to promote curricula based on clear understanding of subject pedagogy to feed into the consultation on OFSTED's new inspection framework.

In Scotland, Stuart Farmer has taken over as National Education Manager following Gordon Doig's retirement. He's working with Education Scotland to promote Career Long Professional Learning for Scottish physics teachers. Meanwhile in Wales, we are launching a gender balance project to increase the number of girls choosing to study physics in Welsh schools.

Six months into the occupancy of our new building in Islington, we have welcomed local school children for discovery days and homework clubs. We have plans for a teacher day before the end of Summer Term – watch out for details.

As always, thank you for your efforts in teaching physics and good luck to your students in their exams. I hope the summer term gives you a chance to draw breath and reflect on a successful year... and enjoy a bit of physics CPD?

By Robin Griffiths,  
Head of Programme: Teacher Professional Support

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## Welcome to the new look Classroom Physics

We hope you enjoy our new design. As well as including more content from Physics Education which is now online-only, the expanded Classroom Physics includes more ideas for the classroom which you can pick up and use. Let us know what you think and any ideas you have for what you'd like to read about by emailing the editor at [caroline.davis@iop.org](mailto:caroline.davis@iop.org).

## With this issue...



### Stories from physics: weird units and wonderful measures

The first booklet in a series collecting physics stories for secondary school students. Historical anecdotes such as how the metre was first defined and some rather unusual units – can your students add some of their own?

### Posters about SI units and measurement

To mark the redefinition of the final SI units on 20 May, we're including three posters from the National Physical Laboratory. Affiliated Schools can get others by emailing [education@iop.org](mailto:education@iop.org). More resources on SI at [npl.co.uk/si-units](http://npl.co.uk/si-units).

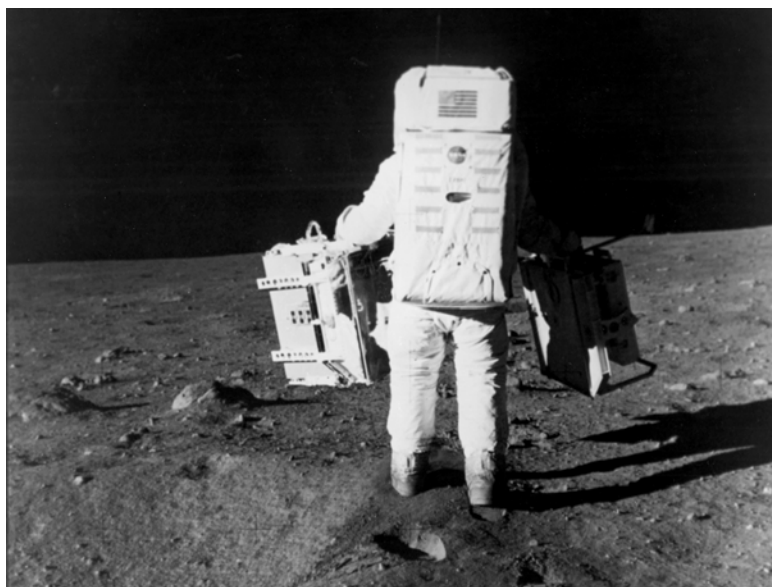


## Classroom physics

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## Student activities

## Reflecting on the first Moon landing



NASA

Buzz Aldrin carries the EASEP in his left hand and the laser ranging retroreflector in his right. This equipment would have been too heavy to carry on Earth!

On 20 July 1969, the Apollo 11 mission touched down on the Moon at what became known as Tranquility Base. It's a fascinating story, with lots of opportunities to explore in the classroom and link in to the curriculum.

In the centre of this issue, we've created activities to help your students understand how the timing of the landing was planned. You could also look at why the lunar lander used rockets rather than a parachute to slow its descent. Or ask your students to research what we have learned about the Moon from the Early Apollo Scientific Experiments Package

(EASEP) left behind by the astronauts. The lunar laser ranging retroreflector (see below) was its longest running legacy.

### Recommended Moon links:

NASA's student-friendly introduction to EASEP at [bit.ly/EASEP](http://bit.ly/EASEP)

Wikipedia's video showing the Apollo 11 landing site at [bit.ly/Apollo11site](http://bit.ly/Apollo11site)

Google Earth's great reconstruction of the descent of the lunar lander on YouTube at [bit.ly/GELunar](http://bit.ly/GELunar)

NASA's article about what Neil and Buzz left on the Moon at [bit.ly/NeilBuzz](http://bit.ly/NeilBuzz)

## Visit the Moon at the IOP

Our Moon Adventure exhibition opens in July. Visit online or at our Kings Cross gallery space. It will be a playful, hands-on look at the physics of the Moon, the realities of being an astronaut and a look to the future of humans in space. Suitable for key stage 2 and above. Look out for the retroreflectors (see below)!

### For more information

about the exhibition and downloadable activities, visit [iop.org/moon](http://iop.org/moon)

Follow our Moon journey on Twitter [#IOPmoonadventure](https://twitter.com/IOPmoonadventure)

## Careers in space

If your students are interested in working in the space industry, the National Space Academy has a great website dedicated to how to get started. There is no fixed route: physics is of course important, but politics, business, geography and even psychology all play a part in current space roles.

### Find out more at

[nationalspaceacademy.org/careers](http://nationalspaceacademy.org/careers)

## Explore retroreflectors

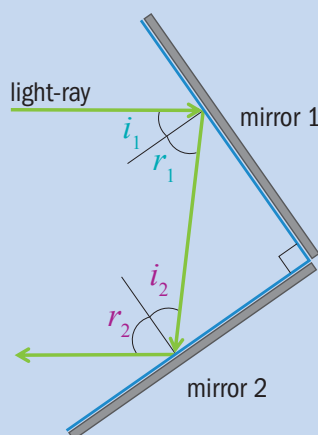
A retroreflector consists of mutually perpendicular reflective surfaces that return a light beam back in the same direction it came. A plane mirror can only do this if the light is incident along the normal (ie angle of incidence is zero).

NASA's lunar laser ranging retroreflector array was placed near the Apollo 11 landing site. Comprised of a 30 cm wide panel with 100 reflectors pointing at Earth, it was used by astronomers to measure the distance of the Moon from the Earth. Detecting



NASA

just a single photon returned from a laser pulse shot from Earth enabled them to time the round-trip and so calculate the Moon's distance precise to a few centimetres out of 385,000km!



Students can investigate why retroreflectors were used by making their own, using a ray box and two mirrors at  $90^\circ$  to each other. It is a simple geometric calculation to show that the light ray returned by the retroreflector is always at  $180^\circ$  to the incident ray. Encourage students to adjust the position of the ray box to change the angle of incidence on the first mirror, explore changing the angle between the two mirrors – and compare their results with using a single plane mirror.

## Case study

## Whole school approach leads to record number of female A-level students

Kingsbridge Community College in Devon has had a real drive to address gender bias and stereotyping – and seen impressive results. In 2018, girls outperformed the boys at GCSE and sent an equal numbers of girls and boys to study physics-based subjects at university. This year, the school is enjoying a record 11 girls studying for A-level physics.

The school's physics lead, Phil Atherton, has run interventions with last year's year 11 girls (lunch club, ambassador days, trips) since they were in year 7. More recently, it sent its PHSE co-ordinator, Lorien Joyce, on an IOP gender workshop.

Joyce, who also teaches philosophy and RE, said, "The training was not only informative but inspiring. Whole school staff CPD was delivered by the IOP to ensure that awareness of gender bias and stereotyping was on the agenda. This has been fully supported by senior leadership and followed up with students as part of their PSHE programme.

"As a research school we use evidence based practice to inform teaching and learning so that a real difference is made in the classroom. Planning and developing a meaningful response to the issue of gender bias and stereotyping involved collaborative research with members of staff, students and external experts in the field.

"This year will see the research put into practical application, including a whole school survey and identifying key areas where data reveals a significant gender gap: in behaviour, academic progress and uptake of subjects at GCSE and A level."

Kingsbridge has a new project hoping to replicate the success achieved in physics by getting more girls into computer programming. It is also tackling boys' underperformance and uptake of A-level subjects with gender disparity by promoting neutral teaching and helping teachers understand how to open up conversations with boys.

Lorien Joyce will be speaking at the IOP's south west regional day on 2 July – [register at bit.ly/TalkPhysicsSWest](https://bit.ly/TalkPhysicsSWest)



IOP

## Research

## Major new IOP research trial to tackle barriers to girls' progression in physics

We've just launched a project working with 160 schools to increase the proportion of girls choosing to progress to A-level physics.

Despite many attempts to encourage girls to continue studying physics post-16, the proportion of A-level candidates who are girls has stubbornly remained at around one in five for over 30 years.

However, recent IOP work on gender balance has suggested potential breakthroughs, leading to the Department for Education (England) to ask us to run a national research trial.

The Improving Gender Balance research trial draws on the success of our recent pilot project across six schools which saw the number of girls taking A-level physics more than treble over two years and the IOP's IGB Scotland programme, which the Scottish government embedded in its STEM education strategy.

Beth Bramley, our Gender Balance Programme Manager explained, "This ground-breaking study will tell us what really works, helping to set the future agenda for

best practice in gender balance improvement in schools.

In fact, a lot of work is not specifically on gender. It's about working out how to make your classroom friendlier to everyone. If you address these principles, your classroom should be more inclusive generally and students should be able to make more informed subject choices across the board, not just in physics."

Drawing on these approaches, our randomised control trial will see half of participating schools receiving a programme of evidence-based support including:

- training and CPD for teachers
- the development of a whole-school strategy to combat gender stereotyping
- options evenings, careers guidance, and student-led projects
- a dedicated IOP coach.

The research will be evaluated by the UCL Institute of Education.

**For more information:**  
[beta.iop.org/IGBTrial](https://beta.iop.org/IGBTrial)

*Addressing gender imbalance in physics can have beneficial effects across your school*

### What can you do to address gender balance issues in your school?

- get in touch with us at [IGB@iop.org](mailto:IGB@iop.org) and follow our Gender Action twitter feed [@\\_gender\\_action](https://twitter.com/_gender_action) or
- visit [iop.org/genderresources](https://iop.org/genderresources) for student and teacher resources
- IOP Regional CPD Days often include sessions on gender balance. Visit [talkphysics.org/events](https://talkphysics.org/events) to find one near you
- Gender Action is a new award programme promoting a whole-school approach to removing barriers. Currently London only, but a wider roll-out is planned for 2020. All schools can access an online library of resources at [genderaction.co.uk/online-resources](https://genderaction.co.uk/online-resources).

## Teacher support

# Shiny happy people: meet our new REMs

The way we support teachers around England has changed. Our new structure is simpler so that teachers have a single point of contact in any region – don't worry, our team contains many familiar faces from our existing teacher support team plus some friendly new faces and extra admin support.

Each region now has its own regional education manager – a single point of contact for all IOP projects in that area. Working with a team of IOP Coaches, they are tasked with supporting physics education in its widest sense.

The regional model allows better tailoring of our approach to local schools and local needs. It should also reduce the number of IOP acronyms thrown at teachers.

Do get in touch with the manager for your region (see below). They will be delighted to discuss the most suitable CPD for you and



*This is what an IOP CPD event looks like*

your colleagues and can also help you with any questions you may have about teaching physics.

### Regional Education Managers

- North-West – **Graham Perrin**  
[education-northwest@iop.org](mailto:education-northwest@iop.org)
- Yorks & N East – **Jenny Search**  
[education-yane@iop.org](mailto:education-yane@iop.org)
- Midlands – **Ian Horsewell**  
[education-midlands@iop.org](mailto:education-midlands@iop.org)
- London, East-Anglia, Kent –  
**Jessica Rowson** [education-leak@iop.org](mailto:education-leak@iop.org)
- South – **Trevor Plant**  
[education-south@iop.org](mailto:education-south@iop.org)

### Wales, Ireland and Scotland visit

[iop.org/teachers](http://iop.org/teachers) to find out about IOP support for teachers. See the back page of this edition of Classroom Physics or visit [talkphysics.org/events](http://talkphysics.org/events) to find out about regional events this summer.

## CPD provider support

## Do you lead physics CPD?

Rachel Hartley heads up our new Professional Practice Group, She writes:

“We are a team of physics enthusiasts with a wide range of experience in the physics classroom and of coaching as part of the IOP education networks. What will we be doing?”

- Building a community for everyone involved in physics coaching
- Developing a CPD curriculum for teachers of physics
- Engaging with current education research on physics pedagogical content knowledge, gender equality and education
- Promoting best practice in inclusive physics teaching
- Providing support for physics teachers who are coaching in their school through regular local meetings
- Evaluating – using the national pupil database to assess the impact of our government-funded projects to date.

- Guiding teachers in their application for Chartered Physicist (CPhys) status, because we firmly believe that teaching physics is doing physics. Email [TeacherCPhys@iop.org](mailto:TeacherCPhys@iop.org) for more info.

“Over the years, we've discovered that what has most impact is getting a critical mass of physics coaches together to talk about what we do, how we do it and why. So there will be a programme of physics coaching seminars running as a combination of day meetings, twilight sessions, half-term and weekend events so that those who know most about physics teaching in schools can attend. You may be interested in hosting a coaching meeting at your school.”

If you are currently coaching teachers of physics or involved in classroom-based research in physics, please join our online discussion group at [talkphysics.org/groups/coaching-practice](http://talkphysics.org/groups/coaching-practice). Alternatively, you can be added to our email list by contacting Rachel.

**To find out more** about the group or to get in touch with your local CPD provider supporter, email Rachel at [rachel.hartley@iop.org](mailto:rachel.hartley@iop.org)

## Social media

**@TakeOnPhysics is now @IOPTeaching**

For those who follow us on Twitter, you may have noticed we have changed our Twitter handle from @TakeOnPhysics to @IOPTeaching.

This isn't just a change of name: it reflects what we want to be to all teachers, technicians, policy-makers and therefore future physicists.

@IOPTeaching will continue to share details of CPD events and resources. But it isn't just a platform – we want it to be a place to have conversations about teaching physics with you. We want you to come here to share resources, hear about CPD opportunities and events, ask questions and get support from IOP education as well as from our fantastic network of educators across the country and our 12,500 followers.



### IOP twitter accounts

- @IOPTeaching**  
– IOP support for teaching physics
- @PhysicsNews**  
– the main IOP account sharing Institute news and projects
- @PhysicsWorld**  
– the IOP members' magazine with physics news and views
- @EducatePhysics**  
– our research journal Physics Education
- @IoPITeachers**  
– IOP Ireland Teachers Network

## Student activities

# Borrow a Vertigo data logger and the sky's the limit

The application of Newton's first and second laws to moving objects is often a challenging and fun learning journey for secondary school pupils. But it is invariably a theoretical exercise. Diagrams, videos and simulations can all support concept acquisition but data to analyse in this topic can be difficult to come by.

Jamie Costello, a physics teacher at Sutton Grammar School wants to change that. The Vertigo data logger was built in collaboration with colleagues and students, with financial support from the Institute for Research in Schools and the ERA Foundation. And from September, there will be 20 units available for schools to borrow free of charge.

Combining accelerometer, gyroscope and GPS data, Vertigo can tell you exactly where it has been and exactly how it has been moving.

Mr Costello said, "The latest edition, Vertigo II, has been designed to allow students with a less technical background to get involved. It's really is good fun to use. And if you needed an excuse to take your students to Alton Towers or Thorpe Park, Vertigo is it."

**To borrow a Vertigo unit and to find out more about the project:** visit [bit.ly/IRISvertigo](http://bit.ly/IRISvertigo).

You can see the web-based Vertigo tool for students at [bit.ly/IRISvertigoweb](http://bit.ly/IRISvertigoweb)

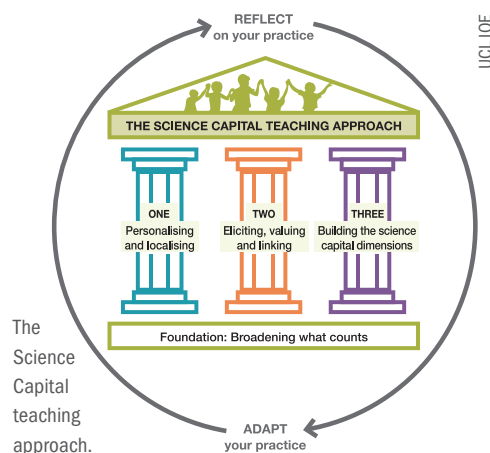
## Pedagogy

## Science Capital: beyond the idea of scientific literacy

I was recently in a Y11 Physics lesson when a student turned and asked me what was the point of learning this? I gave a few useful answers, but could see that the student wasn't convinced.

This student was in one of our partner schools in an area of high social-economic deprivation and low social mobility. In these areas, schools face a plethora of challenges above simply accessing the curriculum. These students are savvy, they need real reasons to engage in something that to them occupies only a small part of their lives. We need to go beyond "you have to do this for your GCSEs" and "it will help you get a good job".

I recently came across the potentially game-changing idea of Science Capital, developed by Louise Archer at UCL Institute of Education. This extends the idea of scientific literacy to a pot of skills, attitudes and behaviours which reflect an individual's exposure to, and engagement with, science such as media consumption, family science skills/qualifications, knowing people in science-related roles and talking about science in everyday life.



We should begin by establishing science-relevant links in the lives of our students and those around them. We then must explicitly value their input and link the curriculum to this before we can build their science capital through practices, activities and opportunities.

A quick example would be using local science resources in the community. I work with schools in the Telford area and the museum at RAF Cosford provides a wealth of opportunities to engage learners and their families.

This is not asking teachers to do more: an investment now could pay dividends in the future engagement, enjoyment and attainment.

**This is an abridged version of a blog post** by IOP Physics Coach Mark Whalley. Read the whole article at [iopblog.org](http://iopblog.org) and look out for more in the series.



To demonstrate some of the device's capabilities, Flt Lt Mikaela Harrison, a parachutist with the RAF Falcons, agreed to take Vertigo on one of her training camp jumps in America.

The results are not the sterile book version of what happens in a jump – the first thing students will notice is just how much signal noise there is, not something they may be familiar with, but an introduction into 'real science'. Within that noise is some brilliant data.

A special point of interest is to see the magnitude of the force when the parachute is first opened. It doesn't last too long, but comes on pretty quickly. It must feel like quite a jolt.

The other area which warrants further investigation is when air resistance and drag are in equilibrium. The graph is anything but smooth, however. And why would it be? Here we have a person, being buffeted around as she moves and adjusts her position within the Falcons Team. Staying perfectly still must be all but impossible.

**Read the whole of Jamie's blog** analysing Flt Lt Harrison's results at [bit.ly/CPvertigo](http://bit.ly/CPvertigo)

Teacher recruitment and retention

# Eight easy ways to keep science teachers

A new report commissioned by the Gatsby Charitable Foundation has outlined eight straightforward interventions secondary schools can use to improve their recruitment and retention of high-quality science teachers. With the shortage of specialist physics and chemistry teachers continuing to grow, the eight cost-effective and low-risk interventions aim to provide school leaders with a means of taking immediate action to tackle specialist subject recruitment and retention challenges.

Based on a thorough review of existing research, the eight principles cover a range of areas, with suggestions for implementation and supportive references provided.

- 1 Too much too soon:** teaching physics, chemistry and biology increases workload. Instead, concentrate on a specialism.
- 2 Let them walk before they run:** get confident with a specific key stage or type of pupil before moving on.
- 3 Dream team:** make your best science teachers available to newbies.
- 4 Here comes the science bit:** offer subject CPD as well as pedagogical.
- 5 Practice makes perfect:** provide coaching in specific skills, practice them in the classroom and review progress.
- 6 Money talks:** a new teacher is more sensitive to pay than a teacher with 10 years of experience.
- 7 The grass is greener:** set salaries with an eye to outside earning potential – science graduates tend to earn more outside teaching.
- 8 Room to grow:** give new teachers autonomy backed up with strong leadership and a sense of shared mission.

Sam Sims, the researcher from UCL's Institute of Education and author of the paper, said: "Given the shortages faced by science departments up and down the country, the principles outlined are not only timely, but much needed. England has



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a severe shortage of teachers, particularly in the sciences, and this is only set to worsen with the secondary-age school population forecast to grow by 19% in the decade to 2026. Despite various initiatives, for the past three years we have seen a worrying decline in the number of physics and chemistry trainees. This paper provides school leaders with research-backed, pragmatic solutions to the current retention and recruitment challenges faced by science departments."

Chris Shepherd, IOP teacher recruitment and retention manager "We very much welcome Sam's insights, especially in the areas of deployment and development which mirror our current research projects. The report offers strong evidence about what works and we will be discussing these ideas with DfE to get them adopted nationally. Similarly, we would urge teachers to discuss this report in their schools."

Gatsby's report came hot on the heels of the English Department for Education's recruitment and retention strategy. Sir John Holman, senior adviser to Gatsby, and president of the Association for Science Education, welcomed that report but added that it would take time to implement. He said, "The principles in Gatsby's latest report provide school leaders with steps they can take in the meantime to bolster science teacher numbers."

*Simple interventions can help schools keep their science teachers – this group is learning about the rope loop model at an IOP CPD day*



GATSBY

**Read** the full Gatsby report at [gatsby.org.uk/uploads/education/increasingscienceteachers-web.pdf](https://gatsby.org.uk/uploads/education/increasingscienceteachers-web.pdf).

**Read the IOP's response** to the DfE's recruitment and retention strategy at [bit.ly/IOPgovretention](https://bit.ly/IOPgovretention) and our joint letter printed in the TES at [bit.ly/CPtesletter](https://bit.ly/CPtesletter)

### How does your school score against these recommendations?

We'd love to hear from schools about what has worked – and what you are working on.

**Join the TalkPhysics discussion** at [bit.ly/TPretention](https://bit.ly/TPretention)



Shutterstock

Would you want to talk to a scientist at a party?

## It isn't just what you know: ways to measure beliefs and attitudes

Researchers in America reported a case of a successful engineering student who became alienated from his course because he felt his view of learning clashed with the culture of his programme. Whilst he was strongly committed to making sense of the material, he felt that the course unfairly rewarded those who rote-learned procedures more than those who wanted to question and think deeply. This and other similar studies highlight the importance of investigating not just students' knowledge of physics but their attitudes to learning.

Although it may be easier to 'measure' if someone understands Newton's second law than how they feel about physics, in recent years researchers have developed, refined and tested ways to give an insight into students' beliefs and attitudes. One of the most widely used tools to explore learning attitudes is the CLASS survey (Colorado Learning Attitudes about Science Survey). Developed at the University of Colorado in the US, it uses a Likert scale (usually 5 points from strongly agree to strongly disagree) to ask

students to respond to statements such as:

- Knowledge in physics consists of many disconnected topics.
- Learning physics changes my ideas about how the world works.

These types of questionnaires are often used before and after a particular intervention or change in teaching approach to help give an insight into what effect it may have had.

One of the interesting aspects of these types of survey is that they often try to separate out a complex idea such as 'attitude about science' into subcategories, each with its own questions to allow a more nuanced look at the students' views and the impact of various changes. Some of the categories that are used in CLASS are:

- Conceptual understanding
- Connections between maths and physics
- Sense making / effort
- Personal interest
- Real world connections

There is some excellent work in this field from the University of York

Education Group, in particular Judith Bennett and Sylvia Hogarth's wonderfully titled research paper *Would You Want to Talk to a Scientist at a Party? High school students' attitudes to school science and to science*.

CLASS is available in science, physics, biology and chemistry variants. Full details including online versions, data analysis tools and research papers on its development and use are available via [colorado.edu/sei/class](http://colorado.edu/sei/class)

There are also some questionnaires along similar lines available as part of the IOP's gender balance work here: [iop.org/genderresources](http://iop.org/genderresources)

If you would like to join other physics teachers interested in engaging with the latest research, discussing classroom applications, attending seminars and getting involved with research, email us at [research@teachphysics.co.uk](mailto:research@teachphysics.co.uk) or join the Physics Education Research (PER) group on Talk Physics at [talkphysics.org/groups/physics-education-research-per/](http://talkphysics.org/groups/physics-education-research-per/)

In this column, James de Winter (University of Uppsala and University of Cambridge) and Richard Brock (King's College London) highlight accessible and usable resources based on research into physics education.



# Lunar phases and launch dates

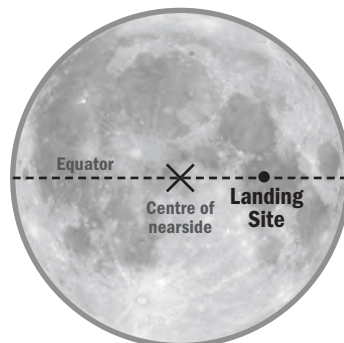
Pull out  
and keep

**We've created some activities to help your students think about how NASA planned the timing of the first manned landing on the Moon.**

The Apollo 11 landing was scheduled for early in the lunar morning. Arriving when the Sun was rising over the landing site ensured good visibility: features on the surface cast longer shadows in the morning, making them easier to see – and avoid if necessary – as they came in to land. It also gave Neil Armstrong and Buzz Aldrin the plenty of time to explore. The astronauts spent 21 hours, 36 minutes on the Moon's surface, though this is just a fraction of a lunar day which is as long as 15 Earth days.



NASA



## Activity 1: Lunar phases

The phases of the Moon correspond to different points on the lunar surface experiencing day and night. Students build a model of the Earth-Moon system to explore the Moon's phases.

Suitable for all students.  
(page 10)

## Activity 2: Planning a launch date

Students follow some of the steps the NASA scientists took to plan the mission by working out when lunar dawn occurs at the landing site and calculating when they need to leave the Earth to coincide their arrival.

Suitable for students who enjoy a challenge.  
(page 12)



NASA

## Activity 3: See the world differently (thought experiment)

Ask your students, in pairs, to try to describe what the astronauts would have seen when they were standing on the surface of the Moon, looking back at the Earth. How would its appearance change as time passes?

After they have discussed this, show them this animation: [bit.ly/lunarday](http://bit.ly/lunarday). The Earth appears partially lit and goes through phases that mirror the Moon's. They would see the Earth spinning. But, because they are standing on a surface that always is facing the Earth, they would not see the Earth rise or set in the sky. It would hang stationary in the sky.

Did anyone get it right?

**For more information:** NASA has a rich archive of resources on the Apollo 11 Moon landing at [bit.ly/CPapollo11](http://bit.ly/CPapollo11)

# Activity 1: lunar phases

The Moon is always half lit (apart from during a lunar eclipse). But from our point of view from Earth, it goes through phases of being fully lit (full moon), to partially lit, to not being visible (new moon) and then back again.

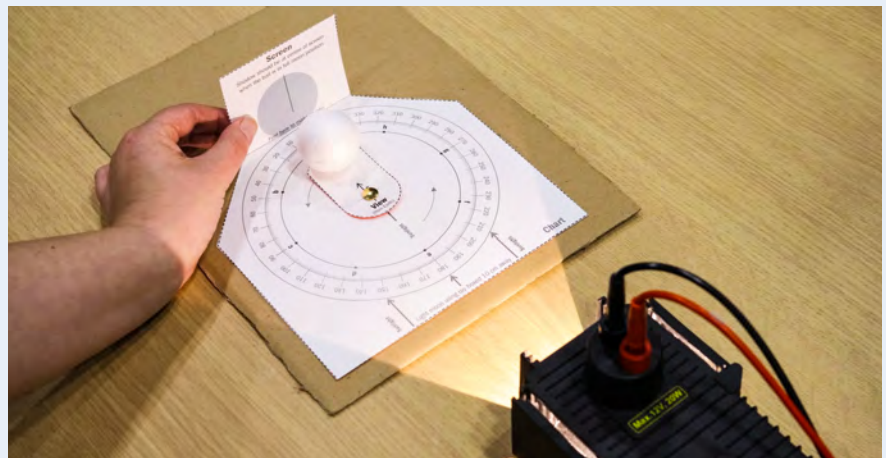
Students use a template to build a model of the Earth-Moon system to explore the Moon's phases. This activity works best in a darkened room. If this is not possible, they may want to cover their models to improve visibility.

## Equipment required per pair of students:

- ✓ 4 cm diameter polystyrene ball (Moon)
- ✓ Ray box
- ✓ The activity instructions (right)
- ✓ Apollo 11 Earth-Moon template (opposite page) copied on to card
- ✓ Two drawing pins
- ✓ Corkboard or thick cardboard
- ✓ Sticky tape & scissors

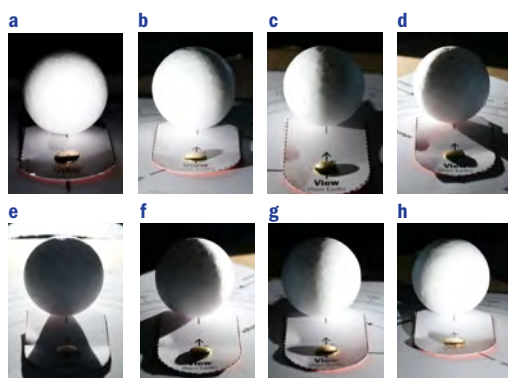
## Limitations of the model

- ➔ This model is not to scale! The Moon is oversized to allow easier viewing of the phases and the Earth is not shown (only its position **E** is marked). To view from Earth they should look along the arrow on the pointer- **taking care NOT to look directly at the light source!**
- ➔ The ray box should be placed about 10 cm from the edge of the model to provide a fairly broad beam and simulates sunlight from a faraway sun.



## Student instructions

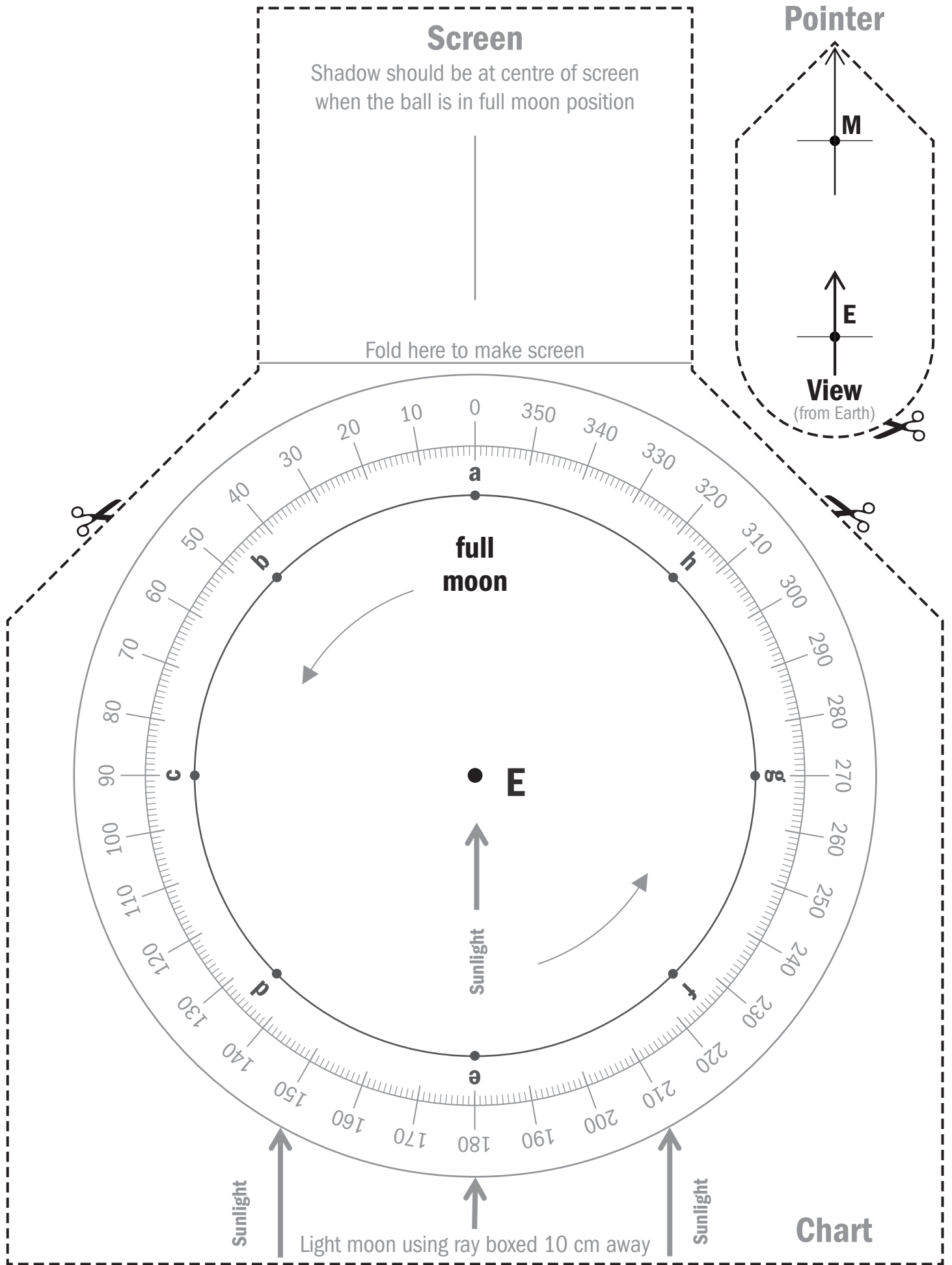
1. Cut out the pointer from the Earth-Moon template.  
Make a hole at **M** using a drawing pin.
2. Attach a polystyrene ball to the pointer by pushing a pin up through the pointer at **M** and into the ball.
3. Cut out the chart from the template and put it on the board.
4. Connect the pointer at its centre by pushing a drawing pin through the Earth position **E** on the top of both pointer and chart.
5. Place the ray box about 10 cm away from the chart on the bench and line up the chart so that the ray box provides light in the direction of the sunlight arrow.
6. Put the ball at position **a** (full moon) and use the shadow of the ball on the screen to check the ray box and chart are aligned. Fold down the screen when you have finished
7. Once aligned, stick the chart to board and board to bench using a bit of sticky tape.
8. For each position of the pointer from **a** to **h**, you can see how the Moon looks from Earth by viewing along the arrow on the pointer.
9. Record your observations by shading in the circles below (the first two have been done for you).



The ball positions a-h, viewed along the line of the pointer.

## Phase chart

Position	a	b	c	d	e	f	g	h
View from Earth								
Angle	0°	45°	90°	135°	180°	225°	270°	315°
	Full Moon	Waning Gibbous	Last Quarter	Waning Crescent	New Moon	Waxing Crescent	First Quarter Moon	Waxing Gibbous



## Activity 2: lunar days and launch dates

In the 27 Earth days it takes the Moon to orbit our planet, it only spins once on its axis. This means daytime lasts a lot longer on the Moon.

The Moon is tidally locked to the Earth and this means that the same part of the Moon (the nearside) always faces the Earth. NASA studied images of the nearside for two years before announcing five potential landing sites for Apollo 11. They also looked for smoothness of the sites, evenness of the approach path and ease of return to Earth should a problem occur on the way to the Moon.

The landing site finally chosen was about 500 miles from the centre of the nearside on the equator.

In this activity, students work out when to launch a future mission in order to arrive at the landing site at first light.

### Equipment required

- ✓ The Earth-Moon model from activity 1
- ✓ Access to this and next month's calendar (eg displayed on the board)
- ✓ The date of the last full moon

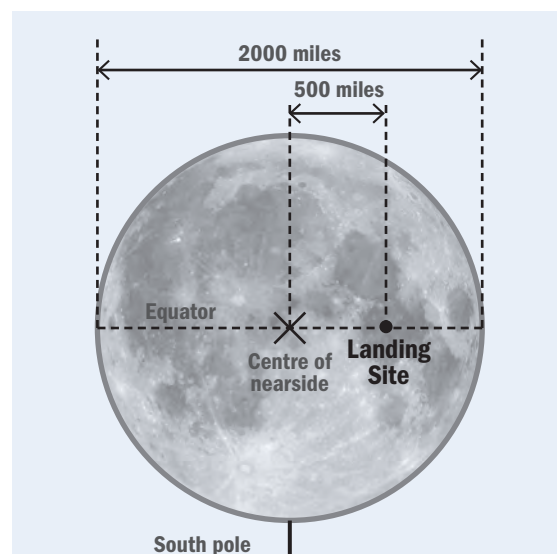
### Expected results



- ➔ **Sunrise at the landing site** (see above) occur when the pointer is at about  $240^\circ$  on the chart (waxing crescent Moon).
- ➔ Three days corresponds to a change in angle of  $3/27 \times 360^\circ = 40^\circ$ , giving the Moon's position for launch at around  $200^\circ$  on the chart (ie about 15 days after a full moon).
- ➔ The launch date will depend on when the students carry out the activity. If, for example, it is the last week of June 2019, the date of last full moon was 17th June, and so they can launch around the 2nd July 2019.

### Limitations of the model

Students should be able to set a launch date to within about  $\pm 1$  Earth day. To improve on this, they would need to account for the motion of the Earth-Moon system around the Sun (eg by detaching the model from the bench and moving in a circle around a lamp), model an elliptical rather than circular orbit and also take account of any small variations in the Moon's path caused by the gravitational pull of other planets.



### Student instructions

1. On your model, mark a cross on the ball's equator, indicating the centre of the nearside of the Moon.
2. Mark a dot 1 cm to the right of the cross on the equator to indicate the Apollo 11 landing site
3. The journey from Earth to the Moon takes three days. You want to arrive just as the Sun rises at the landing site, so first work out the Moon's phase at arrival:
  - a. Move the Moon around the chart again, ensuring that the cross always faces the Earth as it moves, with the dot staying to the right of the cross.
  - b. Find the position on the chart at which it will be sunrise at the landing site.
4. The Moon takes 27 days to complete an orbit of the Earth. Using this information, can you work backwards to find the Moon's position at launch three days earlier?
5. Use the date of the last full moon to set a launch date for your mission.

### How long is a month?

The Moon takes 27 Earth days to orbit Earth (a sidereal month), but the lunar phase cycle, full moon to full moon (a synodic month) is, on average, closer to 30 Earth days. The Moon spends the extra days "catching up" because Earth travels around the Sun during the time the Moon completes one orbit around Earth. Astronomers have many more definitions of a month!

## Moonwalking

The motion of the human leg can be modelled as an inverted pendulum, with the pivot where the foot touches the ground and the body's centre of mass tracing a circular arc as it rises and falls during one step.

Applying the centripetal acceleration formula, a person whose centre of mass is 0.9 m above the ground has a maximum comfortable walking speed around 3 m/s – to reach higher speeds, people typically have to

run or jog. On the moon, the lower gravitational field strength gives a lower upper limit to the comfortable walking speed as 1.2 m/s. Hence astronauts on the moon resort to a hopping motion to move about the surface rapidly.

## Hooke on the moon

Though better known for his research on materials and microscopes, Hooke also constructed a number of telescopes. In October 1664, using a 30-foot refracting instrument to observe the moon, he made a detailed drawing of the Hipparchus crater. Ahead of his time, Hooke realised the moon's surface was not timeless and that craters were formed by collisions.



To test his hypothesis, he mixed tobacco pipe clay and water and dropped lead pistol balls into the powder to observe the formation of craters. Not all his intuitions about the moon were correct. He believed the moon to be 'covered over with some kinds of vegetable substances' which he likened to the 'the short Sheep [sic] pasture which covers the Hills of Salisbury Plains'.

## Lunar weather

Though the effects of the moon's gravitational field on the Earth are small, it has been hypothesised that it can cause changes to the weather. The Earth's atmosphere bulges in the direction of the moon causing a slight increase in pressure in the bulging area and a small increase in temperature. This temperature change increases the atmosphere's capacity to hold moisture and so decreases the probability of rain – though the change is small in magnitude.

## The reclusive selenographer

Mary Adela Blagg made a significant contribution to the study of the moon. In middle age, she attended a series of lectures given by John Herschel's grandson. He expressed frustration that some features on the moon's surface were, at the time, known by multiple names, inspiring Blagg to publish a systematic list of lunar formations in 1913. She also published on the relationship predicting the spacing of the planets and on variable stars. To honour Blagg's research, a lunar crater was named after her. Her obituary reported: 'in all her work she displayed not only skill and judgement, but also originality and courage'.

Follow Richard's stories about physics on Twitter @RBrockPhysics

## Rocket balloon

Marvin & Milo cartoons can be download at [iop.org/stemclub](http://iop.org/stemclub)

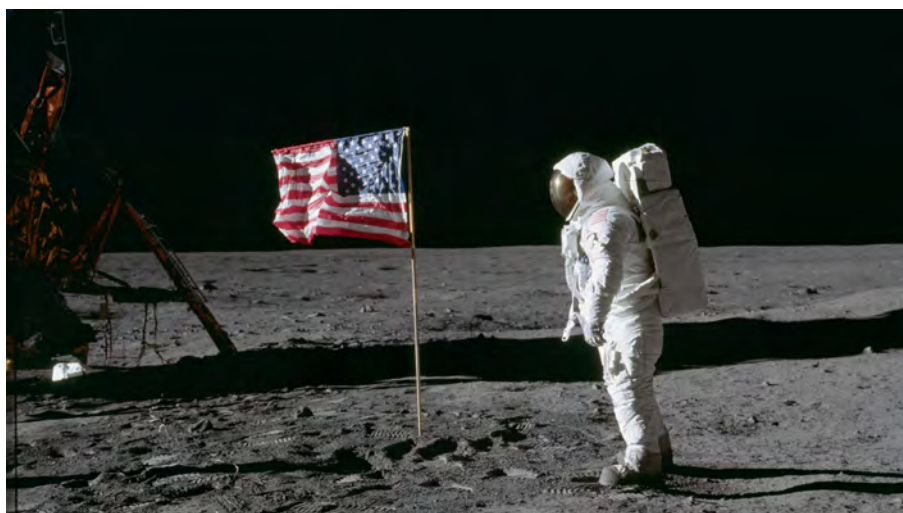


# Physics *education*

Physics Education is our international journal for physics teaching research. Affiliated Schools have access to the journal online at [iopscience.org/physed](http://iopscience.org/physed). Email us at [affiliation@iop.org](mailto:affiliation@iop.org) if you need a reminder of your login details.

There are over 50 years of papers in the Physics Education archive. Here, editor Gary Williams picks his favourites on the theme of the moon.

## Hollywood goes to the Moon: the greatest hoax of them all?



NASA

*One hoax theory centres around there being no stars in this image of Buzz Aldrin on the Moon*

Should you need to head off any Moon landing hoax question then this paper, published back in September 2003, deals with this major misunderstanding. The author writes, "The key to using the Moon hoax theory for study is in applying the scientific process to decide which pieces of evidence are reliable and convincing and which are not. A critical eye is needed to

separate science from pseudo-science. If you can get your students thinking along these lines then you are succeeding in your teaching of physics and science in general."

**Read the paper at** [bit.ly/PEmoonhoax](http://bit.ly/PEmoonhoax).

Written by David Bowdley (Education Projects Manager for the Faulkes Telescope Project)

## Are we living on the Moon?

This is the title of a letter from June 1974 in which the author explains a theory of how the Earth-Moon system formed. The upshot is that it is suggested that what we stand on today, the continental crust, is not of this earth, but was part of a moon that was pulled apart. The material was less dense than the crust that now sits underwater, and so formed the parts of the continents above the sea that we see now.

It all sounds rather strange until you realise that we don't currently have a clear model of how the Moon formed. You may recall that in the past few years, research on samples brought back from the Moon in the

1970s by the Apollo missions, has revealed that the Moon has the same ratios of stable isotopes of oxygen as the Earth – which was not expected.

This 45 year old letter could act as a great hook into your teaching. Space, density, radioactivity, tides, formation of the continents, all could be introduced as part of a research topic to see what students can work out. There is plenty of information online for them to follow the story, exploring contemporary theories of how the Earth and Moon were formed. And what they will discover may suggest that the original letter wasn't a million miles away from the truth.

**Read the full letter at** [bit.ly/PEonthemoon](http://bit.ly/PEonthemoon).

Written by RM Helsdon (Poole, Dorset)

## From red star rising to rocket's red glare: space travel, the early years

For a student-ready account of the run up to the Moon landing then download this easy-to-read paper. Published in July 2007 to coincide with the 50th anniversary of the launch of the first artificial satellite, the article looks at the early years of space travel and some of the key moments during that time. The author tells the story from the first Sputnik to Eugene Cernan, the last man on the Moon, climbing the ladder of Apollo 17's lander in December 1972 and includes lots of great images you can download.

**Read the full article at** [bit.ly/PEmoonchap](http://bit.ly/PEmoonchap).

Written by Stephen Chapman (Institute of Education, University of London)

## Crater measurements

Investigating craters is a favourite activity when looking for something hands-on to do with the Moon. This pair of papers was published in July 2013. The first takes the reader through the process of using the length of a shadow and the angle of the source rays of light to measure the depth of an impact crater. It also enables students to learn the importance of evaluating conclusions by comparing data which have been analysed using different techniques. To take it up a gear, look at the second paper. This provides high ability students with the opportunity to use real scientific data to derive the depth/diameter ratio of rimmed and rimless craters. Data from the rimless craters can then be used to estimate the volume of ejecta material excavated during an impact cratering event.

**Read the papers at** [bit.ly/PEcrater1](http://bit.ly/PEcrater1) and [bit.ly/PEcrater2](http://bit.ly/PEcrater2).

Written by Robert Scott (The Radclyffe School, Oldham) et al

# Physics *education*

Physics Education is our international journal for physics teaching research. Affiliated Schools have access to the journal online at [iopscience.org/phised](http://iopscience.org/phised). Email us at [affiliation@iop.org](mailto:affiliation@iop.org) if you need a reminder of your login details.

The May 2019 edition of Physics Education is available at [iopscience.iop.org/issue/0031-9120/54/3](http://iopscience.iop.org/issue/0031-9120/54/3). Here, editor Gary Williams chooses some highlights from this issue and other recent issues.

## Building a bowling ball pendulum

If you do the “big pendulum” demonstration to introduce the idea of conservation of energy then no doubt you’ll have something big on the end of a rope somewhere.

I saw one teacher from Spain with a rather deadly crane hook. There are plenty of videos online showing this demonstration – just search for “bowling ball pendulum”.

Used ten-pin bowling balls seem to be readily available online. Risk assessment is your own responsibility!

**Read the full article at** [bit.ly/PEbowling](http://bit.ly/PEbowling). Written by Matt French who teaches physics at Poole Grammar School



Brendan Ickringill

## Using small disc magnets to model particle interactions

This article describes a device for mimicking the forces between atoms using magnets. I really like this idea because it provides an opportunity for students to do something hands-on to discover the curve for themselves rather than just being told. The physical models are portable, simple to build and show how both potential wells

and barriers arise from a combination of attractive and repulsive forces.

Mathematical simulations are set up which model the behaviour of the physical systems. Starting off quite simply, the paper shows how you can use the physical model to end up with relatively complex mathematical models. For more guidance on using the mathematical modelling package in this article, the author has another article here to help: [bit.ly/PEsoftmath](http://bit.ly/PEsoftmath)

**Read the full article at** [bit.ly/PEdiscmagnet](http://bit.ly/PEdiscmagnet). Written by Keith Atkin, retired academic

## Low-cost experiments with everyday objects for homework assignments

This paper details simple experiments that students can try at home using everyday objects using either their smartphones or an Arduino for a sensor. I like the idea of this and would like to see more of these examples given that almost all students spend most of their waking hours with a datalogging device on their person. The paper was written with undergraduates in

mind – their feedback was that although some found it difficult, they all found experimental homework motivating. Plenty of inspiration here for homework for secondary school students.

**Read the full article at** [bit.ly/PElowcost](http://bit.ly/PElowcost). Written by F Bouquet (University Paris-Sud) et al

## More recent articles in Physics Education

**Using an electric guitar pickup to analyze bar vibrations**  
[bit.ly/PEguitar](http://bit.ly/PEguitar)

**How accurate is an Arduino Ohmmeter?**  
[bit.ly/PEaccurate](http://bit.ly/PEaccurate)

**Substituting the practical teaching of physics with simulations for the assessment of practical skills: an experimental study**  
[bit.ly/PEpractical](http://bit.ly/PEpractical)

**Free fall in curved spacetime – how to visualise gravity in general relativity**  
[bit.ly/PEgravwaves](http://bit.ly/PEgravwaves)

**Why some balls spin faster than others when they bounce**  
[bit.ly/PEballs](http://bit.ly/PEballs)

**Measuring the speed of sound in air using a smartphone and a cardboard tube**  
[bit.ly/PEairtube](http://bit.ly/PEairtube)

## What happens next?

What happens when an egg is dropped gently into water to see if it floats, and what happens when this simple process is repeated over several weeks (with the same egg) having left the egg outside the refrigerator between trials?

*What happens next?* is a regular Physics Education feature. Find the answer to this question – and view the archive – at [bit.ly/PEwhatnext](http://bit.ly/PEwhatnext)

# physicsworld

Stories from our magazine for the global physics community.  
Visit [physicsworld.com](http://physicsworld.com)

## Event Horizon Telescope takes first-ever image of a black hole

This image of the supermassive black hole that lies at the centre of the huge Messier 87 galaxy has become iconic since its release in April. Katie Bouman, the computer scientist who generated the image, likened the process of observing the black hole to listening to a song being played on a piano with over half of its keys broken – just as your brain can still recognise the song if there are enough functioning keys, algorithms can intelligently fill in the missing information to reveal the underlying black hole image. She hopes the image has captured the imaginations of a generation of new young scientists.

Michael Banks, news editor of Physics World, has a great video about the image and why it matters at [bit.ly/PWblackhole1](http://bit.ly/PWblackhole1)

Read the news story from the May edition [bit.ly/PWblackhole2](http://bit.ly/PWblackhole2)



National Science Foundation

## talkphysics

Edited highlights from our online discussion forum.  
Log in or register to join these discussions at [talkphysics.org](http://talkphysics.org).

### Optical fibres

IOP Coach Dave Cotton is a pro when it comes to shopping for clever ideas for the lab. His latest find is selenite.

“It is that time for teaching optical fibres again. We have a few demonstrations and I have been really pleased to find a great supplier of highly polished selenite.

Selenite and ulexite (caveman TV rock) both have striations running parallel to each other throughout the crystal. These column totally internally reflect the light up from the bottom to the top of the crystal.

Selenite is also great if you make a big spectrum in your classroom. You can capture the spectrum in space as it travels to your screen.”

See a video of his selenite cube in action at [bit.ly/TPselenite](http://bit.ly/TPselenite)

### Why would a diode change colour?

Alex and his year 12s were measuring the Planck constant using LEDs. A student noticed that the yellow LEDs changed colour at different voltages which got him – and the rest of TalkPhysics – thinking.

“At low voltages it was a ‘pure’ yellow but became increasingly redder as the voltage increased. I was unable to explain why this happened. We then experimented with our other LEDs and found

our green ones did the same, becoming increasingly yellow and then orange.

My understanding is that the light photons are produced as electrons transition across the bandgap of the semiconductor in the LED. The photon energy is equal to the bandgap. The bandgap has a fixed value, hence all photons produced are of the same energy and an LED is a monochromatic light source. So



Shutterstock

why would the colour change depending on the voltage?

“Is anyone here able to enlighten me?”

Follow the discussion at [bit.ly/TPdiode](http://bit.ly/TPdiode)

### Highgate day of physics 2019

In March, teachers from the south east of England gathered for a CPD day. The IOP coaches who ran the sessions have posted their resources at [talkphysics.org/groups/highgate-day-of-physics-2019](http://talkphysics.org/groups/highgate-day-of-physics-2019).

- Inclusive Physics outside of the classroom
- Using Electrolyca as a Force Sensor
- Electromagnetism
- Teaching energy
- Academic Resilience

- Forces
  - Inclusive teaching session
  - Embedding Careers into physics teaching
  - Engaging physics
- Well worth a browse at [bit.ly/TPhighgate19](http://bit.ly/TPhighgate19)



# 7 simple rules for science teaching



Information stored in long-term memory is vital for success in science – and not just in school. This information forms the building blocks of all our complex thought, creativity and critical reasoning: without it, our students cannot be the thinkers we would wish them to be.

Unfortunately, most students are unaware of effective study strategies, and instead spend their time on ineffective practices like highlighting. Research has shown that active retrieval of previously learned knowledge is more effective. Termed “retrieval practice”, this is any time in which a student has to actively recall information.

Retrieval practice also provides fertile ground for new learning. It activates old memories and allows new material to be understood more readily.

When thinking about implementing retrieval practice in your classroom, consider:

1. keeping the stakes low
2. ensuring all students are actively engaged
3. how and when to feed back
4. optimum spacing between learning and retrieving
5. whether different topics will be mixed
6. how to support students in preparing for retrieval practice
7. how to respond to students who do not appear to be improving.

The main thing is to actually do retrieval practice and get into a routine. To help, I built a simple program called retrieval roulette. It starts with a bank of pre-written questions, numbered and ordered according to how I’ll teach the various topics. At the beginning of the lesson, I open the program, look at which question I’m up to, and enter that question’s number. It automatically generates five random questions, up to and including that number.

Students come in and answer the questions in their books in silence. When they’re finished, we go over the questions, discuss corrections and move on. This simple routine means every lesson gives students the opportunity to engage with what I consider to be perhaps the best researched memory technique in existence.

Originally published in Education in Chemistry’s as part of a series to support each evidence-based principle in the Education Endowment Foundation’s *Improving Secondary Science* guidance. Written by Adam Boxer, a chemistry teacher at the Jewish Community Secondary School.

**Read the full article** and download the classroom resources series at [rsc.li/2I89sQA](https://rsc.li/2I89sQA)



**CLEAPSS**

CLEAPSS is an advisory service supporting science and technology in schools. Its advice and guidance is recognised by Ofsted and the HSE for safe practice for practical work in schools. It has extensive resources for teachers and technicians. Most schools can access its website and resources through Local Authority subscriptions [cleapss.org.uk](https://cleapss.org.uk)



*The growing and shrinking marshmallow man in a bell jar*

## The Bell Jar

Want to dust off that old vacuum pump and bell jar? We have produced three new guides (and accompanying videos) on the use of a bell jar for various vacuum experiments. There is often confusion about whether or not a trap is needed, or how to set it up well so you don’t hear the ringing bell at all – all is explained within each guide – simply search our website for “bell jar”.

As a bonus, a much requested experiment on a CLEAPSS helpline, the vacuum ping-pong cannon, has recently been tried and tested at CLEAPSS – and we are most impressed by the results. To make and carry out this experiment successfully, so search our website for “vacuum ping pong cannon”. It’s a striking demonstration of air pressure which launches a ping pong ball at a very high speed. There is a video of this in action too, so have a look if you are interested.

## Cloud chambers v2

We have a new cloud chamber design that will knock your socks off. By the time this bulletin goes to press, we should have a video online demonstrating how good it is. A couple of parts are directly available from CLEAPSS – and the rest are commonly found pipe fittings used in plumbing. This cloud chamber has been a massive hit on our RPS course, and at the ASE conference in Birmingham at the start of the year. For more information, see GL256 on our website.

This article originally appeared in CLEAPSS bulletin 165 (Summer 2019).



## Will more air inside a basketball make it bounce higher?

The Great Science Share for Schools is a national campaign to inspire young people into science and engineering by sharing their scientific questions. Last year it reached over 40,000 young people.

You'll benefit from taking part by:

- encouraging young people to communicate their scientific questions and investigations with new audiences
- improving teacher confidence in teaching children to think and work scientifically
- raising the profile of school science, improving the science capital of children and families

Download resources and information at [www.greatscishare.org.uk](http://www.greatscishare.org.uk)  
Any questions or ideas email us at [greatscishare@manchester.ac.uk](mailto:greatscishare@manchester.ac.uk)  
and follow us on [@greatscishare](https://twitter.com/greatscishare)

## YOUTH INDUSTRIAL STRATEGY COMPETITION

### Your students ideas can change the world

The Youth Industrial Strategy Competition is a new national STEM initiative that aims to inspire & challenge young people aged 11-to-19.

Focused around the four Grand Challenges of the UK Government's Industrial Strategy, the Competition calls on students to come up with innovative solutions that have the potential to change our future industries, society and the environment.

Students can work on their own or as part of a team to create their own science or technology project based on the Grand Challenges. For inspiration and ideas, visit the CREST Awards library for a full range of teaching resources, project topics and other helpful tips.

Entries close in November 2019. Find out more about the Competition, including how to enter, at [www.yisc.org.uk](http://www.yisc.org.uk)

## Be part of the Royal Society Student Conference



### Has your school or a school you work with taken part in a STEM scheme?

If so, you could display your project at the Royal Society Student Conference on 19 November 2019. The conference celebrates and showcases investigative project work undertaken by UK secondary school or college students. For further details and to express your interest in attending, please contact the Royal Society's Schools Engagement team at [education@royalsociety.org](mailto:education@royalsociety.org).

*"I thought this was a fantastic opportunity for students... Giving them the experience of having to present on their own has improved their confidence massively and they haven't stopped talking about how they got to present in front of a Royal Society Fellow"*  
Teacher who attended the 2018 conference

THE  
ROYAL  
SOCIETY



From the trenches of the First World War to the latest innovations in cyber security, the Science Museum's Top Secret exhibition (10 July 2019 - 23 February 2020) will trace over a century's worth of communications intelligence and aims to engage KS3 and KS4 students with the skills at the heart of intelligence work.

With historical exhibits and anecdotes from GCHQ staff doing top secret work to defend against terror attacks and serious crime, Top Secret also considers the challenges of digital security in the 21st century.

An interactive puzzle zone will give the chance to practice the logical, linguistic and numerical reasoning skills used by cryptographers and codebreakers themselves.

School visits to the Science Museum and admission to Top Secret are free.

Charges apply for some optional activities. Plan your trip at [sciencemuseum.org.uk/learning](http://sciencemuseum.org.uk/learning) or call 020 7942 4777.

SCIENCE  
MUSEUM



## Astronomy on Tour!

#RASreach2019

**5 December 2019, Life Science Centre,  
Newcastle-upon-Tyne**

The Royal Astronomical Society will be holding an education and outreach training and networking day for anyone involved in astronomy or geophysics, including teachers, amateur astronomers and student.

The programme is TBC, but sessions topics might include:

- Presenting your research in schools
- Diversity, inclusion and equality
- Working with primary age children
- Innovative outreach ideas for unusual situations (e.g. sensory space shows with toddlers)
- Showcasing education and outreach projects going on in the North of England
- Networking with experts in the field, including our Patrick Moore and Annie Maunder medal winners
- Working with under served audiences
- GCSE Astronomy
- STEM ambassador sign up
- Presenter training
- Tour of the new Space Galleries at the Life Science Centre

To register, visit [bit.ly/CPras19](http://bit.ly/CPras19)

[ras.ac.uk](http://ras.ac.uk)



**Royal  
Astronomical  
Society**  
Advancing Astronomy and Geophysics

## ESERO-UK Secondary Space Conference

**25 September 2019 Newport, Wales**

European Space Education Resource Office UK will be holding their annual teacher conference in September alongside the UK Space Conference. Participants will be able to engage in activities linked to ESA's ExoMars mission, the celebration of the 50th anniversary of the First Manned Lunar Landing and the upcoming James Webb Space Telescope.

Attendees gain free access to the UK Space Conference. The conferences will help you to understand how current space missions can provide an engaging context for teaching and you will be able to take part in practical activities which you can deliver in the classroom. You will also learn more about STEM careers in the rapidly growing UK space industry.

Register at [bit.ly/CPesero19](http://bit.ly/CPesero19)



## Isaac Physics in Manchester and Cambridge

**27 & 28 June Manchester**

**12 & 13 July Cambridge**

These free-to-attend (check details on the weblinks below) two-day symposia offer the opportunity to practise the range of questions on Isaac Physics, from Mastery to Problems.

We will work through our Mastering Physics books and extend beyond these questions into related problems to develop confidence and familiarity in core topics. It is available to teachers of Physics (GCSE or A level, or equivalents) and to teachers of A level Maths (Mechanics). Every participant (from a state-funded English school) will be given a free set of our Skills Mastery books.

Every participant can access free teacher support after the symposium to help embed Isaac in your teaching and schemes of work.

Register at [bit.ly/CPisaacman19](http://bit.ly/CPisaacman19)  
and [bit.ly/CPisaaccam19](http://bit.ly/CPisaaccam19).



## Find a CPD event near you at [talkphysics.org/events](http://talkphysics.org/events)



### Teaching magnetic fields using space and planetary physics (IOP and Ogden Trust)

21 June 2019 9:00 am – 4:00 pm  
Lancaster University Physics Department,  
LA1 4YB

Develop your understanding with researchers who use magnetic fields to understand planets, their moons and space weather. Create teaching resources on the day to use with your students. Register at [bit.ly/CPInacs](http://bit.ly/CPInacs) or contact [phil.furneaux@icloud.com](mailto:phil.furneaux@icloud.com)

### North west physics teacher network conference

27 June 2019 9:30 am – 3:30 pm  
Daresbury Laboratory WA4 4AD

Jodrell Bank's Prof Tim O'Brien will talk about 'One Giant Leap: Jodrell Bank and the race to the Moon'. Plus a variety of workshops, a make-and-take session, tours around Daresbury Laboratory and meet apprentices working at Daresbury. Register at [bit.ly/CPdares19](http://bit.ly/CPdares19) or contact [andrea.fesmer@talk21.com](mailto:andrea.fesmer@talk21.com)

### Rocket launcher make-and-take

27 June 2019 4:30 pm – 6:00 pm  
Oakgrove School, Milton Keynes MK10 9JQ

Attendees will make a launcher for paper rockets using plumbing parts, and we will finish the workshop with a discussion on how it can be used in school.

Register at [bit.ly/CProcket](http://bit.ly/CProcket) or contact [lizn@physics.org](mailto:lizn@physics.org)

### South west physics CPD day 2019

2 July 2019 9:15 am – 3:45 pm  
Ivybridge Community College, Devon PL21 0JA

Join us whether you're a physics specialist or not, teacher, technician or trainee. A wide choice of workshops, networking opportunities and our popular 'Have you ever shown them this?' carousel of classroom-ready teaching ideas.

Register at [bit.ly/TalkPhysicsSWest](http://bit.ly/TalkPhysicsSWest) or contact [mandacuthbertson@gmail.com](mailto:mandacuthbertson@gmail.com)

### North east physics teachers' day 2019

4 July 2019 9:30 am – 4:00 pm

Department of Physics,  
Durham University DH1 3LE

This popular annual day for everyone teaching physics is a mix of practical workshops, inspiring talks and congenial networking. All teachers of physics, technicians and trainees welcome. Register at [bit.ly/CPnept19](http://bit.ly/CPnept19)

### South regional teacher day

6 July 2019 9:00 am – 4:00 pm  
Charterhouse School, Surrey GU7 2DE

Join us for a full day of physics CPD workshops whether you're a physics specialist or not. All teachers of physics, technicians and trainees are welcome. Register at [bit.ly/CPsouth19](http://bit.ly/CPsouth19)

### Maths for physics

10 July 2019 4:00 pm – 5:30 pm  
Cheney School, Oxford OX3 7QH

Hints, tips and practical ideas to make the maths in physics lessons more accessible. We'll look at ways to enable students to transfer skills from maths lessons to the physics lab. Register at [bit.ly/CPmaths19](http://bit.ly/CPmaths19)

### KS3 and KS4 electricity

11 July 2019 9am – 2:30pm  
Sir Christopher Hatton Academy,  
Northants NN8 4RP

For non-physicists teaching physics, we'll be offering practical strategies and demos based on the theme of electricity plus a maths for physics session. Build your CPD, gain a support network and implement new ideas into your school.

For details contact [teachingschool@hattonacademy.org.uk](mailto:teachingschool@hattonacademy.org.uk)

### Technicians workshop

12 July 2019 10am – noon  
Sir Harry Smith Academy,  
Cambridgeshire PE7 1XB

A short workshop for lab technicians. Helen Rose, senior technician at the STEM centre, York, will be passing on some practical ideas. Register with [helen@pollardweb.me.uk](mailto:helen@pollardweb.me.uk)

### East midlands annual network day

21 September 2019  
Uppingham School, Rutland LE15 9QE

A lecture, choice of three workshops from eight, lunch, speed physics and free raffle. This event is funded by the IOP, so no cost to you. For details contact [helen@pollardweb.me.uk](mailto:helen@pollardweb.me.uk)

### A day for everyone teaching physics (IOP and nustem)

5 October 2019, 9:30 am – 3:00 pm  
University of Northumbria,  
Newcastle-upon-Tyne NE1 8ST

A mix of workshops, lectures, new ideas, practicals together with convivial networking designed to enhance your skills in engaging the next generation of young people with physics. The day is for anyone who teaches physics, even if you don't consider yourself as physics teacher. Register at [bit.ly/CPnustem19](http://bit.ly/CPnustem19)

### Prepare to teach a-level physics: a 6 day course (IOP and Ogden Trust)

9 Oct, 13 Nov 2019  
26 Feb, 25 Mar, 6 May, 8 July 2020  
Rugby High School, CV22 7RE

Study the concepts underpinning major topics examined at A-level, and consider alternative methods of teaching and learning. Set up and practise practical demonstrations and student experiments, including required practicals. Participants are expected to commit to all six days. Register with [mighalls@rugbyhighschool.co.uk](mailto:mighalls@rugbyhighschool.co.uk) or contact Helen Pollard [helen.pollard@iop.org](mailto:helen.pollard@iop.org)

**All events listed are funded by the IOP and free to attend unless otherwise stated.**