IOP Institute of Physics
Education Supporting Teachers

Classroomphysics
The newsletter for affiliated schools
December 2018 Issue 47

Enrichment

Record-breaking year for RAF100

Students at Roundhill Academy wait to begin their record-breaking attempt. The previous record (more than 600) was held in America.

As the centenary year of the Royal Air Force (RAF) comes to a close, we made an attempt to break the Guinness World Record for most gliders launched simultaneously.

Teachers at Roundhill Academy in Leicester decided to the run the Balanced Flight: RAF glider activity. This activity explores how to keep an aircraft steady in flight, a challenge for early aircraft design.

But Roundhill took it one step further. Teacher Emma Woolman explained, "We realised we had enough students to try and break the Guinness World Record for the most gliders launched at once."

Fortunately, the day of the attempt was clear and sunny. There were 837 gliders correctly launched and we await confirmation of the record from Guinness.

The gliders are just one of the resources created by the IOP in collaboration with the RAF and Historical Association as part of a cross-curricular project to mark 100 years of the RAF.

Covering a wide range of topics, the activities interweave physics and technology with their historical and societal contexts. They fit nicely into lessons or STEM clubs that are 45–60 minutes long.

Taj Bhutta, IOP School Support Manager, said, "We tried to make these activities as flexible as possible and it is great to see schools adapting them. They can be delivered standalone or as part of a sequence and there are plenty of opportunities for extension. When we were developing and trialling them, we worked hard to keep running costs low and avoided using specialist equipment as far as possible."

For more information: view and download the RAF100 STEM activities and associated resources for free from raf100schools.org.uk. So far, more than 15,000 people have visited the website and thousands of teachers have attended our workshops. The website and resources will live on as a legacy and remain available in 2019 and beyond.

The RAF100 school activities: raf100schools.org.uk/activities

ACTIVITY NAME	DESCRIPTION	PHYSICS CURRICULUM LINKS
Origins & Aircraft Design	Build a glider and balance it for steady flight	Centre of mass; Moments
The Battle of Britain & Radar	Use ping-pong balls to find the position of hidden targets	Speed; Reflection of waves
Codebreakers & Communication	Design a circuit and build a scrambler to send secret messages	Series and parallel circuits; Digital signals
Relief Operations & Airdrops	Make a string and paper-clip model to explore precision of delivery	Precision, accuracy; Objects in free fall
The Jet Age & Helicopters	Investigate thrust forces and make your own tin-foil propeller	Controlling variables; Forces and motion
Aerial Reconnaissance & Stereo Images	Investigate lens and how stereo photographs allow 3D viewing	Lenses; Cameras and the eye
The Falklands War & Navigation	Build an anemometer and use vectors to model wind and stay on course	Speed; Velocity
Medicine, War & Rescue	Design a sea-rescue light that uses salt water as an electrolyte	Electrical cells and batteries; LEDs

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

Inside

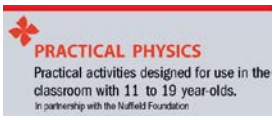
IOP RESOURCES FOR TEACHERS

We have a comprehensive set of resources that cover all syllabuses at secondary level. Plus you'll find lots more ideas and activities at iop.org/teachers

Supporting Physics Teachers
for those teaching up to age 16
supportingphysicsteaching.net

Teaching Advanced Physics
for those teaching ages 16+
tap.iop.org

Practical Physics
for those teaching ages 11–19
practicalphysics.org



Qubit
newsletter for ages 16–19
iop.org/16-19

Classroomphysics

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IOP | Institute of Physics
Education Supporting Teachers

IOP awards

Congratulations winners

Dame Julia Higgins, IOP president, presented awards to seven secondary school teachers at the IOP annual Awards Dinner in London in November. Each received a prize of £300, a paperweight award and a certificate.

The awards celebrate the success of teachers who, by their outstanding classroom practice, have raised the state of physics and science in schools.

The winners are (from left to right): David Hobson of Loreto College, Dublin; Michael Murray of Ayr Academy, Ayrshire; Andrew Notley of Sponne School, Towcester; Cerys Corbett of St Joseph's RC High School, Newport; Sam Skinner of The Cardinal Vaughan Memorial RC School, London; Edith Goakes of Wimbledon High School, London; and Kevin Mosedale of Radley College, Abingdon.


IOP

Teacher training

£28k IOP scholarships

We're pleased to announce that this year the IOP will again be offering 150 scholarships to outstanding individuals entering physics teacher training.

The scholarships have been designed to remove some of the barriers to training to teach:

- £28,000 tax-free funding.
- Pedagogical support from our experienced physics coaches.
- Scholar events provide practical teaching tips and activities.
- IOP membership enables our scholars to maintain their connection to the wider physics community.

Benn Cordrey, 2017 IOP scholar


Benn Cordrey

"I'd be lying if I said the scholarship didn't help me into the profession, but that's what they're there for. I've got access to loads of resources through the IOP – not just lesson plans and worksheets but holistic ways to teach topics that build a scientific context around the teaching." Read more at bit.ly/ScholarBen.

For more information: visit iop.org/scholarships. If your school is looking to recruit a trainee physics teacher, sign up to our School Direct Programme at iop.org/schooldirect to receive marketing materials that you can use to promote physics teaching.

Careers

How to become a physics apprentice

As storms lashed Glasgow in September, we welcomed more than 100 higher students and their teachers to Glasgow City College for our first Scottish Technical Careers Fair. The aim of the event was to increase engagement with physics apprentices and technicians, to be more inclusive and to facilitate interactions between potential apprentices and employers.

Sam Alvey-Taylor spoke about his apprenticeship at the National Physical Laboratory. He described the benefits of learning while working, gaining invaluable industrial experience and transferable skills, adding, "It is important that young people can see the career paths open to them and understand the support available from organisations like the IOP as they undertake apprenticeships."


IOP

Student visitors toured the exhibition area, where they had the chance to meet 10 local companies offering apprenticeships.

For more information: we are planning a London Technical Careers Fair for 2019. Details to follow. For more about physics technical career routes, visit bit.ly/IOPapprentice.

Teacher CPD in England

IOP schools stimulate confidence and diversity

We are delighted to announce that the Stimulating Physics Network (SPN), our support programme for physics teaching in English schools, has been extended for another year.

The emphasis will shift slightly. From April 2019, there will be two equally weighted priorities: to increase teachers' confidence in teaching physics and to increase the number of girls opting for A-level physics.

Robin Griffiths, IOP Head of Teacher Professional Support said, "We look forward to busting more myths about gender and filling some of the empty spaces in physics labs – and other workplaces such as IT offices, banks, media outlets, think-tanks and, of course, schools – that should contain physicists."

He added, "We are now in a strong position to support to schools, with unprecedented levels of funding. We are intensively supporting almost 500 schools this year, with hundreds more taking advantage of our CPD events. Our teacher CPD is increasingly being led from schools, in recognition of the excellent practice and dedication of the experienced professionals teaching across the UK. We're proud to support a career path that values the professionalism of the many excellent physics teachers working in our schools."

First piloted 13 years ago, SPN is funded by the Department for Education. It supports teachers who may not identify as physics teachers but teach physics, offering professional-development sessions from physics coaches focusing on the areas that teachers and students find challenging.

Find your local Lead School (or become one): by emailing spn@iop.org.

Cheney School

Cheney School in Oxford has become our 50th SPN Lead School. Each Lead School forms the hub of a local network of schools and physics teachers. The school nominates a physics teacher who we support as a school-based physics coach for one day a week, covering salary costs and expenses.

A physics coach by any other name

Above all, you want our team to concentrate on helping you and your colleagues to explore and reflect on physics teaching to make it as effective and inclusive as possible. So the people who engage with you in future will just be known as **IOP coaches**, whether they come from SPN, FPL, our Teacher Network or planet Zorb.

What do *you* want from the IOP?

Given the changes in SPN's funding, we are revisiting our offering and asking how we can best support you. We will continue to lead physics CPD, facilitate local teacher networks and organise day meetings. What else would you like to see more of? Email robin.griffiths@iop.org: make your voice heard and we will be able to serve you and your students better.

Teacher CPD

Summer schools 100% success

This summer, more than 180 teachers attended the SPN summer schools at no cost to themselves or their schools. Feedback from participants was excellent, with 100% saying they would recommend the course to a colleague. It was also good to hear that 98.6% said they would attend another summer school themselves – we'll forgive the two who said "maybe, I'll have to check childcare".

The courses are designed for teachers whose specialism is not predominantly physics. This year, teachers joined experienced IOP coaches in York, Oxford and Cambridge for four days of CPD on topics that ranged from forces and electricity to improving gender balance, quantum, electromagnetism and technology in physics education.

Teachers enjoy a workshop at our Cambridge summer school.

With a combined 368 years of teaching experience at Cambridge alone, it was a great opportunity for participants to pick the coaches' brains and those of their fellow teachers.

If you weren't able to attend this year's summer schools, you can find lots of the resources on TalkPhysics.org. Our coaches lead CPD all year round – check talkphysics.org/events for an opportunity near you.

For more information: about next years' summer schools, contact Lily at spn@iop.org.

Girls in physics

Gender balance: where are we now?

Beth Bramley, IOP gender balance manager, celebrates progress.

2018 has been a rewarding year for our efforts to remove barriers to girls choosing physics. We have made positive strides and forged strong school relationships. A-level results day is a time to scrutinise patterns and make comparisons to see what's working. And this year, we have good reason to celebrate.

This year, 599 more girls in England took A-level physics compared to last year – an impressive 8% rise in the number of female entries.

But these aren't just stats. Let's think about these individuals. How will they be using what they've learnt in their next steps in life? Who will they go on to influence? What other seemingly entrenched trends will they stand up to?

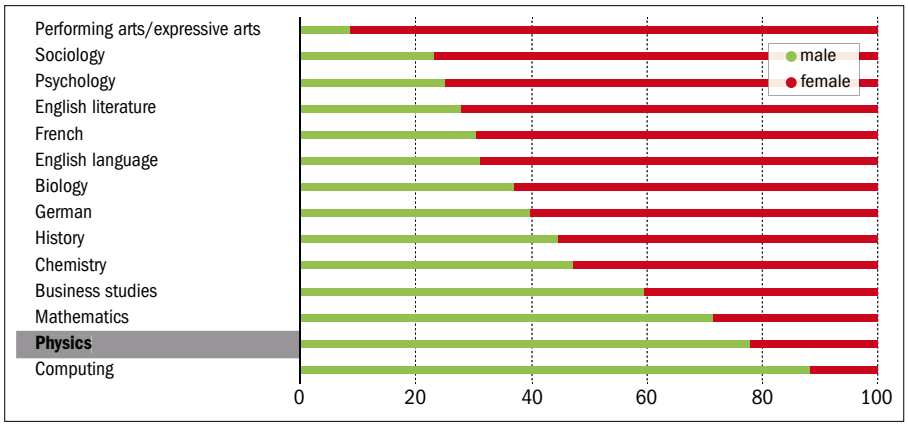
We want to see more girls making the decision to pursue physics past 16, both for their own life ambitions but also for the health of physics. We know that an increase in the number of girls opting for physics is an indication – in fact an exciting harbinger – of wider positive changes.

We are fortunate to work with some exceptional teachers and great schools. Together, the more we can break down barriers – including those perpetuated by the impression of "girls' subjects" and "boys' subjects" – the more we will see genuinely equitable cultures in schools and beyond.

So well done and thank you to anyone having an influence on students to take positive decisions.

Our next plan is to learn more about these figures. Knowing what makes these small changes happen allows us to spread knowledge of what works, and how, to everyone working for gender balance in education.

For more information: visit iop.org/genderbalance to find out more about our research and resources.



Differences between male and female A-level subject choices (UK-wide data from Joint Council for Qualifications, summer 2018).

2018 physics A-level statistics

- Overall entries up 3.4% on last year.
- The largest number of female A-level physics entries since 1993.
- Girls made up 22.2% of entrants – up from 21.5% last year – in England.

Gender balance

Gender Action schools award launched in London

It was a proud moment for physics when more than a decade of combined research and robust evidence gathering was turned into action.

The Gender Action schools award is a charter mark that recognises schools that are challenging gender stereotypes.

It was launched in October by the Deputy Mayor of London and will be rolled out in the capital during 2019. A national roll-out is planned for 2020.

The charter mark calls on schools to pledge their commitment to make lasting and positive changes to structures and mindsets across their institutions.

The award has been developed by the IOP in partnership with the University Council of Modern Languages (UCML), King's College London (KCL) and the Institute of Education (IOE). It encourages a whole-school approach with tiered progression levels.

Professor Dame Julia Higgins, president of the Institute of Physics, commented, "Gender stereotypes damage a whole generation of potential scientists, technicians, engineers, mathematicians and programmers whose talents lie undiscovered because of their experiences at school."

Greater London Authority

"This is an exciting venture beyond physics: gender imbalance in subject choices in education is one manifestation of gender imbalances in many areas of society. Schools can encourage young people to be individuals and be a place where choices are free, not edited through a gender filter."
Beth Bramley, IOP gender balance manager

Professor Claire Gorrara, chair of University Council of Modern Languages, added, "Modern languages is perceived in many quarters as a gendered subject that overwhelmingly attracts female students but we know that the benefits of multilingualism, both personally and professionally, are life-enhancing and need to be promoted for all."

The funding and support from the mayor was announced in October at the Equal Play event, which united figures from industry, policy and education to pledge action on tackling the effects of gender stereotyping.

Greater London Authority

For more information: visit genderaction.co.uk to find out more about the award or join the conversation on Twitter at twitter.com/_Gender_Action.

IOP international

Inspiring young science entrepreneurs in Tanzania

Students in Tanzania have started the second year of an IOP programme that encourages them to apply their scientific training to solve local challenges by creating science-based businesses.

The Future STEM Business Leaders programme, which works with secondary schools in Dar es Salaam, was adapted from a UK scheme to encourage more girls to study physics.

Taj Bhutta, IOP school support manager, explained: "The Science Ambassador workshops were designed to build students' confidence, resilience and communication skills by supporting them to deliver physics outreach for their local community. They were ideal because many of the skills needed for outreach overlap with entrepreneurship and business: you need the confidence to approach funders, resilience to take knockbacks and the communication skills to pitch your idea and explain the engineering behind it."

He said that the Tanzanian students had progressed quickly – after just a week, they were working in teams with students from other schools, pitching their business ideas with confidence.

For the remainder of the programme, students meet with business leaders to apply their new skills and knowledge to their own business ideas, culminating in a pitching competition where they present their business ideas and the science behind them.

For more information: about the Science Ambassador workshops, visit stimulatingphysics.org/sas. Read more about the Future STEM Business Leaders programme at futurestemtanzania.iop.org.

IOP

Students preparing their business pitch in an IOP workshop in September.

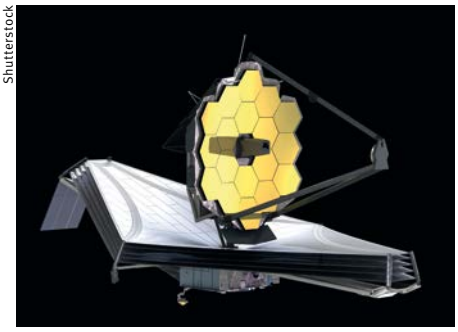
Student research

Find targets for NASA

The Institute for Research in Schools (IRIS), in partnership with the UK Astronomy Technology Centre (ATC), has launched a new project that will enable school students to gain experience in, and contribute to, real science.

Students will be identifying potential targets for the James Webb Space Telescope, scheduled for launch on an Ariane 5 rocket from French Guiana in early 2021. Described by NASA as the world's premier science observatory for the next decade, Webb's unprecedented infrared sensitivity will help astronomers understand more about how planets, stars and galaxies formed and evolved by allowing them to explore massive clouds of cosmic dust.

Astronomers, UK ATC education staff and IRIS joined forces to develop a classroom activity in which students examine and classify existing spectral data from the



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Spitzer Space Telescope. Students will then collaborate with UK ATC astronomers to select potential targets for Webb and develop a proposal making the scientific case for pointing the huge space observatory at these objects.

Like other IRIS collaborations, this project will help professional researchers to go through vast amounts of information that would otherwise take years.

For more information: contact IRIS at info@researchinschools.org or visit bit.ly/IRISwebb.

Discover the jobs available in a real-world STEM project

Black Sea MAP

The Black Sea Maritime Archaeology project was a three-year interdisciplinary expedition researching ancient coastlines and seafaring history of the Bulgarian Black Sea. Meet the individuals and teams working on the project, see STEM skills and technologies in action and experience the challenges of solving problems at sea to uncover the past.

For more information: including short films, classroom and club activities, career profiles and posters visit blackseamap.com/education.

The Royal Society

Schools Network

The Royal Society's Schools Network comprises teachers, technicians and classroom assistants involved in teaching science, mathematics and computing to 5 to 18-year-olds in UK schools and colleges. Network members receive an email newsletter highlighting support, events and resources. They can also book early for events such as the Summer Science Exhibition, access financial support to attend CPD events, receive subject-specific resources and get involved in The Royal Society pilot projects and policy consultations.

For more information: visit royalsociety.org/grants-schemes-awards/schools-network.

Summer science exhibition extra

The Royal Society's Summer Science Exhibition took place in July and it was a wonderful opportunity for school groups to explore and engage with the latest scientific research from across the UK. If you couldn't visit the exhibition, The Royal Society has put it online, showcasing a selection of the exhibits, including the popular Seeking Life on Mars. You will find information about the research as well as interactive activities that could all be used in the classroom. Tickets to visit the exhibition next summer will be available from early 2019.

For more information: visit the online exhibition at bit.ly/RSextra18.

Obituary

Derek Fry: much loved physics and astronomy teacher

As remembered by colleague Philip Britton, former IOP vice-president of education.

Derek Fry was among the first classroom physics teachers to become a Fellow of the Institute of Physics when he was elected in 1997. It was an important moment, with the Institute marking very clearly that teaching physics is to be a physicist, and that this can be done with the distinction that leads to Fellowship.

Few can claim to have had the impact that Derek had over his 50 years of teaching. He continued to teach at The Grammar School at Leeds on a voluntary basis, long beyond retirement, until his sudden death aged 77. His tremendous legacy includes inspiring numerous students to pursue a career in science as well as those who used their physics qualifications to achieve their ambition in areas such as medicine, engineering, the airline industry or the armed forces. More than a dozen former students dedicated their doctoral theses to him.

It was at Leeds that I met Derek for the first time. He was generous with his time for pupils and colleagues, wise and experienced in life and the classroom. He had a terrific sense of timing, using drama in his experimental work with an attention to detail that allowed everyone in his class to be sure they knew what they were doing. His lab wall had on it the slogan, "in pursuit of excellence" and in that lab, the pupils knew that is actually what Derek wished them to do.

The Grammar School at Leeds

Derek with an astronomy class at The Grammar School at Leeds.

Soon after joining the school, Derek introduced GCSE astronomy. This was his passion and he was a Fellow of the Royal Astronomical Society, receiving the Society's Service to Astronomy Award in 2017. He donated the prize money to the school library, saying with characteristic modesty that the award was entirely thanks to his pupils.

Derek also had the distinction of being immortalised in print by former colleague and novelist Joanne Harris, who based characters in *Chocolat* and *Gentlemen & Players* on her friend.

Famous for his handwritten worksheets, formal letters written to an amazing range of correspondents and his love of the slide rule, Derek had ostentatiously allowed social media to pass him by. Nonetheless, the hashtag #RememberingMrFry trended on Twitter when news of his death spread. And a collection of his astronomy handouts and solutions to past papers have been archived online at bit.ly/MrFryAstronomy.

He will be remembered with love and appreciation by pupils, staff, parents and friends for his intellect, dry sense of humour, integrity, kindness and also, with his old-school manners, as a perfect gentleman.

Marvin and Milo

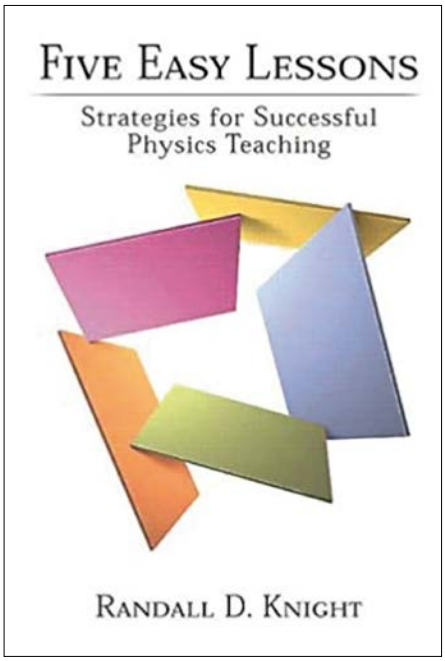
Moody Magnets

Marvin and Milo are the Institute's resident cat and dog experimenters. Download other Marvin and Milo experiments and STEM club ideas at iop.org/stemclubs.

Suggested reading

Five Easy Lessons by Randall Knight

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



What is it?

Five Easy Lessons by Randall Knight offers a synthesis of research on students' alternative conceptions. He also provides specific classroom advice for approaches to take. It is most suitable for post-16 teachers but the overarching messages are applicable to younger students.

Why is it worth reading?

Interesting as it is to understand how students may find it challenging to conceptualise the microscopic behaviour of electrons in a field, you may be thinking: "Great, but what I do with my year 10 class when we do parallel circuits?" This book answers those "so what?" questions with a brief review of the literature.

In a nutshell

The first part of the book, *Teaching Introductory Physics*, is an overview of physics education research. Knight distils this into the five easy lessons to consider and respond to in your teaching:

- Lesson 1: keep students actively engaged and provide rapid feedback.
- Lesson 2: focus on phenomena rather than abstractions.
- Lesson 3: deal explicitly with students' alternative conceptions.
- Lesson 4: teach and use explicit problem-solving skills and strategies.
- Lesson 5: write homework and exam problems that go beyond symbol manipulation to engage students in the qualitative and conceptual analysis of physics phenomena.

The rest of the book, *Topics in Introductory Physics*, is a series of chapters, each beginning with a summary of research into what is known about teaching and learning in that topic. Knight then identifies key learning objectives and moves on to pedagogical approaches, suggested strategies and targeted questions.

For more information: *Five Easy Lessons* by Randall D Knight is published by Addison Wesley/Pearson, ISBN 9780805387025, available for around £15.

- 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 or join the Physics Education Research (PER) group on Talk Physics at talkphysics.org/groups/physics-education-research-per.

Richard Brock's physics stories

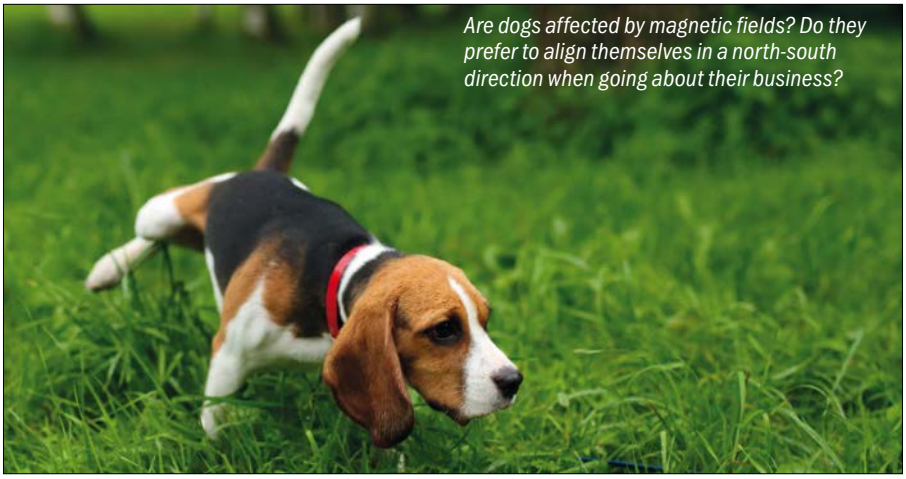
The inescapable pull of magnetism

Animal magnetism

By analysing images from Google Earth, a team of researchers has reported that domestic cattle and grazing and resting red and roe deer tend to align their bodies in a roughly north-south direction. The authors report that the biological significance of the behaviour is unknown. Dogs also appear to be affected by magnetic fields – researchers observed the body alignment of dogs during defecation (1,893 observations) and urination (5,582 observations) and report the animals preferred to excrete when aligned in a north-south direction. These results are controversial and debate over the reality of the phenomenon continues.

How the solar magnetic field might make you unwell

The tidal effect of the Sun on free electrons in the Earth's ionosphere causes small fluctuations, of around 50 nanoteslas, to the Earth's geomagnetic field and an oscillation to the angle of declination of around 1/10th of a degree, over the course of a day. The human retina is sensitive to magnetic fields and changes to the Earth's geomagnetic field can influence melatonin production and so affect the function of the biological clock. This relationship may explain the reported correlation between solar storms and incidents of heart attacks, suicide and psychiatric hospital admissions. Researchers have found that a number of physiological variables, such as pulse and oral temperature, displayed variations that correlated with the 10 to 11-year Sun spot activity cycle. The mechanism that drives these fluctuations is not fully understood but it is speculated that biological magnetic sensitivity may be responsible.


Are dogs affected by magnetic fields? Do they prefer to align themselves in a north-south direction when going about their business?

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Young's magnetic error

The early 19th-century British polymath Thomas Young – of the Double Slit experiment – has an impressive track record of contributing to many different fields: he discovered astigmatism, worked on the decipherment of Egyptian hieroglyphics and advised the admiralty on shipbuilding. However, Young's astuteness did not extend to magnetism. He wrote: "There is no reason to imagine any immediate connection between magnetism and electricity, except that electricity affects the conducting powers of iron or steel for magnetism, in the same manner as heat or agitation."

For more information: join the discussion at talkphysics.org/groups/stories-about-physics.

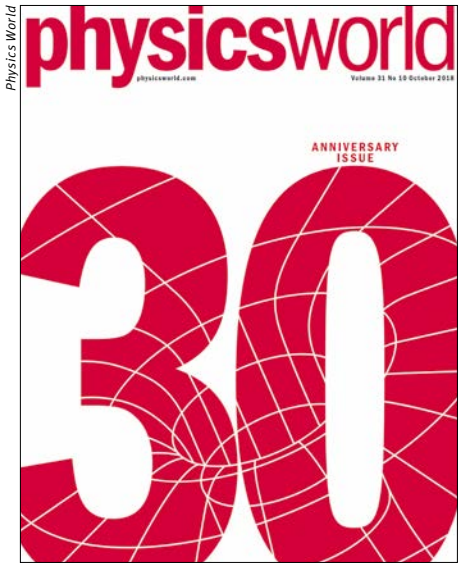
physicsworld

October saw a special edition of *Physics World* to celebrate the magazine's 30th anniversary. Here are a selection of articles that appeared.

The physicists' library

Physics World's reviews editor is often asked to pick her desert-island book, name her must read and reveal the book that got her into physics. She canvassed 15 of today's top physicists to help her put together the definitive *Physics World* reading list. Each physicist selected their favourite popular-science book, a must-read and what they are reading now. Expect some of the usual suspects (Richard Feynman is a firm favourite), but there are plenty of unexpected and well-deserved, choices.

- Full article at bit.ly/PW30books.



Physics World

Back to the future

A look back at the physics news stories of 30 years ago revealed some eerily familiar issues. A lack of funding threatening Britain's membership of CERN led one UK staff member to write: "If Britain leaves it will be unpleasant, but at least we'll know what the position is."

Similarly, a 1988 IOP report found that a third of physics graduates in the UK went into industry, notably aerospace, telecommunications and nuclear technology, with only 5% going into teaching. Those statistics have changed little, with just 4% of British physics undergraduates going directly into teaching.

- Full article at bit.ly/PW30back.

Teenage thermodynamics

In 2011, Michael Bland wrote to *Physics World* with an analysis of teenagers in terms of their thermodynamic properties: "In the early stages, they continue to follow the principles of classical physics: for example, to every action there is an equal and opposite reaction, and it takes a great deal of energy to restore them from a state of chaos back to one of order. But as they fall increasingly under the influence of gravity – thus finding getting out of bed almost impossible – teenagers become more quantum in nature. They have their own version of the uncertainty principle, such that you might know where they are now, but not where they have been or what they were doing. Also, like Schrödinger's cat, for a considerable part of the morning they appear to be both alive and dead at the same time."

- Full article at bit.ly/PW30teen (page 7).

educationinchemistry

We've linked with the Royal Society of Chemistry to reproduce their new series of tips and classroom-ready resources for physicists and biologists teaching introductory secondary-level chemistry topics (rsc.li/EiCteach11).

How to teach acids, bases and salts

Sodium chloride is an example of a salt. It is the source of sodium in our diets, essential for the transmission of nerve impulses and the maintenance of a proper fluid balance in the body. Throughout history, humans have been using this salt to preserve meat, clean wounds and make soap. In chemistry, the term salt refers to a group of ionic compounds formed from the neutralisation reaction between an acid and a base. The concepts of acids, bases and salts are introduced early in secondary-school science. They are developed and refined as students progress and underpin many future topics.

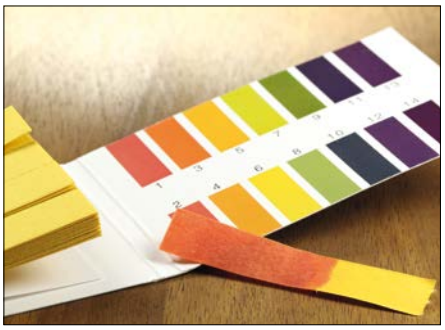
Ideas for your classroom

- Students have a wealth of experience of acids, bases and salts accumulated from school and everyday life. It's worth starting by constructing a mind map of their existing ideas.
- One particular problem that can arise when introducing laboratory acids and alkalis is that they both look like water. Students can struggle to use chemical properties to characterise these solutions. The "sage and scribe" task can be used to demonstrate the limitations of visual description and reinforce the need to look for the presence, or absence, of defined characteristics or properties.
- Aim to introduce acids and alkalis equally rather than focus on acids alone. For homework, ask students to identify household substances that are acids and alkalis. These will be commonly found in the kitchen and bathroom. For example, vinegar and lemon juice are acids, whereas baking powder and toothpaste are alkalis.

Formative assessment

Concept mapping is a useful tool for reinforcing how this topic links across the curriculum. The "revising acids" activity has been adapted as an Assessment for Learning activity.

Provide students with opportunities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to practise both longer answer and multiple-choice questions in preparation for exams. Display the question and give the students two minutes to write their answer on mini whiteboards. Importantly, ask them to write why they chose their answer. This provides the opportunity to identify miscomprehension and provide immediate feedback.

- Naomi Hennah is a biochemist and chemistry teacher. Read the full article, download the classroom resources and find the activities described here in the full article on the *Education in Chemistry* website: rsc.li/2NXG6me.

Physicseducation

Gary Williams, editor of this IOP international physics teaching journal, shares some articles.
If you have trouble following the links, email affiliation@iop.org for a reminder of your login details.

The physics of baking good pizza


Shutterstock

A cremated pizza is an unpleasant experience, but this paper should help you avoid all that charcoal and give you the excuse to set up a series of culinary experiments, hopefully resulting in pleasurable tastes and fullish bellies. The authors illustrate the underlying physics by some simple common examples and then apply them in detail to the example of baking pizza. They conclude that traditional wood-fuelled firebrick ovens do the best job, but repeatability is a cornerstone of the scientific process and hence it is in the interest of science that many more pizzas are eaten and comparisons made.

- By Andrey Varlamov (Institute of Superconductors, Oxides and Other Innovative Materials and Devices, Italy), Andreas Glatz (Northern Illinois University, USA), Prof. Sergio Grasso (Academy of Fine Arts, Viterbo, Italy) in September 2018: bit.ly/PEdpizza.

Van de Graaff development

How much do you know about what the bigger versions of our bench-top open-evening staples can do? This paper was published just after Robert Van de Graaff died in 1967 and, as well as tracking the fascinating history of these machines, gives an insight into their inventor. His politeness was legendary, the impossibility of "getting through a door after Van de Graaff" being the subject of frequent comment. An excellent hook to get classes interested in everything from electrostatics to the structure of the atom, this paper places emphasis on development in terms of use in experimental physics, rather than how the generator was initially built.

- By S E Hunt (University of Aston) in 1967: bit.ly/PEdvdg.

An Arduino experiment to study free fall at schools

There are currently 32 papers referring to Arduino on the *Physics Education* site. If you are new to Arduino, this paper is a good one to start with to help you get to grips with it. Measuring *g* by free fall is a task with a multitude of available methods. Unlike the classical techniques, where the time taken by a body in free fall from a known height is measured, this activity measures values of position as in a coordinate system at approximately regular time intervals. Students over the age of 16 are usually excited to use Arduino. How far you manage to take just depends on your, and their, IT skills.

- By Antonio A Moya, physics teacher (University of Jaén, Spain) in August 2018: bit.ly/PEdarduino.

talkphysics

Caroline Davis, *Classroom Physics* editor, chooses some edited highlights from our online discussion forum for teachers of physics, technicians and teacher supporters. Log in or register to join these discussions at talkphysics.org.

Year 10 physics activities


IOP

Len writes: "I have a year-10 physics group this term but unfortunately all the lessons are double periods (80 minutes). As it is going to be difficult to maintain the concentration of 14-year-olds for this long, I want to break up the teaching with hands-on activities. If anybody could suggest suitable activities I would be most grateful." Several teachers revealed that they start the year teaching density, which lends itself nicely to student practical activities, most of which involve food – a surefire way to get teenagers' attention.

- Follow the discussion in the Teaching Physics 14–16 group at bit.ly/TPy10.

Studying conduction

Daniel wants to do a practical around different materials and their thermal conductivity. He says that his school has only one set of thermal conductivity rods so he's looking for other suggested practicals that the class can undertake. Alan's suggestions included holding a metal spoon and a plastic spoon in a container of very hot water; ice, loaded down in the bottom of a boiling tube filled with water and heated to boiling near the top without melting the ice; and small wide-necked juice bottles containing samples of loft and wall insulation to pass around. Ruth posted: "Have you tried ice cubes placed on top of different materials to look at the rate at which they melt?" Visit the post to find lots of other ideas.

- Follow the discussion in the Teaching Physics 14–16 group at bit.ly/TPconduction.

Circular motion

Alice is a career-changer NQT and is teaching A-level physics. She came across a question about circular motion of the hands of a clock but is struggling to answer it. More experienced teachers picked up her post to help. IOP physics coach Ally knew the question well as he uses it in one of his workshops.

- Follow the discussion in the News and Comment group at bit.ly/TPcircm.

Events

EVENTS FOR TEACHERS

GCSE Core Practicals
Brooke Weston Teaching School, Corby NN18 8LA
8 January
This session is for all teachers who teach GSCE physics. It will focus on building confidence in regards to teaching the required core practicals and will provide opportunities to try out the experiments and to explore alternative approaches.
- Details and registration: bit.ly/CorePracs

IOP Institute of Physics Yorkshire Day
School of Physics and Astronomy, University of Leeds LS2 9JT
9 January
Lectures, masterclasses, workshops and more: all teachers of physics, technicians and trainees are welcome. This popular day for everyone teaching physics is a mix of practical workshops, inspiring talks and congenial networking. Sessions concentrate on ideas to use in labs and classrooms.
- Details and registration: bit.ly/IOPYorkshireCPD

ASE Annual Conference 2019
University of Birmingham
9–12 January
Europe's largest science-education conference with more than 350 CPD sessions, including a mini-science fair on Saturday 12 January and twilight sessions on Thursday 10 January. Student teachers get a day free.
- Details and registration: ase.org.uk/annual-conference

Physics and Horses
Aintree International Equestrian Centre, Liverpool L9 5AS
15 January
The day will include four sessions based on physics-curriculum content such as Newton's laws of motion, balanced forces and equilibrium, thermal insulation and projectile motion. The day will also include a behind-the-scenes tour of the racecourse facilities and a demonstration of showjumping.
- Details and registration: bit.ly/Physicsandhorses

Waves – How to Explore the Invisible
Brooke Weston Teaching School, Corby NN18 8LA
22 January
For those teaching GSCE physics and technicians who have been charged with supporting the required practical work. The workshop will focus on building confidence in teaching and supporting the relevant experimental work and explore the underlying physics.
- Details and registration: bit.ly/WavesCPD

Find a local event at **talkphysics.org/events**

2018 Scholars' Celebration Event

Tyndall Schools lectures
Various dates and venues in Ireland
- Details and registration: iopireland.org/education

KS3 and KS4 Waves and the Electromagnetic Spectrum
Sir Christopher Hatton Academy, Northampton NN8 4RP
7 February
This day-long session will cover and explore a range of practical strategies and demonstrations, which can be immediately implemented in your classroom and shared with your colleagues, based on the theme of waves and the electromagnetic spectrum.
- Details and registration: teachingschool@hattonacademy.org.uk

Teaching Waves
Truro College, TR1 3XX
11 February
Join us for an opportunity to discuss how to make the most of teaching waves at KS4, including how to model a wave, electromagnetic waves, refraction and lenses. Emphasis is placed on getting the most out of a ripple tank for any required practical work. Ideal for those who are new to teaching physics.
- Details and registration: bit.ly/TeachingWaves

Magnets and Electromagnets
Formby High School, Merseyside L37 3HW
27 February
This session is open to teachers, technicians and trainees, and will look at magnetism. It will explore all manner of magnets, starting from the basic magnets we all played with as kids through to electromagnets, the catapult field and motor effect, and more.
- Details and registration: bit.ly/SPNMagnets

Canterbury Teacher Day
St Anselms RC School, CT1 3EN
2 March
Everyone teaching physics is welcome at this free-to-attend day of training and workshops, organised and funded by the Stimulating Physics Network and Physics Partners.
- Details and registration: bit.ly/IOPCanterbury

EVENTS FOR STUDENTS

Science Ambassador Training Day
Bicester Technology Studio, OX26 2NS
4 February
A full day of training for groups of up to 10 year 8 and 9 students from your school, run by the IOP with support from local schools and universities.
- Details and registration: bit.ly/AmbassadorBicester

DEADLINES

IOP School Grants
One-off grants of up to £600 for projects or events linked to teaching or promoting physics and engineering in UK schools and colleges for students aged 5 to 19 years. Deadline for 2019: 1 February, 1 June and 1 November.
- To download an application form and for more information visit: iop.org/schoolgrants

British Science Week
The British Science Association, with funding from the Department for Business, Energy & Industrial Strategy, is offering grants of £150–£700 for schools to run events during British Science Week 2019 (8–17 March). Schools must be UK-based, state funded and meet one of our "schools in challenging circumstances" criteria.
- More details at bit.ly/BSWgrants2019

Royal Society Partnership Grants
Up to £3,000 for investigative STEM projects in your classroom. You will partner with a STEM professional (research or industry) during your project. Apply online from February 2019.
- Further details: bit.ly/RSpartnership

SAVE THE DATE

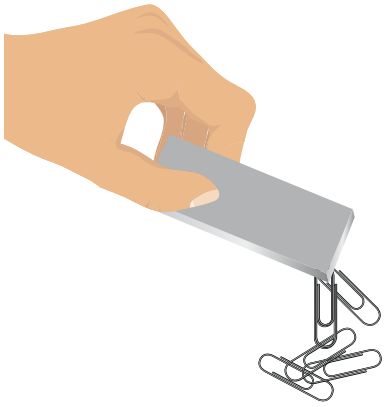
Rugby Teachers Meeting
Rugby School, CV22 5EH
5 June
Booking will open early 2019.
- Further details: ellen.phillips@iop.org

Durham Teacher Day
Physics Department, Durham University
4 July
Booking details to follow.
- Further details: ruth.wiltsher@iop.org

Which magnet is stronger?

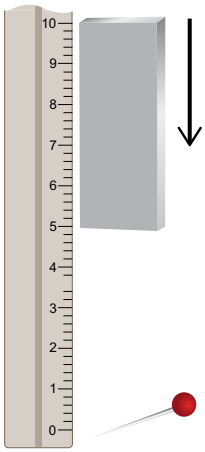
If you have two magnets, one may be stronger than the other. But how can you tell which is stronger? Here are four ways of finding out:

Method 1



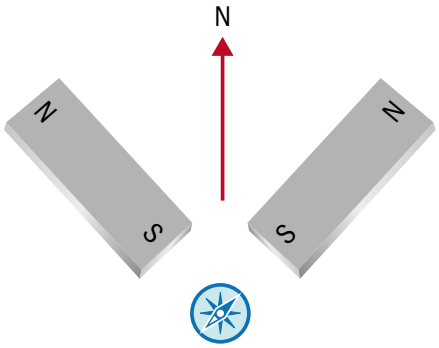
Hang paper clips from one end of each magnet. How many can it hold?

Method 2



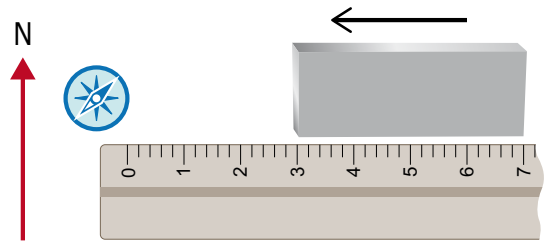
Lower one magnet down towards a pin. How close must it be to lift the pin off the table?

Method 3



Place a compass on the table with its needle pointing north. Place your two magnets symmetrically on opposite sides of the compass. Which way does the compass turn?

Method 4



Slide a magnet towards the compass from one side, either east or west. The needle starts to turn. How close must the magnet be to make the needle turn through 45˚?

- Try out each of these methods.
- For each method, explain how you will know which magnet is stronger.
- Discuss with a partner which you think is the best method. What makes it the best?
- Can you devise a method of your own to compare the strength of your magnets?

Magnetic methods

In this activity, students try out several experimental methods for comparing the strength of two magnets. Not only will they be exploring properties of magnets, but they will also be exploring how to devise appropriate experiments and make sense of their own results.

Equipment required

Each pair of students will need:

- Two weak magnets
- Plotting compass
- Ruler
- Several paper clips
- A pin
- A copy of the worksheet on page 11

Class discussion

Once students have tried out each method described on the worksheet, discuss how it can show which magnet is the stronger.

- Method 1: the stronger magnet holds more paper clips. This time-honoured method is very crude and insensitive.
- Method 2: the further the magnet is from the pin when it lifts it from the table, the stronger it is. This method introduces an element of measurement.
- Method 3: provided the magnets are placed symmetrically, the needle will turn towards the stronger. This is an opportunity to discuss fair testing.
- Method 4: the stronger magnet will be further from the compass when it turns through 45°. The angle chosen is arbitrary – an alternative would be to determine the angle when the magnet is at a standard distance from the compass.

Comparing methods

In teaching physics, we usually show students experimental methods that have been carefully refined over the years to be reliable. Students have little opportunity to compare or improve methods of making a particular observation or measurement.
This activity encourages students to identify the best method and, through that, make them think about what that means in terms of experimental techniques. You can introduce ideas such as fair testing, repeatability and sensitivity as appropriate. Students can then return to their favoured method and attempt to improve it.

This teaching tip was developed by **David Sang**.

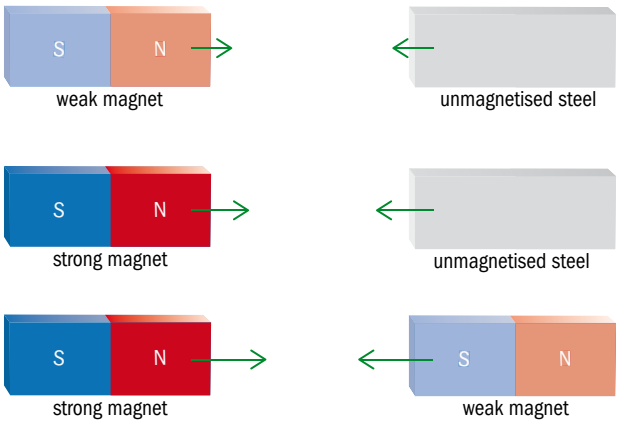
For more information about teaching magnetism see **Supporting Physics Teaching (11–14)**: bit.ly/SPTmagnets or **Practical Physics**: bit.ly/PPmagnets. For ideas for how to introduce magnetic fields for older students see **Teaching Advanced Physics (16–18)**: bit.ly/TAPmagnets.

You may also be interested in an interview with **Richard Feynman**, winner of the Nobel prize for his work on the interaction between charged particles and electromagnetic fields. Feynman discusses the difficulty of explaining why magnets attract or repel: bit.ly/Fmagnets.

If you have a box of weak magnets that have been lying around for years, gradually losing their magnetisation, this is an opportunity to use them. Alternatively, students could make their own magnets by the method of stroking a piece of soft iron or steel with a permanent magnet.

Equal and opposite magnetic forces

Your students may suggest that it would be simpler to bring opposite poles of the magnets together. If they do, explain that magnetic interactions create equal and opposite forces on both objects.



The magnetic interaction between a weak magnet and an unmagnetised piece of steel produces small forces on both objects. A stronger magnet produces larger forces, whilst replacing the steel with a weak magnet produces the largest force. However, in all cases there are two forces of equal size, in opposite directions, on different objects (illustrating Newton's third law).

Note: commercial suppliers often quote the strength of a magnet in terms of the force required to pull an object away from it (sadly often expressed in kg rather than newtons!)

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