IOP | Institute of Physics
Education *Supporting Teachers*

Classroom Physics 10th anniversary 2007–2017

Classroomphysics

The newsletter for affiliated schools

September 2017 Issue 42

CPD

Lead Schools to lead schools

We're looking for schools in England with excellent physics departments and the capacity to share their expertise. In return, we will support you, both financially and professionally, to support 10 local schools and boost their physics teaching.

Your school would become a Lead School, a new feature of the Stimulating Physics Network. Lead Schools are hubs for active local networks of schools and physics teachers.

One of your physics teachers would be seconded to the IOP for one day a week as a School-based Physics Coach (SPC). We pay for their time (usually 0.2 FTE, up to approx. £10,000) and invite them to attend regional and national project meetings. In addition, we give your school resources, coaching and CPD activities.

With this support, your SPC would mirror the work of the SPN Teaching and Learning Coaches. He or she would develop and lead a coherent physics and pedagogy CPD programme for your local network, based on identified needs of the participating teachers, schools and clusters. Your school would provide and facilitate events and undertake outreach to nearby schools.

Trevor Plant, team leader of the SPCs, explained: "We operate on the principle that the most effective mechanism for improving pupils' learning and outcomes is through the provision of high-quality CPD for their teachers. All those involved in the teaching of physics, should have access to high-quality CPD and peer-networking opportunities".

The first eight Lead Schools launched last September, with another 11 beginning this September. Applications for 2018 Lead Schools will open in early October. The Stimulating Physics Network is funded by the Department for Education.

STIMULATING PHYSICS NETWORK

For more information: about becoming an SPN Lead School visit stimulatingphysics.org , or contact the SPC team via trevor.plant@iop.org.

Left: IOP coach Suzanne Woolhouse runs a session at a recent SCHA event for partner schools.

Case study: Sir Christopher Hatton Academy (SCHA), Northamptonshire

SCHA has been an SPN Lead School for more than a year. Dr Abby Bell (right) was the school's only physicist when she approached the Senior Leadership Team about signing up.

"I was nervous to ask to go down to four days a week and spend a day working for the IOP," she said. "But actually, they saw the benefits. The head feels more certain of retaining me, it makes it easier for us to recruit physicists and it puts our school at the forefront of the community and outreach with other schools."

For one day a week, Abby is not timetabled to teach so does not have to worry about cover for her own lessons. So far, she has recruited seven partner schools and has run training in five. She estimates that she has engaged with almost 100 local teachers.

She says that her own school benefits from the challenge of helping others. She finds herself re-examining her own teaching and working with the IOP team has often revealed new approaches. She also believes that being an SPN school helped SCHA to secure external funding to refurbish two labs.

As well as working with SPN, SCHA works with the Ogden Trust. These collaborations have seen SCHA's A-level physics entries leap from two in 2012 to 38 this year.

Headteacher Vicky Bishop said, "I was very thrilled and proud that we've got someone who wanted to do this. If any headteacher or senior leader from another school wants to come and visit, they are more than welcome."

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

In this issue

Editorial

Welcome to the Autumn issue of *Classroom Physics*.

The Institute is currently in the midst of big changes. One important development is that we are refreshing our support for 16–19 year olds (see story on page 3). As part of this, we are introducing a new electronic newsletter called Qubit. Please encourage your post-16 students to sign up at iop.org/16-19. Do note that to be involved, they will need to register, even if they are currently 16–19 members.

This issue has some new regular columns on page 7, which should be thought-provoking and enjoyable. The first is a suggestion from the world of physics education research, to help time-poor and cash-strapped teachers to keep up with the latest thinking. The second column, Stories about Physics, provides some quirky anecdotes that you can weave in to your lessons. We'd love to hear your thoughts about this content.

We've also enclosed some new IOP resources:

- Our **Authentic Research Projects in Schools** booklet is support to enable students to carry out original research. Students gain a huge amount from analysing real data and taking part in, or formulating, their own research projects. We know this approach can improve girls' uptake of STEM subjects, but research shows that all students who are involved in such projects are more likely to progress to STEM A-levels.
- Build your own **RAF100 glider** following our Teaching Tip (page 12) and Worksheet (page 11). We've included an example of the foam sheet that your students will need and a few pages of RAF stickers to get them started.

Wishing you a great start to the new academic year!

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Physics advice from **Taj Bhutta**
Photography by **Daniel Josman**

Recruitment

Why do engineers teach physics?

Shutterstock

We want to find out why engineers hang up their helmets to teach physics so we can find more physics teachers.

The ongoing shortage of physics teachers means looking for different ways to recruit. In June, we teamed up with the Institution of Mechanical Engineers and the Gatsby Charitable Foundation, to hold the first Engineers into Physics Teaching Conference. Engineers currently teaching physics discussed their experiences, shared useful resources and explained what support they need from their professional institution.

Chris Shepherd, IOP Teacher Support Manager, said the event explored what it is to be an engineer teaching physics. He added: "To ensure a good supply of engineers we need more physics teachers." Colin Brown, IMechE Engineering Director said the event had inspired him: "You just get blown away by the enthusiasm of these teachers, they're full of ideas I can take away and use."

The event will inform our ongoing campaign to attract more engineers to enter teaching.

For more information: about engineers in teaching, visit iop.org/engineerteach.

Recruitment

Prepare to recruit your next trainee physics teacher

The next cohort of enthusiastic physicists and engineers will begin to apply for teacher training soon.

If you're looking to recruit for September 2018, sign up to the IOP's School Direct programme for support. You will receive termly emails containing information about ways that we can support you to market and fill your vacancy. You will also receive hard copies of our Get Into Teaching materials and can list your teacher recruitment events on our website. Register at iop.org/schooldirect.

We're also looking for schools to join our School Experience Programme. We will introduce you to prospective teachers who want to observe the physics classroom. This is a great way to meet possible candidates and help to make it easier for individuals to meet the criteria required for their UCAS application.

Sign up at: iop.org/sep.

Education policy

Teachers' air their views at IOP meeting

In July, teachers from IOP affiliated schools across the UK and Ireland attended our Education Forum meeting. They provided invaluable insight and feedback on current IOP projects:

- Attendees carried out user testing on prototypes of our new online teacher resource centre. This will enable us to steer the development work ensuring that we create a new home for our resources that meets classroom teachers' needs.
- We also discussed the changes to our membership structure (see page 3). We want to ensure that the contemporary membership meets the needs of teachers at all career stages so this vital feedback, views and concerns will continue to inform our work.

The Education Forum is open to IOP members and nominated teachers in Affiliated Schools.

For more information: visit iop.org/educationforum.

IOP Awards

Lawrence Bragg Medal and Prize goes to Mary Whitehouse

One of the UK's best-known figures in science education has been awarded the IOP's highest honour for her outstanding and sustained contributions.

Mary Whitehouse, of the University of York, said: "I am very honoured to receive this award. I have worked with many eminent physics educators who have been awarded the Bragg Medal and it is a privilege to join the list. I have always been particularly interested in the assessment side of curriculum development because I know that the examinations will drive what is taught in the classroom."

Mary taught in school and further-education colleges for a total of 14 years, but got involved in curriculum development very early in her career.

In the 1970s, she became a trials teacher for Science in Society. At the same time, she was developing an interest in assessment as an examiner for Nuffield O-level and A-level physics and continued this work when she left the classroom to become a mother.

She went on to lead the assessment development for two major curriculum projects, Advancing Physics and Twenty First Century Science, both of which have driven the development of innovative approaches to the teaching and assessment of physics at GCSE- and A-level in the UK, and are seen internationally as ground-breaking.

Most recently, Mary has worked on the York Science project, helping teachers to shape their use of formative assessment as well as teaching on York's PGCE course. She has been an active member of the physics education community, through the Association for Science Education, which she will chair in 2018/19 and the IOP, where she recently served on Council.

For more information: about IOP awards, including the Bragg gold medal, visit iop.org/awards.

Physics on trend

The physics of fidget spinners

The bottle-flipping craze was barely over before fidget spinners came along to distract students and exasperate their teachers. Fortunately, the physics of fidget spinners is more accessible than those flipping bottles.

TalkPhysics editor Alessio Bernadelli, videoed his son's fidget spinner: "The interesting thing was to see that at some point the spinner seemed to stop and then spin backward on the video. This was a good opportunity to talk to my 12 year old about the frame rate per second that the camera captures. It was a good discussion that could be used in the classroom."

This popular post is worth a look as other TalkPhysics users added their own ideas.

Meanwhile, IOP teacher supporters also had some useful suggestions for the spinners:

- a cheap stroboscope if held up in front of a ripple tank;
- putting different coloured balloons on the ends makes a colour mixer;
- spin one and feel the forces as you rotate your hand, then place another on top, spin it in the opposite direction. The resistant couple has disappeared as you move your hand.
- the only sensible thing to do with these infernal devices is to put them in the bin!

See the TalkPhysics discussion: bit.ly/TPfidget.

IOP membership

New 16-19 offer as members approve historic changes

IOP members have voted to simplify our membership structure and fee bands from 1 January 2018. Following a year-long consultation to find out how we can best support our members, stakeholders and the wider IOP community, sadly, we will no longer offer free 16 –19 membership.

However, students in this age group remain very important to the IOP and we will continue to support them. We are developing a new package tailored to their needs that will offer them new ways to engage with the physics community and access careers advice and support.

Get your students started by registering for our new 16–19 e-newsletter, Qubit, at iop.org/16-19. Please note that current 16–19 members will need to re-register.

For more information: we will be contacting all members soon to explain how the change affects them, but that if you have questions in the meantime, email membership@iop.org.

Wales

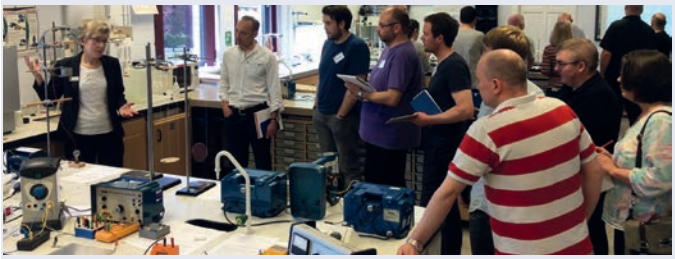
Virtual Diamond Light

The teachers who attended the IOP's annual Bangor teachers' meeting in July enjoyed a 360° Virtual Reality Tour of Diamond Light Source, took part in Teach Physics Resources Speed-Dating and chose two workshops. They also heard a talk from the founder of Ambionics, Ben Ryan, who, frustrated by the wait for his son's prosthetic arm, developed his own using an Xbox scanner and 3D printer.

IOP Wales

Scotland

Keeping the lights on



IOP Scotland

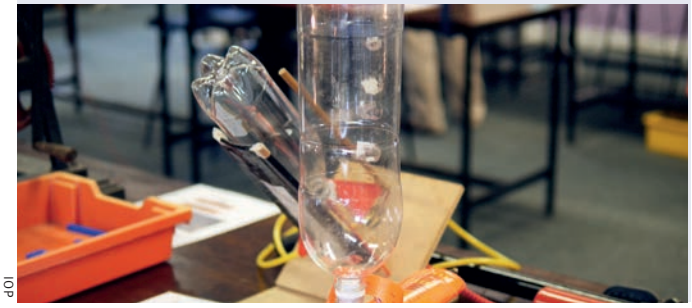
At May's annual IOP Stirling teachers' meeting, Dr Simon Gill (University of Strathclyde) talked about the National Grid and the implications of replacing coal and nuclear generators with renewable sources. Prof. Ian Galbraith's talk covered photovoltaics and semiconductor band gap theory in the new Higher Physics course. Of the 120 delegates, 22 then joined the IOP/SSERC Physics Teachers' Summer School for workshops and a visit to the Royal Observatory Edinburgh.

England

100 experiments in Rugby

More than 160 teachers attended the IOP Rugby annual meeting in June. The morning session comprised short lectures about medical physics and the IOP's work on improving the gender balance. In the afternoon, delegates chose two workshops, ranging from the physics of spinning tops to A-level assessment. Additionally, to support teachers with the new GCSE spec, IOP coaches set up 100 experiments that are cheap and accessible for teachers to set up themselves.

For more information: iop.org/rugby.



IOP

South West regional day

Space science on Earth

Stimulating Physics Network

Exeter University hosted 87 teachers of physics, technicians and trainees at June's annual SW Physics CPD day. Workshops included a make-and-take space physics in a box: one neodym magnet is suspended above another by repulsion and the system is mounted on one side of the box; this is then filmed while in free fall. Tim Peake could have tried this on the Space Station – if he'd been allowed to take up neodyms!

Improving Gender Balance

Scottish competition asks children: are gender stereotypes fair?

IGB Scotland, an IOP partnership with Skills Development Scotland and Education Scotland, aims to empower students, teachers and parents to tackle stereotyping in school subject choice and careers. They recently asked primary school pupils the above question. Over 170 entries were received, including raps, board games, plays and posters. The upper primary winners wrote a letter asking a card company to produce less stereotypically boy and girl cards, backed by their survey showing that 60% of girls preferred blue to pink and 60% of boys liked dancing. The lower primary prize went to this poster featuring a boy playing with dolls and a girl playing football with the inspired slogan, "Is this wrong or are we making this wrong?".

For more information: explore IGB resources at iop.org/genderresources.

IGB Scotland

CPD

Is it ever OK to admit you find teaching biology difficult?

Shutterstock Images

How do you make plant science interesting?

Mary Howell, Professional Development Lead for Biology at the National STEM Learning Centre writes:

It can be difficult to ask for help with biology teaching. Other teachers have told me about the "funny looks" they get. Walking into the prep room and saying you don't "get" physics or that you're struggling to find a way to get a chemistry idea across is more acceptable than saying you are finding biology difficult. That got me thinking about which bits of biology teaching are challenging and where teachers can go for help with tricky biology.

The new curriculum in England, with its greater emphasis on plant biology and microbiology, is causing many teachers problems. Luckily there is lots of support available:

- The Science and Plants for Schools website (saps.org.uk) has free resources and ideas for practical work, teaching about plant diseases and careers.
- Microbiology Online (microbiologyonline.org) does exactly what it says on the tin with everything from Microbial Recipes to Fact Files on current topics.
- Using microscopes to make observations and drawings for the new required practical throws up questions about whether it's safe to use human cheek cells so it's great to see the advice from CLEAPSS (bit.ly/STEMcheek), which covers not just safety, but how to do the practical effectively.
- Another thorny issue is fieldwork, even going out on the school field. Worries about not being able to identify plants or animals and looking foolish in front of the students are common, so try OPAL' s free printable identification guides (opalexplorenature.org). The Field Studies Council also has useful skills training materials (bit.ly/STEMfsc).

View the full post: on the STEM Learning website bit.ly/STEMbiology.

University applications

UCAS statements for physics and engineering applicants

Completing university applications is daunting for students and teachers alike. Every university admissions tutor is looking for something slightly different and every student is unique, so knowing how to advise your students on what to write on their personal statements can feel like a stab in the dark. You may find these online resources helpful:

- **Advice on personal statements for students applying to study physics** by Alby Reid, a blogger who describes himself as physicist and teacher. Alby contacted 41 UK university physics admissions tutors and asked them what they are looking for: bit.ly/AlbyUCAS.
- **Detailed, Step-by-Step Guide on Writing the Perfect UCAS Personal Statement for Physics/Engineering** by Sally Weatherly, physics teacher and founder of online physics teaching resource website Guzled. Sally has written these downloadable self-help guides for students who haven't a clue where to start: bit.ly/GUZphysics and bit.ly/GUZengineering.

CPD

The language of mathematics in science

Chris Shepherd, IOP Teacher Support Manager, reports from a recent workshop at the ASE Futures conference:

"What different people see when looking at the same graph can be quite surprising. I was lucky to go on a workshop led by Richard Boohan, one of the authors of the Association for Science Education's Maths in Science resources (see Classroom Physics, June 2016). It emerged that the teachers from the different specialisms present brought different assumptions and techniques to the table.

"The physics specialists were usually interested in what happens at zero, but graphs in other subjects often had a non-zero origin. We also found that, when presented with what appeared to some to be a scatter of points, the biologists saw a legitimate graph of the variation of enzyme activity with temperature. This revealed the importance of knowing the back story in drawing a best-fit curve.

"I would strongly recommend discussing the subject with a group of colleagues from the different sciences and mathematics to broaden your perspective. There are two ASE booklets that you can download. They cover a whole variety of mathematics, not just graphs. A useful starting place might be to take a chapter as the subject of a group discussion."

For more information: the two *Language of Mathematics in Science* guides aim to clarify terminology and indicate areas students struggle with. They contain explanations of key ideas, guidance about good practice and a glossary of terms, plus examples of ways that science and mathematics departments have worked together. Download them at ase.org.uk/resources/maths-in-science.

ASE Futures is a group for those involved in teachers' professional learning, including university tutors, education consultants, teaching schools, local authority staff, heads of science and CPD leaders. More at ase.org.uk/membership/membership-category/futures.

Science Festival

Inventing the Future of Science Education

The 10th Science on Stage (SOS) festival took place in Debrecen, Hungary, with the theme 'Inventing the Future of Science Education'. It was attended by 450 science teachers from across Europe. They came together to share ideas about science education.

Christina Astin showcased her Young Scientists Journal – a STEM periodical written, edited and run by students across the world – at the festival. "I have returned with hundreds of ideas for myself and colleagues and have learned so much about the way science is taught in different countries," she said. "It is vital, especially in the current climate, that we look beyond our own national boundaries to share ideas and thinking about education. I've met many inspiring people and am exploring the possibility of embarking on a joint project with a colleague from Germany."

Christina Astin

Christina Astin at her Young Scientists Journal stand.

The UK team this year was supported by The Royal Society. Three projects from the UK and Ireland were highly commended.

For more information: about this year's SOS festival, visit sons2017.eu or watch the participants and their projects on the SOS YouTube channel at bit.ly/EUsos. To apply for SOS 2019, or get involved in the UK delegation, visit royalsociety.org/grants-schemes-awards/science-on-stage.

Science on Stage makes grants available for teachers to travel to each others' countries to present workshops from the festival and develop projects. It takes place every two years. The next SOS is expected to be in Portugal in 2019.

External resources

Space as a context for teaching science: the James Webb Space Telescope

In June, teachers and technicians took part in a residential CPD session, hosted at RAL Space, Oxfordshire. They heard from scientists and engineers working on instruments for the James Webb Space Telescope (JWST).

This large infrared telescope will be launched on an Ariane 5 rocket from French Guiana in October of 2018 and is an international collaboration between NASA, the European Space Agency and the Canadian Space Agency.

Tom Lyons, teaching fellow at the European Space Education Office, said: "JWST should do for infrared astronomy what the Hubble Space Telescope has done for astronomy in the visible region of the spectrum. The engineering behind the telescope is just as ambitious as its science. With a 6.5 m primary mirror and a heat shield the size of a tennis court, there are significant challenges involved in just getting the telescope inside a rocket!"

As well as studying the early universe, JWST will be able to image some of the atmospheres of exoplanets to look for signs of life.

The teachers will come together again in October to share their ideas on what they might do in the classroom.

For more information: visit jwst.nasa.gov or follow Tom Lyons (@space_tom). There is a teaching activity linking the detection of exoplanets to measuring Doppler shift at stem.org.uk/uxenm2.

ESERO-UK

Teachers working on a marshmallow and spaghetti spacecraft model to be vibration tested.

Resources

New A-level practical films

Practical work is an integral aspect of the new A-level physics specifications. All the exam boards have handbooks for teachers and students about how to do the individual practicals. But what is the best way to incorporate them into teaching? How are other teachers approaching them? In a single school, it can sometimes be challenging to see the bigger picture and gain the benefit of other physics teachers' experience.

To address this, Northumbria University's NUSTEM project is producing a series of short films about the core A-level practicals. They are intended to be a "virtual prep room", to help teachers (and trainee teachers) to think about the pedagogy of practical work, not just the mechanics. The team creating the films includes A-level physics teachers from very different schools and IOP Vice President, Education, Carol Davenport, who is Nustem's director. She said, "We've spent a lot of time talking about the purpose of the different practicals and how to include a development of skills through the two years of the A-level for all students. Further films are planned."

Each film has online teachers' notes. Funders include Northumbria University, Ogden Trust and Physics Partners.

View the films: nustem.uk/required-practicals.

Applying physics education research

Accessible research-based resources and guidance for the classroom

This new column by James de Winter (universities of Uppsala and Cambridge) and Richard Brock (Cambridge University, King's College London) will highlight accessible research into physics education and useable resources based on this work.

James and Richard recommend teachers draw from research to refine their practice to get the best outcomes for students. So, to save you time and the frustrations of paywalls, they will find, filter and evaluate research into areas such as students' understanding in particular topics, modelling learning about physics and developing research-informed teaching and assessment resources.

Join other physics teachers: for those interested in engaging with the latest research, discussing classroom applications, attending seminars and getting involved with research, email research@teachphysics.co.uk or join the TalkPhysics *Physics Education Research (PER)* group at bit.ly/TPper.

PhysPort

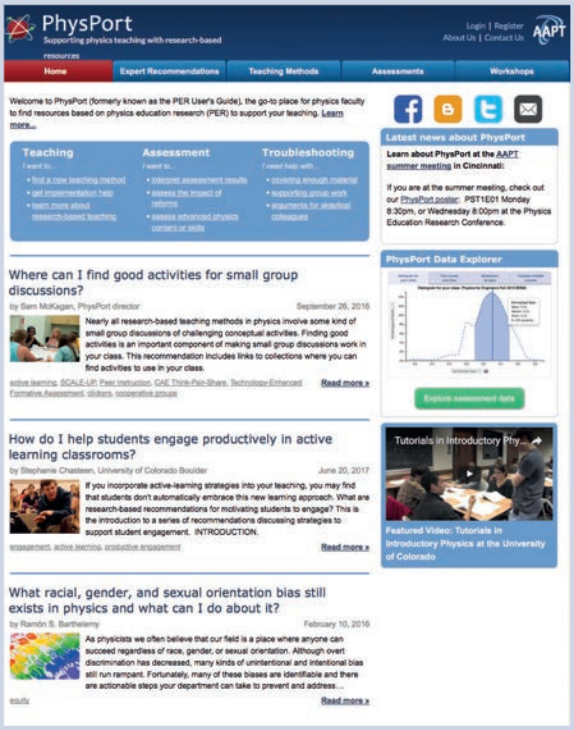
The most comprehensive free collection of research and research-informed guidance and resources available.

This website overflows with riches: expert recommendations, teaching and assessment guides, video workshops and more all designed to improve teaching. Resources are awarded a research validation grading and categorised by student skills developed and instructor effort required. You may know the PhET website: at PhysPort you can explore the research used to develop the resources.

Credentials: it is compiled by the American Association of Physics Teachers. Don't be put off by the term "instruction": in the US, this is often used instead of "teaching". Equally, although lots of the research is based on older students, much of the content is relevant to UK secondary physics teaching.

Our recommendations: short articles, written by researchers offering an overview on a particular topic or theme. The recent "How do I help students engage productively in active learning classrooms?" in the Expert Recommendations section is a good read. There are also lots of tests ("concept inventories") in the assessments section to gauge student understanding in a topic, often used before and after a specific teaching approach. As research tools use these judiciously, but they can be an excellent assessment resource.

See for yourself: visit physport.org.



Stories about physics

Flights of fancy

This is the first in a new series introducing stories from the history of science and contemporary research that may be used to spark students' interest in physics.

Anti-gravity

Roger Babson was an MIT-educated engineer. He credited his successful investments during the 1929 crash that made him a rich man to the application of Newton's third law to the movement of prices on the stock market. His success allowed him to buy Newton's original manuscripts. But following his sister's death by drowning, Babson became obsessed with overcoming gravity, setting up the Gravity Research Foundation to develop "antigravity". He declared: "...'old man Gravity' is not only directly responsible for millions of deaths each year, but also for millions of accidents." Babson donated money to several universities to erect monuments with inscriptions such as this one at Tufts: "This monument ... is to remind students of the blessings forthcoming when a semi-insulator is discovered in order to harness gravity as a free power and reduce airplane accidents."

Is the batcape safe?

An analysis of the potential of Batman's cape as an aid to gliding suggests that, though he may be able to glide a distance of 350 m from a 150 m tall building, he is likely to reach a steady velocity of 80 km/hr, resulting in a probably fatal impact. The authors of the paper conclude: "Clearly gliding using a batcape is not a safe way to travel."

Robert Hooke's flying claims

Hooke experimented with model ornithopters (devices that fly by flapping wings), but found that they were "difficult to keep aloft". He boldly reported that he had carried out an experiment "about the artificiale strength by water, air, fire, by which flying is easy", and told a member of The Royal Society that he could fly but did not explain the mechanism.

Read more: join the discussion on the TalkPhysics *Stories about physics* group at bit.ly/TPphystory. Compiled by Richard Brock.

talkphysics

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

Our Annual CERN Pilgrimage

Dave Cotton has been taking groups of students to CERN every year for the past seven years. Having just got back from his 2017 trip, he talks you through the process: recruiting the students, practicalities and admin, talking to parents, how to run experiments on the flight, planning which research groups to visit and where to find good pizza in Geneva.

- Follow the discussion or share your experiences, in the *Talking Physics* group at bit.ly/TPcerntrip.

CERN

Bridging booklet or leaflet for A-level physics

Rosalba was looking for suggestions for what her students could do over the summer to prepare for starting their physics A-level in September.

It's not too late to try these suggestions now. In particular, sixth-form college tutor Dave Cotton shares the resources that he uses in the first week with his new year 11 students.

- Follow the discussion in the *Teaching Physics 16–19* group at bit.ly/TPAbridge.

Not doing work

Bob had a group of capable students and wanted advice on how to talk to them about work: "The standard GCSE physics calculation of work done is = force × distance moved the direction of the force. So, to lift an object obviously requires me to do mechanical work, and I can make a calculation of the work done if I know the weight of the object and the vertical distance I have raised it.

"This is what is puzzling me: keeping the object motionless (but lifted up) still feels like my muscles are doing work. If I'm not doing work in these situations, what am I doing?"

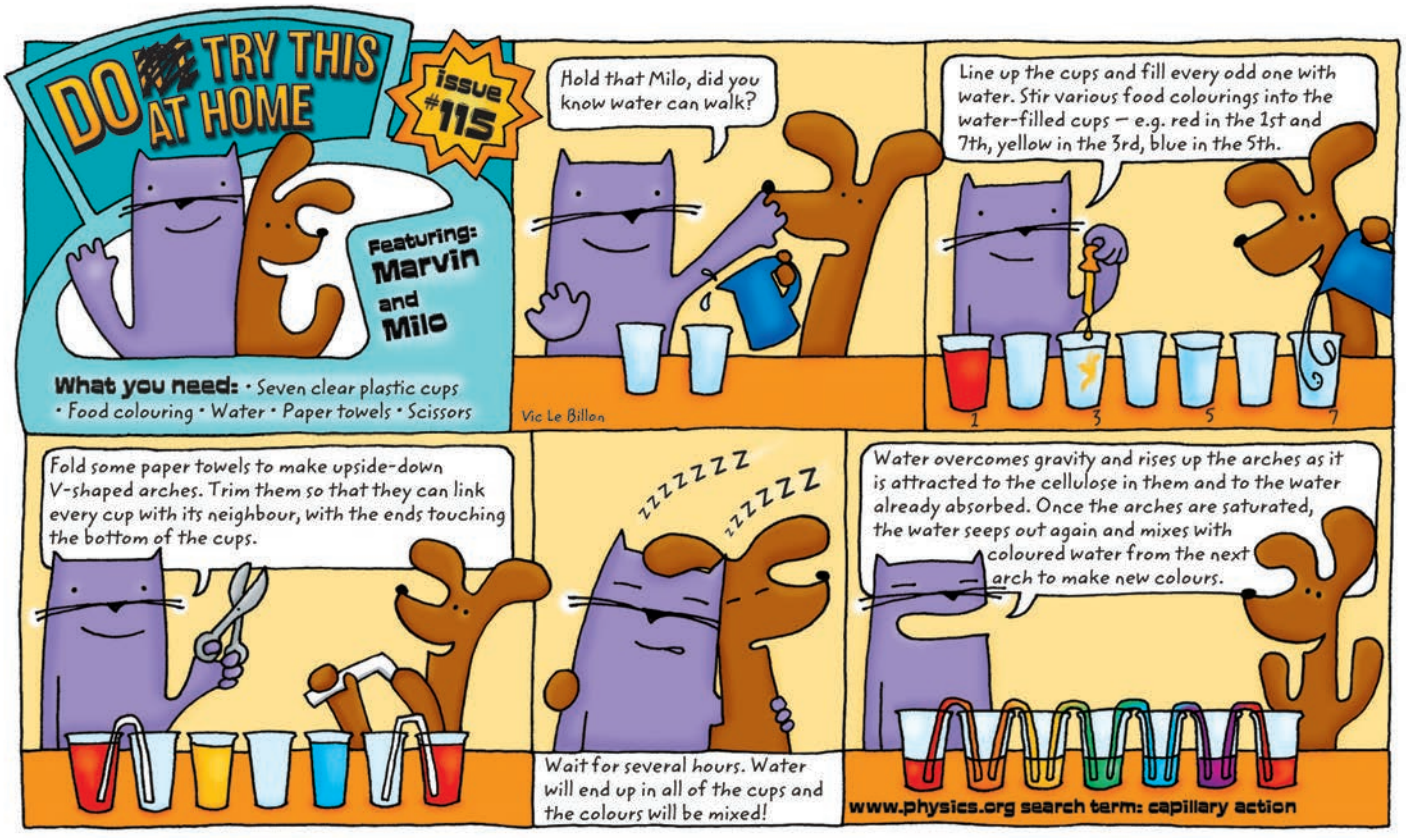
The replies opened up a discussion about using humans as an example versus inanimate objects, the anatomy of our muscles and Ken's closing remark: "Humans are a really bad example for mechanics!"

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

Marvin and Milo

Walking water

Marvin and Milo are the Institute's resident cat and dog experimenters. Every month, they come up with a new easy demo at bit.ly/IOPmandm.



Physicseducation

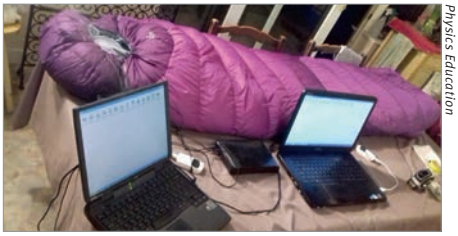
Gary Williams, editor of this IOP international physics teaching journal, shares some articles.
If you have trouble following the links, email affiliation@iop.org for a reminder of your login details.

Investigating comfort temperatures and heat transfer in sleeping bags

The background information about sleeping bags contained in this paper (including explaining the EN 13537 standard) is excellent and the method used is easily reproducible in school labs.

The experiment involves putting a hot water bottle inside a sleeping bag with dataloggers recording the inside and outside temperatures. This would be a great experiment to do before a Duke of Edinburgh Award expedition or a school trip that involves camping or hostels.

- By Trevor Hill (retired Head of Science at Wellington School, Somerset) and Lara Hill (granddaughter and GCSE student) in the May 2017 issue: bit.ly/PEdsleep.



Physics Education

Hand-drawn resistors and a simple tester using an LED

This paper is a neat experiment using very few resources. A colleague introduced me to the basic idea many years ago when he opened a cupboard door to show me a commercial pencil stand packed with every grade of pencil – so that students could draw their own resistors. This paper goes a step further. A thick line drawn on a sheet of paper with a 6B pencil is electrically conductive and its resistance can be roughly estimated using a simple tester made of an LED and a lithium coin-type cell. Using this hand-drawn resistor and the LED tester, these teaching materials help students to understand how electrical resistance varies according to (a) the length of resistant lines, (b) the width of resistant lines, (c) the number of resistant lines and (d) the type of connection between resistant lines.

- By Professor Masahiro Kamata and Mayumi Abe (trainee teacher) at the Tokyo Gakugei University in the November 2012 issue: bit.ly/PEdresist.

Fun with optical fibres

This paper does require you to gain a bit of skill in treating the ends of fibres. But once you have done so, these simple experiment ideas are an easy and cheap way to get school and college students to investigate this crucial technology. From examining the focal length of spherical lenses to making beam splitters, this is the best paper on optical fibres that we've read for a long time.

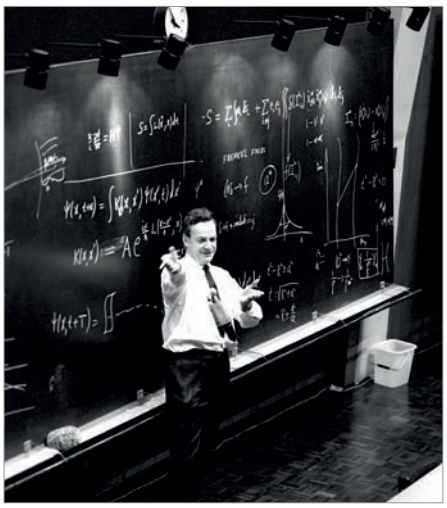
- By Kamlesh of the Alti Sant Gadge Baba Amravati University, Amravati in the May 2017 issue: bit.ly/PEdoptical.

physicsworld

Ellen Philips, assistant editor of Classroom Physics, picks out stories from our magazine for the global physics community.
If you are unable to login, email custserv@iop.org, explaining you are an IOP affiliated school.

The power of the blackboard

Do an online image search for Richard Feynman. What do you notice? Feynman is often standing in front of a blackboard – usually adorned with squiggles that most physicists will identify as the notation of quantum mechanics. Despite us living in an era of PowerPoint, smartboards and digital projection, the traditional blackboard still retains an aura and usefulness for physicists that more advanced technologies can't match. This article explores why the humble blackboard has remained an integral tool for physicists both in the classroom and the laboratory.



CERN

- By Phillip Bell in the June 2017 issue: bit.ly/PWchalk.

Simulating the universe

For centuries people have wondered about the universe and woven creation myths to explain why it looks the way it does. Over 100 years ago, Albert Einstein gave us a different way to ask that question, through Newton's law of universal gravitation. Now powerful computers are allowing cosmologists to solve Einstein's frighteningly complex equations of general relativity in a cosmological setting for the first time. This article explores how this new era of simulations could transform our understanding of the universe.

- By Tom Giblin, James Mertens and Glenn Starkman in the May 2017 issue: bit.ly/PWuni.

Spying on volcanoes

Volcanoes are intractable, majestic and enigmatic and there is something both primal and terrifying about watching them erupt, even at a safe distance.

The juxtaposition of beauty and danger is a heady mix and many people, tourists and scientists alike, are drawn, inexorably, towards them. With that powerful attraction, however, comes risk. Active volcanoes can be incredibly dangerous, especially to those who live nearby, but how do you get close enough to observe one in action? Artificial drones are giving volcanologists unprecedented access to, and high-quality data for, areas that were unthinkable even a decade ago. All we need is for physicists, engineers and geologists to continue working together.

Author Matthew Watson takes the reader on a journey to Guatemala to join an expedition investigating the volcano's activity and the impact of its emissions on the local population.

- By Matthew Watson in the July 2017 issue: bit.ly/PWvolcano.

EVENTS FOR TEACHERS

KS2 and KS3 Overlapping in Science – Raising the Level of Challenge in KS3 Practicals

Davison CE High School for Girls, Worthing
21 September
SPN event offering a range of physics-based activities at KS3 aiming to extend the level of challenge from Y7–Y9 (following the AQA KS3 curriculum). Details and booking: e.quinn@davison.w-sussex.sch.uk.

Frontiers of Physics 2017

Department of Physics, University of Limerick
23 September
For all teachers of physics including junior science teachers. The day will feature lectures, demonstrations, workshops and the opportunity for networking. Details and booking: paul.nugent@gmail.com.

IOP East Midlands Network Day

Ockbrook School, Derby
23 September
For anyone involved in the teaching of physics whether specialists or non-specialists. Keynote speaker and delegates can choose three workshops from a choice of seven. Details and booking: bit.ly/EastMidlandsDay.

Welsh Physics Teachers Conference

Christ College, Brecon
4 October
This Physics Teacher Network free day of workshops is open to all teachers, technicians, newly qualified and trainee teachers. Details and booking: bit.ly/WelshPhysicsTeachers.

SPEED2017

Netherhall School, Cambridge
7 October
All teachers of physics, technicians and trainees are welcome to this SPN event. Sessions will include ideas for those new to physics teaching as well as the more experienced. Book: bit.ly/SPEED2017.

Physics Required Practicals

Davison CE High School for Girls
11 October
An opportunity for teachers and technicians to see examples of required experiments, to use the equipment and to share any common problems with the physics required practicals. Details and booking: bit.ly/Requiredpracticals.

Unpick the Examiner's Report – A-level Physics

National STEM Learning Centre, York
18 October and 23 November
Analyse examiners' subject reports to develop your teaching strategies for the new A-level. Hands-on sessions with examination experts will enable you to delve into the specifics of these new assessments, to integrate areas for development and prepare your students better. Details and booking: bit.ly/STEMUnpick.

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

Technicians Workshop

Kesteven and Grantham GS, Grantham
8 November
This workshop will provide ideas about low-cost alternatives to standard practicals, which allow you to turn a teacher-led demonstration into hands-on experiments for pupils. Details and booking: helen.pollard@iop.org.

Delivering the Latest Science Curriculum – PHYSICS

Chellaston, Derby
14 November
This STEM Learning course will support science teachers in implementing the latest curriculum and tackle any issues that may arise. Details and booking: bit.ly/Deliveringphysics.

Technicians Supporting Physics: 11–19

National STEM Learning Centre, York
20 November
A three-day residential course to explore cost-effective ways of making physics practicals happen especially, for the core A-level and GCSE practicals. Details and booking: bit.ly/Techniciansresidential.

EVENTS FOR STUDENTS

The Women in Physics Group Jocelyn Bell Burnell Award Event 2017

Hallam Conference Centre, London
11 October
Finalists selected for this prize (given to an outstanding very early career female physicist) will give a short presentation about their work, suitable for a non-specialist audience, before the overall winner is announced. School groups (age 14+) are particularly welcome. Details and booking: bit.ly/IOPburnell.

Physics Evening Lecture

Royal Holloway, University of London, Egham
30 October
An evening lecture by Professor Jocelyn Monroe. Jocelyn's research is focused on searching for dark matter, mysterious particles that make up ~25% of the universe, approximately five times more than all the particles we know about. This is the first in a series of evening lectures suitable for GCSE- and A-level students. Details and booking: bit.ly/RoyalEveningLectures.

Year 12 Careers Conference

1 and 20 November
The Careers Conferences aims to raise the profile of the space sector to show the diversity of careers, both academic and vocational, available within the sector. Details and booking: bit.ly/CareersCon.

Science Ambassador Training Days

Various locations in England
Various dates
A full day of training for groups of up to 10 Year 8 and 9 students from your school run by the IOP and the Science and Technology Facilities Council with support from mentors and STEM ambassadors. Includes team-building, presentation skills, confidence building. All-girl groups encouraged to attend. Details and booking: stimulatingphysics.org/sas.

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 5–19 years. Deadlines for 2017: 1 November. To download an application form and for more information visit: iop.org/schoolgrants.

Engineering Education Grants Scheme

The joint Institution of Engineering and Technology and Institution of Mechanical Engineers awards of up to £5000 or £15,000 are to engage young people, develop professional skills of STEM teachers or improve engineering literacy. The deadline is 7 October. For more information and to apply, visit: bit.ly/CPeegs.

SAVE THE DATE

Association for Science Education Annual Conference

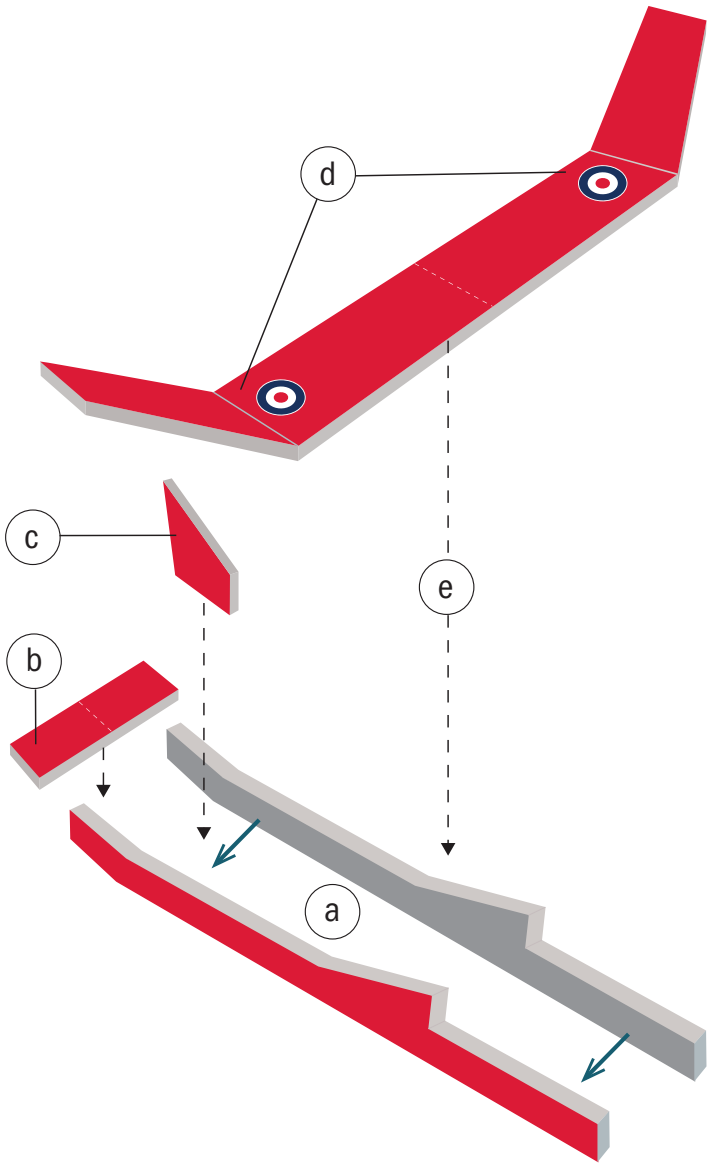
University of Liverpool
3–6 January 2018
With a focus on supporting practical science and an update on the International Review of Practical Science by Sir John Holman. Plus four IOP workshops. Trainee teachers can attend one day for free. Early bird bookings close on Friday 27 October 2017. Details and booking: ase.org.uk/conferences/annual-conference.

Balanced flight

In this activity you will be exploring how the position of the **centre of mass** affects an aircraft's balance.

What you'll need

- RAF100 glider sticker template
- Foam sheet
- Sticky tape or masking tape
- A penny and some Blu-Tack
- Scissors
- String



What you need to do

1. Stick the glider template parts to the foam. Cut out the wing, tailplane, fin and two fuselage parts from the foam.
2. Build the glider using the steps shown in the diagram:
   a) Join the two parts of the fuselage together by taping around the front of the nose and centre of the fuselage.
   b) Tape the tailplane onto the downward sloping section of the fuselage. Make sure it is securely attached.
   c) Slide the tail fin between the two parts of the fuselage and attach it using tape.
   d) Place a ruler along each of the dotted lines on the wing. Press gently downwards into the surface of the wing to make a crease.
   e) Tape the wing onto the upward sloping section of the fuselage. Bend the outer parts of the wing up slightly, along the dotted lines. If the foam cracks, use tape to reinforce it.
3. Find the centre of mass of your glider. If you don't know how to do this ask your teacher.
4. Test-fly your glider. Is it balanced?
5. Aircraft have a heavy engine in their nose. This means that their centre of mass is further forward than in your glider. Change your centre of mass by adding a penny to the nose (the penny can be pushed between the two bits of foam that make the fuselage).
6. Test-fly your glider again. Adjust the position of the penny and/or add Blu-Tack as required until your glider flies level.
7. Find the new position of the glider's centre of mass. What conclusions can you make about how the position of the centre of mass affects the balance of the glider?

Moments and flight

Equipment required per student

- Copy of Balanced Flight activity instructions copied from page 11
- Sticker glider template (two sheets included with this issue)
- 3 mm thick Depron foam sheet, cut to approximately A4 size (sample included with this issue)
- Sticky tape or masking tape
- Scissors
- Blu-Tack
- Penny
- String

The practical activity

Students follow the instructions to construct a glider and estimate the position of its **centre of mass, C_M** (see figure 1). They should find that it is approximately at the centre of the fuselage. When they test-fly their glider, it will be unstable, pitching upwards and stalling.

Moving the position of C_M will balance the glider. Students should attach a penny to its nose and carry out further test-flights, adjusting C_M by moving the penny and/or adding Blu-Tack. Balancing the glider and optimising the throwing technique will take a few attempts, but ultimately, students should be able to achieve horizontal flight over a metre or so.

Discussion

The vertical forces on an aircraft in steady flight are shown in figure 2. The gravitational force acts downwards at C_M and the lift force due to the wings acts upwards. Aircraft designers have to bear in mind that the position of C_M does not remain fixed during a flight because passengers move around and fuel mass is burned.

This means that the gravitational force may not have the same line of action as the lift force, resulting in a turning moment: the lift force will cause the aircraft to rotate around C_M and pitch nose up or down.

For stability, engineers position C_M towards the front of an aircraft. They also use a small upside-down wing, called a tailplane, at the rear to provide a balancing moment.

RAF100 project

This teaching tip was adapted from *Activity 1: Origins and Balanced Flight* of the RAF100 schools project.

There is more background theory on pitch control and stability on the project website where you can also order more glider templates and find information on how to participate.

raf100schools.org.uk

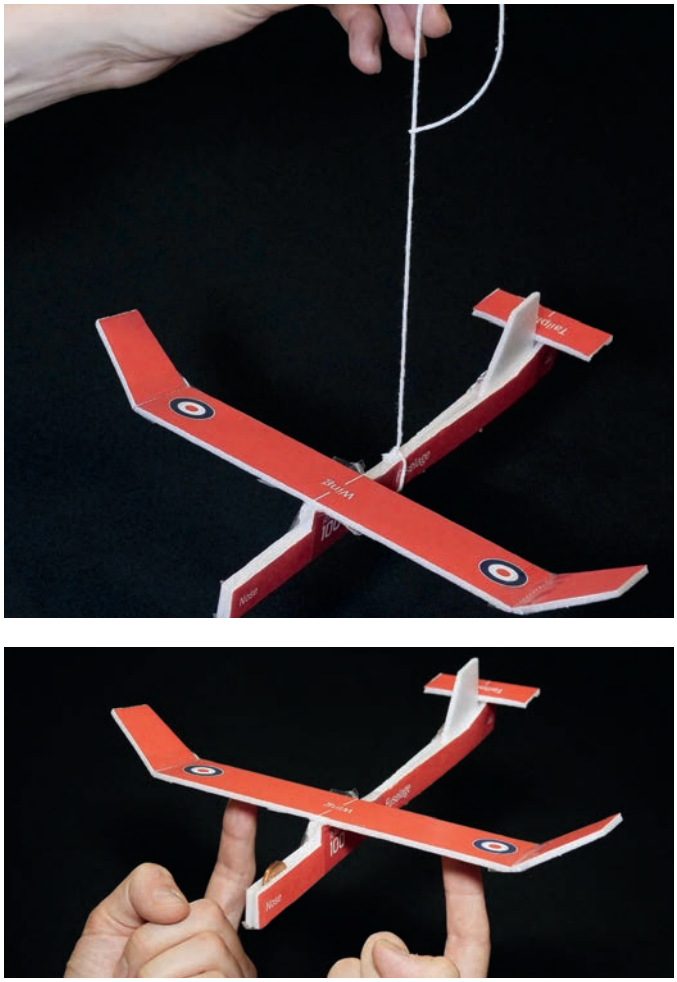


Figure 1. The glider's C_M can be found by finding the point at which it balances. Top: A glider (without a penny) suspended by string at its C_M; Bottom: A glider (with a penny) balanced on two fingers.

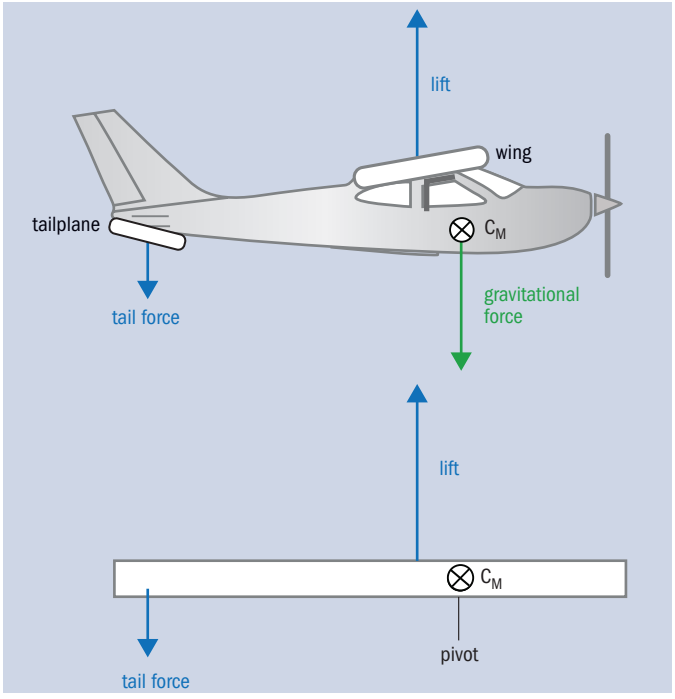


Figure 2. An aircraft in flight pivots around its C_M. To remain level the clockwise moment created by the lift force must be balanced by the anticlockwise moment created by the tail force.

Classroom Physics is published by IOP Publishing, Temple Circus, Temple Way, Bristol BS1 6HG, UK.