

Physics and the Games: a winning formula

The 2012 Schools and Colleges Lecture will explain how scientists and engineers are using physics to boost the chances of national success in the London 2012 Olympics.

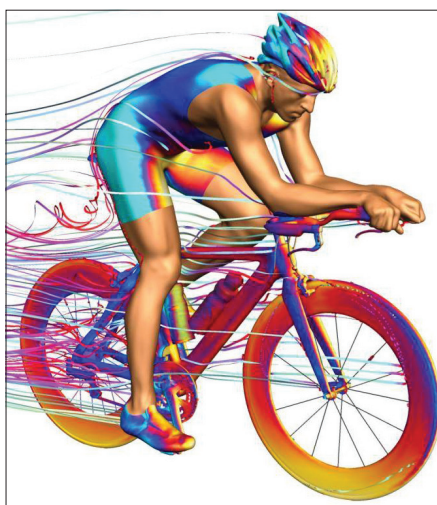
2012 brings the Olympics to London for the first time since 1948. With all of the excitement leading up to such a huge event we should not overlook the important role that scientists and engineers are playing behind the scenes to help boost the nation's chances of success.

Newtonian physics dominates the world of sport, and developments in engineering and technology have defined many of the key periods of sporting history. From drag-reducing swimsuits to the fastest bicycles in the world; from running prostheses to the latest in pervasive sensor technology, the application of science to the world of sport, although sometimes controversial, is always fascinating.

"Physics and the Games: a winning formula" will cover many of the key technologies that have allowed athletes to push the boundaries of human performance and will ask where the future might take us. Has science gone too far in the quest for sporting success perhaps?

The lecture will be presented by researchers from Sheffield Hallam University's world-leading Centre for Sports Engineering Research (which provides technological support for many Olympic teams) and will involve hands-on demonstrations, live experiments and multimedia elements.

Presenters include Dr David James – who was the Institute's Schools and Colleges lecturer in 2004 and the Royal Academy of Engineering's first Public Engagement Fellow in 2009 – and early-career researchers Heather Driscoll and Leon Foster. Heather and Leon both have undergraduate degrees in sports engineering from the University



Technological advances that will aid our Olympic athletes will be discussed in these lectures.

The 2011 Schools and Colleges Lecture "From x-rays to antimatter – the science of seeing inside your body" is available to view online. Visit www.iop.org/schoolslecture and click "watch previous lectures". A DVD-ROM including the lecture film and a suite of complementary teaching resources will be sent out along with the March 2012 issue of *Classroom Physics*.

of Bath and are currently in the process of completing their PhDs. Leon has been modelling the impact of technology on athletic performance and Heather has focused on understanding the traction of football boots.

This free lecture lasts an hour and it is suitable for those aged 14 and over. It will be touring Great Britain throughout 2012. Although the lecture is free, places must be pre-booked with the chosen venue.

For more information: visit www.iop.org/schoolslecture for venues and bookings.



All images courtesy Sheffield Hallam University



Presenters David James (top), Heather Driscoll and Leon Foster will inspire students at the lecture.

Editorial



Welcome to this, the 19th issue of *Classroom Physics*. It includes news of resources and events for January 2012 and beyond. I hope your

term has gone well and you can see the Christmas holiday advancing as a welcome break. If you are looking for last-minute presents, the Marvin and Milo book is ideal for all ages (p3).

2012 looks like it may be dominated by the London Olympics. Our Schools and Colleges Lecture takes the physics of the games as its theme (p1), with news of further resources to use in teaching around this theme on p4. Other resources to engage students beyond the immediate curriculum are the BBC's *Stargazing LIVE*, which is taking place again in early January (p4) and *I'm a Scientist, Get me out of here!*, which gets working scientists and school students talking online (p4).

Other ways of enhancing the experience you give your students are to take them outside the classroom. *Thinking Beyond the Science Classroom* is an online resource designed to help you feel more confident about doing this (p5). One of the activities, "Seeing the world through rose-tinted glasses" is our teaching tip on p8. Page 7 also has some teaching ideas with balloons.

If you are in an affiliated school, you will be receiving a number of resources with this newsletter: these include a copy of *Physics in Concert*, which is described in more detail on p3 and a DVD of resources for the teaching of nuclear physics, from the University of York. There is also a bookmark promoting our new site www.myphysicscourse.org, where you can search for undergraduate courses across the UK and Ireland, as well as our latest version of our study guide for post-16, now called *Pocket Physics*. If you would like further copies of either of these to give to your students, order them by e-mailing education@iop.org.

For those of you on Twitter, follow us and join the conversation at @PhysicsNews. We use #teachphysics for anything linked to teaching.

We look forward to seeing you at the ASE Annual Conference – for more details of our contributions, see p3. As ever, suggestions are always welcome.

Clare Thomson, editor (tel 020 7470 4981, e-mail clare.thomson@iop.org).

Reserve your place at the ever-popular ASE conference

If you have never been to the ASE Annual Conference, now is the time to come. This event is a great way of catching up with all that is new in science education, both in terms of resources and CPD to match your needs. The 2012 conference is taking place at the University of Liverpool on 5–7 January. As usual, the Institute will have a significant presence there. Our stand (B30), in the exhibition marquee, will have a selection of all of our resources and posters for you to pick up. In addition, we welcome the chance to meet you, offer advice if necessary and hear your feedback on what we offer.

The highlight of our programme is the John Lewis Lecture, given this year by Dr Lucie Green from the Mullard Space Science Laboratory and entitled "The highs and lows of solar activity and why we should care". This will be at 11.30 a.m. on Friday 6 January in the Chadwick Lecture Theatre and it promises to be a fascinating insight into ongoing research on our nearest star and its effects on our weather and climate. The lecture is named after John L. Lewis, an honorary fellow of the Institute, who was head of physics at Malvern School in the 1960s and a key figure in the development of Nuffield Physics.



Dr Lucie Green gets to grips with solar issues.

Our ever-popular lecture–demonstration, "The best of *Physics Education*", will be held in the Chadwick Lecture Theatre on Friday at 2.00 p.m. Members of the editorial board will demonstrate some of the best ideas from recent issues of the journal, as well as their favourite ideas, to inspire and engage students everywhere.

We will also be running an extensive programme of booked workshops as well as other talks and special events. Places at the workshops fill up quickly, so you are advised to book your place at the conference soon.

For more information: To register for the conference and view the programme, visit www.ase.org.uk/conferences.

TalkPhysics offers online help

Building on the success of the talkphysics.org website, the Institute is now offering free online



training. Institute staff and our Physics Network coordinators are extending their real-world presence by offering 10-day sessions through talkphysics.org, requiring participants to complete tasks and join in with discussions every day or so. A session held in July on forces for teachers

of 11–14-year-olds, targeted at non-specialists, received 100% positive feedback from its participants. There'll be at

least one session each half-term. In October the CPD session was on forces again and astronomy was the topic in November.

For more information: Join www.talkphysics.org and look out for updates about online training in 2012.

Fellowship funding supports education innovation

Do you have a nascent or dormant idea that could support physics teaching? Or have you had a flash of inspiration that could be brought to life with some funding? If so, you should apply for the Anthony Waterhouse Fellowship. It is generously endowed by Helen Parsons in memory of her brother and his passion for physics and is available to any current teacher of physics to develop an item of apparatus, some original teaching materials or a piece of software.

In 2010, Stuart St John used the fellowship to develop a simple, inexpensive

way of building computer interfaces to make use of oscilloscope and signal-generating software; he has written the project up and it will appear in *Physics Education* in 2012. If you have a pet project or a great idea that you would like to develop further and bring to the world of physics teaching, e-mail Charles Tracy for more information and details on how to apply.

For more information: contact Charles Tracy, head of pre-19 education at the Institute (e-mail charles.tracy@iop.org).

Trainee physics teachers could receive £20 000

As you may be aware, the Institute not only provides support to teachers of physics but also to people who want to become teachers. The shortage of physics specialists in teaching is well documented and our work in this area is vital to ensure that physics as a subject prospers well into the future.

We are delighted to announce the launch of the IOP Teacher Training Scholarships, a programme available to those that have the potential to become outstanding teachers of physics. We have 100 scholarships to award, each worth £20 000, offering a package of support that combines

membership, mentoring and networking opportunities, enabling these scholars to become integral players within the physics-education community.

Funded by the Department for Education, the scholarship is the only one of its kind for 2012 and applications are now open. We urge you to spread the word to anyone who is interested in becoming a physics teacher.

For more information: To see eligibility and application details, visit www.iop.org/teach, or if you have any questions e-mail teach@iop.org.



Guy Hope (head of science, Christ College Brecon), Cerian Angharad (Physics Network coordinator) and Gary Williams (Teacher Network national coordinator) cut the cake to celebrate the 10th anniversary of the Welsh Physics Teachers Conference.

Happy 10th birthday to the Welsh Physics Teachers Conference

On 5 October more than 80 teachers and technicians attended the Annual Welsh Physics Teachers Conference at Christ College, Brecon. The highlight of the morning was a talk given by Dr Lyn Evans on “CERN: now and in the future”. Attendees were able to hear about the last hiding place of the Higgs boson and what happened when a technical hitch occurred at CERN. Dr Evans also gave a fascinating update on the latest talked-about topic in physics: neutrinos that appear to travel at a velocity greater than the speed of light.

Lunch provided the ideal opportunity for teachers to meet exhibitors and talk informally to workshop providers and colleagues. The 10th anniversary of the conference was celebrated with a piece of cake for everyone and a rousing rendition of “Happy Birthday”. This was followed by a variety of afternoon workshops.

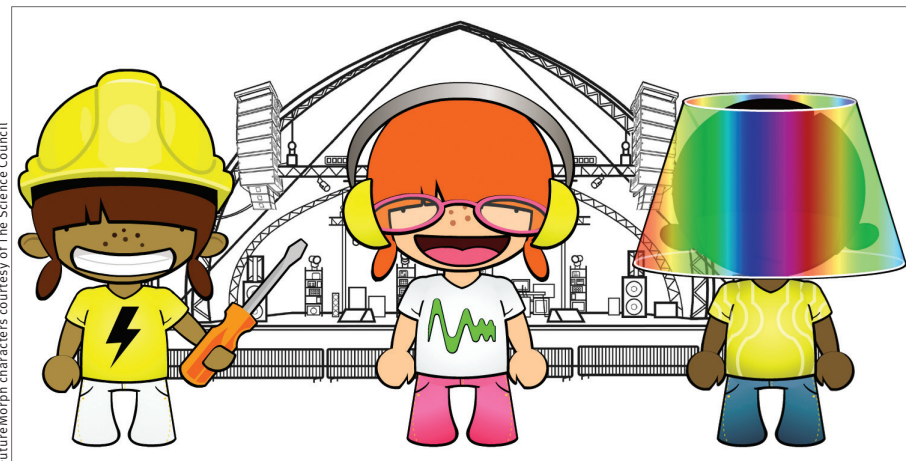
It was a valuable day for both teachers and technicians, which is illustrated by the first-rate feedback received: “[the conference] advances personal understanding on subjects as well as providing practical ideas and resources for use in school” and “an excellent day...very useful, as usual”.

For more information: If you would like to be notified when registration opens for next year’s conference, e-mail physics@iopwales.org and put “Brecon 2012” in the subject line.

IOP Teacher Training Scholarships

Developing excellence

Physics in Concert: exploring careers related to physics



In this new activity students take on one of three roles: electrical, sound or lighting engineer.

Included with this edition of *Classroom Physics* is the booklet for a new activity – Physics in Concert. This resource is based on the highly successful Ashfield Music Festival activity and incorporates many of its features: students work in teams, learn about engineering by taking on different roles and explore how physics applies to the context of planning a music event.

However, Physics in Concert offers greater flexibility in terms of delivery as it does not require the recruitment of external “experts” to help run the activity or take students off-timetable. Developed by the Institute,

as part of the DfE-funded STEM Subject Choice and Careers Project, it is hoped that this type of activity will help encourage more students to consider careers related to physics.

For more information: To download the electronic version of this resource along with the PowerPoint presentation, visit www.iop.org/concert. For further details about the Ashfield Music Festival activity, visit www.iop.org/ashfield. For further information about the STEM Subject Choice and Careers Project, visit stem.org.uk/cx8h.

Stargazing LIVE returns in the New Year

There is a whole world of wonders above your head. Isn't it time you looked up?

The TV programme *Stargazing LIVE* returns to BBC2 on 16–18 January 2012. For the first time the programme's transmission dates fall during term time, so many more schools will be able to get involved. New resources are in production and will include film clips and curriculum links for KS3 and 4.

19 January will be *Stargazing LIVE*'s School Day, where the BBC team will be holding an exciting, interactive live webcast from Jodrell Bank. There is also the opportunity to link this with the *BBC News School Report* project (news.bbc.co.uk/1/hi/school_report), where 11–16-year-olds develop their journalism skills throughout the year with the help of the BBC. If your school is already taking part, why not watch the webcast and write about it as part of the practice *News Day* (where pupils practise broadcasting their own news stories)?

How about holding your own *Stargazing LIVE* event? The BBC *Stargazing LIVE* team can: match your school with a local



BBC Stargazing LIVE

Brian Cox and Dara Ó Briain will be hosting *Stargazing LIVE* on BBC2 in January.

astronomy group or university to provide expertise; give you fantastic resources, including the *BBC Star Guide*, posters and banners; and help you with ideas for activities, for example, holding a sponsored star count or wrapping up warm to make

digital constellations in the playground.

For more information: To be added to the schools e-mail list, please contact the BBC *Stargazing LIVE* team (e-mail stargazing@bbc.co.uk).

Bringing London 2012 into the classroom

The arrival of the London 2012 Olympic and Paralympic Games is an exciting opportunity to engage students in new and interesting ways. Sports provide an engaging context for physics content, from fundamentals like forces and motion to cutting-edge materials research.

SEPnet (the South East Physics Network) is running a competition this academic year for sixth-form students, exploring these links between physics and sport. Participating students get the chance to hear from an athlete and learn about the sport, as well as exploring the physics involved through practical, experiment-based challenges. Challenges will focus on well-known sports and some of the less common ones, from both Olympic and Paralympic perspectives.

The competition has been Inspire-marked by the London 2012 education team



SEPnet

Sixth-formers carry out physics experiments inspired by the London 2012 Olympics.

and there will be eight heats across the South-East and London with a regional final in National Science and Engineering Week. Based on these competitions, SEPnet will be providing teacher resources for hands-on physics challenges in a sports context that can be used in the classroom (these will be available from summer 2012 onwards).

If you are considering how to bring London 2012 into the classroom, you may also be interested in Nuffield's cross-curricular STEM project games. This resource is suitable for years 7 and 8 and develops learning skills in addition to providing lesson material in the context of fitness, fairness and the design of games and sports equipment. It comprises 16 hours of activities that can be used flexibly within lessons or run as an off-timetable activity culminating in individual pupil projects.

For more information: on the SEPnet competition and teaching resources, visit www.sepnet.ac.uk or contact Clare Harvey (e-mail clare.harvey@sepnet.ac.uk). The Nuffield Games resource is freely available from www.nuffieldfoundation.org/nuffield-stem-games.

Registration now open for 2012 online contest

After two very successful events earlier this year, the Institute will once again be sponsoring *I'm a Scientist, Get me out of here!* – the UK's largest online science engagement project. This two-week *X-Factor*-style competition for scientists, where the students are the judges, has proved very popular with both teachers and



students. The teachers who participated in the 2011 events reported that they were keen to take part again next year and 96% felt that their students had a more positive

view of science after meeting and interacting with real scientists online. For 2012, the Institute will be funding a greater number of physics-based zones during the March and June events.

For more information: To register your interest, visit imascientist.org.uk/iop-teacher-registration and use the promotional code "IOP" to indicate that you would prefer a physics zone (only available for IOP-affiliated schools).

Award recognises the best school-science technicians



The Salters' Institute

The 2010 winners (left to right): Gemma Towers, Steve Jarvis, Rosemarie Hogg and Sarah Atkinson.

In 2012 the Salters' National Awards for Science Technicians will be entering its ninth year. Nominations are invited from schools and colleges wishing to recommend a science technician who has a total of five or more years' experience (either full- or part-time) for an award.

The aim of the awards is to acknowledge publicly the immense contribution that science technicians make to the well-being and success of schools and colleges, and, in particular, to science departments. The closing date for nominations is 1 March 2012. If you know a technician who fits the criteria then please nominate them for an award.

Here is an account from Gemma Towers of Balcarras School, a 2010 award-winner: "I was quite nervous when I found I had been

shortlisted for an award but the judging team was incredibly friendly. They were genuinely interested in the school, staff and pupils and what my job entailed. I was very honoured to find that I had been awarded one of the prizes.

Lots of the pupils at my school came up and congratulated me and were really pleased that I had won. The day at Salters' Hall was wonderful, especially the very moving talk that Prof. Waddington gave before the awards. The day made me feel very special and was thoroughly enjoyable."

For more information: To download a nomination form, visit www.saltersinstitute.co.uk or contact the publicity coordinator (tel 020 7628 5962 ext 260, e-mail publicity@salters.co.uk).



King's College London

A student from Chelsea Academy is framing and describing activity on the school roof.

Thinking beyond the (physics) classroom

By using the term *Classroom Physics* this newsletter embraces all the places where young people might learn physics. However, teaching physics well in contexts other than the classroom can be challenging and requires adapting classroom strategies to unique environments. In response to these challenges and in pursuit of an increasing understanding of what makes a quality learning experience, the Thinking Beyond the Classroom Programme has been developed by King's College London and the Field Studies Council with funding from the AstraZeneca Science Teaching Trust.

The programme team, alongside secondary-science teachers in London, has developed 10 outdoor science activities in various topic areas, including light and forces. Lesson activities are structured around group discussion, cognitive challenge and teacher questioning. When these aspects are incorporated into teaching, research has shown that they can increase the potential for student learning. Therefore, several lesson activities within the programme have been developed to support student group work, questioning and "scientific" observation skills. These areas were considered important for indoor lessons but essential for success outside of the classroom.

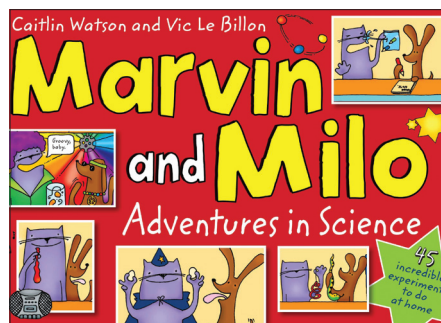
The activities can be used as stand-alone lessons but teachers have also incorporated them into KS3 and 4 schemes of work to develop their students' scientific conceptual understanding alongside scientific skills. The programme's website (see below) contains exemplification material in the form of video extracts of an outdoor lesson focused on "cognitive challenge" and "teacher questioning". These extracts can be useful for departmental professional development sessions.

For more information: For activities and lesson structure, visit www.azteachscience.co.uk/resources/cpd/thinking-beyond-the-classroom/view-online.aspx.

Marvin and Milo launch book

Marvin and Milo have been encouraging readers of *Interactions* (the Institute's member newspaper) and visitors to www.physics.org to "Do try this at home" since 2004, but they've finally hit the big time with their own book – *Marvin and Milo: Adventures in Science* – containing 45 of the pair's popular physics cartoons. In each adventure, Marvin the cat (bossy, talkative) and Milo the dog (gullible, eager to please), conduct a simple physics experiment using everyday household objects.

In the book, Marvin's original one-line explanations have been expanded on the page facing each cartoon to include more of the science behind each experiment. Marvin and Milo's experiments are devised by Caitlin Watson, IOP's head of public engagement, who tests all of the experiments and explanations out at home before they are brought to life by artist Vic Le



Billon. A perfect present or prize for children of all ages, *Marvin and Milo: Adventures in Science* is available now in all good bookshops and from online retailers.

For more information: Caitlin Watson and Vic Le Billon's *Marvin and Milo: Adventures in Science* was published in September 2011 by Macmillan (ISBN 9780230758490).

EVENTS FOR TEACHERS

ASE Annual Conference

University of Liverpool
5–7 January

Meet the Institute's education department staff and enjoy varied workshops and lectures as well as a major exhibition. Highlights include the Institute's John Lewis keynote lecture, given by Dr Greene from the Mullard Space Science Laboratory, and the Best of *Physics Education* lecture. Details and booking: visit www.ase.org.uk

Conference for Early-career FE Lecturers

Ramada Inn, Ealing, London
20–21 January

FE lecturers in the early years of their career can attend the Science Learning Centre London's conference. There is a course fee of £200 but lecturers can claim an Impact Award of £200 to cover the cost. Accommodation is included. Details and booking: visit www.slcs.ac.uk/network/11345

Physics for Non-Specialists

Science Learning Centre, London
8 February, 8 March, 11 May, 4 July

This is a four-day course for non-specialists. Book all four days or select the days focusing on the topic you particularly want. The course costs £150 (day) or £525 (complete series); an Impact Award of £200 a day can be made available. Details and booking: visit www.slcs.ac.uk/network/11068

Practical SHAP

University of York
27–28 March

This course is designed for teachers and technicians who use Salters Horners Advanced Physics (SHAP). The main focus will be on activities and a selection from both AS and A2 years will be showcased. Details and booking: contact Joanna Macdonald (e-mail joanna.macdonald@york.ac.uk)

Spring Physics Update

Royal Holloway, University of London
30 March – 1 April

A three-day residential course featuring a mixture of talks and hands-on workshops based at the university's physics department. Details and booking: visit www.iop.org/update or e-mail Manchi Chung (manchi.chung@iop.org).

Physics Refresher Course

University of Kent
2 April, 10.00 a.m. – 3.30 p.m.

The School of Physical Sciences is offering a free day course for physics teachers. Posters designed by research students for outreach purposes will be on display and a competition will be run in which teachers will decide the winner. Details and booking: contact Vicky Fitzgerald (e-mail science@kent.ac.uk)

Stirling Meeting

University of Stirling
23 May

The 38th annual meeting organised by the IOP in Scotland will feature a day of lectures and workshops, as well as an exhibition. Details and booking: visit www.stirlingmeeting.org or contact Lauren Stacy (e-mail lauren.stacy@iop.org)

Rugby Meeting

Rugby School, Rugby CV22 5DW
14 June

The 24th annual meeting for teachers of physics in schools and colleges will offer information, stimulation and communication, as well as an exhibition. Details and booking: visit www.iop.org/rugby or contact Manchi Chung (e-mail manchi.chung@iop.org)

A Day for Everyone Teaching Physics

Durham University
21 June

This free day for anyone teaching physics will feature a keynote lecture by Prof. Mennell, linking physics to the latest developments in forensic science. There will also be workshops (D Featonby's "Toys and medical physics" and H Pollard's "Another variety of experiments") and an exhibition. Details and booking: visit www.sciencelearningcentres.org.uk/centres/north-east

South West Physics Teachers' Conference

St Luke's Campus, University of Exeter
22 June

This is for anyone involved in the teaching of physics. There will be a lively programme of lectures and workshops. Details: contact Alison Alexander (e-mail alisonalexander@aol.com)

Summer Physics Update

University of Birmingham
6–8 July

This three-day residential course will feature talks and hands-on workshops based at the university's physics department. Details and booking: visit www.iop.org/update or contact Manchi Chung (e-mail manchi.chung@iop.org)

EVENTS FOR STUDENTS

IOP 2012 Schools and Colleges' Lecture – Physics and the Games: a winning formula

This free lecture for 14–16-year-olds, given by a team from Sheffield Hallam University's world-leading Centre for Sports Engineering Research, starts its UK tour. Details and booking: visit www.iop.org/schoolslecture

Olympics Physics Competition

9 February – University of Surrey
21 or 28 February – University of Kent

You are invited to bring a team of six year-12 students to a SEPnet partner campus to participate in a full-day challenge activity exploring the hidden physics in sport. Details: contact Clare Harvey (e-mail clare.harvey@sepnet.ac.uk)

Physics in Perspective: an Enrichment Course for Sixth-formers & College Students

University College London/Royal Institution
12–14 February

This three-day event aims to give students a taste of the excitement, relevance and fun of studying physics at university. The programme comprises six demonstration-lectures with free time to allow attendees to explore London. Discounted accommodation is available through Minerva Travel. Details and booking: visit www.iop.org/pip or contact Manchi Chung (e-mail manchi.chung@iop.org)

National Science & Engineering Week 9–18 March

In 2012, National Science & Engineering Week explores "our world in motion". For more information and a copy of this year's *Move It!* activity pack, visit www.britishtscienceassociation.org/web/NSEW.

The Big Bang UK Young Scientists & Engineers Fair 2012

NEC, Birmingham
15–17 March

This free event is a great opportunity for students to experience STEM in a fresh new way. Get hands-on with a range of activities, enjoy theatre shows and meet some of the country's leading science talent. Details: visit www.thebigbangfair.co.uk

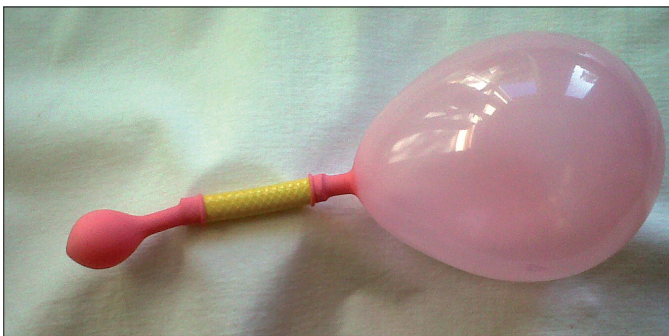
Space School

University of Kent
4–5 and 11–12 August

The university is recruiting 11–18-year-olds for the 2012 school. Held on campus during the first two weekends of August, it will coincide with the Perseid meteor shower. Details: visit www.kent.ac.uk/physical-science/spaceschool

Teaching physics concepts with balloons

All images courtesy IOP



1. Demonstrating a surprising pressure difference

Two balloons are inflated to different sizes. Both are attached to a piece of hose and a clip is placed to stop any air moving between them. What will happen when the clip is removed? Will the two balloons even out in size? Will the smaller balloon get smaller and the larger balloon larger? Or will nothing happen at all?

For a demonstration and explanation, visit www.bbc.co.uk/programmes/p00kpd1.

2. Demonstration of lift

Take a very large balloon (diameter at least 50 cm). Ask someone to raise it by blowing air from a hairdryer at it from below – no joy. Now direct a gentle air flow from the hairdryer over the top surface. The balloon is large enough so you can arrange that no air flow from the hairdryer travels under the balloon – but “hey presto”, it levitates. This is an example of a demonstration that seems to give the lie to the “air flow splitting and rejoining” argument to explain aircraft lift.

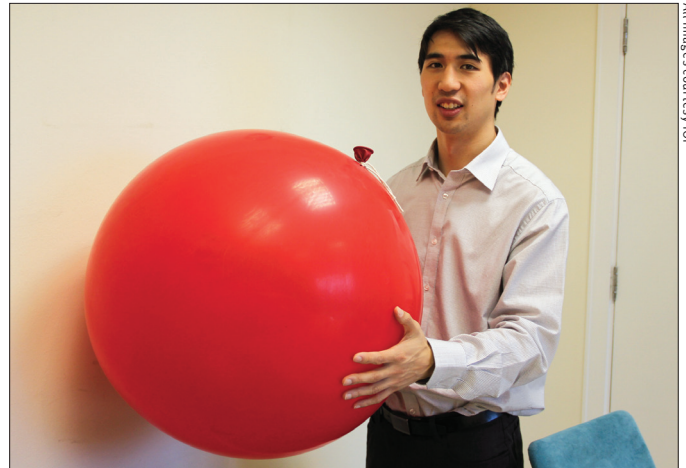
For more detail on the physics of lift, see “How do Wings Work?” Holger Babinsky *Physics Education* vol 38 no 6 p497.

3. Inertia effect of a mass of air

Another use for a large balloon – its volume is typically 0.1 m^3 , and it contains about 200 g of slightly compressed air. Lifting the inflated balloon is easy as it displaces its own volume of air and thus experiences an upthrust virtually equal to the weight of air contained, so you only have to lift the balloon skin. For comparison, lift $2 \times 100 \text{ g}$ plus a balloon skin.

See the surprised look on a pupil’s face when first you throw the empty balloon at his or her back, followed by the inflated balloon with its 200 g of air inside. (The large contact area between the balloon and the pupil’s back keeps the pressure down but does not affect the total impulsive force as the balloon rebounds.) The effect can be magnified by using a larger balloon or inflating it further, so that it contains more air.

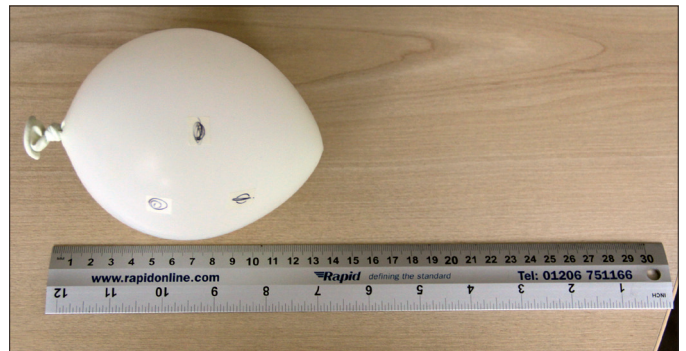
Large balloons are readily available to buy on the internet.



Easy to lift but hard to throw.

4. Demonstrating the expansion of the universe

Take a slightly inflated balloon and put two or three stickers a few centimetres apart on it. These represent galaxies. Inflate the balloon further and show that the galaxies are now further apart than they were before. It is best if you put the stickers towards the base of the balloon, as this is where the rubber expands the most as the balloon is inflated. You need to emphasise that the galaxies have not expanded but space has. This represents the universe expanding at all points. Observers in any galaxy see most of the other galaxies in the universe moving away from them.



The balloon before and after inflation.

For more information: *Marvin and Milo’s Adventures in Science* include a lot of activities using balloons; you can download these from www.physics.org/marvinandmilo.

With thanks to **Dr Yoji Takikawa**, University of Tokyo.

'Seeing the world through rose-tinted glasses'

This lesson explores the ideas of learning through questioning as explained in the Thinking Beyond the Classroom CPD unit, and it is a slightly amended version of what can be found on the website (www.azteachscience.co.uk/resources).

Science context

The colour of an object depends on the wavelengths of light that are scattered and absorbed.

Lesson summary

In this activity, students will identify what colours they see as they walk along a route in and outside of the school. In pairs, at particular points, they will compare what colours they see with and without filter glasses. This will feed into a discussion to consider what they think the glasses do. This activity will help students to reveal what they understand about how we see colour and how coloured filters work in this process.

Cognitive potential

This activity will introduce students to the ideas of absorption, transmission and scattering of light, and will probe their prior knowledge of how we see colours. Through the discussions the students may encounter various possible explanations and a feeling of uncertainty. Students will need to listen to alternative ideas from other groups to reconsider their original theories of how coloured filters work.

Key resources

- Class set of green- and red-filter glasses. These can be purchased from www.rainbowsymphonystore.com.
- A table to complete, with the following headings:

Point/object	Partner 1 with red (green) filter glasses	Partner 2 without	Partner 2 return journey with red (green) filter glasses	Partner 1 return journey

Setting the scene (5 minutes)

Introduce the pupils to a plan diagram of a map of the school grounds. Ask students to locate specific areas on the map to familiarise themselves. Tell students that they will need to annotate the map with their route later.

Write a message on the board using green and red pens and hide it. Give out filtered glasses and reveal the message on the board. Tell students that they are going to consider what filters do to light and colour that affects how things are seen.

Observations outside (15–20 minutes)

Ask students, in pairs, to walk a specific short route that covers some inside school space (hall, gym and library) and some outside space (playground). One partner will wear the red filter glasses. At each stop, the partner without the glasses points to objects/pictures and asks the partner with glasses to describe the colours/textures etc that they see. They then tell their partner what colours they see without glasses. They record these descriptions in a table. On the return route, they swap over and go back to the same points/objects and re-record the colours again. This activity is then repeated, this time with the green-filter glasses.



Rooftop study: students can take their science lessons outside with 'Seeing the world through rose-tinted glasses'.

Sharing ideas and provoking conflict (15 minutes)

Back in class get the pairs to join together into larger thinking groups for discussion. Get them to talk to each other about what colours they saw with and without the glasses. Ask them: "What do you think these glasses do?"

Then ask and collect ideas on what is similar and what is different about seeing:

- with red glasses and without;
- with green glasses and without;
- between red and green glasses.

Is it always true that people see things the same?

Why might that be? (You may not want to ask all of these questions and focusing on one filter colour may be sufficient). Again ask: "What do you think these glasses do?"

Give the groups time to talk about this and ask them to take one point/feature that they recorded and use this as the basis of an annotated diagram to illustrate their thinking.

Linking ideas together (15 minutes)

Gather the groups together for a whole-class discussion. Invite different groups to share their illustrations. Encourage the listeners to consider the different ideas and compare/disagree/agree. Pose questions like: "What do you think about that idea?", "Who thinks something else?" and "What's easy and what's difficult to explain about the changes you saw?"

After this class discussion, ask the students to reflect and write down their thoughts individually in their books. Suggest that they consider questions such as: "Has your thinking changed?" and "What do you think the glasses do?"

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