Classroom physics

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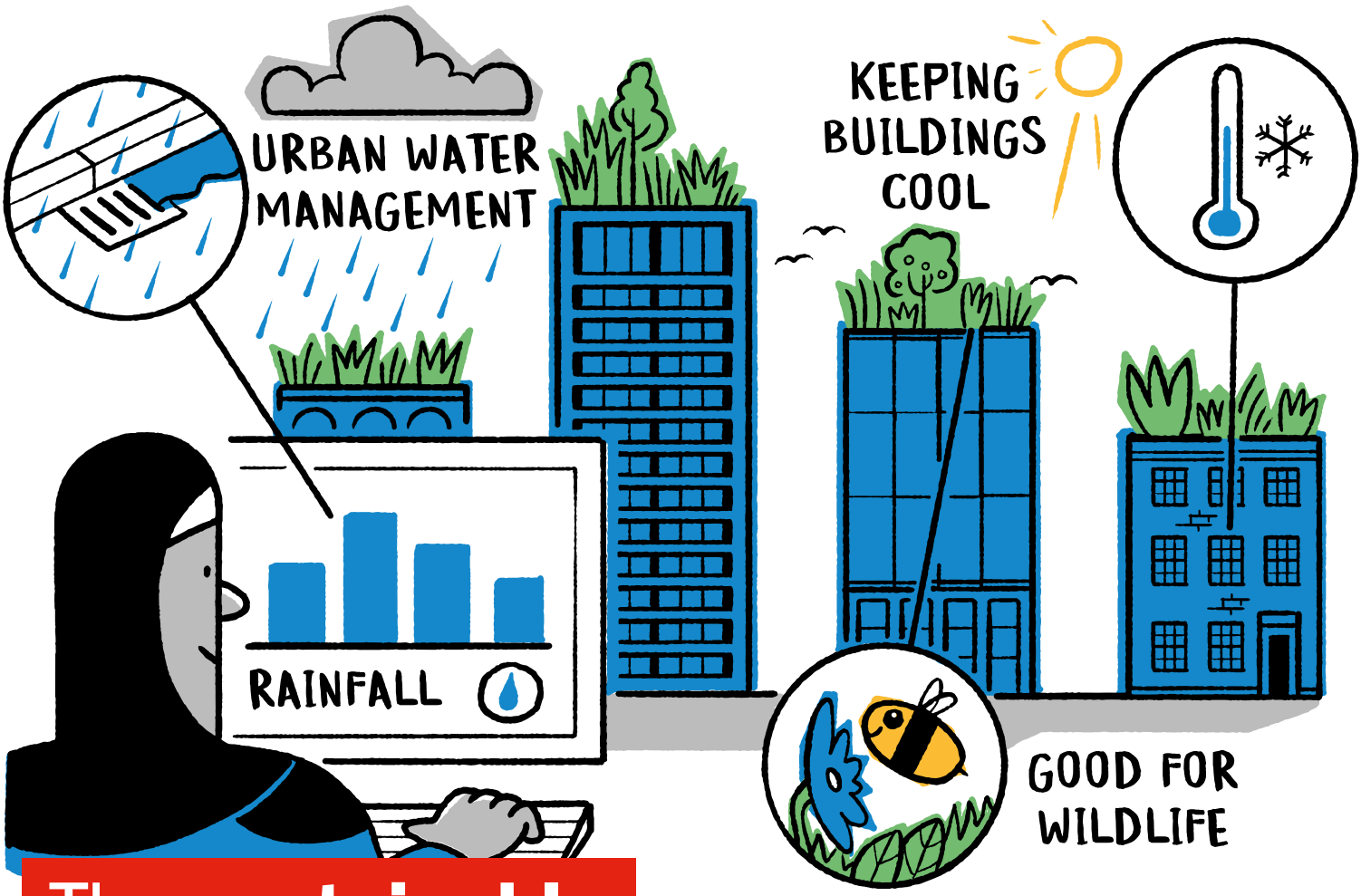
The magazine for IOP affiliated schools



The **sustainable physics** issue

Changes to IOP support for teachers, schools and colleges

Surprisingly green physics careers

Getting students involved in school sustainability

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IOP Institute of Physics

This issue

News

Features

Resources

Digests

Listings

Credit: John Gomez / Shutterstock

14th February 2020. Student activists with banner at the Youth Strike 4 Climate demonstration rally at Parliament Square

The sustainable physics issue

"Climate change is widespread, rapid, and intensifying, and some trends are now irreversible, at least during the present time frame." This is the conclusion of the UN's sobering 2021 climate change report, published in August.

Professor Paul Hardaker, Chief Executive Officer of the Institute of Physics, commented: "There has never been stronger evidence that we need to act now and together. This report is a reminder not only of our latest understanding of the scientific evidence, but also of the huge amount of work that thousands of scientists put in to help us all understand that our climate is changing, what is causing that change and what we can do to mitigate the impacts."

The measurement tools developed by physicists have enabled the report writers to know definitively that our world has warmed. The forecasting models are physics-based and the solutions - from net-zero carbon emissions to a green economy - will be physics-based. Physics is key to both the diagnosis of the problems and the cure.

No group has been more vocal about the need to act than the current generation of school students. Their future is at stake and the importance of physics has never been greater.

So in the lead up to the United Nations Climate Change Conference - COP26 – which will take place in Glasgow in November, this issue of Classroom Physics focuses on the physics of sustainability.

On page 5 we introduce our latest podcast series, *Looking glass: a green future* which discusses the seismic changes we need to make to ensure a green and sustainable future for our planet. On page 6 we look at some unexpected career paths in sustainability involving physics and then we meet a cosmologist turned sustainable food campaigner on page 7.

The central physics pull-out suggests a range of activities using an infrared thermometer to help students understand heating effects in their environment, with a suggestion for a whole-school activity to enable students to reduce the carbon footprint of their institution. Throughout this issue there are links to resources for teachers to support the sustainability agenda.

We hope you enjoy this edition and find reasons to be optimistic that together we can help our students towards a greener future.

Caroline Davis
Classroom Physics editor

Editor
Caroline Davis
caroline.davis@iop.org

Physics pull-out
Taj Bhutta
taj.bhutta@iop.org

Cover Illustration
Scriberia

With this issue...

The Institute of Physics' manifesto for change
We need your support! Share the manifesto with your colleagues – it isn't just about physics. (See page 4 for more details)

Follow the IOP Education Department on Twitter **@IOPTeaching**

Read Classroom Physics online and access previous editions at **spark.iop.org/classroom-physics**

Changes to the way we support teachers, schools and colleges

As the IOP starts to implement an ambitious new strategy, *Unlocking the future*, we are changing how we work in partnership with other organisations.

In line with our move away from direct delivery towards partnership working, the Stimulating Physics Network (SPN) and our work to promote inclusion will be moving to other organisations.

We have led SPN on behalf of the English government since 2009, supporting schools to grow the number of pupils progressing to A-level physics. Although we will retain oversight of SPN, STEM Learning will take up responsibility for providing sustained mentoring, coaching and CPD for 50 lead schools and 350 partner schools between September 2021 and March 2022. Engagement in the network will focus on improving physics teaching knowledge – including substance and pedagogy – to grow A-level physics take-up. The network will run alongside support delivered through the existing network of Science Learning Partnerships and at the National STEM Learning Centre in York.

Louis Barson, Director of Science, Innovation and Skills at the IOP, expressed his gratitude to the IOP coaches, many of whom will now be employed by STEM learning. He applauded those who led the CPD whilst continuing to teach and acknowledged the dedication of teachers who have given their own time to develop their physics pedagogical content knowledge.

Credit: IOP

SPN summer schools have worked with many teachers - and the occasional Gruffalo - over the years

He said: "Our extended team and many friends in schools and teacher-support have done an amazing job. The SPN project has had a huge impact since we established it in 2009 – resulting in both a significant increase in the numbers of young people choosing physics A-level and in girls choosing physics. We've achieved this through increasing the confidence of many thousands of out-of-field teachers and supporting a culture of physics in science departments. We're delighted that this will continue, and that STEM Learning will be delivering this important work. This marks a significant step towards our new model of partnership working, which we believe will enable quicker progress towards our aspirations, and support better, more inclusive physics teaching across the UK and Ireland."

SPN will continue to complement the IOP's Physics programme, which focuses on the environment of the physical sciences, from nurturing skills for the future and retaining our physicists to supporting a vibrant physics industry. It will also complement our Limit Less campaign, which addresses the societal as well as education barriers that lead to underrepresentation (see page 4 for more details).

IOP has also awarded a contract to the Association for Science Education (ASE) to run the government-funded Inclusion in Schools project. The primary purpose of this project is to significantly increase the number of students from under-represented groups progressing to physics-based routes (A-level physics, vocational or technical) post the age of 16. It will do so by adopting an approach which involves targeted interventions to address barriers to inclusion at a whole-school level.

more...

Find out more about our support for teaching physics at **iop.org/education**

Support our manifesto for change

The IOP has launched a new manifesto for change across the UK and Ireland, outlining how we want schools and nurseries to be more inclusive and encourage more young people to choose to study physics - and we need you and your school to show your support.

We need to show policymakers the appetite for change in the education community. We believe there needs to be a transformation in our nurseries and schools. Our governments and senior leaders in schools must take the lead to make this change happen. So we have developed a manifesto for change, included with this issue of *Classroom Physics*. It calls for ten areas of improvement that can help make physics, and nurseries and schools in general, more inclusive.

We are calling on teachers, schools, colleges and nurseries to pledge their support by adding their names to our call to our leaders to make the Limit Less manifesto a reality.

Stereotypes and limited expectations hold young people back, not only in physics but across all subjects, and misconceived ideas about physics create even more barriers.

Our Limit Less campaign is looking to challenge this, and ensure all young people have the same opportunities to change the world.

Teachers are one of the main influencers of young people and we know that your work is crucial to encourage more young people from underrepresented groups to study physics in school and consider a career using physics.

The Limit Less campaign has already run a series of careers events, collaborated with YouTube Learning and started conversations with parliamentarians about this manifesto. Your voice will help us challenge the government to make this Limit Less dream a reality.

more...

Please add your name to the manifesto for change and send this link to your headteacher, or relevant member of SLT, so that they can also sign your school up in support of the manifesto: **campaign.iop.org/manifesto**

New edition of *Teaching Secondary Physics*

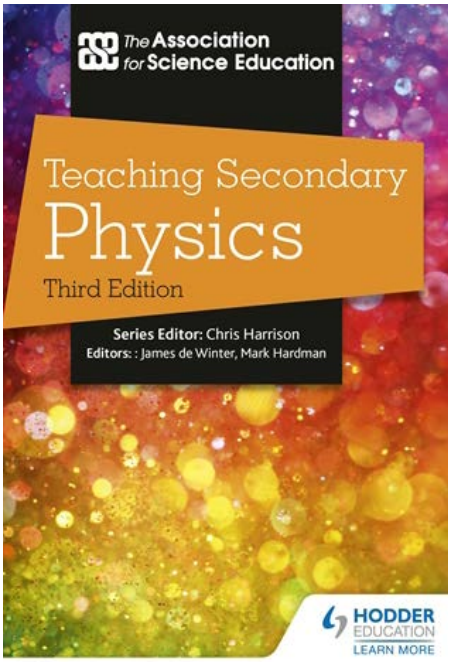
The Association for Science Education has recently published the third edition of the *Teaching Secondary Physics* guide.

A staple of many science teacher training courses, the text is aimed at those teaching up to age 16 and is described by the ASE as “the trusted teachers’ guide for NQTs, non-specialists and experienced teachers”. Chapters cover a broad range of areas and include some thoughts on energy that are the culmination of many years discussion and refinement.

The IOP education team has been heavily involved including Rachel Hartley (Professional Practice Lead), Stuart Farmer (Education Manager for Scotland) and Charles Tracy (Head of Education). The edition was co-edited by James de Winter (ITE tutor and physics education research contributor to *Classroom Physics*) and also includes contributions from Carol Davenport (Director of NUSTEM and former IOP Vice-President for Education), Tom Norris (former IOP coach) and *Stories from Physics* author Richard Brock.

more...

Buy online at the ASE bookshop
millgatehouse.co.uk



A Green Future: the IOP podcast returns

Our Looking Glass podcast is back for a second series, focusing on the climate crisis and how our global economy must evolve to address it. Through thematic episodes, *Looking Glass: A Green Future* looks at the part physics has to play and how it can help to power a new green economy.

Host Gemma Milne speaks with leading experts from across the political, scientific and social spectrum to discuss the seismic changes we need to make to ensure a green and sustainable future for our planet.

In the first episode, *We're not all there is,* Gemma discusses the issues that are likely to face future generations, with guests Sophie Howe, the Future Generations Commissioner for Wales, and Dr Suchitra Sebastian, matter physicist at the Cavendish Laboratory, University of Cambridge.

Rachel Youngman, IOP Deputy Chief Executive and series commissioner said, "This year at COP26 the world will look to its leaders to accelerate actions towards reducing carbon emissions. The threat of the climate crisis is real and present. But there are opportunities to build new industries, look to new sources of growth, and in a way that recognises the value of the natural world. Listening to experts from different backgrounds helped me to reflect on some complex questions that we have to ask of ourselves, as well as global leaders."

more...

Looking Glass: A Green Future is available through all major podcast apps and at **iop.org/lookingglass**. It is aimed at adults with an interest in science and is suitable for older school students including those beyond the science department with an interest in climate change.

Our second podcast series discusses the climate crisis and looks at the part physics has to play in powering a new green economy

Welsh projects continue

The Wales team has been awarded funding from the Welsh Government to continue its successful Stimulating Physics Network (SPN) and Whole School Inclusion projects through to March 2022.

The SPN supports teachers of physics to improve their subject-specific knowledge for teaching, particularly those working outside of their own subject discipline, newly qualified and early career teachers.

We are currently recruiting teachers for our Whole School Inclusion project (WSI). WSI helps schools to tackle the barriers faced by young people that lead to underrepresentation in physics, whether by gender, socio economic background or ethnicity. A course of free CPD will assist teachers to identify their school's individual needs, and to help them develop a programme of interventions that can be delivered internally to staff, students and the local community. The project will commence in September, so please contact us if you are interested in hearing more.

Freya (8) and Tegwen (7) are physicist/engineers of the future whose parents came along to the North Wales Physics Teacher conference bridge building workshop.

The North Wales Physics Teachers' Conference was held online in July, including a range of digital CPD and networking sessions. Gareth Jones, a Trustee of the Thomas Telford Heritage Centre in Anglesey also led an informative walking tour around the Menai Suspension and Britannia Bridges, with a bridge building workshop to close.

more...

If you are interested in participating in our Welsh education projects or would like support in any way, please email **education-wales@iop.org**

Surprisingly green physics careers

From astronomers to quantum scientists, physicists of every kind have a big role to play in building a better, more sustainable world.

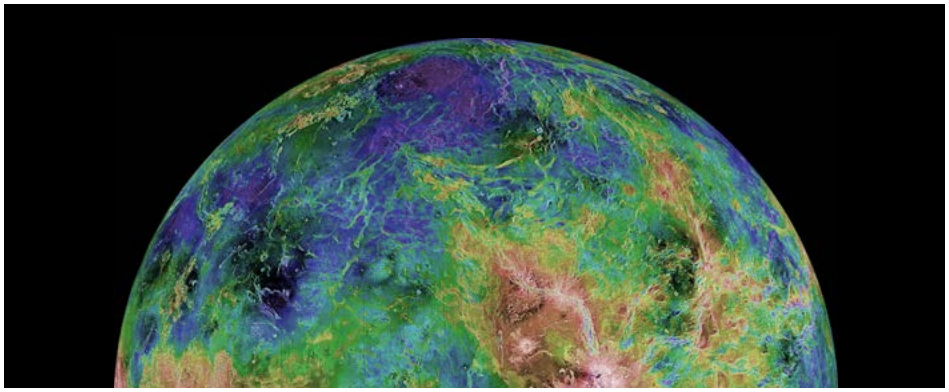
Physicists are renowned for being driven by the desire to unravel the mysteries of how the world and universe work. Less well known is that they are crucial to solving the greatest challenge facing society: how to improve the lives of everyone, everywhere while also protecting the planet. If your students have a knack for physics and a passion for our planet, honing their skills might be key to ensuring a more sustainable world.

There are plenty of careers out there where students will be able to apply physical principles to environmental and sustainability problems. Some are obvious, like geophysicists who study the inner workings of the Earth to discover energy resource supplies or estimate the risk of natural disasters. Environmental physicists are also in demand, building atmospheric models to track climate change and pollution, or developing clean energy technology.

But there are other physics roles where the link to sustainability may be less obvious. And even more exciting are sustainability-focused physics jobs that don't even exist yet.

Sustainability Physics for Schools

This website, for both teachers and students, has eight themes including batteries for future energy storage and nanotechnology. It showcases a range of inspirational careers for students to aim for as well as valuable jobs in the field of sustainability via interviews with engineers, scientists and researchers explaining the applications of their work. Plus ideas for schemes of work, data analysis activities and self-assessed homework for students. These link to current research at Lancaster and other universities. **wp.lancs.ac.uk/sustainability-physics**



Credit: NASA/JPL/USGS

What can understanding the surface of Venus tell us about the fate of our planet?

Share these careers ideas and videos with your students

Quantum coders

Quantum computers use the properties of quantum physics to store data and perform computations that would take a normal supercomputer the lifetime of the universe to solve. So far, no one has built a useful quantum computer. But the likes of Microsoft, Google and IBM think a breakthrough is just around the corner and are already plotting how quantum computing could be applied to climate change and environmental sustainability. Someone working in this area could code algorithms that set a quantum computer on the path to discovering new materials for energy production and storage. They could task the quantum computer with solving global societal issues, modelling and optimising how we should use the world's land and water to minimise the impact on our planet while still comfortably feeding and housing society.
bit.ly/CPquantumphys (Microsoft)

Planetary scientists

Planetary scientists study every type of moon and planet, both in the Solar System and beyond. What has that got to do with sustainability? As it turns out, quite a lot. 'Earth's twin' Venus is so hostile probes can't even survive on the surface for more than minutes. But researchers studying Venus have discovered that in the planet's early life it was habitable. Venus was home to liquid-water oceans and boasted temperatures similar to today's Earth. At some point, something triggered a catastrophic greenhouse effect. Using measurements of the atmosphere and geology to model how the planet evolved over time, some planetary scientists aim to discover why this happened – to help us avoid a similar fate here on Earth.
bit.ly/CPplanetary (NASA)

Condensed matter physicists

More potentially green physics roles can be found in condensed matter physics. Studying the condensed states of matter (liquids and solids), people in this field are investigating and developing electronic materials to build, for example, more efficient photovoltaic cells for solar power or thermoelectric materials that can convert waste heat into clean energy.
bit.ly/CPcondensed (University of Oxford)

Geophysicist

bit.ly/CPgeophysicist
(British Geological Survey)

Environmental physicist

bit.ly/CPenviroscience
(Natural Environment Research Council)

Solar energy researcher

bit.ly/CPsolarenergy (IOP)

Energy efficient architect

bit.ly/CPefficient (IOP)

TOMORROW'S ENGINEERS

Tomorrow's Engineers Week

8 - 12 November
Taking inspiration from COP26, #TEWeek21 will look at how engineers and engineering can contribute to tackling climate change and achieving net zero.
tomorrowsengineers.org.uk/tomorrow-s-engineers-week/

Credit: Sarah Bridle

Professor Sarah Bridle is a transdisciplinary researcher driven by the need to tackle climate change

Meet the cosmologist turned food scientist

Sarah Bridle is Professor of Astrophysics at the University of Manchester, working at Jodrell Bank. But she is also driven by the need to tackle climate change. Her recent work has focused on a quantitative approach to helping transform food systems.

"I'm trying to help reduce the impact of food on climate change by understanding the possible changes we can make, from how food is produced to the choices we make about what to eat. The current food system has the potential to help reduce climate change, but we need to make big changes, fast. I'm passionate about helping people make more informed choices. In practice I do this by doing calculations to understand and make new numbers, writing documents and giving public talks and researching how we can influence people to help transform the food system.

"At first I used my image analysis expertise, using the same pieces of computer code I'd used to analyse galaxies viewed through telescopes to look at fields of crops observed by satellites. But I realised that this type of work could only make so much difference and the choices we make about what to eat are far more significant. I'm still crunching numbers using my data science and computing background but a lot of what I was doing in cosmology was about working well with people, coordinating teams and communicating with the public and others - and those skills are directly transferable.

"The most important research challenges of the coming century are heavily multi-disciplinary - meaning that people with a physics background are going to be welcomed with open arms. These range from understanding the interaction between soil and fertilizers and the greenhouse gas nitrous oxide, to technology monitoring chickens or cows to make sure they are in optimal health, or technology to evaluate food freshness and quality. I'm particularly proud of having set up the STFC Food Network+ which specialises in helping people from astronomy, particle and nuclear physics backgrounds address food challenges.

"I couldn't have written my book (see below) if I didn't have a physics background: I was trained to simplify complicated problems to their barest essentials, and that was absolutely necessary when trying to work out the most important contributions of each part of the complex food system to climate change. I've met several former astrophysicists who are now leaders in food and the environment, so there must be something good about our training!"

more...

sarahbridle.net

The Science & Technology Facilities Council (STFC) food network is at **stfcfoodnetwork.org/blog**

IOP book recommendation

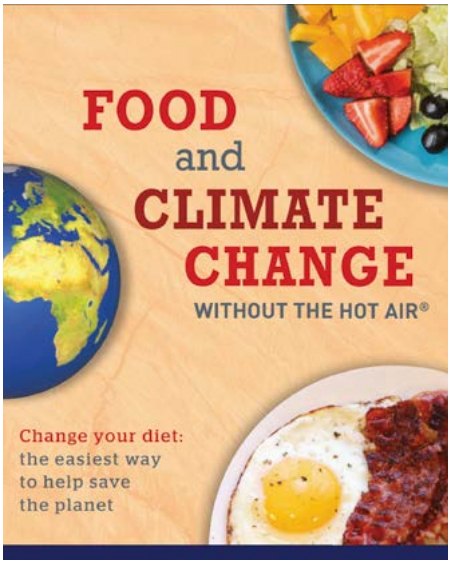
Food and Climate Change without the Hot Air by Sarah Bridle

Reviewed by David Cotton, IOP coach and TalkPhysics editor

I came across this book when Sarah spoke at an IOP event for teachers last summer. She was inspired by Sir David MacKay's work and his book, *Sustainable Energy - Without the Hot Air* and decided she needed to do something positive to help halt the increasing temperature of the planet for future generations, including her own children. Working with other scientists, including food psychologists and nutritionists, she used her skills of statistical analysis originally honed in the field of cosmology to analyse the data for food production, transportation and waste.

The book includes the science of greenhouse gases and how they are emitted during food production and transportation around the globe. It also lays out the climate costs of our food choices. It is very easy to read with lots of notes for further clarification and facts and figures of great use to science teachers in the classroom. Key points and clear diagrams also make the book easy to use for quick reference.

This is a book for classrooms and kitchens. Eating food is something we all need to do and this book shows us simply how we can all make an individual contribution to tackle climate change, offering a comprehensive guide to the factors from production to plate and the disposal of waste. Sarah turns a complicated topic into an easy to digest, educational and fun book for all. For me, I have reduced the amount of meat I eat and I also think more about the transportation of food. I would say this book is great for anyone from 11 years upwards.



Physics education research

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

Get involved with physics education research discussions by joining the **Physics Education Research** group on Talk Physics at **talkphysics.org/groups/physics-education-research-per** or email **research@teachphysics.co.uk.**

Climate change and supporting students' understanding of models

Credit: Svigacheva Elena / Shutterstock

Some students may take greenhouse modelling too literally

Given the urgency of the crisis, supporting students' understanding of the physics of climate change is a significant aspect of physics teachers' work. Concerns about climate change arise partly from models that predict how global temperatures will change in the future. A useful teaching approach is giving students simple climate models (for example, in Microsoft Excel) to predict climatic change under different conditions (see the resources below).

Teaching about climate modelling can be challenging because of students' preconceptions about scientific models. The use of the term 'model' may lead students to believe that scientific understanding of climate change is especially tentative and open to denial. Moreover, students can find it challenging to appreciate the interaction of multiple causal factors in climate models and take analogies (such as 'trapping of heat') too literally.

Tasquier and colleagues proposed a five-lesson teaching sequence to overcome such difficulties which included:

a) explicit teaching about the nature of scientific models and complex causality

b) the evidence scientists have for climate change

c) physical models of climate change including

i) an introduction to thermal equilibrium through heating metal cylinders

ii) the construction of model greenhouses

d) a consideration of social and political consequences of climate change.

The lesson sequence was delivered to a class of 16-year-old Italian secondary school students (N=28). Three questionnaires (pre-, during and post-intervention) were given to investigate students' understanding of modelling. The pre-test data reported students' naïve views of scientific models, for example one student wrote: "For me, a model in physics is a scale model representing something, like in the case of DNA."

The authors concluded that the intervention, with its inclusion of explicit teaching about the nature of scientific models, caused a significant shift in the language students used to talk about modelling and led to the development of a more nuanced appreciation of scientific models. The study highlights that teaching the physics of climate change involves more than supporting students' appreciation of underlying physical processes, but also requires developing their appreciation of the nature of scientific models.

more...

Request the paper *Exploring students' epistemological knowledge of models and modelling in science: results from a teaching/learning experience on climate change* by Tasquier, Levrini and Dillon at **bit.ly/CPtasquier**

The Perimeter Institute has great resources for teaching about evidence for climate change at **resources.perimeterinstitute.ca/products/evidence-for-climate-change**

The Royal Meteorological Society has a good modelling exercise in the **Climate Models** section at **metlink.org/resource/useful-links**

Pull out and keep!

Sustainable physics

Inside this pull-out:

- **Activity 1:** Down to Earth: temperatures in our built environment
- **Activity 2:** Blue sky thinking: thermal radiation and the greenhouse effect
- **Whole school activity:** Set up a student CO_2 sustainability team

With thanks to Melissa Lord and David Cotton for their contributions to this pull-out

Bringing sustainability into the physics classroom

The UK is undergoing a rapid change in infrastructure. Vehicle and building design have an increasing focus on sustainability. Many students are rightly concerned about climate change, and learning physics in this context can bring relevance and provide an evidence basis for wider learning and discussion.

Addressing the climate crisis will involve every field of human endeavour and necessitates a very diverse range of skills. Physics will be fundamental: we'll need people with increased physics knowledge but everybody will need higher levels of physics literacy.

A read through *Physics World, New Scientist, Ingenia* or any recent engineering magazine reveals the plethora of ways physics is fighting or mitigating climate change. Bringing climate relevance to your class will help show students why physics matters for their future, from reducing their personal carbon footprint to the very positive steps that are being taken in research. This is an area where the fields of employment are likely to increase rapidly and understanding of physics concepts will be invaluable.

Trees can act as air conditioners and are increasingly used by planners to reduce urban microclimates

This pull-out contains two activities you can carry out with infrared thermometers to explore heating in the environment. These devices have become common during the pandemic and many schools will have bought batches of them that you might be able to access - your students might even have one at home.

We also share an activity which could become whole-school, based on a case study in Manchester. We'd love to hear if you decide to implement it in your school!

more...

Visit the **Sustainability Physics for Schools** website for resources on the importance of physics to a sustainable future and how using physics can be key to the careers in a low-carbon economy **wp.lancs.ac.uk/sustainability-physics**

Find out more about sustainable building design – and in particular the IOP's recently completed new headquarters – at **iop.org/explore-physics/sustainable-building-design**

Classroom starters

Use these ideas to help students link physics with sustainability: identify the relevant physics concepts and get them doing energy calculations.

Natural air-conditioners

A large oak tree loses about 400 litres of water per day from its leaves to the air. For this water to evaporate, energy is required. This comes from the surroundings, so their temperature drops. What are the benefits of planting trees especially in urban areas where temperatures are increased.

Domestic physics

The average washing load contains about 1 kg of water when it has been spun in a dryer. We overfill our kettles when boiling them, take baths or long showers and leave fridge doors open too long. What are the energy savings from changing our behaviour?

The physics of icecaps

Why does ice float and what proportion of it is below the surface? How does the water level change as floating ice melts and why does meltwater sink? Go cross-curricular and link to the importance to the survival of life under frozen water surfaces.

Activity 1

Down to Earth: temperatures in our built environment

In this activity, students use an infrared thermometer to explore the temperature of objects in their environment and think about the use of insulation.

Credit: Melissa Lord

These images show garden surfaces on a hot July day in Manchester – the coolness of the grass being a function of both its colour (or albedo - the ability to reflect incoming light) and the transpiration (so evaporative cooling) occurring from it.

Equipment

Each group of students will need:

- Infrared thermometer (IRT) **[NB disable any lasers for eye safety]**
- Pen and paper to record results

Procedure

1. Introduce/review the concept of thermal radiation. Remind students that most objects they see in their day to day life are reflecting light from the Sun or an artificial source. This light lies in the visible part of the electromagnetic spectrum. All objects also emit (thermal) radiation because the atoms inside them are wiggling. Hot objects such as the Sun also glow visibly, while those that are cooler, like people or the Earth's surface, emit only the invisible waves in the infrared part of the electromagnetic spectrum (right, Melissa's cat Boris glows with infrared radiation).

2. Ask students to point the infrared thermometers at objects in the classroom. They could also measure the temperature of their hands or foreheads.

3. Once the students are familiar with the controls, take them outside. If it is a warm sunny day, ask them to point the infrared thermometers at objects on the ground, comparing those in direct sunlight to those in the shade, comparing the temperatures of surfaces of different colours and textures. Which surface colour is coolest? How does vegetation compare with concrete? They could consider how to better adapt their surroundings to cope with the future extremes of heat we experience in UK summers.

4. If it is a cool dull day (so that the surfaces are not directly affected by sunshine) they could investigate – what is warmest, walls, windows or doors? The less well insulated a warm building is, the more radiation it is letting out and the warmer the outside of the building will be. Are older buildings less well insulated than newer ones? Where would you recommend the school to invest in insulation?

Teachers' notes

Explain that when designing, building, retrofitting and installing the places where we will spend our time, we will need to minimise environmental impact as a part of tackling changing climate. After completing the activity, students can carry out open-ended investigations into how we can design our urban environments to be cooler.

Credit: HBarrison / wikipedia

Manchester and Santorini: how wise is it to have black infrastructure as seen in the new roofs? The answers may be different depending on where in the world people live.

New: quick demonstrations & activities

A collection of over 30 activities which are all easy to set up, require minimal kit and take less than 20 minutes to run. They have been created to support purposeful, frequent and varied practical science in schools.

spark.iop.org/quick

Activity 2

Blue sky thinking: thermal radiation and the greenhouse effect

In this activity, students use an infrared thermometer to explore temperatures in the sky. It is a good way to introduce students to the physics of the greenhouse effect and requires taking the students outside for five minutes on a bright clear day.

Credit: IOP

Figure 1: Measuring the temperature of the sky with an infrared thermometer

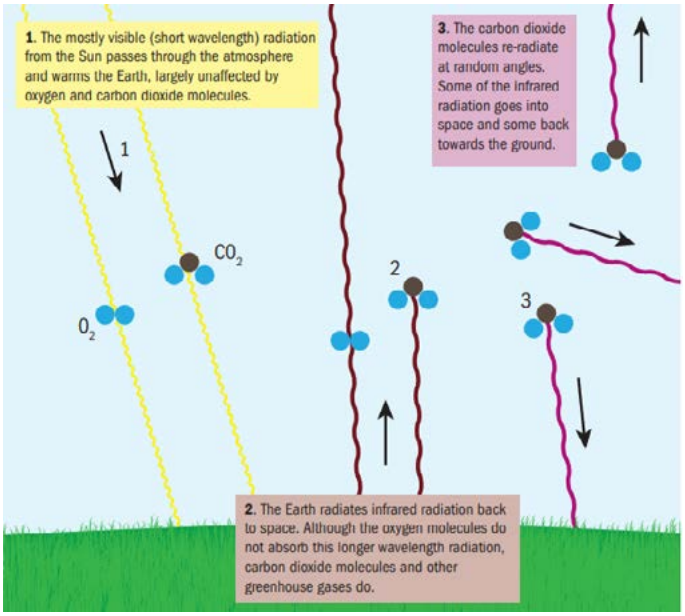


Figure 2: The physics of the greenhouse effect.

Equipment

Each group of students will need:

- Infrared thermometer (IRT) **[NB disable any lasers for eye safety]**
- Pen and paper to record results

Procedure

1. Introduce/review the concept of thermal radiation. Remind students that hot objects (such as the Sun) glow visibly, while cooler objects (such as the Earth) emit mainly in the infrared part of the electromagnetic spectrum.

2. Ask students to point the infrared thermometers at objects in the classroom. They could also measure the temperature of their hands or foreheads. For small objects, the infrared thermometer needs to be close to the object in order to get an accurate reading – this is best done at a few centimetres distance.

3. Once the students are familiar with the controls, take them outside and ask them to point the infrared thermometers at objects on the ground (in the shade) to find the temperature at ground level.

4. Next, ask them to point the thermometer at a patch of clear blue sky and record the temperature, being careful to avoid pointing the thermometer at the Sun (see figure 1).

5. Return to the classroom and discuss the results.

Teachers' notes

Ask the students what they think they measured when pointing the thermometer at the sky. Some will respond with "the temperature of the ozone layer", others may give the answer "the temperature of space". Point out that space is much colder (–270°C) and that, although the ozone layer is a sensible answer, it is too high up to have a major impact on the temperature measured.

Discuss the composition of the atmosphere and explain that what they are actually measuring is infrared radiation emitted by, and hence the temperature of, greenhouse gases (see figure 2).

With thanks to Sylvia Knight, Royal Meteorological Society, for permission to adapt one of their activities.

more...

View more IR experiments including calculating the temperature of clouds at **metlink.org/experiment/experiments-with-an-infrared-thermometer**

Whole school activity

Students can help your school become more sustainable with a little help from Fermi

Parrs Wood High School in Manchester is a large diverse 11 to 18 state school. Follow its example by setting up a Student CO_2 Sustainability Team.

Credit: Parrs Wood High School

The Student CO_2 Sustainability Team at Parrs Wood High School, Manchester

Physics teacher Chris Baker manages a group of sixth formers with a passion for sustainability. Over the past nine years, they have worked tirelessly to cut annual carbon emissions, saving the school 630 tCO_2eq (equivalent tonnes of carbon dioxide) and around £135,000 per annum. They have successfully bid for around £670,000 of external energy efficiency funding and their projects have included energy saving, recycling and carbon offsetting.

Chris explained, "We've found that given the opportunity and support, students are keen to move beyond protesting and awareness raising to actual problem solving. This work has excellent links with parts of the GCSE physics and science syllabuses but also involves a whole range of other areas such as the psychology of behaviour change, literacy and clear messaging, numeracy, lifestyle choices and the creative arts to explain and promote operational change.

"Importantly, it gets across to students that education is not about learning all the 'right' answers by the time they leave school, but rather developing a lifelong ability to ask relevant questions when faced with problems - something which many students are afraid to do for fear of appearing 'ignorant'. It's a key life skill which universities and apprenticeships look for. Additionally, as a result of this work an increasing number of our students have chosen related degrees and careers."

more...

Chris is happy to be contacted via
c.baker@parrswood.manchester.sch.uk

Articles about the project
bit.ly/ParrsWood1 **bit.ly/ParrsWood2** **bit.ly/ParrsWood3**

Apply for government funding for your school to improve energy efficiency, reduce carbon emissions and lower energy bills via Salix
salixfinance.co.uk

Parrs Wood's tips for success

Published materials can be a good starting point but looking specifically at inefficiency and waste in your own school, as opposed to relying on generic sustainability materials, creates a sense of agency.

Students should quantify everything before and after any changes to ensure they've had the desired, or indeed any, effect. For example, evidence shows that in large, shared spaces, putting up signs up saying "please turn off the lights" alone doesn't work. Instead, assess energy use before and after a room is used - apply for funding to install occupation sensors if necessary. This is equally important for new schools as there is strong evidence that they frequently have poor operational (DEC) energy ratings owing to the occupants' inability to understand complex and confusing controls.

Nobel Prize winner Enrico Fermi challenged his students to use estimation, common sense and numerical reasoning to work out quantities that were difficult or impossible to measure, emphasising the process rather than the answer. This approach makes the work more engaging and of far greater education value. Your students could tackle questions such as:

- How many sheets of paper could we save a year?
- How much electricity could we generate from renewable sources on site?
- How much water could we save in a year?
- How much money would we save if we upgraded all the lights to LED?

For example, to answer the last question, the first thing we need to know is how many lights there are in the school. On a small site it's easy to count. In larger schools with multiple buildings and hundreds of rooms, the answer can be found in a number of ways including basic estimation, calculating typical lighting densities for classrooms and examining site plans. Each have pros and cons, but this allows students to develop different skills, and to compare results and evaluate the methods.

Calculating payback time and annual savings in tCO_2eq naturally follow and are essential measures when applying for government funding such as Salix.

Sustainability stories

Casting a cloud over air travel

Aviation accounts for around 4% of global anthropogenic climate change. As aircraft move through the atmosphere, their jet engines release water vapour that mixes with the surrounding cold, low pressure gases to form condensation trails (contrails). Under certain conditions, contrails can expand to form ice-clouds which may persist for up to ten hours – a unique form of artificial cloud known as *cirrus homogenitus*. The clouds allow most (77%) short wavelength radiation from the Sun to pass through and reflect 33% of long wavelength radiation reflected from the Earth back to the surface. Cirrus homogenitus, therefore, cause a net radiation imbalance (10% during the day and 33% at night) contributing to global warming. Surprisingly, it is estimated that 55% of the contribution of aviation to global warming is from aircraft induced clouds and only 39% from CO_2 output (the remainder is from other greenhouse gases emitted). In addition, whilst the CO_2 emitted by aircraft may take several decades to cause changes to temperature, the effect of aircraft induced clouds is instantaneous. Several solutions to the problem have been proposed including: reducing the soot counts of kerosene jet fuel, as soot acts as a seed for ice crystal formation; planning flight paths to avoid specific areas in the atmosphere that are particularly likely to produce clouds; and (a strategy described as impractical) rearranging schedules so peak aircraft traffic occurs round sunrise and sunset, as the angle of incident sunlight at these times leads to greater reflection from the clouds into space.

In Common Air.		In Carbonic Acid Gas.	
In shade.	In sun.	In shade.	In sun.
80	90	80	90
81	94	84	100
80	99	84	110
81	100	85	120

Foote's data showing the thermal absorption of CO_2

Putting your best Foote forward

It had been widely believed that the first experimental evidence of the thermal absorption properties of greenhouse gases had been found by John Tyndall. However, recently, the prior claim of a remarkable American scientist, inventor and activist, Eunice Newton Foote, has been acknowledged. In her 1856 paper, *Circumstances affecting the heat of the Sun's rays,* Foote reports temperature readings from tubes of different gases exposed to sunlight. Referring to 'carbonic acid gas' (CO_2), Foote concluded: "An atmosphere of that gas would give to our earth a high temperature." Though not prohibited from presenting, Foote's paper was read at a meeting of the American Association for the Advancement of Science by Joseph Henry, a founder of the Smithsonian Institution, who commented: "Science was of no country and of no sex. The sphere of woman embraces not only the beautiful and the useful, but the true."

more...

spark.iop.org/stories-physics

These stories were collected by Richard Brock, lecturer at King's College London and former physics teacher.

Follow him on Twitter **@RBrockPhysics**

Physics*education*

Physics Education is our international online journal for everyone involved with the teaching of physics in schools and colleges.

Editor-in-chief Gary Williams highlights his favourite papers on **sustainability physics** from the archive and the current volume. These papers should provide support for developing a topic for your scheme of work that could include environmental issues, mathematical modelling and hands-on experiments.

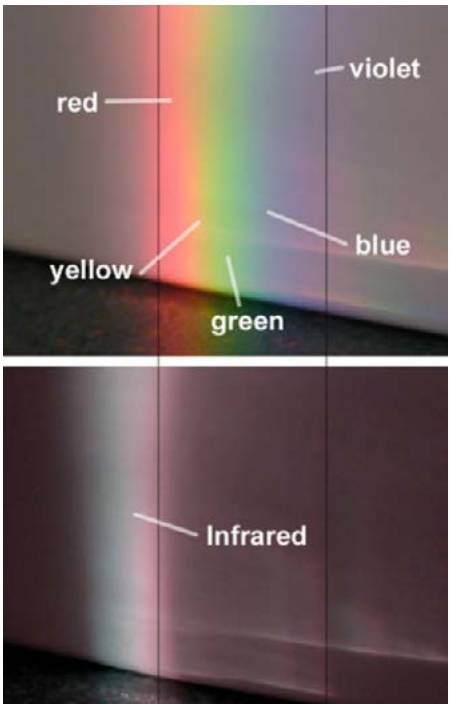
Access over 50 years of articles at **iopscience.org/physed**

Affiliated schools have free access – email **affiliation@iop.org** for a reminder of your log in details.

Exploring the greenhouse effect through physics-oriented activities

This 2003 paper by Kerry P Browne and Priscilla W Laws describes the work done in building a topic-based module for teaching older students (16+), and how it was received – particularly the description of problems that were encountered. One example is the idea of dynamic equilibrium. That appears not to have been introduced to students but was deemed to be necessary to students' understanding of the issues. Presumably students were unable to arrive at an understanding of the concept in the context of the experiment described. This is quite a common finding in the broader literature – students do not generally learn a specific outcome unless it is specifically taught. This has quite important ramifications for physics teaching when it comes to the students' need to use maths. Have they been taught it, or are you hoping they will pick it up as they go? Another issue that is mentioned but should now cause fewer problems is the range of CO_2 sensors available – this could be used as a discussion point with students about the characteristics of sensors generally.

Read the paper at **bit.ly/PEDgreenhouse**



Credit: Physics Education

Images of a rainbow generated by a prism. The top image was taken without a filter, while the bottom image is taken with a Hoya R72 infrared pass filter that screens out almost all of the visible while passing the near infrared.

A few ideas for teaching environmental physics

Going back a few decades, "global warming" was a much simpler issue. It was clear that humans needed to reduce the greenhouse gases they were releasing into the atmosphere, and the way to do that was to stop burning fossil fuels. Nowadays, issues connected to climate change are far more complicated. In future we will surely have to spend more time and effort considering the environmental impact of activities we want to pursue. This 2016 paper by Kyle Forinash is for anyone teaching environmental issues. It covers a huge amount of background material ranging from efficiency to energy density and transportation to the economy. The paper is easy to understand and could be given straight to older students. The references are plentiful and provide links to many data sources that are publicly accessible and which students can delve into. The links between the physics, the climate and the way we live are clearly laid out, and it is not all doom and gloom; the author points out several environmental issues that have been successfully dealt with. An easy read and eye-opening at the same time.

Read the paper at **bit.ly/PEDforinash**

Climate change made simple

As if to illustrate the point about simplicity, in 2007 Dudley Shallcross and Tim Harrison published this paper which describes a 'One Layer Atmosphere Model of the Earth' and goes through the thinking about some of the parameters to include and how they fit into the model. The model is then tested against reality. Of course, it does not perform that well, but in the process of constructing it, students will have looked at black body radiation, the electromagnetic spectrum, modelling and weather patterns. This activity is a great way to set the scene for introducing a model that uses more layers and gives more accurate predictions.

Read the paper at **bit.ly/PEDwafer**

Quick Links

An analogical simulation for teaching electric circuits: a rationale for use in lower secondary school

bit.ly/PEDelectricsim (open access)

How can GeoGebra support physics education in upper-secondary school—a review

bit.ly/PEDgeogebra (open access)

Magnetic levitation: a physical tool to measure the density of unknown diamagnetic materials

bit.ly/PEDmaglev

What's inside the pink box? A nature of science activity for teachers and students

bit.ly/PEDpinkbox

Estimating star distances with a light bulb

bit.ly/PEDstardist

Binary-star eclipse simulated with PC drawing package

bit.ly/PEDbinarystar

Measuring the electrical power of solar panels

There is something about little houses that always seems exciting to students. I have seen them made out of a variety of materials, but mostly card, and double glazed with cling-film, heated with resistors or film canisters full of water or sand, and even cavity insulated. This paper describes three experiments that use a small wooden house and a solar cell. The inside of the house is occupied with an Arduino which processes the signal and the phyphox app is used to display the data. The experiments are really for older students but simpler versions could easily be constructed taking advantage of the little house effect. There is clearly the opportunity here to feed the experiments into a climate change topic.

Read the paper at **bit.ly/PEDsolarhouse**

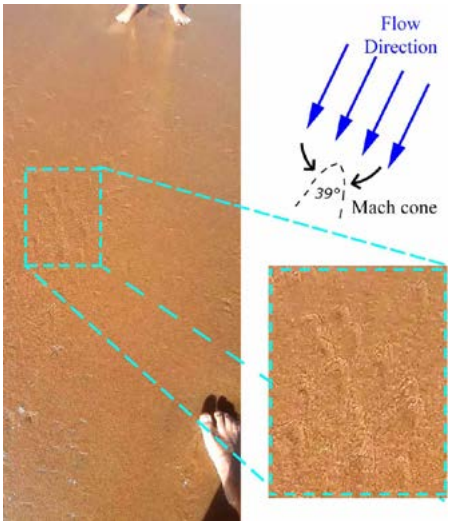
Credit: Physics Education

An experiment to explore the angular dependence of a solar cell's power output.

Evaluating shallow water waves on the beach

When school trips visit the seaside you may struggle to think of physics experiments that can be done safely. In this paper, Felipe Veloso describes a fairly full treatment of the little fan shapes you see when the water on the beach passes either side of an object, like a pebble or shell, known as *Mach cones*. A video camera, like that on a phone, is needed to start getting quantitative data from what is seen, but younger students could easily be tasked with simpler targets like finding cones with different angles. It is a very pleasing read to see how a simple observation can be used to determine so much and could make an enjoyable trip even more satisfying.

Read the paper at **bit.ly/PEDmachcones**



Credit: Physics Education

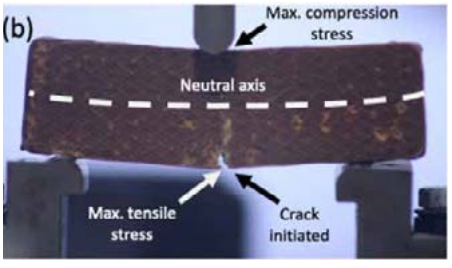
Mach cones observed on a beach

Bending bad—testing caramel wafer bars (#TestATunnocks)

Other snacks are available but this paper looks at one specifically. Although the testing is thorough by engineering standards when performed with the appropriate apparatus, this paper describes how similar testing can be done with the hands and by concentrating on what the tester feels happening. By testing the bars at different temperatures, conclusions can be drawn about changes to the rigidity of the "beam" and by testing in different orientations the impact of the layering of materials can be investigated. Students could easily try out the tests at home, using the snack bar of their choice. The authors don't mention how many caramel wafer bars were consumed in their quest for knowledge, but the paper has a surprising number of authors and the acknowledgements note that the test pieces were provided by the manufacturer.

Food science is popular with students. Search the archives of *Physics Education* for papers on pizza, baked alaska and toffee bridges amongst others.

Read the paper at **bit.ly/PEDwafer**



The bending of the material, showing the locations of the maximum stresses, neutral axis through the centre of zero stress

talkphysics

David Cotton, editor of our online discussion forum, chooses his favourite TalkPhysics discussion threads on **sustainability physics.**

Log in or register to join the conversation at **talkphysics.org**

Climate change slides

During the pandemic, the IOP regional days carried on in remote form and many of the resources from these have been uploaded on TalkPhysics.

Stuart Farmer, IOP education manager for Scotland presented a workshop about climate change in July 2020 – you can access his slides and resource links from his session at **bit.ly/TPclimatechange**

IOP coach Kerry Colyer has shared resources and slides from her *Physics of the weather* session in July 2021 at **bit.ly/TPphysicsweather**

Sustainability: making physics really relevant today
Melissa Lord, co-creator of the *Sustainability Physics* website put a call out for linking physics topics at GCSE with sustainability. You can catch up on ideas for how physics and sustainability can be linked in the classroom here – and feel free to add your own!
bit.ly/TPsustainability

Demonstration of greenhouse effect of CO_2
Loren was attempting to set up apparatus to demonstrate the greenhouse effect but had drawn a blank looking online. This led to a discussion about what might be possible in the classroom, plus links for a video demonstration.
bit.ly/TPgreenhouse

Climate change group
This discussion group was set up over 10 years ago. It has been quiet for several years but is likely to get active in the run up to COP26. There are lots of good links and resources which are still relevant and well worth a browse.
bit.ly/TPclimatediscussion

physicsworld

Stories from our magazine for the global physics community. Visit **physicsworld.com**

Credit: istock/Greyfebruary

Solving the Proton Puzzle

Measuring something as small as the radius of a proton is a challenging task. Many experiments have used spectroscopy measurements, detecting the precise wavelength of light emitted by an electronic transition. Until 2010, these experiments agreed within their error bars, resulting in a value of around 0.88×10^{-15} m. Then Randolf Pohl performed a new spectroscopy experiment using a hydrogen atom in which the electron was replaced with its heavier cousin, the muon. The extra mass meant that the resulting transitions produced more precise results and a more precise calculation of the proton radius. This sparked a divide amongst nuclear physicists as Pohl's results indicated a proton radius 4% smaller, and outside the range of error, than the official value. In this article, Edwin Cartlidge explores both the science and politics of the Proton Puzzle, reporting on theoretical results, ignored data and how these decisions get made.

Full feature: **physicsworld.com/a/solving-the-proton-puzzle**

2020: Europe's hottest year on record

Last year was the warmest on record for Europe, in part due to an exceptionally warm winter over the northeast of the continent. It was a year that saw wildfires rage in the Balkans and Eastern Europe, while Storm Alex brought record rainfall and led to above-average river discharge across much of western Europe.

James Dacey summarises key points from this year's *European State of the Climate Report* which looks at not only temperature data, but also carbon-dioxide levels and methane concentrations. The previous year's weather conditions in Europe and the Arctic are analysed in the context of global climate trends, based on data from satellites, ground stations and computer modelling. It confirms, among other things, 2020 as the warmest year, winter and autumn on record for Europe with temperatures in winter 3.4 °C above the average.

Full article: **physicsworld.com/a/2020-was-europes-hottest-year-on-record-finds-report**

EIC is the Royal Society of Chemistry's magazine for teachers. Visit edu.rsc.org/eic

Credit: hitandrun/Debut Art

Simple steps to integrate sustainability into chemistry lessons

Use these articles and dedicated resources to weave the UN's goals into science curriculum topics

Recognising that sustainability, the climate emergency and recycling aren't far from anyone's minds, and with the UN Climate change conference (COP26) taking place on our doorsteps this year, *Education in Chemistry* is creating a set of articles and resources to help you incorporate the UN's sustainable development goals into your existing teaching for students aged 14–18.

Each article puts a goal into real-world contexts that are relevant to your chemistry lessons. It also suggests how you can use existing resources from well-known and trusted sources to link the goal to key specification topics within the sciences and describes strategies for using the UN's own materials in your existing lesson plans.

Each article comes with a resource to download. These resources are classroom-ready activities that support your teaching. In fact, the articles and resources together give you everything you need; simply add them to your schemes of work.

All the articles and resources are written by classroom teachers. So you can rest assured that these ideas and approaches work.

The first articles and resources are already online. For example, the article and resource for *Goal 6: ensure availability and sustainable management of water and sanitation for all*, cover separation techniques, potable water and wastewater treatment. Read them now and check back weekly for new ones.

more...

The set of articles can be found at edu.rsc.org/eic/collections/sustainability-in-chemistry

CLEAPSS is an advisory service supporting science and technology in schools. Its advice and guidance is recognised by Ofsted and the HSE for safe practice for practical work in schools. Visit www.cleapss.org.uk

Credit: Rabbitmindphoto/Shutterstock

Bunsen burners need to change as we try to cut carbon emissions

Is the future hydrogen?

Back in the late 1960s and early 70s CLEAPSE (original name for CLEAPSS) provided a lot of support and research on the development of new Bunsen burners to cope with the UK conversion from town/coal gas to natural gas (methane). This work involved redesigning jets and the important secondary air holes at the top of the Bunsen chimney to ensure good flame stability.

This development work will soon need to start again at CLEAPSS with new exciting UK projects to test and roll out the use of hydrogen within the main gas supply systems. There are two systems under development. One is called 'HyDeploy' which uses a mixture of 80% natural gas and 20% hydrogen and is already being tested in a small village and a university setting. This will not require a change in burners but will clearly help reduce the amount of carbon dioxide being produced. The second is called 'H21' and uses 100% hydrogen. It will require new burner equipment and changes to the distribution network. However, it will be a carbon-free fuel source. A small test site is being built to test the changes that may be needed to the distribution networks and burners.

The roll out to homes and industry is projected to be within the next ten years, as the UK strives to meet its carbon reduction targets. CLEAPSS is working with various industry and regulatory bodies, and the Department for Education to carry out tests on both HyDeploy and H21 systems. We are aiming to ensure the humble Bunsen burner continues to be available in school labs for future generations of students to both enjoy and support their learning.

more...

To find out more about these pilot projects visit hydeploy.co.uk and h21.green

> **This type of subject specific CPD was not offered in my school or NQT programme. I feel it has increased my knowledge about how students learn but also focussed on some of the aspects students have difficulty with.**

> **It is a very helpful group filled with camaraderie: we shared ideas, we gained insight into each others' techniques and the way we coped with challenges.**

NEW IOP support for Early Career Physics Teachers

We invite newly qualified physics teachers and those entering their second year of teaching to register for our Early Career Professional Learning (ECPL) programme which is offered at no cost to ECTs or their schools. Participants benefit from physics-specific pedagogy led by experienced IOP mentors and from being part of a network of physics ECTs. A group of 60 physics teachers joined this programme from January 2021. They took part in group mentoring sessions, received 1:1 support or worked independently through resources which complement the early career framework. Kick-off event (online) Saturday 25 September 2021.

Read about the experiences of this first ECPL cohort and register interest in getting involved at **iop.org/ecpl** or email **ecpl@iop.org**

IOP Institute of Physics

SUSTAINABLE DEVELOPMENT GOALS

Science on Stage Europe: Social media competition

Start your school year with the Sustainable Development Goals

Sustainability is an important topic – especially for students. That's why we are looking for your ideas on how to implement the 17 Sustainable Development Goals (SDGs) in STEM lessons.

If you are a primary or secondary STEM teacher, living and working in one of Science on Stage Europe's member countries you can take part.

Upload a 90 second video on Instagram (using IGTV) and show your project and how you implement it in the classroom. Tag **Science on Stage Europe** or **@sceinceonstageeurope** in these videos, so we can share them too. The most liked video will get a small prize and the competition runs from 1 October to 1 November.

More information on this competition can be found here:

science-on-stage.eu/sdg-competition-instagram

SCIENCE ON STAGE EUROPE

Sustainability resources from the IET

Do you want to help your students make our world a greener, cleaner place to be?

The Institution of Engineering and Technology (IET) has created a suite of resources dedicated to the topic of sustainability to help enhance your teaching and bring students' learning to life.

From finding out what can be done to reduce the carbon footprint of the school community to designing a new pair of futuristic sunglasses or the car of the future, why not check out these free curriculum-linked resources and practical activities. Introduce your students to real-life innovative examples of engineering and technology from around the world.

theiet.org/sustainability-resources

IET The Institution of Engineering and Technology

Electronics Everywhere – free resources for schools

The UK Electronics Skills Foundation (UKESF) is offering state-sector schools free resources as part of their *Electronics Everywhere* project, which focuses on raising attainment among sixth formers and promoting electronics.

For each school, they provide – free of charge – a classroom set of 10 boards which are robust, reliable and re-usable. These boards provide an engaging and practical way for teachers to deliver the core electronics and electrical parts of the A-Level physics curriculum. They are also offering to train teachers via an on-line CPD course and provide supporting materials.

Find out more by contacting the UKESF via email on electronics.everywhere@ukesf.org

UK Electronics Skills Foundation

Teaching & learning resources for remote study iop.org/covid-19

Resources by physics topic

- 1. Earth and Space
- 2. Electricity and Magnetism
- 3. Energy and Thermal Physics
- 4. Forces and Motion
- 5. Light, Sound and Waves
- 6. Properties of Matter
- 7. Quantum and Nuclear Physics

Resources by age range

- 11 – 14 year olds
- 14 – 16 year olds
- 16 – 19 year olds

Resources by type

- 1. Videos to watch at home
- 2. Home experiments
- 3. Questions to check understanding and identify misconceptions

Credit: ©agnormark

Can your school help investigate local climate and biodiversity issues?

Apply now to receive up to £3,000 to run an investigative STEM project in your classroom through the Royal Society's Partnership Grants scheme. As part of the scheme the Society is keen to encourage projects that look to tackle issues around climate change and biodiversity loss which directly impact schools' local environments, through an extension called *Tomorrow's Climate Scientists*. This programme aims to give students across the UK not just a voice, but an opportunity to take action themselves to address these issues. To find out more about the scheme and to book on to a free online training session where you will receive hints and tips for the application process visit royalsociety.org/partnership or contact the Schools Engagement team via **education@royalsociety.org.**

Credit: ©Sunvincible

Free climate change and biodiversity loss teaching resources

The Royal Society has recently published two new sets of free resources to engage students of all ages in discussions about climate change and biodiversity loss. These evidence-based Q&A resources, *What do you want to know about climate change?* and *What do you want to know about biodiversity loss?,* are available in two ability levels to suit 7 – 18 year olds and to enhance teacher knowledge. The resources are available as slide decks, hand-outs and classroom posters in A4 or A3. To access the resources and the Society's other free resources for teachers visit royalsociety.org/teaching-resources. Please do share any feedback on how you have used the resources with the Society's Schools Engagement team via **education@royalsociety.org.**

THE ROYAL SOCIETY

For all teachers of physics: the Welsh Physics Teachers Conference 2021

8 – 15 October 2021 online and in Brecon

Join us for a fabulous week of presentations and workshops for teachers, technicians and trainee teachers, with opportunities to network with colleagues both online and in person. There will be workshops each evening as well as a choice of shows and presentations, culminating in a virtual whiskey tasting live from the Penderyn Distillery in the Brecon Beacons on Friday evening. Teachers will have an opportunity to meet at the Alpaca My Boots farm on Saturday 9 October for physics workshops as well as an alpaca trek and networking in peaceful surroundings. Sunday will see a series of workshops on *Physics and Religion* which will include discussion and debate. Technicians are invited to attend all sessions plus special workshops on Wednesday 13 October.

Credit: Alpaca my boots

Don't miss the workshop on the Physics of Alpacas at the 2021 Welsh Physics Teachers conference

For further details please contact **cerian.angharad@iop.org**

Register at welshphysicsteachersconference2021.eventbrite.co.uk

Find online physics teaching CPD at talkphysics.org/events

All our teacher CPD is currently online. This includes our IOP DOMAINS programme which restarts in late September, with workshops and online self-study videos covering *Forces, Energy & Thermal Physics, Electricity, Matter & Nuclear Physics, Earth & Space* and *Light, Sound & Waves*. Find out more at iop.org/domains

Introducing Forces and Force Arrows for 11 - 14
21 September | 5 - 6 pm

Teaching Forces to Post-16 Students
23 September | 5:30 - 6:30 pm

The Frontiers of Physics 2021
25 September | 9 am - 1:30 pm

Exploring Newton's Laws for 11 - 16
28 September | 5 - 6 pm

Teaching Circular and Simple Harmonic Motion to Post-16 Students
30 September | 5:30 - 6:30 pm

Forces in Context for 14 - 16
5 October | 5 - 6 pm

Trainee Science Teachers 2021
7 - 8 October 9 am - 3:40 pm

Misconceptions and Models for Electricity for 11-14
12 October | 5 - 6 pm

Top Tips for Successful Electricity Practicals for 11-16
19 October | 5 - 6 pm

Teaching about Electricity to Post-16 Students
21 October 2021 | 5:30 - 6:30 pm

Contact your IOP regional education manager to find out about teacher support in your area:

Scotland
Stuart Farmer
education-scotland@iop.org

Ireland
Fiona Longmuir
education-ireland@iop.org

Wales
Samantha Borley
education-wales@iop.org

England

Yorkshire and north east
Jenny Search
education-yane@iop.org

North west
Graham Perrin
education-northwest@iop.org

Midlands
Ian Horsewell
education-midlands@iop.org

London, East Anglia and Kent
Jessica Rowson
education-leak@iop.org

South
Trevor Plant
education-south@iop.org

For support running CPD, contact our Professional Practice Group

Rachel Hartley
education-ppg@iop.org

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