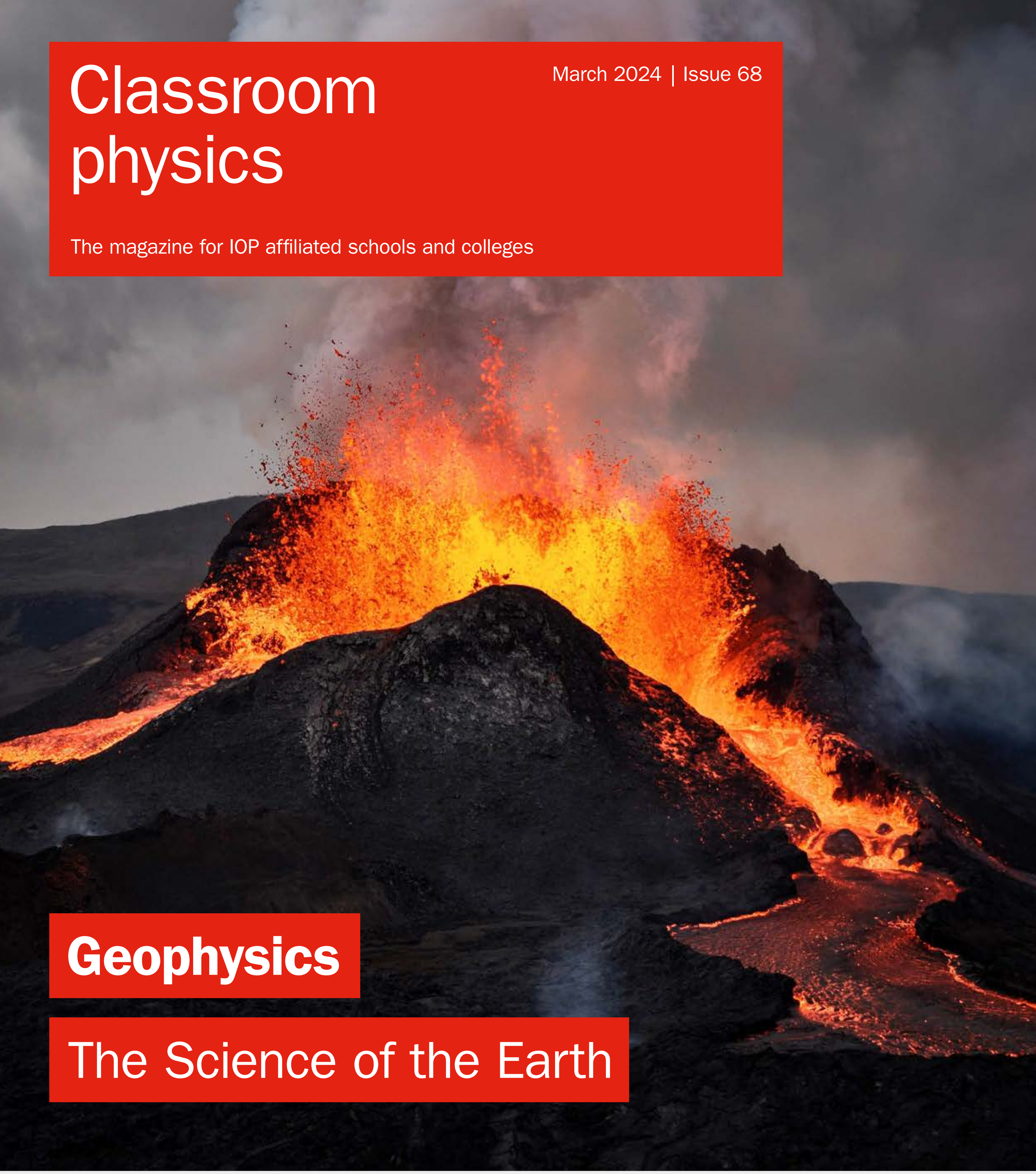
March 2024 | Issue 68

Classroom physics

The magazine for IOP affiliated schools and colleges



Geophysics

The Science of the Earth

Core understanding: exploring our planet's density and magnetic field

Dangerous liaisons: working up-close with volcanoes

Geophysics and green tech: how Earth science can support net zero

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IOP Institute of Physics

This issue

Editors' note

For this issue we've been thinking about how physics supports our understanding of the Earth. It's certainly one of the more dramatic themes we've explored. Earthquakes and volcanoes are incredibly powerful and impact millions of lives – as the recent eruption in Iceland, and last year's tragic earthquake in Syria and Turkey made all too clear. On page 6 we hear from a geophysicist about the sometimes perilous task of monitoring volcanoes.

But geophysics is not all about death and destruction. Volcanoes have a role to play in cooling and heating the planet (see pages 16 and 17), and we also look at how geophysics may play a role in a key process for decarbonisation (page 7).

More fundamentally, there is a relationship between the planet's physical processes and life itself. As discussed in the pull-out section (pages 9–12), the Earth's liquid outer core generates a magnetic field that protects us from the solar wind and stops our atmosphere eroding away. For a long time, it has been thought that tectonic plate movements were essential to the beginnings of life, but this theory looks like it might need some revision (see our Physics World highlights, page 16).

It's from our geology that much of our understanding of Earth's history – and, increasingly, other planets' – stems. We're grateful to the Royal Geographical Society and British Geological Survey, whose resources can help teachers bring this to life in the classroom (see page 19). But, as Amy Gilligan from the British Geophysical Association writes, it's clear that these topics are not attracting as many students as they once did at university level. Physics students may not realise how important their subject is to the ongoing study of our planet. Please spare a few minutes to help build BGA's understanding by completing their survey on page 17.

We're also pleased to include an item from one of the two 2023 IOP Technician Award winners, Razika Berboucha, who describes a lab experiment to measure impact craters (see page 18). Nominations for this year's Teacher and Technician Awards close on 30 March – see **bit.ly/IOPAwards24CP** for full details.

We are grateful, as ever, to the many other organisations and colleagues who have shared resources and links to information.

Finally, a quick heads up about our next issue: it will be about 'Physics on Screen' and we'd really like to hear your thoughts on the best (and worst) examples of physics in films. Please send us your ideas by email or on Twitter/X at **@IOPTeaching**.

In the meantime, we hope you enjoy this issue, and the Easter break when it arrives.

Dan, Taj and the Classroom Physics team

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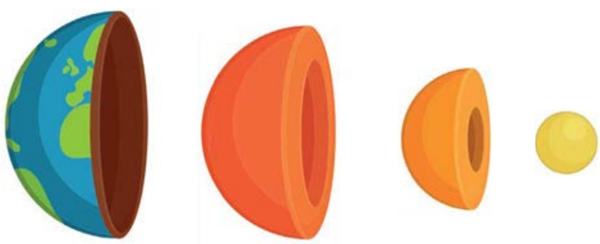
IOP affiliated schools and colleges will receive with this issue...

Window stickers showing the thicknesses and densities of the Earth's layers. See our matching activity on page 11.



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

Activities round-up

The beginning of the year was marked by a strong IOP presence at the ASE conference in January. IOP Learning and Skills staff hosted several well-attended sessions. Two stood out for their particular popularity among delegates: one about maths confidence for teachers, and the other on teacher retention. Their popularity reflects the high level of interest in these issues at the moment.

We were particularly pleased to see that the Limit Less resources were being talked about and referred to by delegates, indicating that the campaign is gaining traction across the teaching community.

Our Limit Less competition for young people across the UK and Ireland is back for 2024. The Eurekas provide a unique platform for young people to showcase their creativity and innovation. Entries open this month and the deadline for applications is 10 June. For some inspiration, check out last year's submissions at: **theeurekas.co.uk/submissions-2023/**

Some other important developments in the last few months have been submissions at the end of 2023 to the Scottish Government as part of ongoing consultation on education reform in Scotland. This and other IOP Scotland responses can be read at: **bit.ly/IOPScotlandConsultations**

IOP Ireland's Tyndall lecture series ran at campuses across the Republic of Ireland and Northern Ireland throughout February. The speaker was Martin Hendry, professor of gravitational astrophysics and cosmology at the University of Glasgow, who spoke about the latest research into gravitational waves in a lecture targeted at students in transition, fifth and sixth years. The series also marked the bicentenary of physicist Lord Kelvin – who was born William Thompson in Belfast in 1824.

New IOP strategy prioritises skills, science and society

The Institute of Physics has launched a new five-year strategy, Physics for the Future, with a clear and central commitment to learning and skills.

The strategy is structured around three 'themes for change', based on the need to secure diverse physics skills, the importance of support for science, and the need to ensure physics is seen and valued as a vital solution to society's challenges.

Under the skills theme, the strategy reaffirms IOP's commitments to closing the physics teacher gap and ensuring every young person has access to a specialist physics teacher; and continuing its work to break down stereotypes which are preventing too many young people from choosing physics. The strategy also commits to working with physics-powered sectors to identify skills needs and championing new ways to meet them, such as through apprenticeships and retraining; and supporting an inclusive physics community.

Credit: Pexels

These challenges relate to the shortage of vital physics skills in the economy, which is holding back the potential benefits of physics to society, as well as denying opportunities to young people.

Head of Learning and Skills, Hari Rentala, commented: "Physics for the Future has the future generation – their skills, their potential and their ambition to change the world – at its heart. If young people don't have access to specialist physics teaching and world-class physics education, and if we do not tackle the barriers that prevent them from pursuing physics no matter who they are or where they come from, physics cannot achieve its potential for our society."

more...

Find out more about the strategy at **iop.org/strategy**

IOP launches major report on physics and the green economy

In November, IOP launched 'Physics Powering the Green Economy', a report analysing the role of physics in driving technologies to help the UK and Ireland reach net zero.

Credit: Pexels

Onshore wind energy, one of the many renewable sources vital to the green transition. The report also details teachnology development for nuclear, hydrogen and alternative fuels, energy storage, and carbon capture, usage and storage.

Among the findings highlighted is a survey of IOP members, which found that 83% believed the UK wasn't on track to meet its climate goals, based on current policies and investment.

The report analyses levels of government investment into technology areas that will underpin the energy transition. It also sets out the many 'physics dependencies' for these technologies – showing how physics research and development is needed to unlock technological capabilities. The key areas of focus are renewables, nuclear, hydrogen and alternative fuels, energy storage, and carbon capture, usage and storage. The report includes case studies from businesses around the UK working in these fields.

The report shows the huge impact physics has had on the development of green technologies – from the fundamental understanding of concepts such as nuclear physics and photovoltaics through to the implementation of the latest reactors and solar cells – and the essential role it will play in the future. At the report's core is an argument for a healthy physics ecosystem. The report highlights voices from across the physics community who provide insight on what that ecosystem should look like – including a focus on skills, diversity, equity and inclusion.

A team from IOP travelled to the COP28 meeting in Dubai to host a day of discussions about the role of physics in green technologies, bringing together international thinkers from academia and industry.

Alongside the full report, IOP has published interactive dashboards which give access to the datasets used in the research, and timelines showing the historical role of physics in developing green technologies.

See **bit.ly/IOPGreenEconomy** for the full report, dashboard and timelines.

Solving Skills One Year On

During National Apprenticeship Week in February, IOP published 'Solving Skills One Year On: Partnerships powering apprenticeships', a report highlighting opportunities for young people to enter physics-based roles without a university degree.

More than half of physics-related jobs – almost 1 million jobs in the UK and Ireland – don't require a degree-level qualification. This is not widely known by young people considering their post-16 options. In fact, apprenticeships can offer a viable and rewarding pathway into roles across all levels of qualification.

The report spotlights nine case studies of organisations playing a significant role in increasing local awareness of apprenticeship opportunities, working in partnership with other employers, training providers and local and regional government to meet local skills needs. It also profiles the IOP 2023 Apprentice Award winner, Saskia Burke (who readers may recall wrote for CP in our last edition).

'Solving Skills One Year On' follows from last year's 'Solving Skills: Powering growth through physics-related apprenticeships' (see our March 23 issue) which revealed barriers including low awareness among students, insufficient engagement between schools and local businesses, and a focus on traditional academic pathways from schools and colleges.

The new report is based on engagement work by IOP over the past year at events with businesses, training providers and local governments around the UK and Ireland. It shows how these barriers can be tackled by organisations of all sizes, and through partnerships.

more...

Read the report at **bit.ly/IOPSolvingSkills**

Science Teacher Survey indicates shortfall of physics teachers in state schools

Findings from the 2023 Science Teacher Survey were published in January.

The annual survey was led by the Royal Society of Chemistry but included specific questions from IOP about the experience of physics teachers. More than half of all responses to the survey were from physics teachers, making this a particularly strong dataset for understanding physics teachers' experiences. The IOP team have drawn out key fundings for the physics teaching community.

In total, 46% of the survey's 2456 respondents said their school was understaffed for physics teachers – more than twice the proportion as for biology teachers.

Within that 46% there is significant variance between the state and private sectors. More than half (52%) of teachers in mainstream secondary schools said their schools were understaffed in physics, while only a fifth (22%) of teachers in private schools reported experiencing the same issue.

Additionally, the shortfall isn't evenly spread, with the problem less pronounced in Scotland and the Republic of Ireland than in England, Wales and Northern Ireland.

The data also paint a worrying picture of low morale, with an overall satisfaction score among physics teachers of 6.2 out of 10. 30% of physics teachers said they wanted to leave their school by 2025 – of which 27% wanted to leave the education sector altogether.

The findings are set against reports from December which found that the government had reached only 17% of its target for physics teacher recruitment in the last year. The IOP estimates there is now a gap of 3500 physics teachers in England.

Louis Barson, IOP's director of science, innovation and skills, commented:

"This simply isn't good enough. This is not just an issue for teachers – it is unfair for young people, especially those in our state schools, who face a two-tier lottery of opportunity which reinforces inequalities.

"We must act now, and this is why the Institute of Physics are calling for a multi-pronged approach to tackle the issues across teacher recruitment, retention, and through supporting established teachers to retrain. The dire shortage of teachers, especially in physics, plus retention issues, coupled with the wider equity challenges pupils face, is a ticking timebomb and undermining young people's futures."

Credit: IOP

House of Lords committee calls for curriculum reform

The House of Lords committee on Education for 11–16 Year Olds published its report in December, arguing for reform of the curriculum to fully prepare pupils for the future.

Charles Tracy, IOP's senior adviser for learning and skills, gave evidence to the committee in April, stating that the curriculum "can leave the impression that physics is a large compendium of disparate facts," and calling instead for a curriculum that "develops a deep understanding of the discipline … built on a smaller number of big ideas and explicitly including the practices and ways of thinking".

The report now published does call for a review of the 'overall content load' of the curriculum. But, commenting on the report's recommendations, Louis Barson, director of science, innovation and skills, pointed out that "this change alone will not solve the problems physics education faces – namely staffing shortages and the barriers to entry that deter too many students from all backgrounds taking physics in the first place".

Among other recommendations the report also calls for a new GCSE in applied computing, and for a certificate of digital literacy to ensure students have the digital skills needed for further study and the workplace.

more...

Read the full report here: **bit.ly/LordsEducationReport**

GCSE Astronomy teachers' network launched

Teachers of GCSE Astronomy are invited to join a new network for sharing ideas, resources and information on CPD.

Jeremy Thomas, a GCSE Astronomy tutor and credible specialist with education and exams body Pearson, is behind the new grouping. He said: "As a teacher of GCSE Astronomy for over twenty years, I have been asked by a number of other Astronomy teachers to help set up an informal network so that we can hold occasional, online teachmeets to share our experience, ideas and resources."

The network has attracted backing from the Royal Astronomical Society, and plans are underway to develop a full-day GCSE Astronomy CPD course at Oxford University in the summer term.

To find out more or register interest, please complete the online form at **bit.ly/ASTROEDUNET**

Sleeping giants

In 1997, an eruption of the Soufrière Hills volcano on Montserrat killed 19 people and destroyed the island's capital, Plymouth. Today, the city lies abandoned, submerged in rock and compacted ash, and serves as a powerful reminder of the devastation volcanoes can cause to people and communities in their vicinity.

Monitoring volcanoes, to try to predict when and how they will erupt, is a vital role for geophysicists. We spoke to Jurgen 'Locko' Neuberg, a professor of physical volcanology at the University of Leeds, about his work with the Montserrat Volcano Observatory.

A pyroclastic flow from the Soufrière Hills volcano

Credit: Jurgen Neuberg

Classroom Physics: How did you get into geophysics and volcanology?

Jurgen Neuberg: I liked physics in school but also outdoor activities and travelling; studying geophysics combined both as it covers a large range of theoretical but also practical aspects applying fundamental principles of physics to planet Earth. I got into volcanology after I obtained my PhD, when I worked for a government aid project at Gajah Mada University in Yogyakarta, Indonesia. There I was surrounded by active volcanoes and making volcanoes my research target was the obvious choice.

CP: What is it about volcanology that most appeals to you?

JN: Volcanology is a multi-disciplinary field where geophysics plays a major role in monitoring volcanoes, modelling the physical processes within their plumbing systems, and forecasting eruptions. It is important to protect people living right next to volcanoes but also to keep the airspace safe, as volcanic ash could have an impact on aviation.

CP: What are you investigating in Montserrat?

JN: Our major concern at the moment is that the entire island of Montserrat is inflating [rising up as the magma chamber refills below ground] at a constant rate – but no magma has reached the surface for the last 12 years. In cooperation with the Montserrat Volcano Observatory, we invesitgate these deformation patterns and try to find out if the magma reservoir is being replenished or if other processes could explain the inflation.

CP: How does physics support your work?

JN: Different magma types lead to very different eruption styles such as lava fountains and flows, or violent explosions with high eruption columns. Tools like geophysical fluid dynamics allow us to study and model the eruptive behaviour. Sound waves (seismic signals) that are recorded on a volcano are caused by brittle failure of rock or oscillations in a hydrothermal system and indicate where and how fast magmatic fluids are moving. Processes within the magma itself, like crystallisation and degassing, are controlled by thermodynamics. Ground deformation is governed by the visco-elastic interaction between magma and the volcanic edifice. Hence, a volcano is a complex system of many interacting physical processes.

CP: How does the study of volcanoes make people safer?

JN: We cannot prevent a volcano from erupting, but through geophysical monitoring we can detect signs of volcanic unrest, sometimes months before an eruption occurs. This gives civil defence agencies enough warning time to prepare for evacuation or alert aircraft to avoid a certain airspace.

CP: What other volcanoes have you studied?

JN: I worked on several volcanoes in Indonesia, on Stromboli in Italy, Ruapehu and White Island in New Zealand, Piton de la Fournaise in La Reunion, and Tungurahua in Ecuador.

Montserrat is a UK overseas territory in the Caribbean. After eruptions in the 1990s, about two thirds of the population was evacuated, mostly to the UK, which hosts a vibrant diaspora community. While people and tourism have started to return, and a new capital is under construction in the north, access to much of the southern part of the island remains restricted.

CP: How do you mitigate risk to yourself and your team?

JN: The best mitigation strategy is to stay as short a time as possible close to an active volcano when deploying geophysical instruments. Those can then be remotely accessed and can transmit data directly to an observatory. Using helicopters for equipment maintenance minimises the time spent in critical areas of a volcano. Satellites are nowadays increasingly used to monitor temperature, gas emission and ground deformation from space, without getting close.

CP: What will the next generation of geophysicists be investigating?

JN: A volcano monitoring system generates huge amounts of data. Geophysicists used automated data acquisition, processing and interpretation long before the term 'Artificial Intelligence' was created. In future, this trend will continue towards computerised evaluation of integrated data streams as the time for decision-making in a volcanic crisis is critical. However, the application of fundamental principles of physics to the complex volcanic system comes first and will remain the main task of a geophysicist.

CP: How can young people interested in geophysics embark on careers in this area?

JN: A solid background in maths and physics is essential. This, combined with the motivation to tackle some of the most critical challenges our planet faces, will offer a broad range of careers. By studying geophysics, students will develop fundamental expertise in the physics of the Earth, including ocean and atmospheric physics and the dynamics of Earth and planetary interiors. They will apply this knowledge to urgent issues including the climate emergency and sustainable use of the Earth's resources, and natural hazards such as earthquakes, volcanoes, extreme weather, and space weather.

CCUS: Putting carbon back in the ground

Of all the technologies that will support the transition to net-zero, Carbon Capture, Usage and Storage is the most controversial. We look at the debate around CCUS, and the role of geophysics in making it a reality.

While the world is racing to cut carbon emissions, there are concerns that clean energy sources may not come on stream quickly enough to meet all our needs in the meantime. Renewable electricity generation is by nature intermittent, so 'base load' electricity still has to be generated somehow – but in the UK, new nuclear power stations are still several years away.

Road transport is rapidly electrifying and new petrol and diesel cars and vans will no longer be sold from 2035, but other forms of transport – particularly heavy vehicles and planes – are less suited to battery power. Oil and gas are still used for some industrial purposes, and coal remains important in steel making. So, a key technology development that governments and industry are focusing on for managing the energy transition is Carbon Capture, Usage and Storage (CCUS).

CCUS is a system that separates out CO2 from the waste gases from burning fossil fuels, then either uses it to make other chemicals, or stores it underground.

Geophysicists have an important role to play in making CCUS a reality. The IOP's report on the green economy (see page 4) considers the physics processes and technologies that need to be in place for CCUS to be widely deployed.

The report identifies geophysics as essential for locating and modelling stable underground cavities for storing carbon. Once the carbon is placed in the ground, the sites need to be monitored for leak detection and any seismic activity. Understanding the dynamics of the Earth's crust may become vital, not just for monitoring volcanoes, but for protecting from carbon leaks.

Critics argue that CCUS is expensive to implement and inefficient. It's currently only possible to extract about 95% of CO2 from fossil fuel waste, using chemical 'scrubbers' to react with the gas and lock it into other chemical compounds. Worse still, it prolongs the role of fossil fuels, and takes the pressure off oil and gas companies to stop drilling.

For its proponents, CCUS provides a vital bridge to a world without fossil fuels. It is even hoped it may one day be used to take carbon out of the air and create 'carbon negativity' to rebalance the atmosphere and steady the climate.

Whatever your viewpoint, CCUS has become part of official scenario planning at the International Energy Agency, and is attracting growing interest from governments and investors. And when the IOP team hosted an event at the Dubai COP meeting in December, CCUS was a hot topic among delegates. There is certainly a logic to placing carbon back in the ground after we've used it – but the technology remains controversial.

more...

The IOP's 'Physics Powering the Green Economy' report is published, alongside histories of key green technologies and interactive datasets, at **bit.ly/IOPGreenEconomy**

Credit: IOP

Physics education research

In this column,
James de Winter
(University of Cambridge and University of Uppsala)
and **Richard Brock**
(King's College London)
highlight publications and resources from physics education research and suggest how they may be used to inform classroom teaching.

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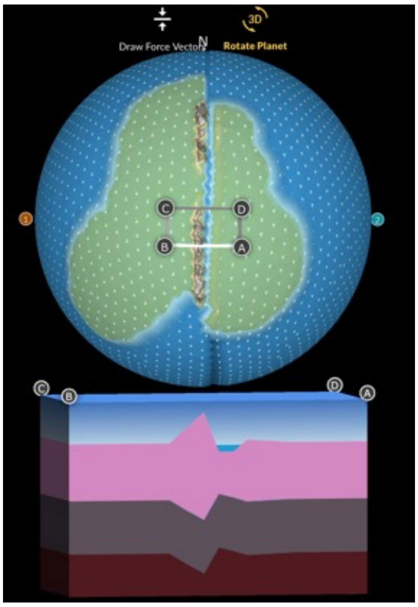
Credit: tectonic-explorer.concord.org



Cross-sectional and top-down views of a plate boundary, *Tectonic Explorer*

Using simulations to teach geophysics

Simulations have been proposed as valuable learning aids in several areas of physics, and geophysics is no exception. However, there are caveats teachers should bear in mind when using simulations.

In a recent paper, Pallant, Pryputniewicz and Lee investigated the impact of a simulation of plate tectonics (*Tectonic Explorer*, available here: **tectonic-explorer.concord.org/**) on US middle and secondary students' explanations of plate tectonics. *Tectonic Explorer* allows students to engage with simulations of the forces that act at plate boundaries, changing the orientation of the boundaries and the forces. Students can view cross-sections of fault lines and observe changes to plates and forces over time. In the study, 25 teachers implemented a module using the simulation and the researchers analysed students' (n=950) explanations of tectonic processes, written whilst they used the simulation. The researchers were interested in students' geo-sequential reasoning – that is, their thinking about the logical sequencing of events to explain tectonic phenomena.

A range of views

The researchers note several findings. First, they report that the quality of students' explanatory reasoning improved when both a cross-sectional and top-down view of the plate boundary was included in their explanation (as in the image). For example, when explaining the formation of mountains, seeing both views enabled students to link the growth of mountains to the motion of plates. The finding echoes evidence from previous studies of the value of including multiple forms of representation in teaching.

A second finding suggests teachers should carefully consider the scaffolding required when students use simulations to maximise their effectiveness in supporting learning. Simulations often include a range of features that can draw attention. *Tectonic Explorer* presents an engaging 3D model of the Earth, which students can pan around, and includes representations of earthquakes and volcanoes. The researchers note that students required scaffolding to focus on appropriate aspects of the simulation. Students have freedom to make decisions about elements to include in their simulations and the researchers note that, in unstructured engagement, some students lost orientation and focused on boundaries that were not relevant for addressing the task set.

Finally, the researchers highlight the challenge of geo-spatial thinking. In some simulation tasks, the students needed to connect processes that happen at some distance in the simulation (for example, a converging boundary at one side of a plate and a diverging one at another). Support, either embedded in the simulation or from a teacher, could help to focus attention on explanatorily relevant aspects that occur at some distance in the simulation.

Attentional guidance

The authors conclude by emphasising students' need for 'attentional guidance' when engaging with a simulation. They suggest that asking students to capture images or short videos of particularly salient events and processes from the simulation would help to support meaningful engagement. They also suggest that novices may struggle to interpret the simulation and need to have sufficient knowledge of plate tectonics to engage meaningfully with the representations in the simulation.

This study raises general questions for teachers using simulations: how can students be supported to visualise three-dimensional models from multiple perspectives? And, how can scaffolding provide 'attentional guidance' to support learning from simulations?

References

Pallant, A., Pryputniewicz, S. & Lee, H. S. (2023). Developing geo-sequential reasoning about tectonic processes using computational simulations. *International Journal of Science Education,* 45(18), 1571–1599.

Pull out and keep!

Magnetism and Density

The Earth

Inside this issue:

- **Activity 1: Earth's magnetism (11–14)**
- **Activity 2: Earth's density and core (14–16)**
- **Worksheet: Plasticine planets (14–16)**

Geomagnetic news

Inside this pull-out are two activities on the theme of the Earth's core and magnetic field. It's a topic rich with contexts to include in your teaching. Here are our top three picks for 2024.

The British Isles: Compasses point true north for the first time in 360 years

There are two norths at any location on our planet. 'True north' is the direction of the geographic north pole, and 'magnetic north' is the direction a compass needle points when it aligns to the Earth's magnetic field. The two rarely coincide and the angle between them is called the declination.

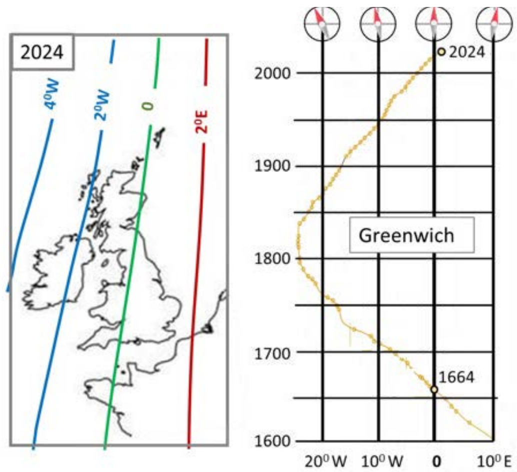
Due to their importance in navigation, maps of declination have been produced for centuries. As can be seen in the map (right), the line of zero declination (green) – known as the agonic – is passing over the UK.

For over 300 years, compasses in the UK and Ireland all pointed west, but in a process that started in 2017 when the agonic made landfall on the east coast of England, this began to change. As it advanced across the British Isles, declinations reduced to zero and then started becoming east – a change that reached the historic milestone of Greenwich in London (home of the prime meridian) in 2019.

Over the next few years the agonic will continue this journey west into Wales, Scotland and then Ireland, turning compasses east in its wake. The British Isles is however quite narrow, and declinations only vary by a total of 5° across its breath. Even if you aren't exactly on the agonic, your declination will be close to zero while this process completes. All British and Irish compasses are pointing to true north (±3°) and will continue to do so for the next few years, something that hasn't happened in over three centuries.

The Arctic: The north magnetic pole races towards Russia

Ever since it was first located in the Canadian Arctic in 1831, the north magnetic pole has been on the move. It spent most of the 20th century wandering around northern Canada at speeds of up to 15 km/year.



Left: declinations across the British Isles in 2024. Right: changing declinations over time for Greenwich, London.

In 1990, however, it started to accelerate and made a dash for Russia. When it crossed the international date line in 2017, it was travelling at a speed of 50 km/year – the highest since records began. It is now heading south, and computer modelling suggests it will reach Siberia within a decade.

Weather forecast: Solar storms ahead

The Earth's magnetic field extends far into space and shields us from erosion of our atmosphere by high-speed charged particles emitted by the Sun (the solar wind). The small percentage of particles that do make it through are deflected to our planet's poles where they create the greatest lightshow on Earth: the northern (and southern) lights.

The Sun's activity peaks, on average, every 11 years and is predicted to do so again in 2024. Expect more northern lights – maybe even as far south as the UK and Ireland.

more…
See **bit.ly/NCEIdeclination** for historical declination maps

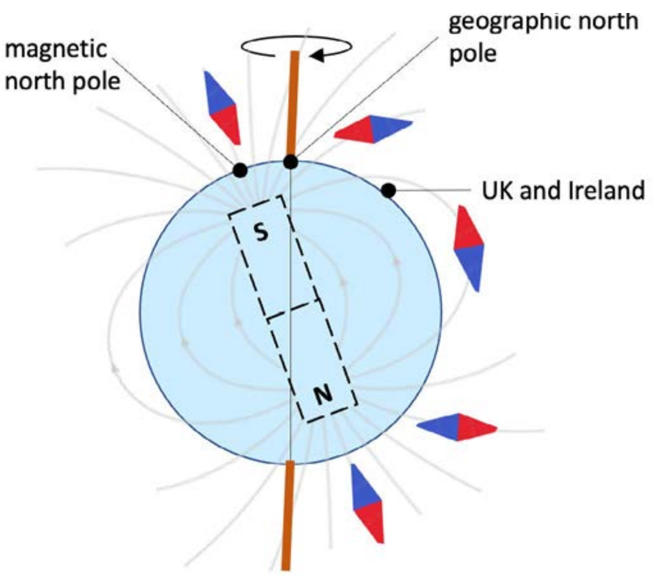
Read more about how magnetic flux elongation in the Earth's outer core may be responsible for the north magnetic pole's motion in Nature Geoscience at **bit.ly/NatGeo2020**

With thanks to Ciaran Beggan of the British Geological Survey for his advice

Activity 1: Earth's magnetism (11–14)

In this activity, students find the direction of the magnetic field in the classroom and are introduced to the shape of the Earth's magnetic field with a model Earth.

Credit: IOP



Equipment

Each group of students will need:

- Large beaker of water
- Slice of cork
- Steel needle
- Magnet
- Smartphone (optional)

You will also need:

- A ball of plasticine with a diameter of least 12 cm
- A strong large bar magnet (e.g. 7 cm length)
- A Magnaprobe™ (a tiny magnet suspended in gimbals in a plastic frame)
- Two map or drawing pins
- A barbecue skewer

Preparation

Make a magnetic model of the Earth by cutting the plasticine ball in half, placing a barbeque skewer and a bar magnet inside it (see diagram above) and then reconnecting the two halves. You may want to offset your magnet to emphasise that the geographic and magnetic poles don't always align.

Students will need access to an online map to know which way the classroom is oriented relative to geographic north. This can be via an online map on their phones, or you could show them on a smartboard.

Procedure

1. Move the Magnaprobe along the surface of the model of the Earth to show the shape of the magnetic field. Mark magnetic north and south pole positions using pins.

2. Introduce terms:

Geographic pole	The point where the spin axis of the planet meets the planet's surface.
Magnetic pole	The point where a compass needle points straight up/down

3. To make a compass, ask your class to:

   a. Stroke a needle about 20 times in the same direction with one end of a magnet (lifting the magnet after each stroke)

   b. Place the magnetised needle on top of the slice of cork and then float it on the surface of water

   c. Wait for the needle to rotate and settle before standing and facing the direction it points

4. Show an online map of the classroom's orientation to confirm their needles are aligned north-south.

5. End by placing the Magnaprobe on the model Earth at the location of the classroom (i.e. British Isles) to show which direction it points.

Teaching notes

The needle only becomes temporarily magnetised in this activity, but the effect lasts sufficiently long for it to show compass-like behaviour. Whether it will point north or south will depend on which direction students stroked their needle, and which end of the magnet they used.

Some students may notice that the Magnaprobe points down as well as to north at their location on the model. Explain that the reason their needle doesn't dip is because it is in contact with the cork floating on the water.

Of course, the Earth's magnetic field isn't created by a bar magnet. Geophysicists think it is generated by the turbulent motion of liquid iron (and nickel) in the outer part of the Earth's core. To emphasise that it must be generated by something moving inside our planet, you could discuss how maps of declination change over time and/or discuss the motion of the magnetic poles (see page 9).

more...

Your students can check the declination at their location and access a compass on their phones at **bit.ly/NOAAcompass**

For a quick introduction into how molten metal spun up to high speeds is being used to experimentally model how Earth's core generates a magnetic field, watch **bit.ly/SpinningSodium**

Activity 2: Earth's density and core (14–16)

In this activity, students use the average density of the Earth to estimate what percentage of its volume is taken up by the iron core.

Equipment

Each pair/group of students will need:
- Mass balance
- Measuring cylinder
- Steel block (eg 2 cm cube of the type found in density kits)
- Sand (about 100 ml)

You will also need:
- A steel ball (any size)
- A ball of plasticine (of about the same volume as the steel ball)

Procedure

1. Introduce the idea that planets have layers by wrapping plasticine around a steel ball. Its density will be between that of plasticine (2 g/cm^3) and steel (8 g/cm^3).

2. Explain that our planet consists of an iron core surrounded by a rocky exterior. Students will be modelling it using steel and sand.

3. Provide the density of the Earth:
   Earth's density = 5.5 g/cm^3

4. Ask students to:

   a. Place the measuring cylinder on the balance and zero it

   b. Measure the dimensions of the steel block and estimate its volume (in cm^3): **volume of steel = length x width x height**

   c. Place the steel block on the balance to determine its mass in g and then calculate its density (in g/cm^3): **density of steel = mass of steel/volume of steel**

   d. Leaving the steel block on the balance, pour about 10 cm^3 (10 ml) of sand into the measuring cylinder. Record the volume of sand and the total mass (sand and steel combined)

   e. Calculate the total volume of steel and sand by adding the volume calculated in step b to that measured in step d: **total volume = volume of sand + volume of steel**

   f. Calculate the planet density for the sand-steel mixture: **planet density = total mass/total volume**

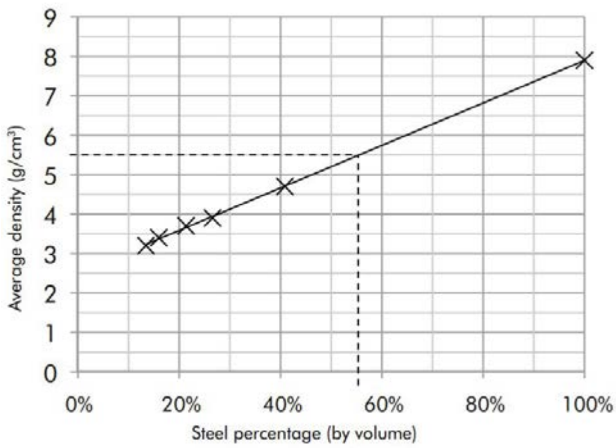
   g. Calculate the percentage of the volume that would be taken up by its core: **percentage-core = volume of steel/total volume x 100 %**

   h. Repeat steps d to g to obtain at least six data points and tabulate findings under headings: total mass, total volume, planet density, percentage-core (by volume)

   i. Plot a graph of average density against percentage of steel and use it to estimate the percentage of the Earth's volume made up by the core

Teaching notes

Students should find that density decreases from that of steel as more sand is added. A graph of density against percentage-core provides a straight line from which the percentage that gives a density of 5.5 g/cm^3 can be read. We plotted the one below using a 2 cm cube of steel to get an answer of 55%:



To explain why their estimate is an upper limit of the size of the core, discuss the composition of the Earth. Highlight that:

- Although the Earth's crust has a similar density to sand, the rock in the mantle has a higher density.
- The iron at the centre of our planet is at much higher density than steel because of the extreme pressures found in the core.

Current estimates based on seismological data suggest that the core takes up only 15% of the Earth's volume.

Mark scheme: Plasticine planets (on page 12)

1. 8 g/cm^3 ✓

2. Use measuring cylinder with water ✓
Take readings of volume before and after inserting ball into cylinder ✓ Calculate ball's volume by finding difference between two readings ✓

OR

Use ruler and set squares (or other calliper arrangement) ✓ to measure diameter ✓ and calculate volume using 4/3*π*radius^3 OR 1/6*π*diameter^3 ✓

3. total mass = 360 g OR total volume = 90 cm^3 ✓
density = 4 g/cm^3 ✓

4. use of mass = density x volume OR ratios ✓
density = 5 g/cm^3 ✓

A student makes a model of a planet using a ball of plasticine and a ball of steel.

1. Complete the table below by calculating the density of steel.

ball	mass (g)	volume (cm^3)	density (g/cm^3)
plasticine	120	60	2
steel	240	30	

[1 mark]

2. To measure the mass the student used a balance. How could they have determined the volume?

....

....

....

....

....

....

[3 marks]

3. To make the model the student wraps the plasticine around the steel ball.
Calculate the density of their model planet.

....

....

....

[2 marks]

4. Another student uses equal volumes of steel and plasticine to make their model.
What is the density of their planet?

....

....

....

....

[2 marks]

Geophyiscs stories

The mutable world: Darwin and the earthquake

Among the many novel experiences on his voyage on the *Beagle*, in 1835, Darwin observed a significant earthquake in Concepción-Valdivia in Chile. He had disembarked from the *Beagle* when the earthquake struck, and observed in his research journal:

It came on suddenly, and lasted two minutes; but the time appeared much longer … There was no difficulty in standing upright, but the motion made me almost giddy. It was something like the movement of a vessel in a little cross ripple, or still more like that felt by a person skating over thin ice, which bends under the weight of his body.

Darwin reported that the earthquake destroyed all the houses in Concepción and Talcahuano and that a 'great wave' followed. Scholars have argued that the event may have primed Darwin to the idea of the world existing in constant change, shaped by powerful natural forces – paving the way for his theory of natural selection.

Looking up to predict earthquakes

A route to predicting earthquakes may exist in an unexpected direction.

As tectonic plates shift, some scientists suggest changes in the ionosphere are detectable. The ionosphere is a layer of the upper atmosphere (located between approximately 50 and 1000 km above the Earth's surface) that contains electrons and other charged particles. A still-controversial theory suggests that changes in the density of electrons in the ionosphere can predict earthquakes.

In 2010, a team from MIT using the Haystack Observatory in Massachusetts observed a spike in electron density, 25 days before a magnitude 7.2 earthquake in California. Similar results have been reported for other earthquakes. One proposed theory is that stresses in plates create piezo-electric currents, producing positive ions which in turn influence the ionosphere – but the theory is contested.

'Sonic boom' earthquakes

So-called 'supershear' earthquakes, when compared with similar magnitude tremors, are particularly destructive. For example, in 1979, a 6.5-magnitude quake in California's Imperial Valley caused injures to people in Mexico and an estimated US$30 million of damage.

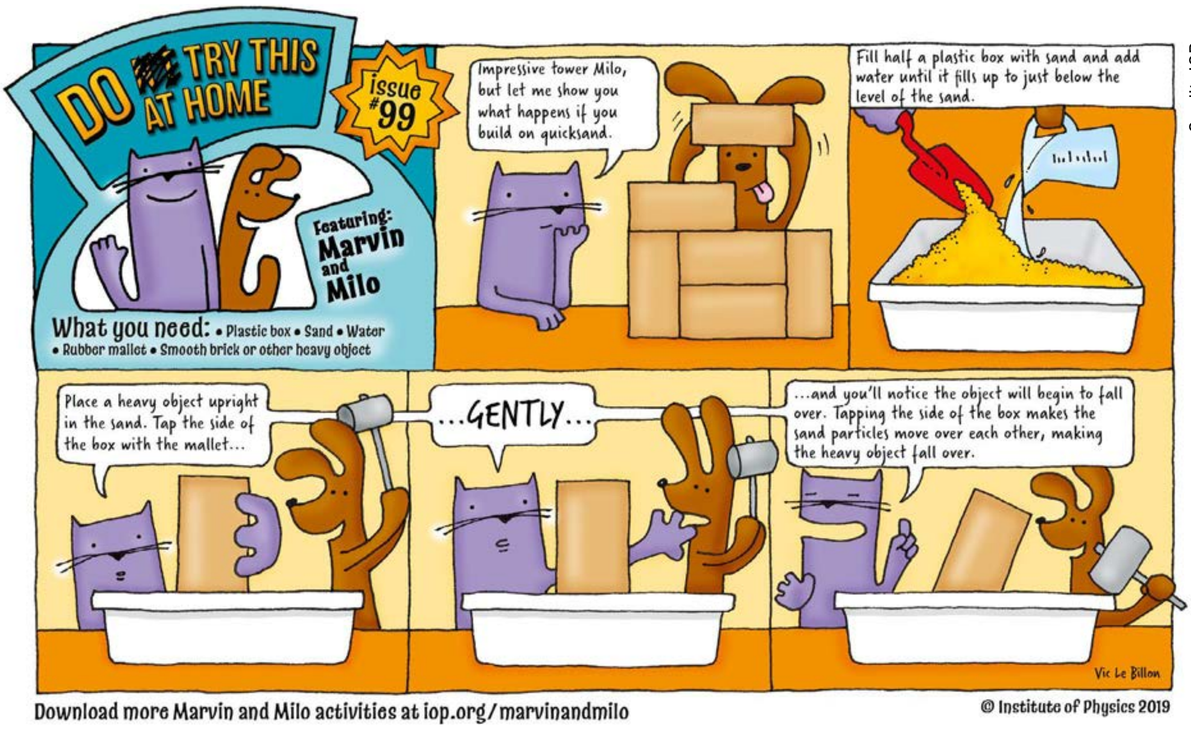
In a supershear earthquake the speed of the rupture to the ground exceeds the speed of the s-wave, in a phenomenon like a sonic boom, which concentrates the seismic energy from the quake. The effect is associated with strike-slip faults – where the fault plane is close to vertical and the edges of the fault move laterally, either right or left.

Estimates suggest that, amongst earthquakes of magnitude 6.7 or greater in the period 2000–22, 14% were supershear quakes.

spark.iop.org/stories-physics

Compiled by Richard Brock.

Follow him on Twitter at **@RBrockPhysics**



Credit: IOP

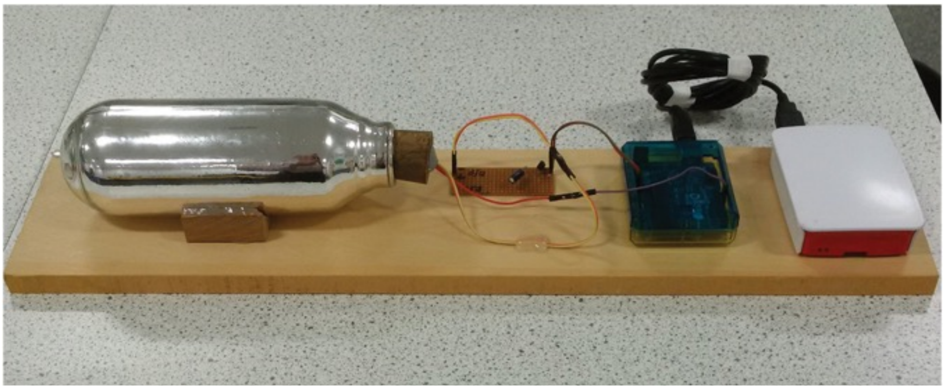
Physics*education*

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 **geophysics** from the archive and shares some highlights from the current volume.

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.



Credit: IOP

An Arduino in action, as part of a solar wind monitor.

Geophysics

Historically geology, and subsequently geophysics, has had a lot to offer physics teachers when it comes to interesting students in the subject. These range from rocks, strata and earthquakes to more recent concerns such as energy resources, the atmosphere and climate change. It's also worth mentioning that geology is never far away: the UK has fascinating geology with counties like Shropshire having some of the greatest diversity of geology anywhere on this planet.

In "Novel infrasound monitor project: real geophysics research on a budget", a well-established, open source geophysics project to monitor atmospheric infrasound is described with all the detail needed to enable you to put this project together with your students. Infrasound may be generated by natural and manmade events. Natural sources include volcanoes, earthquakes, avalanches, tides, lightning – especially in the upper atmosphere – and meteors. This device monitors infrasound in the environment and can run 24 hours a day. There are lots of connections to the curriculum that can be made as well as just being a real science investigation. Costs are of the order of £100 but some of this is for reusable items.

There are a number of papers in Physics Education on solar cells but in "Solar power from schools and homes" by Frank Thompson, there is very useful data about real solar panels on a real house which have been in operation for a number of years. The author describes the set-up and provides information on installation as well as costs and returns. This sort of concrete, real-world experience may help some students decide on the pros and cons of doing this themselves in the future, and provides a little more science capital than just seeing data on a website.

Ian Robinson, co-author of the infrasound paper, also brings us a magnetometer activity, "Solar wind monitor—a school geophysics project", again at a relatively low cost. This time the experiment uses an Arduino, a device which is used by used in hundreds of projects described in Physics Education. The device can also operate for prolonged periods by itself. You might also be interested in "Guiding lights: a classroom light system for knowing when to chase aurora", which describes an alarm system for aurora alerts. Who knows, you might be able to make your whiteboard light up when your magnetometer detects a change in the Earth's magnetic field caused by the solar wind!

"Novel infrasound monitor project: real geophysics research on a budget"
bit.ly/PENovelInfrasound

"Solar power from schools and homes"
bit.ly/PESolarPower

"Solar wind monitor—a school geophysics project"
bit.ly/PESolarWind

"Guiding lights: a classroom light system for knowing when to chase aurora"
bit.ly/PEGuidingLights

Recent papers

In the ‘Directions’ section in Physics Education, we include papers that suggest future directions the subject might follow. These include a range of issues, from what should be in the curriculum to whether physics and engineering courses should be merged at university for their first year. They do not require hard data to make a case – experience of teaching over many years counts too.

“Making an IMPRESSion: mapping out future directions in modern physics education” (an open access paper) raises the question of what modern physics should be taught. Most teachers of physics will be aware that ‘modern physics’ in many specifications is over a century old! So, what should we teach if students are to have a genuine and stimulating experience of the subject?

Forming a useful comparison with Frank Thomson’s paper on solar panels, “Investigating the efficiency of air-source heat pumps in the secondary school physics laboratory” (also an open access paper) takes a portable air-source heat pump and gathers data to calculate the coefficient of performance. It suggests that comparison figures for heating using other means could be easily obtained. I must admit that I

Credit: IOP

The Completely Hackable Amateur Radio Telescope (CHART)

Credit: IOP

A portable air-source heat pump in the lab.

didn’t know such a small-scale device existed before reading this paper. This might well be apparatus worth investing in if you plan to teach a topic about climate change or domestic heating or electricity usage.

Another open access paper describes a slightly more involved project in “The Completely Hackable Amateur Radio Telescope (CHART) project”. The final radio telescope system can detect 21 cm emission from the Milky Way. If you want to introduce your students to some real astronomy but don’t have dark skies or don’t want to be restricted by time and weather, then this may be the project for you. It might look daunting at first, but the authors of the paper claim that no previous radio science knowledge is needed.

“Making an IMPRESSion: mapping out future directions in modern physics education”
bit.ly/PEImpression

“Investigating the efficiency of air-source heat pumps in the secondary school physics laboratory”
bit.ly/PEHeatPump

“The Completely Hackable Amateur Radio Telescope (CHART) project”
bit.ly/PECompletelyHackable

Physics*education*

Quick Links

The use of astronomical databases to perform practical work in the process of teaching astronomy

Big data doesn’t feature enough in the curriculum – here’s a chance to introduce it

bit.ly/PEAstronomicalDatabases

Snow white, the seven dwarfs and the photoelectric effect

Another fun analogy with the photoelectric effect

bit.ly/PESnowWhite

Solar energy revisited: creating and using Grätzel cells at school

Making your own solar cells

bit.ly/PESolarRevisited

Open access

With an infrared camera in an amusement park: heating and cooling of magnetic brakes

With an IR camera you can see the heating done by magnetic brakes

bit.ly/PEInfraredCamera

Thermoelectricity: from the iron arc of Alessandro Volta to radioisotope thermoelectric generators

Thermoelectric generators may help students understand circuits more easily

bit.ly/PEThermoelectricity

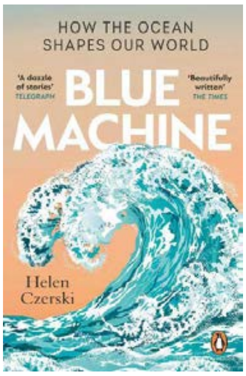
One setup for many experiments: enabling versatile student-led investigations

Setting up the lab to allow students to get hands-on with ease

bit.ly/PEOneSetup

Book corner

IOP professional support coach Ruth Wiltsher writes about 'Blue Machine, how the ocean shapes our world', by Helen Czerski.



Credit: Penguin

The physicist and oceanographer Helen Czerski's 'Blue Machine, how the ocean shapes our world' takes an in-depth look at the science and history of the oceans and our interaction with them.

The book divides into three main sections, detailing the currents, winds, chemicals and living organisms within the many layers of water and at its edges, describing the oceans as an engine with dozens of interactions.

The book stretches to more than 400 pages, with frequent footnotes, no mathematics, and not many illustrations – though a look at the illustrations at the end reminds one just how much of the Earth *is* ocean.

Czerski describes her own explorations, from Hawaii to the Arctic, in canoes and on research ships.

The history of human interaction is covered, with two ships described in detail: the *Fram* (now in Oslo) and the *Cutty Sark*. The dependence of living organisms, from plankton to whales, and the effects of war, are all explored. There are some fascinating sections, such as those on whale earwax, and even the herring lassies. The book explores how light, sound and new ways of investigating the seas (submarines, satellites, autonomous buoys and vehicles) have increased our understanding.

The book ends with a plea for more investigation, care and understanding of our dependence on the 'blue machine'. The book is enthusiastically written and very informative, but not an easy or short read. Helen Czerski's Ladybird Expert book 'Bubbles' covers some of the same ground in a simpler manner.

physicsworld

Stories from our magazine for the global physics community.

Visit **physicsworld.com**

Zircons, plate tectonics and the mystery of life

Plate tectonics are essential to life on Earth because the movement of the crust back into the mantle plays an important role in the carbon cycle. This article by James Dacey explains how the process may not have been happening when life began.

Researchers measured the magnetism of iron compounds inside zircon crystals which formed between 3.9 and 3.4 billion years ago. The strength of the magnetic force correlates with the latitude where the crystals formed, because magnetic force gets weaker with distance from the poles. The team found that the magnetism was constant throughout the 600 million years over which the crystals formed – meaning they didn't change latitudes, so plate tectonics had not begun.

The fossil record suggests life began about 4 billion years ago, so these findings suggest the conditions for life starting required a different type of plate movement on the Earth's surface. The research may help in the search for life on other planets.

bit.ly/PWZircons

Weathering and ocean burial of rocks could have triggered Earth's ice ages

In this article by contributing editor Isabelle Dumé, Physics World reports on a study that explains how plate tectonics are linked with episodes of global cooling.

Ophiolites are rocks created under the sea that are pushed up to the surface by plate tectonics. Once exposed to the elements, they erode rapidly to form rocks called smectites, which settle back on the sea floor. Smectites have a structure with a large surface area, making them very good at locking in carbon. Over millions of years the erosion of ophiolites has a cooling effect on the Earth because it removes carbon from the atmosphere and returns it to the sea via smectites.

The researchers have linked this process to the four great ice ages in Earth's history, including the 'snowball Earth' (see page 17). The findings could also have implications for understanding the Martian climate, as much of Mars is also covered in smectite.

bit.ly/PWWeathering

Dr Amy Gilligan, outreach and schools liaison officer for the British Geophysical Association, looks at the challenges facing this important area of study.

geophysics.org.uk

Raising awareness of geophysics

Geophysics is a very broad subject, encompassing the whole of our planet from the core to the atmosphere. It applies physics to gain fundamental understanding of how the Earth (and other planets) work, and addresses pressing societal needs, such as managing water resources, facilitating the energy transition, and helping mitigate hazards caused by earthquakes.

But it's perhaps not a subject many young people have considered studying at university. The British Geophysical Association (BGA) aims to promote geophysics as a subject, but in recent years we have seen the numbers of students studying geophysics decrease.

Geophysics degrees exist at undergraduate and postgraduate level at a number of universities across the UK. Geophysics can also be studied as part of broader degrees in subjects such as Geology, Earth Sciences, and Geosciences. As well as immersing themselves in the subject material, students develop skills in areas including coding, and have the opportunity to spend time outside conducting geophysical surveys.

Graduates of geophysics degrees go on to a wide variety of careers. This could be conducting archaeological investigations using near-surface geophysical methods, surveying the seabed to help with deciding where to place wind turbines, and advising governments about tsunami risk, just to name a few!

To help us better understand the decline in student numbers, and what we can do to change it, we have launched a survey for key stakeholders, including teachers and school careers advisers. We would be grateful if you could share your experiences and opinions, and pass the survey on to your colleagues.

bit.ly/CPBGASurvey

Sylvia Knight, head of education at the Royal Meteorological Society, describes how volcanoes have impacted the Earth's climate – and culture.

rmets.org

See an albedo demonstration at **bit.ly/RMetSAlbedo**

Volcanoes and climate change

Volcanoes produce sulphur gases which can react with compounds in the atmosphere to form particulates and create sulphate aerosol. Some volcanoes are powerful enough to push those gases into the stable stratosphere (over about 10 km above the Earth's surface). If the volcano is in the tropics, then the circulation of the stratosphere redistributes the aerosol and the volcano has a global effect.

Sulphate aerosol has high albedo, meaning it reflects a large proportion of the Sun's light and shortwave infrared radiation, which never reaches the Earth's surface to warm it. Explosive, tropical volcanic eruptions can therefore cool the climate.

The combined eruptions of La Soufrière (1812), Mayon (1814) and Tambora (1815) had catastrophic global effects, leading to a 'year with no summer' in 1816, without which we probably wouldn't have Frankenstein's monster or Dracula, and the invention of formula baby milk may have been delayed.

The eruption of Pinatubo in 1991 resulted in a global cooling of up to half a degree for a couple of years.

It's been suggested that during the Proterozoic era (850–630 million years ago), the positive albedo feedback associated with ice accumulation led to a 'snowball Earth', with ice covering the whole planet. If that happened, volcanic emissions of greenhouse gases like CO_2 would be necessary to warm the Earth again.

Today's climate change will make it harder for volcanic material to reach the stratosphere, as the boundary between it and the troposphere below rises. On the flip side, there's some evidence that climate change can influence the number of volcanic eruptions in places like Iceland. As glaciers melt and the water runs off into the sea, there's a redistribution of mass, reducing the pressure on the mantle below the volcanoes there, which in turn leads to decompression melting and a greater amount of magma.

Razika Berboucha, a technician at Lampton School, was one of the recipients of the IOP Technician Award, announced at the end of 2023. She describes an experiment suitable for 11–14 year-olds to explore how craters are formed on the Earth's surface.

The equipment set up with the ruler clamped into place at the correct angle.

Deep impact

Impact events played an important part in Earth's formation and the evolution of life on our planet. In this experiment, students learn about the factors which affect the size of an impact crater by dropping a ball bearing into sand.

Variables:

- The independent variable: the height of the ball
- The dependent variable: the size of the crater
- A control variable: the size of the ball

Equipment:

Goggles, ball bearing, ruler, sand tray and a magnet (to collect the ball bearing when dropped on the sand).

Method:

Hold the marble at different heights above the sand and allow it to drop. Measure the diameter of the crater, level off the sand and repeat. Plot a graph of the drop height (x-axis) against crater diameter (y-axis).

Conclusion:

The higher the ball bearing, the greater the size of the crater in the sand. More sand is moved because the higher the ball bearing, the greater the impact speed. Students' graphs should show a directly proportional correlation between the independent and dependent variables.

The effect of random error can be reduced by repeating the investigation and calculating the mean averages. To avoid a systematic error, students can use a set square to ensure the ruler is clamped vertically.

Nominations for the 2024 IOP Technician Award are now open, with a deadline of 30 March.

See **bit.ly/IOPTechnician24** for details.

The Ogden Trust

making physics matter

Dr Caroline Neuberg, senior lecturer at the School of Education, Leeds Trinity University, provides some real-world contexts for the waves topic.

Caroline is an Ogden Trust regional rep and helps to deliver KS3 Physics CPD to teachers at partnership schools. Waves is one of six topics covered in this CPD.

ogdentrust.com

Seismic science

Geophysicists use their knowledge of waves to try to predict the location, time and magnitude of earthquakes. Monitoring tectonic plate boundaries involves satellite and ground-based observations. Numerical models of seismic shaking in sediment layers can help predict local accelerations. Early warning systems detect the arrival of the P-wave (one of the two main seismic waves) to shut down power stations and stop trains, to minimise damage.

Geophysics can also provide useful cross-curricular links for younger pupils who learn about volcanoes and earthquakes at KS2. Earthquakes can be modelled using a brick connected to a Newton meter by an elastic band; dragging the brick across sandpaper creates an unpredictable and jittering motion like the crustal movement during an earthquake. Teachers can take the learning further by creating a 'shake table' to test the durability of 'buildings' created from marshmallows and spaghetti.

There are many examples of geophysical applications to pressing societal challenges, including the climate emergency and sustainable use of resources, and the mitigation of natural hazards such as earthquakes, volcanism, extreme weather and space weather. These challenges provide valuable real-world context for the topic of waves in KS3 physics and beyond.

Create a school seismometer at **bit.ly/MakeASeismometer** or **bit.ly/TC1Seismometer**

Access recordings of live seismic waves from a network of seismometers around the world, at **bit.ly/SeismicWaveSoftware**

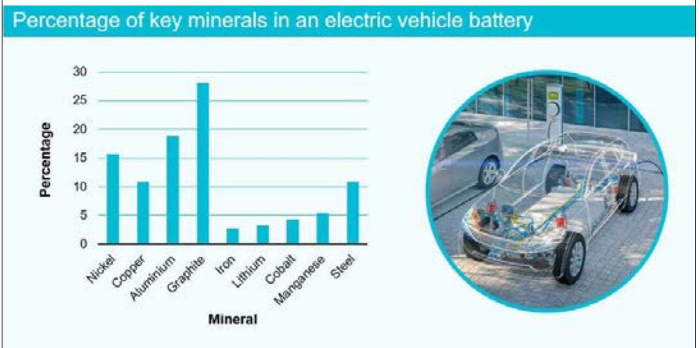
Discover Geology with the British Geological Survey

The British Geological Survey is a world-leading independent research organisation providing objective, expert geoscientific data, information and knowledge.

Our Discovering Geology web pages bring together learning resources exploring the processes that have shaped current and past landscapes and how our planet's diverse range of rocks and minerals formed. Find out how rocks and fossils can be used to explain the changing climates of the past, and why learning from the past is the key to understanding our sustainable future.

Explore our series of lesson plans focusing on critical minerals, beginning with defining and identifying rocks and minerals. Loan boxes containing specimens can be borrowed to support lessons, which look at the minerals we use in everyday life and enable students to think about the source of these minerals and how the UK will supply them in the future.

Find out more at **bgs.ac.uk/discovering-geology/**



Resources and connections with The Geological Society

The Geological Society has created a wide range of curriculum-linked resources that include dynamic activity and factsheets, insightful lesson plans, captivating presentations and more! Check out our suite of work on an array of topics including energy and natural resources at **geolsoc.org.uk/resources**

As well as our popular resources, we have launched a new online network dedicated to education and outreach. GEON (Geoscience Education and Outreach Network) is a virtual space designed for professionals, educators and enthusiasts to share opportunities, seek and offer funding or support, and stay informed about the latest developments. We invite everyone to join the conversation, connect on GEON, and contribute to the collaborative spirit of our community!

To join GEON, head to **geolsoc.org.uk/GEON**

Earth and beyond: an early years resource from the British Science Association

Developed in partnership with the Odgen Trust, the British Science Association (BSA) has launched a new CREST resource for early years, 'Earth and beyond', to help children aged 3–5 discover a love of science.

This CREST Star for early years pack includes eight activities. Each takes 45–60 minutes to complete and involves hands-on investigation, decision making and group discussion. During the activities, children are encouraged to think about what the Earth is, how to land on the Moon and what its surface looks like, as well as learning about the night sky, how to block light out, and what it's like to be an astronaut.

The pack comes with comprehensive teacher guides and demonstration videos on what the activity will support pupils to do, how to conduct the activity, and a full kit list including materials and preparation instructions.

The resource is completely free to download.

bsa.sc/CREST_EY

CREST AWARDS

BRITISH SCIENCE ASSOCIATION

Plan your visit to *Energy Revolution: The Adani Green Energy Gallery* at the Science Museum, London

Discover how the world can generate and use energy more sustainably to urgently decarbonise and limit climate change in the Science Museum's new, free gallery.

In *Energy Revolution*, families and school groups will learn about the past, present and future of energy systems through intriguing objects and interactive exhibits that highlight how we can journey to a more sustainable future – and what our role is in achieving that low-carbon world.

Linking to science and geography curriculum topics, a visit to this gallery is ideal for KS3 and KS4 pupils.

Open for group visits from 15 April 2024.

bit.ly/AdaniGallery

Upcoming events…

For the latest information on IOP events, see **spark.iop.org/events**

IOP Scotland summer events

Thursday 23 May

The 49th IOP Stirling Physics Teachers' Meeting
Stirling Court Hotel

The annual conference for physics teachers in Scotland will have its usual mix of sessions on cutting-edge physics and on improving the teaching and learning of physics in the classroom as well as an exhibition of resources.

See **iop.eventsair.com/stir2024/** for details and registration.
Early bird registration deadline is 21 March.

Friday–Saturday 24–25 May

IOP Scotland/SSERC Raising Attainment in Physics course (formerly known as the Physics Teachers' Summer School)
SSERC, Dunfermline

This is a slightly revised two-day version of the previous summer school. It takes place immediately after the IOP Stirling Meeting. Unlike recent years, it is not included as part of the 'Summer School' package but may be booked separately with IOP.

Register your interest at **bit.ly/IOPScotlandSSERC**

Physics Partners

Physics Partners summer regional conferences

These one-day events are aimed at non-specialists and will be filled with workshops for KS3 and KS4 teachers:

Saturday 29 June
East Midlands Festival of Physics
The Kimberley School, Nottingham
physicspartners.com/EastMidlands2024

Saturday 6 July
Winchester College Festival of Physics
physicspartners.com/events/Winchester2024/

Spark curiosity and excite your class with science and engineering at The #BigBangFair. Experience hands-on activities, careers panels and incredible shows that will leave you on the edge of your seat.

thebigbang.org.uk/the-big-bang-fair/

ASE spring events

ASE runs a CPD programme for teachers and technicians. ASE members receive up to 50% off. Full details at ase.org.uk/Events

Thursday 14 March
Technicians Leadership: Working with and training others
Online

Friday–Saturday 15–16 March
ASE South East Asia Conference
Bangkok

Thursday 18 April
Technicians Leadership: Organising your technical service
Online

Thursday 2 May
Technicians Supporting Physics
Online

Wednesday 5 June
Leading the Design of Science Curriculae for Pupils
Online

Friday 7 June
ASE Northern Ireland Conference
Belfast

Saturday 8 June
ASE Scotland Conference
Online

Friday 21 June
ASE Futures Conference
London

Seen elsewhere…

History of Earth's magnetic force revealed in ancient bricks

Iron oxide particles found in ancient clay bricks from Mesopotamia have enabled scientists to plot the history of changes to the Earth's magnetic field, based on which ancient king made the brick.

bit.ly/MesopotamianBricks

Credit: Pexels

Physics, maths and geography for a career in climate change mitigation

This case study from the Royal Geographical Society profiles Sally Brown, principal scientist in flood risk and climate change adaptation at the Environment Agency.

bit.ly/RGSProfile

Credit: Pexels

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