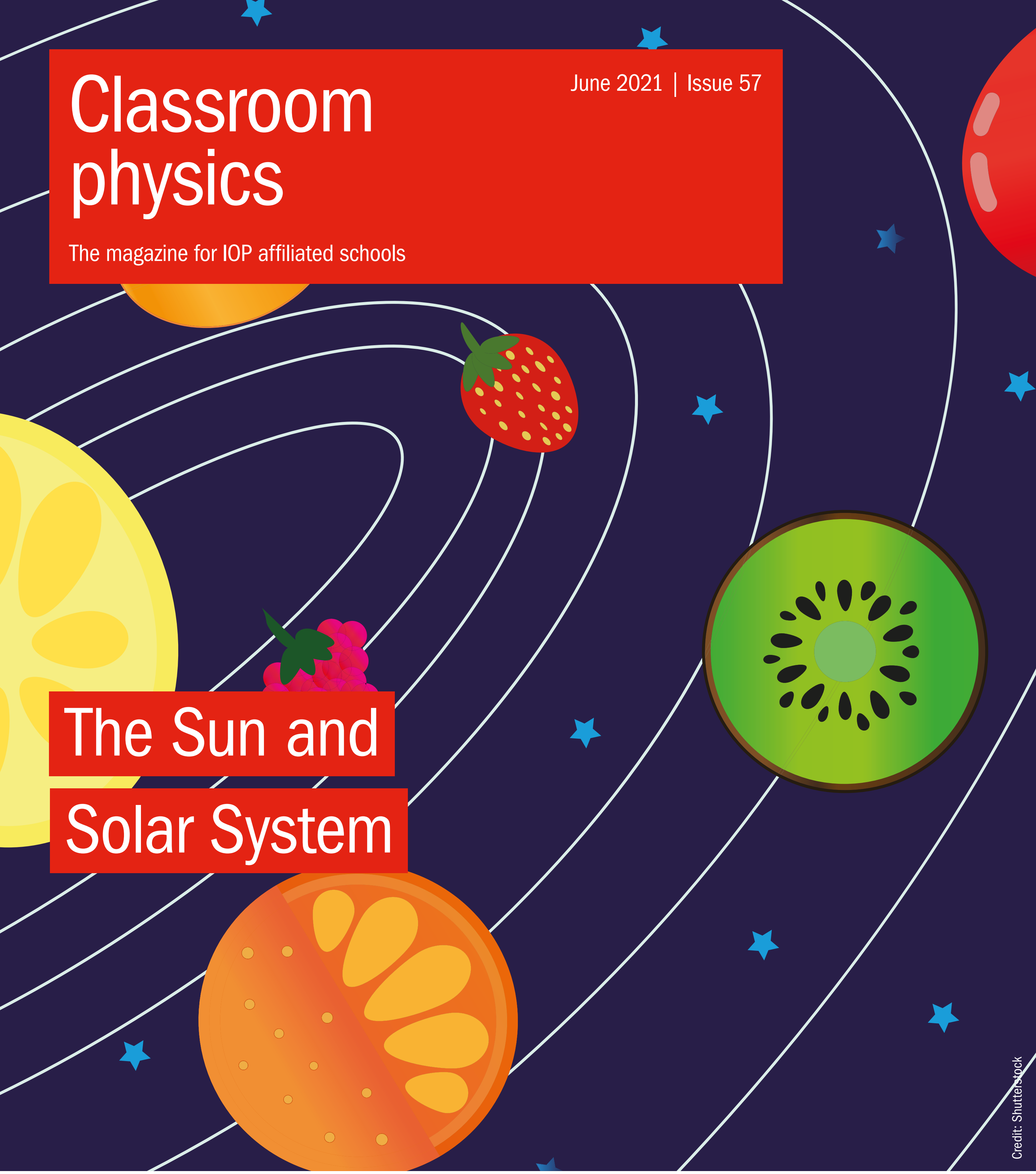
June 2021 | Issue 57

Classroom physics

The magazine for IOP affiliated schools



Credit: Shutterstock

The Sun and Solar System

Addressing student misconceptions

A solar scientist talks about her job

The toilet roll solar system

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This issue

News

3 Addressing misconceptions in physics

4 Postcards from Space

5 IOP book recommendation

Feature

6 Up close and personal with the Sun

7 A solar scientist

Resources

8 Knowing and explaining in the context of Earth and space

9 - 12 The Sun and Solar System pull-out

13 Stories from physics

Digests

14 - 15 Physics Education

16 TalkPhysics & Physics World

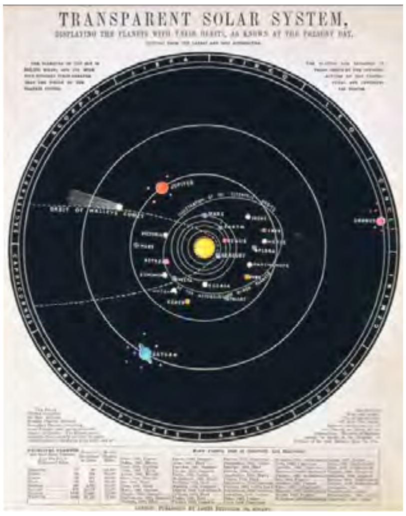
17 Education in Chemistry & CLEAPSS

Listings

18 Opportunities

19 Remote teaching and learning resources

20 Events listing



Draw the Sun: this image is one of a selection from the Science Museum's collection. It was used as an example in a recent online workshop chaired by Imperial College artist and physicist Geraldine Cox to encourage young people to make solar artwork **greatexhibitionroadfestival.co.uk/explore/families/draw-sun**

Astronomical Diagram Transparent Solar System, circa 1860

Bring some sunshine into the classroom

As we approach the end of a second disrupted academic year, we are beginning to see rays of sunshine emerging. Like you, we sincerely hope that this is the last time teachers will have to end the school year with the pressure of assessing students who have been unable to sit public examinations.

We have missed being able to meet you in person at our teacher workshops. We look forward to being able to offer face-to-face help and support again very soon, getting hands-on with practical kit together and networking. But over this year we have also learned new ways of working which enable more teachers to join our events. In future, our teacher CPD offering will be a blend of online sessions and videos with traditional live events held at local venues. Turn to the back page for more details of our teacher CPD offering.

In anticipation of summer, we have chosen the Sun as part of the Earth in Space topic as the focus for this edition of Classroom Physics.

The Sun is central to our lives from the very beginning, so it's not surprising that by the time they reach secondary school, many students have confused ideas about our star. Our new set of Earth and Space misconceptions (page 3) will help you untangle this thinking.

We look at Sun observation from Earth (page 3) and from space via NASA's Parker Probe (page 6). We also probe IOP member and renowned solar physicist Dr Helen Mason (page 7) about her career and ask her advice for any aspiring sun scientists. Our central pull-out contains activities for the classroom, including the classic toilet roll solar system activity (page 11). For software to enable weatherproof astronomy (page 15) as well as a clever way to explore the Sun with a tuning fork (page 14), visit our Physics Education digest.

Wishing you a good end to the term and a relaxing summer break.

Caroline Davis
Classroom Physics editor

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With this issue...

Stories from Physics: astronomy and space
The seventh booklet in our series. For more see **spark.iop.org/stories-physics**

Postcards from Space
A free set of resources for teaching space. 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.**

Addressing misconceptions in physics

Identifying, addressing and challenging misconceptions held by students are essential to teaching physics well. Former physics teacher Jessica Howell manages the IOPSpark Misconceptions resources and explains how they can help in the classroom.

A central purpose of physics education is to develop students' understanding of the most fundamental explanations for how the universe behaves. Despite a teacher's best efforts to nurture this, students sometimes do not grasp certain ideas in physics.

Decades of research has delved into students' thinking around these ideas. Notably, Rosalind Driver suggested that students form their understanding of the world through observations and experiences, making a model of misconceptions for their world that is based on common sense but is not always correct (Driver, R et al. 1994). Furthermore, Schaefer stated that if the ideas taught at school are not related to students' everyday lives, they may not grasp the concepts properly and instead just learn isolated 'packages' of information (Schaefer, 1979 in Cimer, 2007). Therefore, students must become unsatisfied with their prior theories and be open to viewing the world in a different, sometimes analogical way (Nussbaum and Novick, 1982; Posner, Strike, Hewson, and Gertzog, 1982; Driver et al, 1996 in Cimer, 2007).

Today, a key part of teaching physics involves identifying, addressing and challenging misconceptions or incorrect theories that students hold. To make this less time-consuming in lesson preparation, the Practical Implications for Physics Education Research (PIPER) team have been reviewing the literature and compiling a list of common misconceptions complete with diagnostic questions and resources to address the ideas.

more...

spark.iop.org/misconceptions

spark.iop.org/conducting-research-using-piper-resources

Earth and Space misconceptions

Examples from our newest collection:

- Most pupils think it is cold in the winter because the Sun is further away from the Earth
- Some pupils think that all stars are the same size
- Some younger pupils may hold the belief that the Sun travels around the Earth
- Some pupils have ideas that the Sun gets covered and that is what causes night

IOPSpark misconceptions
What you'll see:

- a summary of the misconception and, where possible, a longer description with information pulled out from the literature about ways the misconception may appear in students
- where available, relevant diagnostic resources from the IOP and York University's BEST (Best Evidence Science Teaching) and EPSE (Evidence based Practice in Science Education) projects
- IOPSpark teaching resources to address the misconception
- detailed references from each study, distilled into a form with suggestions and comments from our review team.

IOPSpark misconceptions
Topics covered:

- Forces and Motion
- Electricity and Magnetism
- Energy and Thermal Physics
- Light, Sound and Waves
- Earth and Space
- Quantum and Nuclear Physics*
- Properties of Matter*

(the sections are due for completion by autumn 2021)*

Share your students' misconceptions

Studies into students' misconceptions mainly took place between 1980 and 2010. While many of the findings are still current, a changing environment and curriculum mean new ideas will have developed that fit with students' understanding of the world around them today.

We want to make sure all these ideas are captured – and this is where you come in. Please submit the misconceptions that your students hold so we can add them to our bank on IOPSpark.

bit.ly/IOPmisconceptions

Postcards from Space

Each IOP Affiliated School will have received a set of 12 postcards with this edition of *Classroom Physics*. They were created by Miles Hudson, PGCE physics tutor at Newcastle University.

Aimed at older primary and younger secondary students, the PostcardsFromSpace deliberately extend beyond the statements of the National Curriculum to offer greater depth and breadth. Each card links to a web page which includes additional information, animations, videos and activities to extend students' learning. Developed during lockdown, Miles ensured equipment requirements are minimal.

He suggests the cards could be particularly useful for Science Clubs, delivering more than a term's worth of activities. The range of space objects and activities is large, so students could be set to work with different ones and cross compare, or the group could all work from the same card and steadily progress along the journey together.

Written as postcards from a friend, junior astronaut Tanno and his faithful dog Iguda, the informal writing style makes them highly accessible and engaging.

Miles said, "The delivery of literacy in science was a cornerstone of their development from the outset. There are facts and figures, but the real world application of concepts comes through in the adventures that Tanno and Iguda have on their travels. Learning the size and surface temperature of Pluto is one thing, but what would it actually be like to walk on the frozen surface?"

PostcardsFromSpace.co.uk

more...

postcardsfromspace.co.uk

Follow **facebook.com/PostcardsFromSpace** for a daily Space Fact of the Day

Out-of-this-world research using neutrons

The Sun recently started a new solar weather cycle, Solar Cycle 25. As it enters the more active phase of its cycle – expected between now and 2025 – solar activity is likely to increase, resulting in a period of space weather that can have major impacts on technology on Earth and in space. Scientists at the Rutherford Appleton Laboratory (RAL) are investigating space weather and its effects on electronics.

Cosmic rays originate from both the Sun and from beyond our solar system. As they collide with the Earth's atmosphere, they produce high-energy particles, including neutrons, which can reach down to the ground. These cosmic ray neutrons can disrupt the normal operation of electronics and cause havoc in devices and systems.

The ISIS Neutron and Muon Source at RAL has a synchrotron that accelerates protons to 84% of the speed of light and fires them into targets to produce beams of neutrons. These neutrons are used in a variety of experiments from investigating superconductors to studying samurai swords.

ChipIR is a unique instrument at ISIS that mimics cosmic ray neutrons to test the effect of these high-energy particles on electronic devices. ChipIR has been used to test electronics critical to systems in aircraft, satellites, spacecraft, autonomous vehicles and even the internet, revealing their vulnerabilities.

Recently, ChipIR and its fast neutrons were used in an unusual, out-of-this world experiment: investigating simulants of moon dust for use as radiation shielding for future lunar habitats, crucial for establishing manned bases on the Moon.

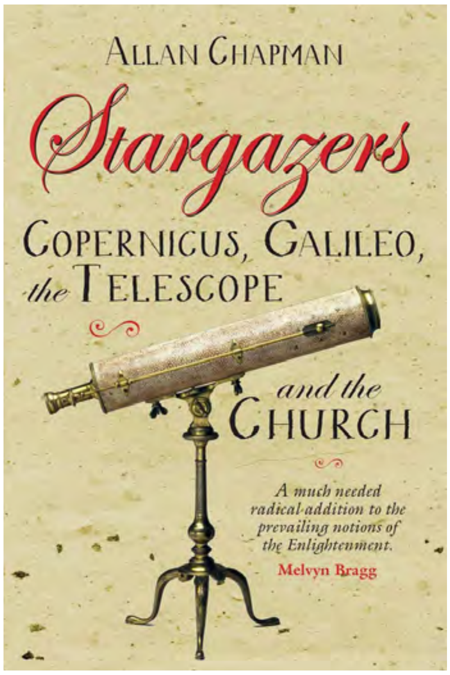
more...

Find out more about this experiment and explore Space Science Research at ISIS at **bit.ly/ISIS-ScienceStories**

The Rutherford Appleton Laboratory (RAL) is a national scientific research laboratory operated by the Science and Technology Facilities Council. RAL regularly hosts tours and workshops for teachers and school students. Email **visitRAL@stfc.ac.uk** for more information.

IOP book recommendation

Stargazers: Copernicus, Galileo, the Telescope and the Church by Allan Chapman



Reviewed by Mark Whalley,
IOP Education Manager

This is an excellent book for anyone interested in the history of astronomy. Very well written by one of the leading experts in the field, you will definitely be pleased you've read it!

The Scientific Revolution is often presented as starting with Copernicus and the publication of De Revolutionibus in 1543. It then proceeds through Kepler and Galileo and arrives at Newton. These four figures are understandably placed at the centre of the birth of modern physics and astronomy, but a focus on these alone misses so many stories and so much of the context.

Science does not exist in a vacuum. It is still often portrayed in Western thought as being pursued by lone geniuses dependent in no way on the world around them. This is simply a myth. Science exists and develops within historical, cultural, technological, economic and geographical contexts. In addition, there have always been many more people involved in science than most books give credit for: from the manufacture of the paper on which these giants wrote down their findings to the blowing of the glass from which they ground their lenses.

This is not the case in *Stargazers: Copernicus, Galileo, the Telescope and the Church,* by the historian of science Allan Chapman. He rightly gives a great deal of attention to the four central figures, but recognises and discusses the broader contexts of the time, a period of religious and political upheaval across Europe. This book adds colour and texture to the familiar stories and introduces us to the less well-known, but utterly fascinating, characters involved in astronomy in the period 1500-1700. For example, William Crabtree from Salford, Jeremiah Horrocks from Toxteth and William Gascoigne, the inventor of the micrometer, are all given their 15 minutes of fame, as well as providing extra local richness to the book.

If you enjoy this book, I would also recommend Allan Chapman's follow-up on the history of astronomy from 1700-2000: **Comets, Cosmology and the Big Bang: From Halley to Hubble: A history of astronomy from Edmond Halley to Edwin Hubble.**

Careers videos:

physicists addressing global challenges

Matthew Watkins is an Engineering Technician at Imperial College London. A former apprentice, he helps researchers with the design and manufacture of tailored parts for projects at the cutting-edge of technology, ranging from prosthetic legs for ballet dancers to prototype ion thrusters for spacecraft.

Raquel Velasco is the head of product for an artificial intelligence start-up. She helps cities and councils improve the way they manage the movement of people and traffic. In particular, she has been part of a team which developed an AI-based system to improve traffic lights. It is important to her that what she does has a positive impact on both individuals and society.

These are just a couple of examples of the 12 physicists who took part in a series of recorded panel discussions organised for schools by the IOP during National Careers week in March 2021. They are part of our Limit Less campaign to support young people to change the world and fulfil their potential by doing physics.

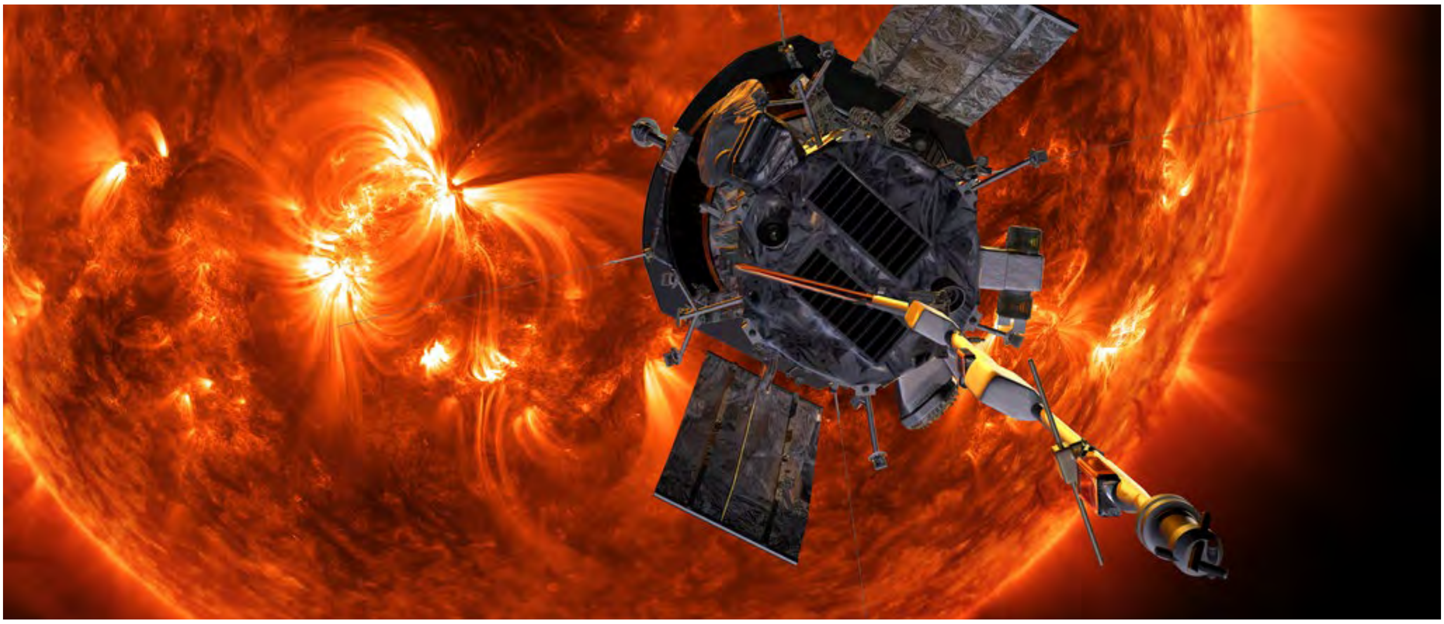
The recordings are great for use in the classroom. They bring together relatable role models from across the UK and Ireland to discuss the role of physicists in tacking global issues in climate change, robotics & artificial Intelligence (AI) and medicine. One student commented: "I enjoyed hearing about some of the speakers' personal experiences, it felt real and less like an advert for the industry."

Watched live by almost 1,000 teachers and students, the recordings include questions from students. They wanted to know more about what our panellists did day to day - their successes, their failures and their hopes for the future. They also used the opportunity to ask the panellists for advice. How can they get into coding? What are the good books and resources to read? And perhaps, most importantly, what to do in the case of a robotic uprising...?

more...

Watch the three panel discussions at **iop.org/careersweek**

Limit Less



Credit: NASA/Johns Hopkins APL/Steve Gribben

An illustration of the Parker Solar Probe approaching the Sun.

Up close and personal with the Sun

During the launch of NASA's Parker Solar Probe in 2018, headlines would have had you believe that the spacecraft was on a mission to touch the Sun. It will get close, very close in astronomical terms, but no probe could handle a temperature of 5,500 °C and radiation spewing from the Sun's fiery surface.

Speeding ever faster and ever nearer to our home star, with the assistance of seven gravity kicks from Venus, the Parker Solar Probe's 24 looping orbits over its seven-year mission will end in a dramatic 700,000 km/h flyby. It will be the first spacecraft to graze the edge of the Sun's atmosphere – just 6.9 million km from the surface.

This may still sound far away, but beats all past efforts hands-down: the previous record of 43 million km was set by Helios 2 in 1976 (which the Parker Solar Probe smashed in January this year when it swept past 13.5 million km from the Sun).

Even 6.9 million km away, the spacecraft requires an 11 cm-thick carbon-composite shield to protect its instruments from 1,400 °C temperatures and deadly radiation. Its computer system also circulates water around the spacecraft and tucks solar panels behind the shield when necessary, allowing the instruments to stay at a cool 26 °C.

Why NASA wants to send a probe so close to the Sun is simple: the Sun's atmosphere, called the solar corona (the jagged ring you can only see during a total eclipse) still holds many mysteries that can only be solved close-up.

For decades, scientists have been stumped as to why the corona is so hot. Why does this thin atmosphere reach temperatures in excess of 1 million °C when the surface is so much cooler? They also want to know how the Sun produces space weather closer to home. The Sun drives a stream of high-energy particles, known as solar wind, in all directions across the Solar System. These particles jet past Earth at speeds up to 800 km per second, shaking Earth's magnetic field and scrambling satellites. Can we predict when the solar wind gets stormy so we can protect satellites?

To solve these mysteries, the small car-sized spacecraft is packed with four instrument suites that study magnetic fields, plasma and energetic particles, and image the solar wind. Data from these instruments are already helping scientists learn more about the corona and high-energy solar particles. And it is hoped that by the mission's conclusion in 2025, before the spacecraft meets its fiery end in the heart of the Sun, the Parker Solar Probe will have finally exposed some of the Sun's most elusive secrets.

Dr Benjamin Skuse
Freelance science writer

more...

For the latest updates, follow the Parker Solar Probe's blog: **nasa.gov/content/goddard/parker-solar-probe**

A student activity to explore the Earth's magnetic field: **spark.iop.org/earths-magnetic-field-activity**

A Story from Physics about early quantitative measurements of the Sun: **spark.iop.org/measuring-sun**

Early ideas about the solar system: **spark.iop.org/early-ideas-about-solar-system**

Credit: Henry Kenyon

Dr Helen Mason OBE

A solar scientist talks about her job

Dr Helen Mason OBE is a solar physicist and public engagement fellow at the University of Cambridge

"We live in an age which depends on technology. The Sun interacts with the Earth causing 'space weather' which can damage satellites, disrupt electricity transmission, harm astronauts and be problematic in many ways (it is high on the UK's National Risk Register). We need to understand our Sun better if we are to understand other astrophysical objects. We also need to understand how it interacts with the Earth's environment.

"I am involved in analysing space observations of the Sun, specialising in solar spectroscopy in UV and X-rays. I have worked on many solar space projects, most recently on SoHO (Solar and Heliospheric Observatory), SDO (Solar Dynamics Observatory) and Hinode. We have created an atomic database called CHIANTI which is used by everyone analysing solar spectra. We are able to determine the temperature, density, elemental abundances and motion of the solar plasma. We can then compare these to theoretical models.

"I work best with a team of people, with a variety of skills. Solar space observations require the skills of many different people. I like to think of myself as one piece in a jigsaw puzzle. On a daily basis, I help analyse new observations, discuss scientific results with my colleagues, do some calculations on a computer and write papers. It is very exciting when we get new results and a new understanding of a feature in the solar atmosphere.

"I have worked with collaborators all over the world, in particular the USA, Europe, Japan and India. I have spent quite a lot of time at NASA's Goddard Space Flight Center where SoHO and other spacecraft were operated. I have also worked closely with colleagues at the High Altitude Observatory, Boulder, Colorado and the Center for Astrophysics, Cambridge, Massachusetts. I have been fortunate enough to experience three total solar eclipses: Guadeloupe in 1998, the UK in 1999 and in 2017 as NASA's solar expert in the Great Smoky Mountains National Park.

"If your students are interested in a career in solar physics, I would advise them to aim for a BSc in physics or mathematics and look for options in space physics or astrophysics. During my physics degree, I did a dissertation on the solar wind during my physics degree and then a PhD at UCL on solar observations (eclipse observations), supervised by Prof Mike Seaton, who was one of the world's experts in atomic physics.

"For me, science is about asking questions, sometimes leading on to other questions, and space science really encourages this."

more...

Listen to Helen's BBC Radio 4 In Our Time about the Solar Wind, just before the launch of Solar Orbiter: **bbc.co.uk/programmes/m000dg9n**

Watch Helen's interview with the Royal Institution, *A closer look at our Sun* **youtube.com/watch?v=eptVGN9XQ68**

Helen received the Royal Astronomical Society's Annie Maunder Medal for Outreach in 2018.

SunSpaceArt links scientists and artists in schools

Dr Helen Mason's latest project, SunSpaceArt, brings together a team of scientists and artists to work with upper primary and lower secondary age students. The aim is to develop creativity and encourage innovation.

"Astronomy and space science simply grab the imagination!" explains Helen. "Our workshops explore what the Sun means to us here on Earth, how it is just a star like many other stars in the sky, how it was born and will eventually die. We think about how beautiful but fragile our Earth is, as seen from space and how we need to look after it. We think about the possibility of life existing elsewhere in the universe."

She says that linking science and arts as a cross-curriculum activity both develops creativity and reinforces the science learning. She adds: "It builds confidence in students when they present their work to the rest of the class and sometimes to the whole school. Teachers have found that students with Special Educational Needs respond particularly well, with longer than average attention spans and interest."

The SunSpaceArt website has activities including worksheets, blogs and videos. Until March 2020 activities were delivered 'in person'. Then the project had to move online with virtual workshops. This actually enabled us to reach many more students and to involve more scientists, educators, artists, musicians, poets and even a dancer.

more...

SunSpaceArt is funded by the Science and Technology Facilities Council

sunspaceart.org

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.**

Knowing and explaining in the context of Earth and space

From 24 hours to 365 days and from MVEMJSUN* to OBAFGKM, learning about the features of the universe may not seem to hold the same conceptual challenges that, for example, Newton's Laws demand and can slip into recall-only territory.**

However, supporting students to develop a meaningful understanding of the complex, multi-bodied, three-dimensional motions of astronomical objects beyond rote memorisation, presents many challenges. Justification of ideas can be problematic – can you convincingly provide evidence, from your own experience, that the Earth ***does*** go round the Sun?

Steinberg, Cormier and Fernandez carried out research to explore how American high school students (14-16-year-olds) were able to justify their answers to the question: *Which of the following do you think best approximates the relative motion of the Earth and the Sun?*

A. The Sun goes around the Earth.
B. The Earth goes around the Sun.
C. Neither A nor B are correct.
D. I do not know.

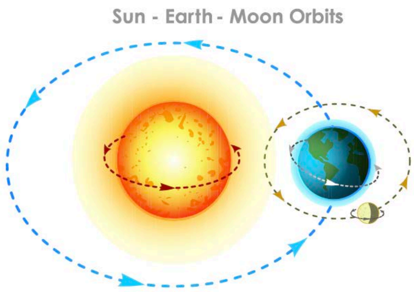
As best as you can, provide a proper and complete scientific argument for your answer.

Most students selected the correct answer (B=93%) and the researchers focused on students' ability to provide a 'complete scientific argument'. Responses were assessed on a scale from:

(1) Students use jargon, authority, circular reasoning or irrelevant observations or experiments.

to:

(5) Student cites observations or experiments distinguishing between two models and supports choice with proper explanation relevant to their answer.



Credit: Grayjay at Shutterstock

The quality of explanatory responses was initially consistently low and the researchers implemented a teaching intervention to support students' scientific argumentation with the following aspects:

- Teachers emphasise the process of science, rather than the presentation of facts.
- Students are asked to build models of the Earth and Sun's motion with balls/nails/torches and then to justify observations.
- Students are not given the answers but are guided to develop explanations for their observations.
- Students are constantly asked to justify, explain, reason and interpret.

After the intervention, there was a significant increase in the quality of students' correct scientific justification for their answers. In addition, the students scored well on a task asking them to explain a context not covered in the course (black holes).

As with all studies, caution is needed in suggesting that this is the correct/best/only way to teach. However, the paper contains useful aspects including:

- a rubric to assess the quality of student explanations
- suggesting a correct answer, by itself, does not indicate full understanding and so teaching and assessment should focus on students' explanatory abilities
- a teaching approach to support students' explanations.

* Order of the planets from the Sun
** Classification of the stars by their spectra and temperature

more...

The paper, *Probing student understanding of scientific thinking in the context of introductory astrophysics,* is freely available at **doi.org/10.1103/PhysRevSTPER.5.020104**

Pull out and keep!

The Sun and Solar System

This pull-out gives suggestions for ways to explore the Sun and the Solar System

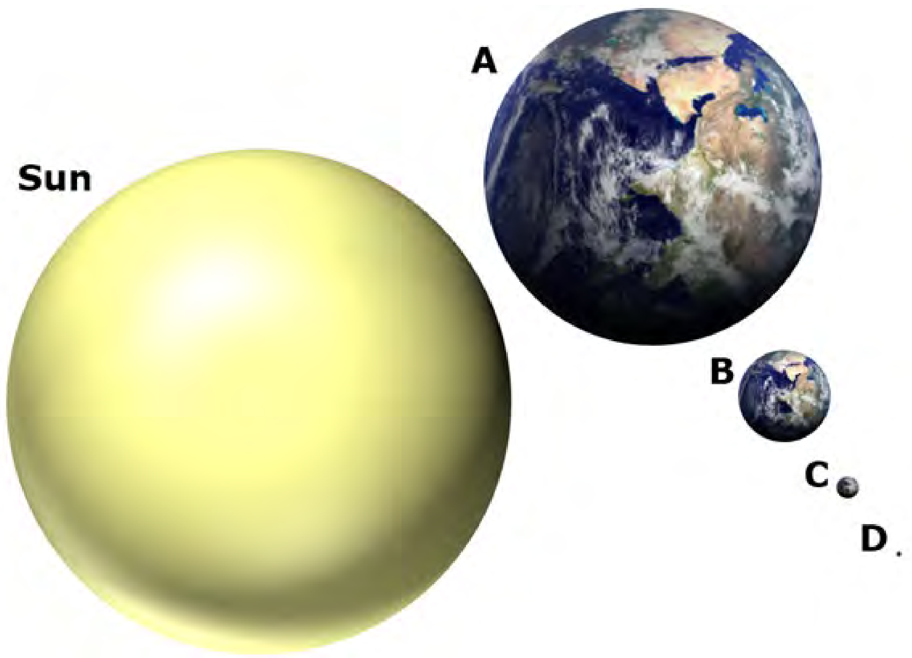
- Activity: Colour and temperature of stars for 11 - 14 year olds
- Demonstration: Stellar convection for 14 - 16 year olds
- Student worksheet: Toilet roll solar system

The Solar System to scale

Space is very, very big and hard to imagine. It is so big that an accurate picture of the Solar System does not fit into a book and pictures that we see of the Solar System are usually wrong.

It can be tempting to teach this topic in a way that is simple and descriptive, when in fact the scales involved are conceptually demanding. The fact that diagrams in books and on posters are often poorly drawn and not to scale can lead to persistent misunderstandings about planetary sizes and interplanetary distances.

Adapted from ***The*** **size of space** *- a Best Evidence Science Teaching Resource*



How big is the Earth compared to the Sun? A question from the BEST *The size of space* diagnostic resource

Creating a scale physical model is a fun and memorable way to address this. For a model made out of fruit that shows the relative size of the planets and their distances from the Sun, you'll need an outdoor space at least 11 m long, a 15 m long tape measure and the fruit listed in the table below. Emphasise that the scale for the size of the planets is not the same scale as that used for the distance between them.

As an alternative, the worksheet on page 12 talks through building a model at home using a roll of toilet paper and a few sheets of A4 paper.

Also included in this pull-out is an activity to help students better understand how the colour of the Sun is linked to temperature and a demonstration to show the role convection plays in its appearance.

Planet	Fruit	Distance from sun / cm
Mercury	Cherry	12
Venus	Plum	22
Earth	Plum	30
Mars	Larger cherry	46
Jupiter	Watermelon	155
Saturn	Coconut	285
Uranus	Apple	574
Neptune	Orange	900

more...

Download the full BEST resource including diagnostic questions at **spark.iop.org/solar-system-scale**

Watch our toilet roll solar system video at **iop.org/episode-11-toilet-roll-solar-system**

Build a fruit solar system at **spark.iop.org/building-model-solar-system-fruit**

Activity: Colour and temperature of stars (11-14)

In this activity, students use a variable resistor and an incandescent light bulb to illustrate how the colour of a star is related to its temperature.

Equipment

Each group of students will need:

- Power supply
- Incandescent bulb (with rating matched to power supply
- Variable resistor
- Connecting wires

Procedure

Ask students to:

1. Connect the power supply in series to the variable resistor.
2. Adjust the variable resistor so that voltage across the lamp is low. The lamp should glow red.
3. Slide the variable resistance to increase the voltage across the bulb. It should now glow with an orange colour.
4. Slide the resistor so that the voltage across the bulb is a maximum. It should glow white.

Teachers' notes

A school hall or theatre can be a good place to demonstrate this change in colour as lights are dimmed.

Students will have seen that when a lamp has a small current passing through it, the light emitted is red or orange. However, most will not have thought that this could be related to why cooler stars are redder or why hotter stars are whiter.

In this activity, the current through the lamp is increased by reducing the resistance of the variable resistor. Increasing the current increases the temperature of the bulb and this means that as well as glowing more brightly, the bulb will change its colour. Emphasise that there is a direct link between temperature and the colour of light emitted.

Discuss how our Sun's surface temperature (5,500°C) means that it glows white hot. Cooler stars glow red. Although not possible to demonstrate with this experiment, you may also want to discuss that stars hotter than our sun glow blue hot.

more...

Watch the video at **spark.iop.org/colour-and-temperature-stars**

Our violent and brilliant Sun

Solar physicist Lucie Green reveals her lifelong fascination with our nearest star and explains how space telescopes allow us to see it in greater detail than ever before. Explore how solar missions reveal sunspots, solar flares and coronal mass ejections, and what effect such violent phenomena can have on our life on Earth.

Find this video and more to support teaching astronomy and space at **spark.iop.org/astronomy-and-space-videos**

Lucie Green explains that the Sun is the power source for the entire solar system in her video *Our violent and brilliant Sun*

Demonstration: Stellar convection (14 - 16)

In this demonstration, students see that if there is temperature difference between the bottom and top of a coloured liquid, the top surface moves. You can use it to introduce solar convection.

Equipment

You will need:

- Electrical hotplate
- Flat-bottomed aluminium food tray or pie tin
- 5 coins of the same denomination
- 50 ml liquid soap (eg moisturising face wash)
- A few drops of red food colouring
- 500 ml of water
- Torch (or other white light source)

Preparation & safety

The liquid soap/shampoo will need to contain **glycol stearate, glycol distearate or glycerol stearate** in order to make the convection cells visible. Moisturising products with a pearlescent appearance often contain one of these. Check ingredients on the bottle.

Be careful not to touch the hotplate when it is turned on. The liquid temperature should not exceed 50°C (check with a thermometer).

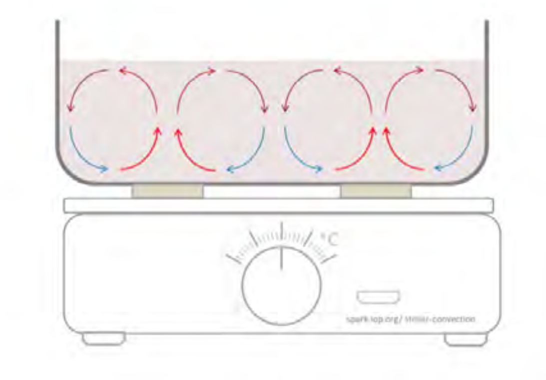
Procedure

Ask students to:

1. With the hotplate off, place the five coins in a cross pattern on top of the plate.
2. Place the food tray on top of the coins.
3. Pour in cold water until the tray is half full.
4. Add 50 ml of liquid soap and a few drops of food colouring; mix well using a finger.
5. Switch the hotplate on to a low setting. Leave for a few minutes.
6. Shine a torch at an angle onto the tray to make it easier for the students to see the water rise and sink.

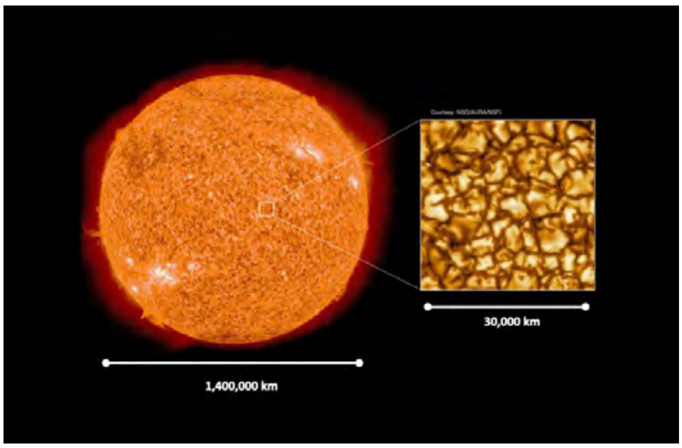
Teachers' notes

Students may talk about heat or energy rising. Emphasise that neither energy nor heat are substances. Convection is a mechanical process that it is best described in terms of fluids at a higher temperature expanding and floating, and then cooling and sinking. In this experiment it is driven by the hotspots created by the coins at the bottom of the tray.



The columns of rising and falling fluid are called **convection cells.** When we look down on the tray we see the top of the cells: the liquid appears as it rises to the surface, moves across the surface and then disappears at it sinks back below. The process is a repeating one so the water gets circulated continuously as long as there is a temperature difference between the bottom and top.

Link the demonstration to stellar convection by providing an image of the Sun's surface. The giant granules they can see are the top of very large convection cells formed by plasma rising upwards from the hot interior to the cooler surface.



A close up of the Sun's surface

more...
Watch the video and download the resources at **spark.iop.org/stellar-convection**

Do Try This at Home
From the Institute of Physics

Toilet Roll Solar System

This activity takes the 4.5 billion kilometres from the Sun to Neptune and squishes them onto a single loo roll. On this scale most of the planets are too small to see – so you will have to cheat and make them 100 times larger than they should be.

How long this activity takes

Estimated time: 1 hour

What you'll need

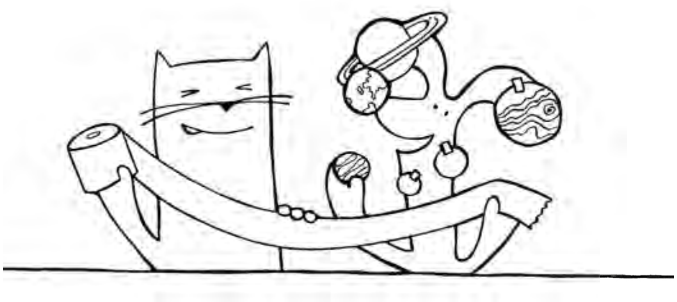
- A fresh roll of toilet paper with at least 150 sheets
- Felt tip pens or colouring pencils
- Ruler
- 6 sheets of A4 paper
- Scissors
- List of planet sizes and distances (below)

What to do

1. Make your Sun and planets

a) Make your oversized Sun by sticking together six A4 sheets of paper to make a 60 cm square. Then draw a circle that's 60 cm across and cut it out.

b) Make your planets using the cut-offs using the guide below. Colour in and label each planet.



Planet	Diameter	Colour	Number of toilet roll sheets from Sun
Mercury	2 mm	Brown	2
Venus	5 mm	White	3 ½
Earth	5 mm	Blue and green	5
Mars	3 mm	Red	7 ½
Jupiter	62 mm	Brown stripes with red spot	26
Saturn	50 mm	Brown with rings	47 ½
Uranus	20 mm	Light blue	95
Neptune	20 mm	Dark blue	149

2. Build your Solar System

a) Start with the Sun and place the loo roll at the edge. The start of the toilet paper is the start of space.

b) Unroll the loo roll and stick down Mercury at the right distance from the Sun (two sheets).

c) Then do the same for all the other planets. Remember to keep track of how far you've gone!

d) Roll up your Solar System and treasure it forever.

What next?

Remember that the Sun and planets are all 100 times too big for the toilet paper. Why not make everything to the right scale by going for a 2 km walk or bike ride?

- Make an extra set of planets exactly the same size as above
- Start at your house or a local landmark
- Plan your route using the Solar System Model Map at **bit.ly/CPsolarmodel**

more...

You can watch a video at **iop.org/episode-11-toilet-roll-solar-system**

Hypatia's astronomical achievements

Hypatia of Alexandria made significant contributions to philosophy, mathematics and astronomy during the third to fourth century of the common era. While her father's research is now seen as of limited originality (he was also a mathematician), Hypatia has had an enduring legacy. She developed approaches to long division that were used to compute astronomical tables, in particular an approach to the calculation of the arc swept out by the Sun in a day. Hypatia taught students and gave public lectures on philosophy, becoming a popular figure who commanded significant political influence. On the death of Theophilus, the bishop of Alexandria, Hypatia took a stance against Theophilus' nephew and successor, Cyril. Cyril's supporters spread false rumours that Hypatia was a practitioner of black magic. The smear campaign enflamed a mob of angry Alexandrians, who dragged Hypatia from her carriage and murdered her with roof tiles or oyster shells (translations vary). Hypatia has been honoured with an asteroid and a lunar crater being named in her memory.

The unresolved elliptical wager

On 24 January 1684, at an evening meeting of the Royal Society, Christopher Wren, Robert Hooke and Edmond Halley discussed Halley's idea that the inverse square law would explain Kepler's third law of planetary motion, namely that the square of a planet's orbital period is proportional to the length of the elliptical orbit's longest diameter cubed. Wren was intrigued by the idea and offered a prize that would delight any scholar – books to the value of 40 shillings (equivalent to £1200 today). In a move that must have prompted scepticism from his colleagues, it is reported, 'Mr Hook[e] than sd [sic] that he had it, but that he would conceale [sic] it for some time that others triing [sic] and failing, might know how to value it, when he should make it publicly'. The first deadline for the bet, the end of March, passed without Hooke or Halley claiming the prize. In August, Halley travelled to Cambridge to discuss the issue with Newton. Echoing Hooke, Newton claimed he had already completed the proof, but it had been lost. Newton, however, followed up on his claim, writing a nine-page manuscript (*On the Motion of Bodies in Orbit* or *De Motu* for short, in its Latin version) which he sent to Halley in November. De Motu contains derivations of Kepler's Laws and would form the basis of Newton's *Principia Mathematica.* Whether the 40 shillings worth of books were awarded is not known.

The Brunel sibling birthday alignment

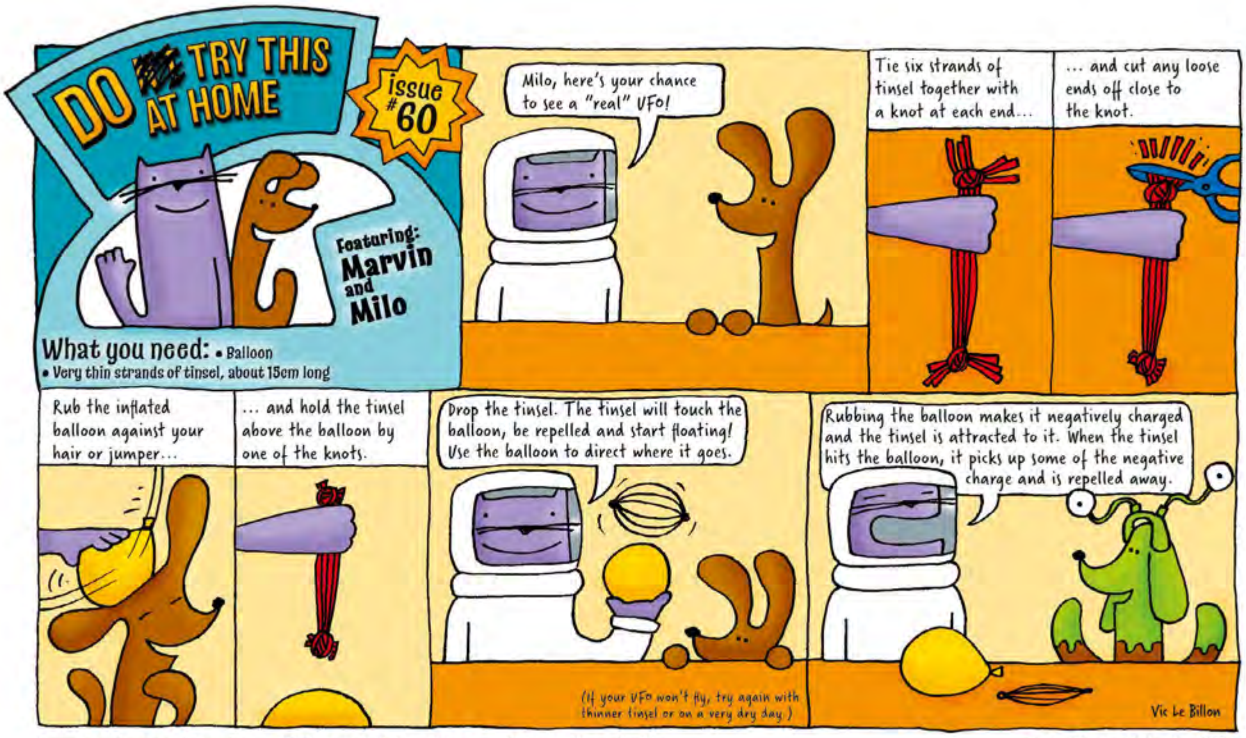
In 2020, the Guardian newspaper reported attempts to investigate the claim that the engineer Isambard Kingdom Brunel had aligned the two-mile-long Box railway tunnel (located close to Corsham, Wiltshire) so that the rising Sun would shine through it on his birthday. When the tunnel closed for engineering works in 2017, disappointed observers noted that the alignment of the Sun's rays with the tunnel on 9 April was good, but imperfect. A retired physicist and engineer, Peter Maggs, has since explained the misalignment by noting that Brunel's sister, Emma Joan, was born on the 6 April and has speculated that the tunnel is aligned for her birthday, not her brother's.

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**



Download more Marvin and Milo activities at iop.org/marvinandmilo

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 **the Sun and solar system** from the archive and the current volume

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

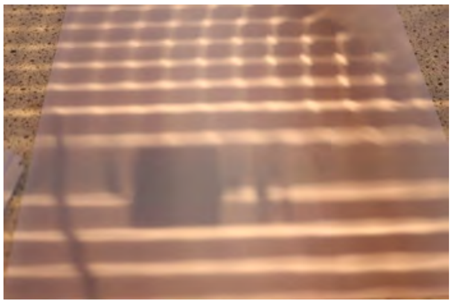
Affiliated schools have free access – email **affiliation@iop.org** for a reminder of your log in details.

Teaching waves: two distinct kinds of displacement

Within the archives are a number of articles from a physics educator by the name of John Warren. These articles are always stimulating and this short letter from 1980 on the teaching of waves is no exception:

"A fundamental fact, which rarely receives sufficient emphasis, is that each kind of wave involves two distinct types of disturbance of the medium. An electromagnetic wave transmits equal amounts of energy through its electric and magnetic fields. A sound wave has oscillations of both pressure and particle velocity. Surface waves in liquids are combinations of horizontal and vertical movements, that is the waves are both longitudinal and transverse. Vibrating strings have transverse motion and oscillation of tension. Any account of stationary waves should take account of this."

Read the letter at **bit.ly/PEDwaves80**



Credit: Alexander Gold at Shutterstock

In the ripple tank, which two disturbances are happening?

What happens next? On Facebook

Credit: David Featonby

If you compare the "outside" curve of one banana with the inside curve of the other, which the set up invites you to do, then the answer is confusing.

David Featonby's series of short *What happens next?* experiments is now on Facebook.

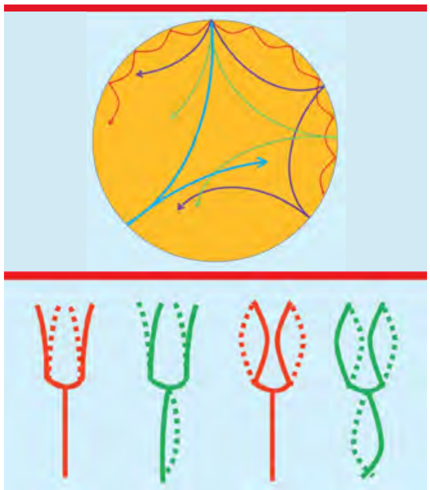
Each experiment uses familiar equipment and is stopped at a critical stage to see if what we think might happen really does. David reveals what happens the next day.

Access over 200 experiments on Facebook by searching for **What Happens Next Experiments** and requesting to join the group. You can also freely access experiments from the *Physics Education* archive at **iopscience.iop.org.**

Learning about the Sun with a tuning fork

Bringing together the topics of waves and the Sun leads on to a 2015 paper entitled *Teaching about mechanical waves and sound with a tuning fork and the Sun.* This took data from the SOHO satellite's recordings of the sound of the Sun and related this back to the teaching of sound. This is an interesting hook for older students mixing the use of technology to analyse the sounds in space and astronomy with some basic wave ideas.

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



Credit: Physics Education

The first four in-plane vibrational modes of a tuning fork and the propagation of rays of sound in a cross-section of the solar interior.

Teaching physics and the nature of science together

A paper quite different from everything mentioned so far is this one from Mick Nott from 1994. He looks at Brownian motion and uses it as a vehicle to try and get across some ideas concerning the nature of science. Brownian motion is part of the evidence for the existence of atoms presented to students, often quite early on in their secondary schooling. Linking Brownian motion and other evidence for the existence of atoms to the nature of science can provide a structured topic much like the *Children's Learning in Science Project* **(stem.org.uk/elibrary/collection/3069)** did a few decades earlier. This not only helps students learn about the existence of atoms but also scaffolds one of the ways in which science works.

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

Build a radio telescope

For something a little more hands-on, observations of the Sun are a way to do astronomy during the day, unless it's cloudy. There is surely some value in students understanding the impact of weather on back yard astronomy but when trying to teach a syllabus it's just a hindrance.

A radio telescope can solve some of these problems, not requiring the Sun to be visible to someone on the ground. In the paper *Space weather interference in Earth communications and construction of a small-scale radio telescope for Sun observation in radio waves using Arduino* the authors describe how to build a radio telescope using various readily available parts. It would be a stretch to describe this as an easy project, but the parts are not that difficult to source and I was surprised to find that I have many of them already just because I've purchased them at electronic stores out of wanting to have a play, for example, with a satellite finder.

bit.ly/PEDtelescope

Credit: Physics Education

The home-made radio telescope

Weatherproof astronomy

Teaching the astronomy side of schemes of work can be tricky because students are only in school during the day and the more easily visible objects of astronomical interest need a few hours more of the Earth rotating into its own shadow to be seen. One weatherproof solution is to enjoy some of the planetarium and space simulation software available - Stellarium **(stellarium.org)** and Celestia **(celestia.space)** are first rate and are well deserving of further investigation.

For ideas about what to do with it, read Vassilios McInnes Spathopoulos's papers about making the software show past astronomical events and even take measurements from them.

Using freeware planetarium software to simulate the astronomical measurements of ancient Greeks

bit.ly/PEDgreeks

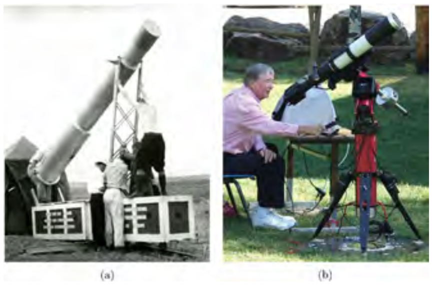
A set of student activities for the simulation of ancient and medieval astronomical observations

bit.ly/PEDancient

Bringing solar eclipses into the classroom

Many students will enjoy linking astronomy with the idea of expeditions: just as explorers chart unknown lands, astronomers explore phenomena we have yet to understand. I have vivid memories of travelling down to Plymouth with a party of students and other teachers to see the eclipse of 1999. We didn't see much of that eclipse but it was a very memorable expedition as we camped out the night before in a howling gale. Students can research these historically important expeditions online, but they can also access the database of experimental results presented in this paper *A century of light-bending measurements: bringing solar eclipses into the classroom* and explore the relevance of these astronomical observations to the world today.

bit.ly/PEDsolareclipses



Credit: Physics Education

Nowadays, Einstein's theory can be verified with high accuracy using cheaper and smaller equipment.

Quick Links

Measuring the speed of sound in air using a smartphone and a cardboard tube **bit.ly/PEDsmarttube**

Bend it like dark matter! **bit.ly/PEDdarkmatter**

The sound of music: determining Young's modulus using a guitar string **bit.ly/PEDyoung**

Clarifying misconceptions about Ohm's law and power dissipation in grid electricity transmission **bit.ly/PEDclarifyohm**

A simulation object with LabVIEW: simultimeter (simulated multimeter) **bit.ly/PEDlabview**

Commercial virtual reality headsets for developing augmented reality setups to track three-dimensional motion in real time **bit.ly/PEDheadsets**

talkphysics

Dave Cotton, editor of our online discussion forum, chooses his favourite TalkPhysics discussion threads on the Sun.

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

Credit: University of Chicago Photographic Archive apf6-00273

Margaret Huggins worked at the Tulse Hill Observatory in London

The Sun as a blackbody

I am currently exploring this idea of why the Sun's photosphere is an example of a blackbody and have a post on using the Sun as an example as a blackbody radiator to teach the concept both at GCSE and A level. Comments welcome!

bit.ly/TPblackbody

Sharing stories of women in physics

The IOP teacher CPD sessions resources are uploaded on TalkPhysics. A recent Sharing Stories of *Women in Physics* event included the story of Margaret Burbidge and her role in discovering stella nucleosynthesis. You can also find a presentation on Margaret Huggins's contributions to solar spectroscopy and how to make a spectroscope to use with your students.

bit.ly/TPsharing

The colour of the Sun and other stars

A teacher who was not a physicist asked for ideas for teaching blackbody radiation and this led to a long and fruitful discussion, with lots of suggestions for resources. It also gave me the opportunity to explain why there are no green stars – something I have always enjoyed doing!

bit.ly/TPthesun

Earth in space from the Welsh teachers' conference

The seasons, amongst other things, can be taught through a selection of simulations. You can find suggestions for this – plus many more great ideas for teaching this topic – on the page following up the Brecon 2020 conference.

bit.ly/TPbrecon20

physicsworld

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

Credit: Noctiluxx at iStock

Sunny superpower: solar cells close in on 50% efficiency

Researchers are working to improve the efficiency of multi-layer solar cells. Richard Stevenson explores whether their practical benefits are more likely to be realised in space than on Earth

For solar cells, efficiency really matters. This crucial metric determines how much energy can be harvested from rooftops and solar farms, with commercial solar panels made of silicon typically achieving an efficiency of 20%. For satellites, the efficiency defines the size and weight of the solar panels needed to power the spacecraft, which directly affects manufacturing and launch costs. To make a really efficient device, it is tempting to pick a material that absorbs all the Sun's radiation. That might lead you to build a cell out of mercury telluride, which converts nearly all of the Sun's incoming photons into current-generating electrons. But there is an enormous price to pay: each photon absorbed only produces a tiny amount of energy, which means that the power generated by the device would be pitiful.

Full article at **bit.ly/PWsunny**

Counting muons in schools

Andrew Ferguson is a device physicist. He used an IOP School Grant to work with pupils to teach them about muons, design a muon detector and install one in the school

"Primary-school children, and the rest of us too, are continuously being showered by unseen muons, a heavier relative of the more familiar electron. These muons are created when energetic cosmic rays, including protons and alpha particles, hit our atmosphere and produce a shower of particles as they slow down. Muons remain unnoticed unless you have the right equipment to look for them. I read about a US-based outreach project called Cosmic Watch. Started by particle physicists, it allows members of the public to make muon detectors for less than $100 and observe these tiny particles for themselves. At the heart of the detector is a silicon photomultiplier chip, which measures the few blue photons emitted by a plastic scintillator whenever a muon passes through."

Full article at **bit.ly/PWmuon**

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

Credit: MK Studio at Shutterstock

The science of sunscreens

As summer approaches, link sunshine with environmental concerns around sunscreens. There are two types of ultraviolet (UV) rays which reach the Earth's surface from the Sun. Long wave UVA light penetrates our skin causing wrinkles and sunspots. Short wave UVB light mostly attacks our outer layer of skin leading to sunburn and tanning. Both cause skin cancer.

Worldwide public health advice recommends liberal use of a broad spectrum sunscreen, for protection from both UV types. For decades, the reputation of sunscreens has remained remarkably clean. However, the tide of legislative opinion is turning.

Every year thousands of tons of sunscreen end up in our oceans. Research has indicated that some of the chemicals these products contain can be absorbed by corals, doing harm such as causing bleaching. Governments are starting to act, banning sunscreens containing certain chemicals.

Ingredients that are now banned include organic molecules, such as oxybenzone and octinoxate, that absorb UV rays and convert them into a small amount of heat. Sunscreens sometimes use inorganic molecules, such as zinc oxide and titanium dioxide, which mostly block or reflect UV radiation. There are environmental concerns around their use too.

So what is the alternative? One possibility is using larger particles of zinc oxide and titanium dioxide, another is natural organic molecules, for example shinorine.

Shinorine is used by some marine organisms to shield themselves from solar damage and can be extracted from a type of red algae harvested from the wild.

more...

Read the full article by Nina Notman and download a worksheet on the chemical structures in sunscreen for age range 14–16 from **rsc.li/3wEfLkJ**

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 **cleapss.org.uk**

Practical work on the solar system

Students are intrinsically curious about space, but it is an area of the curriculum which is often overlooked with respect to practical work. Teaching this area of physics is often left to models as the ability to do practical work is somewhat limited. However observations are very much possible throughout the school year.

CLEAPSS has a guide on telescopes and how they can be used to take pictures of the Sun, the Moon and planets. It discusses the difference between reflector and refractor telescopes, the different mounts for your telescope, the basics of astrophotography and more.

Credit: CLEAPSS

It is immensely rewarding to take pictures of objects in the solar system. This picture shows the transit of Mercury back in 2016 and we were very excited to capture this moment with a £150 telescope, a solar filter and a D-SLR camera. It is important to fit an appropriate solar filter in the telescope's aperture and, even after fitting, not to look down the eyepiece at the Sun. Special adapters can connect a D-SLR camera to the eyepiece, so one can use the LCD screen on the camera to look at the Sun.

It is also possible to capture images of planets: Jupiter, Saturn and Mars are all easily viewed with an entry-level telescope and photos can be taken with some very accessible equipment. With our budget telescope, we were able to make out Jupiter's moons and its giant red spot as well as Saturn's rings. Mars' polar ice cap is also visible.

The Moon makes an easy target too. Software can stitch together photos giving a nice composite image such as this one we took a few years ago, shown to the right.

Credit: CLEAPSS

more...

Search **science.cleapss.org.uk** for **GL187: Viewing the Cosmos** and **PS017: Viewing the Sun**

Sustainability Physics

This website (due to launch on 15 June 2021) shows how important physics is to the careers that will make a difference to our zero-carbon society of 2050.

There are seven general themes including:

- Building design
- Future energy stores
- Renewables
- Transport for our future

Each topic has interviews with people at the forefront of a low carbon future, from university researchers to innovators in business and industry. There are also videos for lesson starters or watching at home, plus interactive questions for students.

The site is pitched at GCSE-level, with sections of challenge for ambitious post-16 students. Focussing on north-west England, it provides opportunity for examples of Science Capital, but is suitable for students anywhere.

wp.lancs.ac.uk/sustainability-physics/

Join the launch at **bit.ly/IOPsustain**

The Ogden Trust
making physics matter


Frozen Life - Young Weather Photographer winner 2020
Kolesnik Stephanie Sergeevna

Weather Photographer of the Year

The Royal Meteorological Society's annual competition is now open for entries, with a youth category for 13-17-year-olds and a new mobile phone category. Whether you climb mountains, chase storms, scour coastlines or sit in your back garden capturing the wonder of weather on your camera, the judges want to see your photos. Photography is also a great way to document our changing climate and share your local story with the world.

Entries are free and close on 29 June 2021. Visit **photocrowd.com/wpoty**

Weather and Climate: A Teachers' Guide

Providing UK teachers with everything they need to deliver relevant, engaging and thorough weather and climate lessons to 11–14+ year old students. This new guide and its accompanying online, free teaching resources can be found on the Royal Meteorological Society's education website **MetLink.org**

RMetS

CHARTERHOUSE

PHYSICS

SUBJECT KNOWLEDGE ENHANCEMENT COURSE 2021

Free **residential* courses aimed at boosting Physics subject knowledge**

Week 1: Monday 5 July to Friday 9 July

Week 2: Monday 12 July to Friday 16 July

Experienced teachers deliver talks and supervised laboratory work covering the basics of Key Stage 4 and 5

**A topic introduction and lesson will be running each morning on Zoom for those unable to attend the residential in person, and pre-recorded videos covering the practical work will be made available*

CHARTERHOUSE SCIENCE DEPARTMENT

For an application form to register for the residential or virtual course email:
science@charterhouse.org.uk
Closing date: Monday 7 June 2021
Registered Charity 312054


Credit: fizkes at Shutterstock

Do you have a physics NQT starting in school this September?

Encourage them to register for the IOP's Early Career Professional Learning (ECPL) programme. We're offering support from friendly, experienced IOP coaches during your NQT's first two years of teaching: small-group mentoring and professional development (physics pedagogy, subject knowledge and practical work). Regionally based, so lots of opportunities to build local networks with peers and established teachers.

No cost to your NQT or your school.

Future NQTs can find out more & register **iop.org/ecpl** or email **ecpl@iop.org** for more details.

IOP Institute of Physics

Teaching & learning resources for remote/blended 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: BSA

BRITISH SCIENCE ASSOCIATION

CREST AWARDS

Investigative practical science in the curriculum: making it happen

Benchmark 8 in the Good Practical Science Guide (Gatsby, 2017) recommends that 'students should have opportunities to do open-ended and extended investigative projects', yet less than 25% of students have the chance to do so. The British Science Association has launched a guidance pack that explains how to embed investigative practical science into the secondary science curriculum.

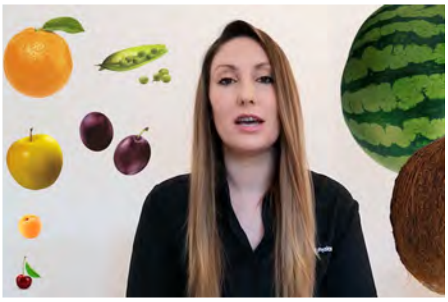
The pack is the outcome of a pilot study which followed ten schools to plan and deliver CREST Awards within curriculum time. The intention of the study was to enable all students to experience the benefits of investigative work, without staff having to supervise students during lunchtimes, holidays or after school.

The aim of the student-led projects is to:

- Provide students with a wider view of the scientific method, leading to less 'cookbook' practical work and a more realistic impression of how scientists operate.
- Extend investigations beyond an individual lesson in order to effectively sequence and retrieve procedural knowledge.
- Develop independence and resilience

The pack can be downloaded at **secondarylibrary.crestawards.org/investigative-practical-science-in-the-curriculum/65418842**

Teaching Earth and Space for all age groups



As we come to the end of an academic year like no other, we'll be uploading three videos about teaching Earth and Space, our final topic in the teacher CPD programme.

Watch the videos at **spark.iop.org/space-CPD-videos**

Book your sessions at **talkphysics.org/events**

The Scale of Space: 11 – 14s

Students often struggle with relative sizes and distances as well as the myriad of units used. We discuss ways to model the solar system and address the distances involved.

Redshift: 14 – 16s

We cover an aspect that students find fascinating but is not well understood: redshift. This video will give you some techniques to develop deeper understanding of spectroscopy, absorption lines and the expansion of space.

Understanding Stellar Radiation: 16+

This video continues the spectroscopic content. We discuss blackbody radiation as well as Wien's Law and the Stefan-Boltzmann law which both give us so much information about the universe we live in.

The IOP DOMAINS physics teacher CPD programme

The IOP DOMAINS online teacher CPD programme has been a great success. Each half term, we have focused on how to teach a particular topic on the curriculum, with live online CPD workshops coupled with accompanying videos. We have been delighted to see so many teachers and schools represented and the programme has established a regular following of teaching colleagues to our CPD sessions.

If you missed any of the topics, the videos are available online and can be watched anytime and as often as you like at **iop.org/domains**

Forces	**Energy & Thermal Physics**	**Electricity**
Matter & Nuclear Physics	**Earth & Space**	**Light, Sound & Waves**

Summer schools for NQTs

Do you have NQTs starting in September that are keen to improve their physics subject knowledge? Let them know about our online IOP summer school - a week-long programme covering some of the main KS3 physics topics and how to teach them including forces, electricity, energy and waves.

Running from 5th – 9th July and 16th - 20th August, find out more and register at
talkphysics.org/events/summer-school-july-2021
talkphysics.org/events/summer-school-august-2021

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

Scotland
Stuart Farmer
education-scotland@iop.org

Ireland
Lucy Kinghan
education-ireland@iop.org

Wales
Cerian Angharad
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England

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For support running CPD, contact our Professional Practice Group

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