Classroom physics

June 2024 | Issue 69

The magazine for IOP affiliated schools and colleges

Physics on screen

Putting you in the picture

The physics of film: science advisors, special effects and AI

Practical activities charting the evolution of the camera

Screens in teaching and learning: which approach works best?

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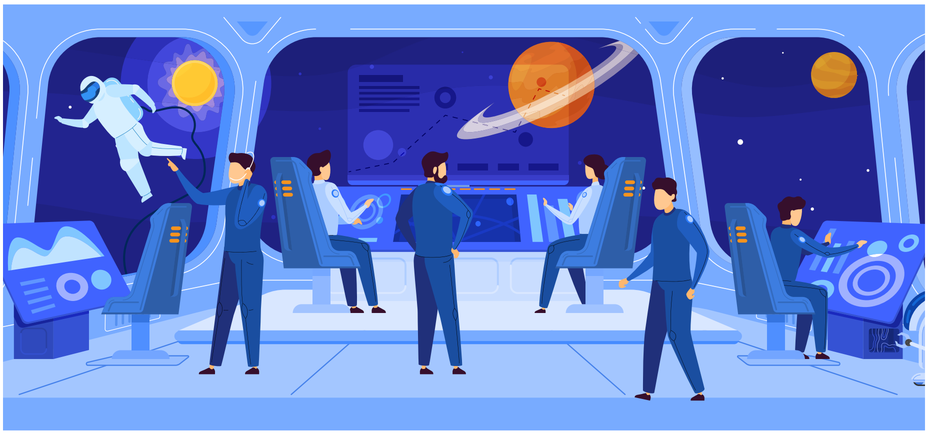
IOP Institute of Physics

This issue

Editors' note



Welcome to this summer blockbuster edition of Classroom Physics, where we celebrate physics on screen.

For this issue, we've had a lot of fun thinking about physics and the movies. With the huge success of *Oppenheimer* last year – and an Oscar-winnning portrayal of such a significant physicist – the world-changing role of physics was brought to life for millions of people. All this is important for perceptions of physics and public understanding of its impact.

Our lead feature (page 6) picks up on this theme with an article about the Nobel-winning physicist Kip Thorne, who has played the role of science advisor on a number of films, including *Oppenheimer* and *Interstellar*. But advice isn't the only thing people with physics skills can bring to a movie set. As our second feature (page 7) reveals, the rapidly advancing world of special effects, and related fields like computer games development, uses an understanding of physics to build computer models which simulate, and sometimes alter, real-world phenomena.

In our pull-out section (pages 9–12) we look at the camera. We've got practical activities that chart its evolution from the 11th century up to the modern day – from the pinhole camera, through the adoption of lenses, to digital devices.

We're grateful to the many partner organisations who have contributed a fantastic array of other resources, each of which considers creative uses of the screen in teaching and learning.

Be sure also to look out for a range of upcoming events during the rest of summer and into autumn.

Enjoy the holidays when they arrive, and we'll be back in the autumn with an issue on transportation.

Dan, Taj and the Classroom Physics team

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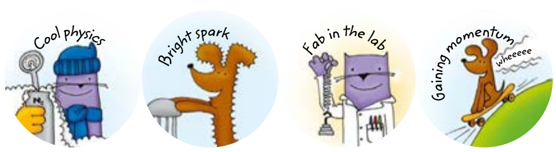
IOP affiliated schools and colleges will receive with this issue...

Our Marvin and Milo stickers – for rewarding students that are doing good work, gaining momentum in their studies or are fab in the lab!



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IOP activities round-up

The IOP has responded to some important education policy developments in recent months.

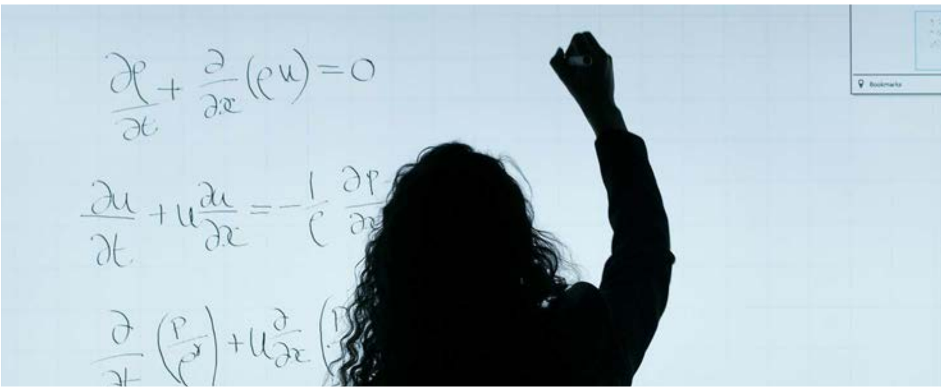
At the end of last year the Westminster government began consulting on a proposed new 'Advanced British Standard' (ABS) to replace A levels. The ABS would consist of three 'majors' including English and maths, and two 'minors'. A parallel 'ABS (Occupational)' would consist of a double specialism (equivalent to two majors), a single specialism equivalent to one major, minors in maths and English, an industry placement, and an 'employability, enrichment and pastoral' module.

Hari Rentala (Head of Learning and Skills) and Alex Heatley (Policy Advisor) took to the IOP blog in April to outline the IOP's response. While the extension of compulsory maths education is welcome, they "feel that if there is to be meaningful education reform, it needs to be more ambitious, holistic, and coherent than what is currently being proposed. In the current proposal, ABS, for example, is not significantly different from three A-levels and two AS-levels with the compulsory inclusion of maths and English."

They also point out that the 'occupational' route, which would subsume or replace existing technical qualifications and T-levels, is being branded as a subset (and implied poor relation) of the ABS, which is not helpful for attracting students.

You can read the whole response here: **bit.ly/ABSresponse**

Meanwhile the IOP voiced opposition to the Department of Education's decision to cut short a pilot scheme which provided grants for relocation to the UK for trainee teachers of physics and languages. The programme was stopped without any evaluation, in spite of the clear need to boost numbers of physics teachers. IOP CEO Tom



Credit: Pexels

Grinyer outlined the scale of the problem in an article in TES magazine **(bit.ly/GrinyerTES).** A similar announcement was made in April about the 'Now Teach' programme.

Careers and CPD in Scotland

In March, the IOP Scotland team joined more than 40 other organisations at Glasgow Science Centre to promote careers in the engineering and advanced manufacturing sectors in Scotland. Around 200 teachers from across the country attended the event, which included a panel session where four apprentices described their route into, and experience of, an engineering apprenticeship, including graduate apprenticeships.

The event was a good occasion to explore the opportunities studying physics at school can open for young people, as well as promote IOP's 'Solving Skills' reports and the important messages in the Limit Less campaign to ensure increased diversity and inclusion in physics and engineering.

In May, the annual Stirling meeting for Scottish physics teachers took place. Alongside workshops on curriculum, skills and sharing experiences, delegates enjoyed two keynote addresses. In the first, teacher and author Alom Shaha explored the under-appreciated art of explaining, and its importance for science teaching. The closing keynote, from Professor David Fowler, Centre for Ecology and Hydrology, looked at the intersection of science and policy in applications of environmental physics.

Inclusion and equity in Wales

In Wales, work has continued to support teaching practice and physics participation through the inclusion and equity network. The latest TeachMeet in May was hosted by Equal Education Partners, who shared their work and opportunities around STEM education, including a programme linking schools in Wales with expert trainers from the Massachusetts Institute of Technology. The TeachMeets are a great opportunity for teachers to come together and learn from one another in person or online. All resources from the events are made available to the whole network.

60 years of the Ireland committee

In Ireland, the IOP has responded to consultation on the new Leaving Cert physics curriculum proposed by the National Council for Curriculum and Assessment. Drawing on the recommendations of the Primary Curriculum Advisory Group, the team is currently providing feedback on the proposed curriculum for primary science, technology and engineering.

The IOP Ireland Spring conference at the beginning of April marked the 60th anniversary of the IOP Ireland Committee. Highlights included the annual Rosse medal for postgraduate science communication, and a demonstration of new Irish Sign Language signs for STEM terms – developed by IOP in partnership with Dublin City University (see our March 2023 issue).

Credit: Physics Partners


Charlotte from Bishop Luffa School, Chichester

Lighting up physics

The winners of a new student video competition were announced at a residential physics event at Oxford University in April.

Nearly 100 schools from across England submitted entries to the first ‘What Lights Up Your Love Of Physics?’ competition, run by Physics Partners, in conjunction with Oxford University’s Department of Physics and Merton College.

Schools submitted a short video by a team of up to three students, on a physics topic of their choice. Entries were watched by a panel of three judges from Oxford University – Professors Simon Saunders, Alan Barr and Oliver Pooley. The top ten were invited to an overnight residential at Merton College Oxford, where they showed their films and took part in Q&A sessions with the judges. Topics ranged from black holes and exoplanets to the physics of sport and the elusive ‘theory of everything’.

The overall winner was Charlotte from Bishop Luffa School, Chichester. Her video, titled ‘The Man Who Measured Time to Save Lives’, explored the remarkable story of John Harrison (1693–1776) who invented the marine chronometer to enable measurement of longitude at sea. All the shortlisted schools were given a tour of Oxford University’s physics department, and enjoyed a formal dinner with a talk by Dr Becky Smethurst, the astrophysicist and YouTuber, about her career path from school into research and science communication.

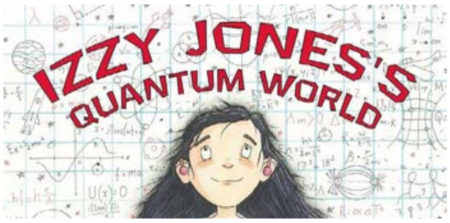
Winners received cash prizes for their schools. As the overall winner, Bishop Luffa School was also awarded funding to visit CERN.

The competition was supported by the John Templeton Foundation.

more...

View the ten shortlisted videos on the Physics Partners website:
physicspartners.com/competition-shortlist/

Credit: Artful Fox Creatives



The Great Science Share for Schools

The Great Science Share for Schools, a campaign to inspire children's interest in science, held a celebration day on 11 June.

This year’s campaign, on the theme of ‘sustainable science’, includes a series of guided enquiries about quantum physics. These are linked to a new book, ‘Izzy Jones’s Quantum World’ by Jules Pottle, which was commissioned especially for the project. Each enquiry comes with a suite of resources including a video, teachers’ notes and links to activities for students.

The Great Science Share for Schools, recently granted UK UNESCO patronage, began in 2016 and encourages 5–14 year-olds to ask, investigate and share the scientific questions that really matter to them.

more...

Visit the Great Science Share for Schools website:
bit.ly/GreatScienceShare

IOP launches 2024 election hub

With a UK general election just round the corner, the IOP has set out the policies that will be most important for physics and the physics community in the years ahead – including key demands around education and skills.

In ‘2030 Britain: powered by physics’, the IOP details three key asks for the next government. The first is to radically increase physics R&D to drive productivity, jobs and economic growth; the second is to equip more people with the technical skills needed for the 21st century, unlocking social mobility and growth; and the third is to tackle the barriers in the education system that prevent young people from enjoying the opportunities that physics provides.

Under the education banner, the document identifies two key reasons for many young people not pursuing physics as negative messaging, and a shortage of specialist physics teachers – a problem more marked in disadvantaged areas. Specific policy demands to address this problem include making whole-school equity plans mandatory, along with reform of teaching standards, teacher training and CPD, and inspection. Pointing to the ‘physics teacher gap’, where low levels of recruitment are compounded by high levels of attrition as many teachers are leaving the profession within the first five years, it calls on the next government “…to value physics teachers appropriately: urgently invest in recruiting, retraining and retaining the next generation of specialist physics teachers, including addressing the root causes (such as high workload) for teachers leaving the profession”.

more...

Read details of all the policy areas and download the leaflet at
iop.org/policy/general-election-hub

New resources supporting representation for secondary science qualifications

OCR, the examinations body, has developed a set of resources to support teachers of GCSE and A level science to celebrate the diversity of people working in STEM and highlight career paths for their students.

The resources feature a diverse group of 'STEM contributors' – people who contribute to the development of STEM knowledge and understanding, or who contribute to society through their work using their STEM knowledge and skills. These range from early career researchers, apprentices and students through to those working in industry, public service and academic research. The individuals included in the contributor list have been selected with reference to the groups identified by the IOP's Limit Less campaign as particularly under-represented within physics. They comprise women, people from minority ethnic backgrounds, people who are LGBTQIA+, people who have a disability and/or neurodiversity, and people from a poorer socioeconomic background or likely to have lower science capital.

Each of the different OCR GCSE and A level physics, chemistry and biology courses, as well as A level geology, has a dedicated resource. Within each resource, each part of the course specification is matched with STEM contributors' work, providing brief biographies and links to useful external websites.

Ally Davies, science subject advisor at OCR, explained the thinking behind the resources. "For many years, STEM has been perceived as lacking diversity, and indeed *has* lacked diversity," he said. "The current stereotype of a scientist is an old(er) white man. We want to help teachers to challenge this stereotype by highlighting to students that STEM contributors are diverse, and that roles in STEM or using STEM are varied and rewarding. We want students of all identities and backgrounds to know that they can feel valued, happy and well-rewarded working in STEM-related jobs."

In a blog published when the resources were first released in December 2023, Ally also commented on how the resources can support teachers to meet the Gatsby Careers Benchmark 4. The benchmark states that 'All teachers should link curriculum learning with careers. For example, STEM subject teachers should highlight the relevance of STEM subjects for a wide range of future career paths'.

more...

Access the resources and read Ally's blog at: **bit.ly/OCRblog**

Funding cuts for inclusion programmes

The Association for Science Education (ASE) has described as 'disappointing' the Department for Education's decision not to renew funding for the Inclusion in Schools and Inclusion in Science programmes from August 2024. The programmes have received high praise from participants for helping make science more accessible to under-represented groups.

Vicki Parry, inclusion consultant for ASE, commented: "Despite this setback, ASE is committed to making science engaging to all students, and we know many teachers and schools are as well. We are working hard on the next stage of our Equity in Science offer which builds on the success of the DfE-funded projects."

Find out more at **www.ase.org.uk/equity-in-science-education**

See page 19 for details of the next Inclusion in Science conference.

Representing Physics 2024

The Blackett Lab Family, the network of Black physicists, has announced two summer schools for year 11 and 12 physics students of Black or mixed Black heritage. One is online and the other is a three-day in-person, (non-residential) event based at Imperial College London.

The events are designed to give a taste of undergraduate physics life and provide valuable opportunities to hear from university admissions tutors and scientists. Students are encouraged to apply even if they're not sure physics is for them, as the events will help support decision-making.

The project is in partnership with IOP, the National Physics Laboratory and Ogden Trust.

more...

Visit **theblackettlabfamily.com/events/rp2024/** for details.

New UK astronauts

A UK astrophysicist has become one of Europe's newest astronauts after completing basic training as part of the European Space Agency's Astronaut Corps. Rosemary Coogan graduated from the European Astronaut Centre in Cologne, Germany, in April, and is now eligible for selection for future space flights.

Born in Northern Ireland, Rosemary attended school in Brighton before university studies at Durham. Following doctoral research at the University of Sussex, she worked at the Max Planck Institute for Extraterrestrial Studies near Munich, before joining the space programme in 2022.

Meanwhile, a British former paralympic athlete has been taking part in feasibility studies at ESA to become the world's first disabled astronaut. John McFall, who had a leg amputated after a motorcycle accident as a young man, is helping ESA to understand how facilities and equipment can be made more accessible, and to look at the impact of astronaut training on a person with a prosthetic limb.

Reel physics

Nobel Prize-winning physicist Kip Thorne has the Midas touch in accurately bringing physics to life on the big screen, explains science writer Dr Benjamin Skuse.

The famous 'Gargantua' black hole from *Interstellar*

If the movies stuck to the physics script all the time, they would be pretty dull. Gunshots wouldn't knock victims off their feet, destroy padlocks or blow up cars. Only Batman and a handful of the less colourful superheroes would still be depicted on the silver screen. And space would just be a vast and largely empty vacuum where, to butcher a classic movie quote, "no one can hear you scream… or hear the Death Star explode for that matter."

Successfully combining storytelling and physics is a feat few moviemakers have achieved. But when they have, the results have been spectacular – classics such as *2001: A Space Odyssey* hold up just as well now as they did when they were first released. If a blockbuster needs to get the physics right, real-life physicists are brought in to tweak the writing, or help directors and actors understand some of the key concepts. Perhaps the busiest physics advisor in recent years has been Kip Thorne.

Thorne was one of three physicists to win the 2017 Nobel Prize for the first direct detection of gravitational waves. He also made important contributions to understanding astrophysics, quantum measurement and time travel. But in 2009, Thorne quit his post at the California Institute of Technology to focus on communicating science to a broader audience.

Thorne's first foray into Hollywood was the 2014 sci-fi blockbuster *Interstellar*. Directed by Christopher Nolan, the film follows a group of astronauts leaving a dying Earth on a quest to find humanity's next home. Involved in writing, producing and advising on *Interstellar*, Thorne insisted that nothing in the film violated the laws of physics and that any speculative science came from real theories. Even with these restrictions, the story is mind-bending, featuring wormholes, alien worlds, and the most realistic black hole ever depicted on screen.

Visualising a fast-spinning supermassive black hole, named 'Gargantua' in the movie, involved close collaboration between Thorne and visual effects company Double Negative, in particular its Chief Scientist Oliver James. Via correspondence totalling over a thousand emails, Thorne provided the equations that describe the behaviour of light near a black hole like Gargantua, based on Einstein's theory of general relativity. James then converted them into a visual representation. Tracing light beams around the black hole involved developing completely new software, using thousands of powerful computers running in parallel. An individual frame could take up to 100 hours to render, and the entire sequence showing Gargantua took about a month to complete. However, the hard work was worth it, as Thorne later wrote in his book 'The Science of Interstellar': "For the first time ever – and before any other scientist – I saw in ultra-high definition what a fast-spinning black hole looks like."

Most recently, Nolan turned to Thorne for advice on his acclaimed biopic *Oppenheimer*. The movie chronicles the life of J. Robert Oppenheimer, the American theoretical physicist who directed the Manhattan Project's Los Alamos Laboratory during World War II. Tasked with developing the world's first nuclear weapons, Oppenheimer succeeded in 1945 with the Trinity test nuclear explosion. Less than a month later, the atomic bombs dropped on Hiroshima and Nagasaki would kill over 150,000 people instantly, and many thousands more due to after-effects in the months and years that followed.

For a movie focused on an individual at the centre of a scientific revolution, it was important not only to explain some of the important science – including wave-particle duality, and nuclear fission and fusion – but also to convey how this revolution was affecting the people involved. The film highlights the moral and political factors surrounding the Manhattan Project.

Nolan also wanted to mine Thorne's first-hand experience of what some of the main characters were like in real life. "I knew Oppenheimer when I was a graduate student at Princeton, from 1962 to 1965, and a postdoc from 1965 to 1966," said Thorne in an interview with Nature. "So there was some discussion about Oppenheimer as a person." He also had personal knowledge of some of the dozen or so other famous physicists in the

more…

Kip Thorne biography
bit.ly/AboutKip

The Science Museum explains the science of *Interstellar*
bit.ly/SMInterstellar

Deep dive into creating the *Interstellar* black hole
bit.ly/BlackHoleDeepDive

See page 16 for more about Kip Thorne's 'The Science of Interstellar'

film, not least his former colleague Richard Feynman. This made him uniquely qualified to clarify what the interactions between the various personalities would have been like.

Being involved in the accurate portrayal of both Oppenheimer and the dawn of the nuclear age is something Thorne is proud of, particularly given current geopolitical issues. It's a film that has messages that are tremendously important for the era we're in," he told Nature. "Hopefully it raises the awareness of the danger of nuclear weapons and the crucial issue of arms control."

Driving the future of film

Filmmaking brings together a huge variety of skillsets, and physics has an increasingly important part to play. Many skills developed through physics are central to the visual effects that make modern cinema so spectacular.

In one of Neon Futures' career profiles, Eugenie von Tunzelmann talks about how her school physics studies led to a degree in computer science and engineering, enabling her to pursue a career combining her twin passions of science and the dramatic arts. Eugenie works for Double Negative (now DNEG), one of the world's leading special effects studios, which is regularly commissioned to support Hollywood blockbusters. Recent DNEG projects include *Dune: Part 2*, *Oppenheimer* and *The Last of Us*.

As she explains, the process of creating seemingly magical effects begins with understanding how physical laws impact on objects. "It's always a combination of modelling real life and allowing a certain amount of artistic direction. If you didn't model real life you wouldn't have things that looked real at all," she says. "For example on *Hellboy II*, I was concentrating on fire. So, the first thing I would do is study the physical phenomenon in the real world. I studied real fire, reading papers on why it is the shape that it is and understanding the dynamics. Then, we'd start modelling that inside the computer."

Once the computer model is created, developers can bend the laws within the system, to generate life-like renderings of otherwise impossible events. "If the fire had to put on a performance – if it had to form into a shape that wouldn't happen in the real world – we would find out how to relax and bend those forces of physics to allow that to happen and control that artistically."

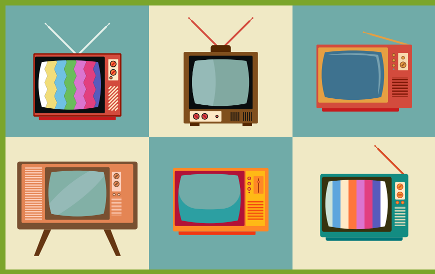
A similar principle applies in computer gaming. As games become more complex, programmers have moved away from animating the way characters behave. Instead, they construct a 'physics engine', which sets the rules that apply to objects within the game – say, the strength of gravity, or the momentum of a projectile. This then allows the computer to determine how an event unfolds according to what rules are in place.

The impact of computing on filmmaking is further expanding through AI, which can now create life-like images, animations, special effects and music, with minimal human input. This has led to a fierce debate about the future of the industry. Some believe it will radically reduce the costs of creating content, opening up opportunities for everyone to tell their stories. For others it presents a dangerous threat to creativity and livelihoods. Recent strike action by writers' unions in America was fuelled in part by a desire to protect content creators from being supplanted by machines.

One thing is certain, the science of putting characters on a screen is becoming as important as the art.

more...

Read the full profile of Eugenie at Neon Futures: **bit.ly/NeonMovieMagic**



Credit: Shutterstock

Physicists on screen – the best and worst

We asked the physics community for nominations for the best and worst portrayals of physicists in films and TV. Here's what they told us...

BEST

"Stephen Hawking in *The Theory of Everything* played by Eddie Redmayne. A great portrayal of Hawking, contrasting his huge success in physics with being diagnosed with motor neuron disease in his 20s."

"Einstein and Eddington in *Einstein and Eddington*, played by Andy Serkis and David Tennant. I love how the two corresponded... It shows physicists as real people."

WORST

"Professor Frink from *The Simpsons*. The typical nerd – with thick glasses and buck teeth – used to poke fun at scientists in general and in this case physicists in particular."

"Sheldon from *The Big Bang Theory*. A character constructed of stereotypes that not only define who he is, but we are invited to laugh at him because of them. He's not a physicist, he's a cartoon."

"The thing I hate most in movies is the depiction of physics as a solo lone wolf male activity, when it's actually done by diverse teams."

With thanks to Beth Bramley, Eleanor Clapp, Tom Grinyer and Tara Shears

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.

research@teachphysics.co.uk

Credit: Shutterstock

Humanising physics explanation videos: hands down the best learning?

Recent decades have seen a proliferation of physics explanation videos. Teachers use videos that explain physics concepts as part of their lessons or as activities for students to engage with in their own time – for example, in flipped teaching. When choosing which videos to show, or when creating explanatory videos, teachers make choices about which features best support learning. The study we focus on here, Schroeder and Traxler's 'Humanizing Instructional Videos in Physics: When Less Is More', looks at whether emphasising the role of a human teacher in a video supports learning.

The authors suggest that previous research presents a mixed picture on the value of including pedagogical agents, by which they mean human teachers, such as a talking head, in videos. Interestingly, Schroeder and Traxler chose to focus on a seemingly trivial approach to including a human pedagogical agent – the inclusion or not of a human hand that writes solutions to physics problems.

The participants in the study were 99 undergraduate students at a US university, with a mean age of 19 years – not too dissimilar from sixth-form students. The students were randomised, whilst working on laptops, to watch a video explaining how to solve a problem on forces acting on a block on a slope. The control video included a narrated explanation of the problem. The condition video humanised the explanation with a small addition: a human hand writing the model solutions.

Prior to and after watching the video, the students answered five conceptual questions testing their knowledge. In the post-test they also completed additional conceptual questions about blocks on slopes. The participants were then asked to describe their perceptions of the teacher.

The researchers reported that there were no statistically significant differences in knowledge between the control and condition groups prior to watching the videos. After watching, they found that the inclusion of the hand had a statistically significant negative impact on learning. The researchers hypothesise that the human hand acted as a distraction and increased the cognitive load of the condition video. The data related to students' perceptions indicated that there were no differences in their views of the teachers in the two styles of video.

The researchers recommend that, when making (or choosing) videos that teach complex content, videos should minimise extraneous content. Material that is included with the intention of humanising, or capturing attention, may backfire and distract from learning. It is noteworthy that even a seemingly small change – the inclusion of a human hand that writes model solutions – saw a statistically significant difference in learning between two groups. As the title of the paper suggests, when creating videos, and perhaps in explanations in general, less is indeed more.

References

Schroeder, N. L., & Traxler, A. L. (2017). *Humanizing instructional videos in physics: When less is more. Journal of Science Education and Technology, 26, 269–278.*

Pull out and keep!

Light (11–16)

The camera

Inside this issue:

The evolution of the camera

The history of the camera can be traced over a thousand years. Inside this pull-out are activities that chart its development from pinhole, through lenses to modern digital devices.

Today's cameras use image sensors made up of millions of microscopic light detectors, each with their own colour filter that break the image down into red, green and blue picture elements (pixels).

The investigation on page 10 looks at pinhole cameras and introduces lenses. On page 11 is an extension activity in which students add a lens, and four quick activities on the theme of pixels. On this page are some photographic firsts that you may want to share with your class to add historical context.

Photographic firsts

First explanation (11th century)
Ibn al-Haytham, an Islamic scholar in what is present-day Iraq, was the first person to explain image formation using light rays travelling from object to screen. He projected an image of the outside world onto a wall in a dark room using a hole in the opposite wall.

First photo (1820s) (1)
Joseph Nicéphore Niépce, a French inventor, was the first person to take a photograph, using a lens to project the image of a window onto a plate covered in photosensitive chemicals.

First colour photo (1861) (2)
Scottish physicist James Clark Maxwell created the first colour photo by taking black and white photos of a ribbon through red, green and blue filters, and making a composite.

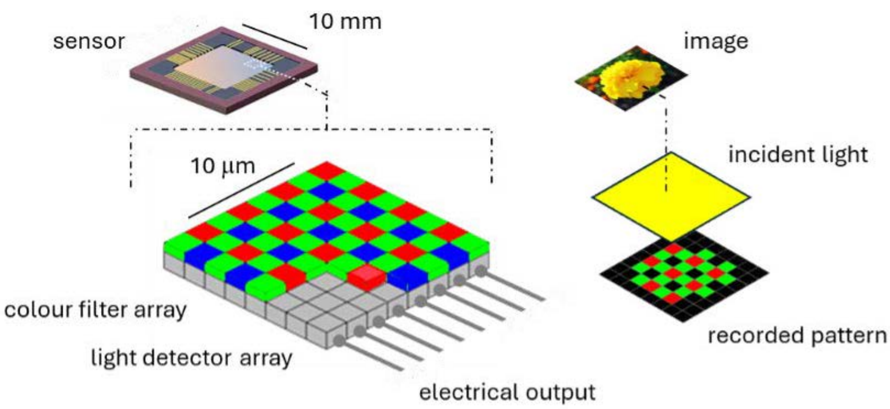
First pixel image (1972) (3)
British-born engineer Michael Francis Tompsett published the first pixel photo – an image of his wife projected through a large prism onto light detector (CCD) arrays.

First instantly shared photo (1997) (4)
French engineer Philippe Kahn instantly shared a photo of his newly born daughter across the internet, using a digital camera, an early cellphone and a laptop computer.

Inside an image sensor

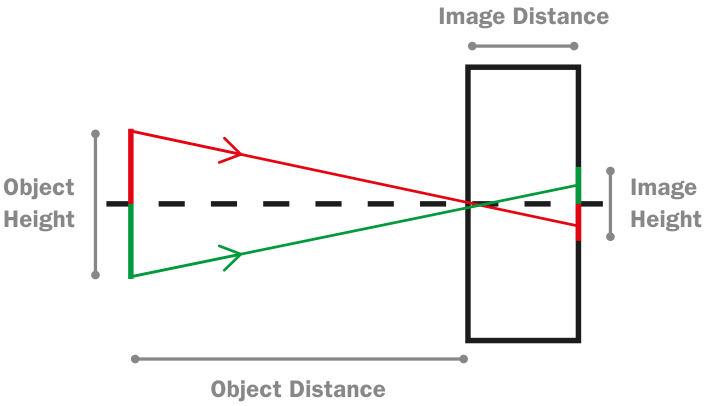
A small section of an image sensor (64 pixels).

Right: The light pattern recorded for a yellow segment of an image.

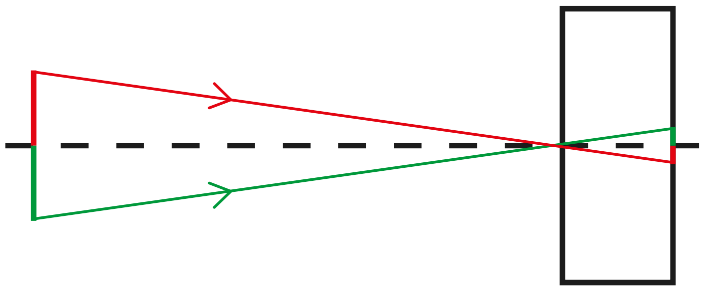


Investigation: Pinhole camera and image height

In this activity, students make a pinhole camera and predict and test how image height varies with object distance.



Pinhole camera with object and image distances and heights



Object distance for half the image height

Preparation

Our suggested pinhole camera design uses a crisp tube (see page 12). You could ask students to bring in their own. Alternatively, provide aluminium foil that can be attached to the end of a cardboard tube, or search online for other designs and adapt the instructions.

Try the activity before the lesson in the room where the students will carry it out. Judge how dark the room needs to be and how much space each group needs to safely navigate around the benches in semi-darkness.

Equipment

Each group of students will need:

- A copy of the activity sheet (page 12)
- Empty Pringles crisp tube (cleaned inside)
- Push pin (width of approximately 1 mm)
- 30 cm or 15 cm clear ruler
- Sharp pencil
- Scissors or craft knife
- Baking paper or tracing paper (at least 15 cm x 15 cm)
- Masking tape
- Clear sticky tape
- Strong kitchen foil – enough to wrap around the whole of the Pringles tube
- Light source, e.g. light bulb in holder, desk lamp or torch
- A4 sheet of card
- Two different colour filters (e.g. green and red), each approximately 10 cm x 5 cm
- A lens with a 5 cm focal length (optional, for extension activity)

Procedure

Ask students to follow the instructions on their activity sheet to:

1. Make a pinhole camera out of the crisps tube.
2. Make an 'object' out of card, colour filters and a light source.
3. Determine object distance for an image height of 2 cm.
4. Predict the object distance for an image height of 1 cm and then test the prediction.
5. Repeat for an image height of 0.5 cm.

Teaching notes

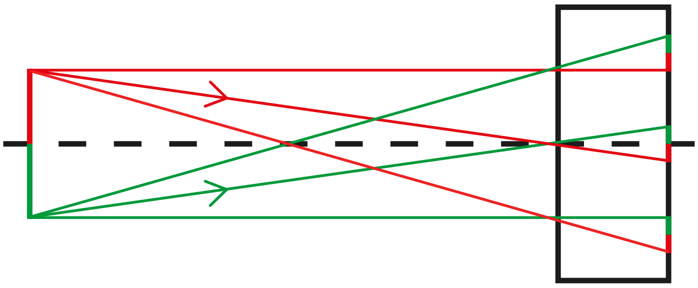
When predicting object distance, encourage students to sketch ray diagrams and/or consider ratios for similar triangles. The diagrams above illustrate that **object distance/object height = image height/image distance**. Halving the image height requires doubling the object distance.

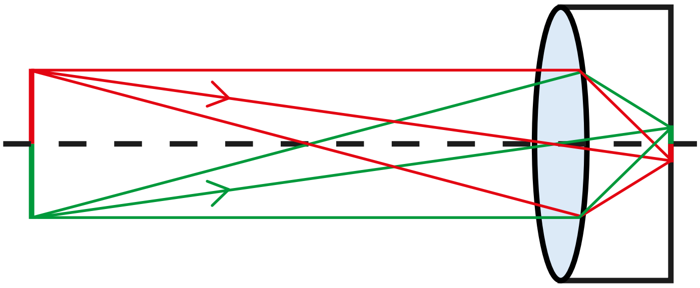
Activity developed by Niloufar Wijetunge.

Did you know?
The nautilus doesn't have a lens eye. Instead, it uses a seawater-filled cavity with an adjustable pinhole to see.

Extension activity: From pinhole to lens camera

In this activity, students see how adding a lens increases image brightness.





Procedure

Ask students to:

1. Use a pin to add several more pinholes to their pinhole camera.
2. Place the camera on the bench directly in front of the object (they should be able to see multiple images).
3. Slide the lens in front of the pinholes (the central image should get brighter).
4. Move the camera and/or lens towards or away from the object to find the best position (they should soon find the location for a single brilliant image).

Explanation

A lens produces a brighter image because it collects multiple light rays from each point on an object (see diagram). To get a single bright image, students need to move the camera and/or lens towards or away from the object because, unlike a pinhole camera, a lens can only produce a sharp image for one object distance.

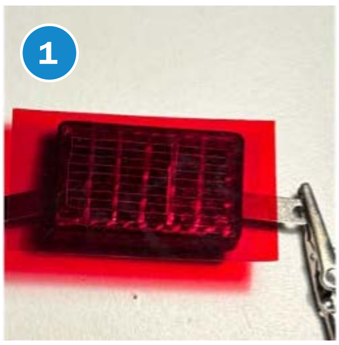
Quick activities: Introducing image sensors and displays

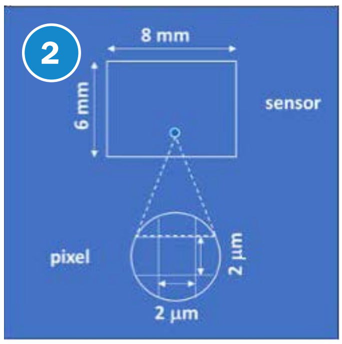
Sensor pixel demo (1)
Model how one of the millions of pixels in an image sensor creates an electrical signal by shining light through a red, green or blue filter onto a solar panel connected to a voltmeter.

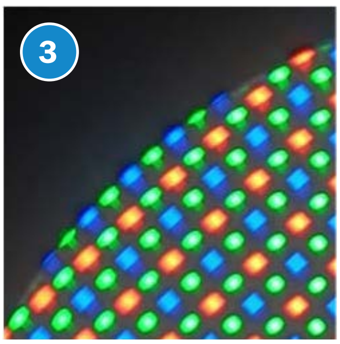
Megapixel maths (2)
Calculate pixel count from sensor data to explain what a megapixel is. For example, for an 8 mm x 6 mm sensor with 2 µm pixels:

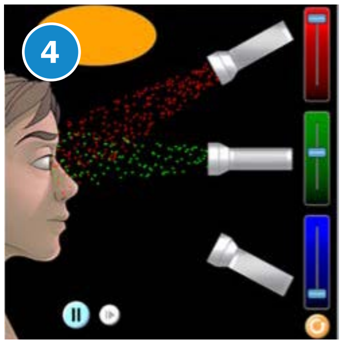
- Number of pixels across sensor = 8 mm / 2 µm = $8 \times 10^{-3} / 2 \times 10^{-6}$ = 4000 pixels
- Number of pixels down sensor = 8 mm / 2 µm = $6 \times 10^{-3} / 2 \times 10^{-6}$ = 3000 pixels
- Total number of pixels = 3000 x 4000 = 12×10^{6} = 12 megapixels (or 12 MP)

SI prefix	Symbol	Standard form
milli	m	10^{-3}
micro	µ	10^{-6}
mega	M	10^{6}







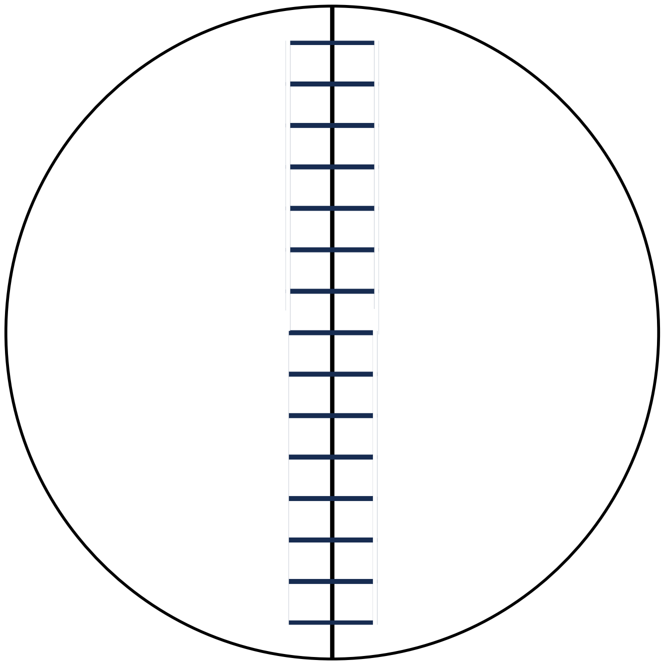


Pixels under the microscope (3)
Ask your students to search for ‘white screen’ on a smartphone or tablet and place it under a microscope. When they bring the pixels into focus, many will be surprised to see only red, green and blue light emitters. Repeat for a ‘yellow screen’.

Colour mixing with pixels (4)
Explore the many colours that can be created using just red, green and blue pixels at **bit.ly/PhETcolour**. Select RGB bulbs and move sliders up and down (e.g. orange is R: 100%, G: 65% and B: 0%).

Pinhole cameras and image size

In this activity you will be working with a partner to make a pinhole camera and an object. You will then use this to investigate how image height varies with object distance.



Instructions

1. **Making a pinhole camera:**
   a. Draw a line 5 cm from the base of an empty crisp tube.
   b. Cut the tube along the line to divide it into two. You will be using the short tube to make your camera.
   c. Carefully push a pin through the centre of the base of the short tube to make a small hole.
   d. Place the crisp tube's plastic lid on the tracing paper and draw around it.
   e. Line up the circle you have drawn with the one above.
   f. Trace the scale using a ruler. Each of the marks should be **0.5 cm apart.**
   g. Cut around the circle and place the tracing paper cut-out at the open end of the tube. Add the lid to hold it in place.
   h. Tape around the circumference of the tube where the lid, tracing paper and tube meet.

2. **Making an object:**
   a. Cut an 8 cm high and 2 cm wide rectangle out of A4 card.
   b. Stick the red and green coloured filters behind the cut-out.
   c. Fold over the edges of the card to stand it up.
   d. Position a light source behind the filters so they are lit brightly.

3. **Investigating image size:**
   a. Place the camera on the bench directly in front of the object so that you can see a large upside-down image of the object at the centre of the screen.
   b. Keeping the image at the centre of the screen, move the camera away until the image is **2 cm** tall. Ask your partner to measure the distance between object and screen (this is the object distance).
   c. Swap roles and repeat the measurement to get two more readings of object distance to find an average value.
   d. Predict the object distance for the image to be **1 cm** tall. Test your prediction.
   e. Predict the object distance for an image height of **0.5** cm. Test your prediction.

Physics on screen

Scientists being extra

The director of *Oppenheimer*, Christopher Nolan, employed scientists from the Los Alamos National Laboratories as extras for some scenes in the film. The intention was for the scientists' reactions to the actors' scripted comments to provide greater authenticity. "The actors were riffing on what the extras were giving them," he later said. In fact, according to some of the extras, the stars took a great interest in the science. Shane Fogerty observed that: "Talking with the stars at length for several days between shots, I found them to be kind, articulate and very interested in science!" Fogerty reported that Robert Downey Jr. (who plays Lewis Strauss) was interested in fusion energy, and Josh Hartnett (Ernest Lawrence) wanted to know about the origins of the moon. Fogerty even discussed the Fermi paradox with Enrico Fermi (as played by Danny Deferrari).

Stellar connections

There are several familial links between movie stars and physicists. The *Grease* star, Olivia Newton-John, is the granddaughter of Max Born, a founding figure of quantum mechanics and a Nobel laureate. Max Born is also connected to Ben Elton, the comedian and writer of *Blackadder* – Elton's grandfather was Born's first cousin. Paul Eddington, famous for his role as Jim Hacker in *Yes Minister* and *Yes, Prime Minister,* was related to the astronomer Arthur Eddington. Sally Field, who starred in *Mrs Doubtfire* and *Forrest Gump,* is the sister of Rick Field, a physicist at the University of Florida who works on the CMS collaboration at the Large Hadron Collider and worked alongside Richard Feynman.

Physics for superheroes

Physicist Clifford Johnson has a unique role as the Marvel Cinematic Universe science advisor. Born in London, Johnson now works at the University of California, researching superstring theory. Through a group set up by the US National Academy of Science, he was approached by the Marvel film producers. In his role, Johnson reads drafts of scripts and advises on scientific content. He advised on the look of wormholes in *Thor: Ragnorak* and, when working on *Agent Carter*, provided the content for the blackboards in Howard Stark's laboratory, ensuring the equations fitted the physics of the time.

spark.iop.org/stories-physics

Compiled by Richard Brock.

Follow him on X (Twitter) at **@RBrockPhysics**

Physics*education*

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

Editor-in-chief Gary Williams highlights his favourite papers on **physics on screen** 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

A tabletop *Italian Job*

Readers above a certain age will recognise the picture above and know what film it relates to…

In Mike Follows's paper *"The Italian Job*: an exercise in turning forces*"*, the author discusses how the final cliff-hanging scene can be used to teach moments. The calculations are suited more to older students but using the film's ending as an introduction to moments is suitable for almost any age. If you're not familiar with the film (spoiler alert…) the escape bus ends up balancing on the edge of a cliff with gold bars threatening to spill out into the ravine below!

A more recent Hollywood blockbuster is discussed in "Investigation of *Skyscraper*'s feat" by Costas Efthimiou, a paper which investigates whether the apparently impossible feat shown in the movie and on film posters is humanly possible. The calculations would be suited to students aged 16+ but it could also be used as a Fermi problem for younger students.

These days, superheroes are a large part of the stories told through the medium of film and they, as well as lots of other science fiction movies, provide a rich context for teaching physics. "Using superheroes such as Hawkeye, Wonder Woman and the Invisible Woman in the physics classroom*"* by Barry W Fitzgerald looks at Hawkeye and linear motion, Wonder Woman and bulletproof materials, and the Invisible Woman and optics. There are plenty of opportunities to bring in conservation laws and superheroes, especially when they change size (conservation of mass) or reach a high speed and suddenly stop (conservation of momentum and energy).

Given the popularity of the film *Oppenheimer*, the paper "The Manhattan Project—a part of physics history*"* by Ann-Marie Mårtensson-Pendrill is worth a visit. *Oppenheimer* seems to be regularly covered by the arts so it's worth looking for some of the other productions that have featured the story. The ethics of the situation are a rich ground for discussion and making sure students see the importance of physics in wider society.

With greater access to cameras than ever before, especially those that shoot high frame rate video, but also the ability to do timed exposures, students can produce their own movies to explore physics. In "Exploding balloons, deformed balls, strange reflections and breaking rods: slow motion analysis of selected hands-on experiments", Michael Vollmer and Klaus-Peter Möllmann demonstrate a number of

Credit: IOP

Human waves, as demonstrated by the Thai army fascinating scenarios that students could film for themselves. These include bouncing balls and breaking sticks and spaghetti.

Of course another aspect to modern life is the viral video and in “Understanding ‘human’ waves: exploiting the physics in a viral video” by Chantal Ferrer Roca, the author explains how a fantastic video of the Thai Army doing a synchronised movement display can be used in teaching waves. The video is entertaining to watch and can be used with most age groups – from simply introducing waves to more detailed analysis.

“The Italian Job…”
bit.ly/PEItalianJob

“Investigation of Skyscraper’s feat”
bit.ly/PESkyscraper

“Using superheroes…”
bit.ly/PEUsingSuperheroes

“The Manhattan Project…”
bit.ly/PEManhattan

“Exploding balloons…”
bit.ly/PEExplodingBalloons

“Understanding ‘human’ waves…”
bit.ly/PEHumanWaves

Credit: IOP

Detailed images of a bouncing ball, captured by filming

Open access papers

In the open access paper “Drones as observers and students as data points: a large-scale demonstration of sound waves”, by Sebastian Kilde Löfgren, Mathilda Virta, Javier Tello Marmolejo, Annie Ringvall-Moberg, Jonas Enger and Dag Hanstorp, the authors describe how they used a drone to photograph students as they reacted to sound demonstrations. Looking down from above, the students’ positions make them look like mobile detectors. A number of interesting ideas can be taught from their positions, such as measuring the speed of sound. One of the things I liked about this paper was that it didn’t require a great deal of skill flying the drone. There’s also a video that goes with the paper.

Another open access paper that could involve film or photographs is “A total rip-off—crack propagation in paper” by Joanna Bates and Julian S Dean. The paper covers crack propagation using advanced machines but then brings things down to classroom level by looking at much simpler experiments using common secondary and perhaps even primary school equipment. There’s an opportunity here for students to link what they feel happening with their senses to what sensors tell them is happening.

Finally, it seems to be increasingly common for schools to be able to put their own cameras up to the edge of space. Recovery can be an issue but GPS trackers can help and cameras needn’t cost that much. In the open access paper “Experiments at the edge of space: balloon flights to the stratosphere”, the authors (M H Denton, L Blum, R Kivi, S Bruce, P Ramos, M Feinland, T Ulich and J J Denton) describe in detail how they sent a camera up on a weather balloon and took their own picture of the edge of space. This is great information for if you’re thinking of trying this as a project in school.

“Drones as observers…”
bit.ly/PEDronesAsObservers

“A total rip off…”
bit.ly/PERipOff

“Experiments at the edge of space…”
bit.ly/PEEdgeOfSpace

Physics*education*

Quick Links

“Cinema, Fermi problems and general education”
More links to films and Fermi problems

bit.ly/PECinemaFermi

“Science in science fiction”
An exploration of more ways to link sci-fi to the lab

bit.ly/PEScienceFiction

“Low-cost optical home-lab experiments”
An open access paper on cheap optics experiments

bit.ly/PELowCostOptical

“The need for speed: putting the thrill back into data collection”
One of mine, using computer games for teaching speed-time graphs

bit.ly/PENeedForSpeed

“How videos are used in secondary school physics teaching”
An analysis of a useful resource of moderated physics videos

bit.ly/PEVideoSecondary

“Stopping a roller coaster train”
A slightly different film, using IR movies to look at heating in magnetic brakes

bit.ly/PERollerCoaster

Credit: Shutterstock

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J. Robert Oppenheimer

Robert Oppenheimer: How cinema has depicted this icon of the nuclear age

Physics Today has published a range of articles in the wake of the *Oppenheimer* phenomenon. This piece, by Sidney Perkowitz, looks at other depictions of the Manhattan Project and its leader.

The earliest, *The Beginning or the End* (1947), is presented in documentary style, with 'newsreel' of a time capsule bearing information about atomic energy for people in the 24th century. The feature film that follows, we are told, is among the items in the capsule, and tells the story of the development of nuclear weapons.

Another film, *The Day After Trinity* (1981), is a true documentary, with archive footage from the US government of the Manhattan Project and interviews with several key players. Perkowitz sees this as the best portrayal of the inner world of Oppenheimer, as it engages more deploy with the moral questions posed by the bomb.

bit.ly/PWOppenheimer

Loners, renegades and evil geniuses

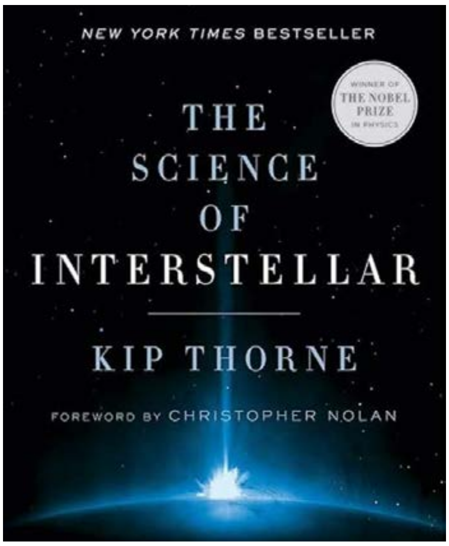
This article from 2005 by Andre Bormanis is a review of 'Mad, Bad and Dangerous?: The Scientist and the Cinema', by Christopher Frayling. It provides an interesting reflection on the ongoing problem of how scientists are depicted on screen.

From Frayling's analysis of 100 years of films, Bormanis concludes that "most celluloid scientists are aloof, socially inept, amoral creatures driven by pathological obsessions with the secrets of the universe and the power that understanding these secrets might bestow".

The book sprang from news of a 1957 survey asking US high school students for their impressions of scientists. Bormanis reports, "The common denominators – a "brainiac" in a white lab coat and horn-rimmed glasses, surrounded by test tubes and Bunsen burners – confirmed the pervasiveness of the familiar stereotypes… Suffice to say that little has changed in nearly 50 years."

bit.ly/PWEvilGeniuses

IOP physics coach Niloufar Wijetunge describes 'The Science of Interstellar' by Kip Thorne. See our feature on page 6 for more about Kip Thorne's work.



Book corner

"Love is the one thing that we're capable of perceiving that transcends dimensions of time and space."
This line from Dr Amelia Brand in Christopher Nolan's film *Interstellar* captures the blend of human emotion and the vast, seemingly impersonal world of physics. In 'The Science of Interstellar', the film's physics advisor, Kip Thorne, takes readers through the scientific concepts that shape the film, making complex ideas accessible and engaging.

Thorne, a Nobel Prize-winning physicist, ensured that *Interstellar's* depiction of phenomena like black holes and the bending of spacetime was scientifically grounded. His book uses the film's plot as a springboard to dive into 'real-world' science, providing a deeper appreciation of the universe's mysteries.

One of the book's strengths is its balance between detailed scientific explanations and an entertaining narrative style. Diagrams and illustration help demystify some of the most complex concepts. Thorne also addresses where the film diverges from scientific accuracy to enhance the story. This candid discussion highlights the collaboration between science and cinema, and the need for compromise.

'The Science of Interstellar' is recommended for anyone curious about the physics behind the film. Thorne's insights offer a behind-the-scenes look at how advanced physics can inform popular culture. For teachers, it's a goldmine of examples that can make physics lessons more engaging, showing the application of theoretical concepts. The book showcases the power of scientific imagination in shaping the stories we tell about the universe.

THE ROYAL SOCIETY

One person synonymous with bringing physics to the screen is Professor Brian Cox. He has produced a set of films with the Royal Society featuring experiments for 11–14 year-olds on new and emerging STEM technologies, available for free to teachers.

#BrianCoxSchoolExperiments

royalsociety.org

Brian Cox school experiment resources

The Royal Society has produced a new set of free videos and resources, presented by Professor Brian Cox, based around new and emerging STEM technologies, including machine learning, genome editing and ocean acidification.

Each of the topics features a classroom experiment aimed at 11–14 year-olds. A secondary school teacher, accompanied by Professor Cox, carries out the experiment with a science class. They discuss the equipment, set-up, and any issues that may crop up throughout the lesson. Alongside each of these experiments are resources including student worksheets, teacher and technician guidance documents, and diagram sheets. These documents can be downloaded from the Royal Society website.

The series also focuses on highlighting STEM career pathways and skills that may be needed for students to pursue future jobs in science. Each topic spotlights a scientist working in academia and industry, and the videos feature many different laboratories and organisations across the UK. These include researchers from the John Innes Centre, who are seeking to improve the nutritional content of the wheat genome, and companies such as Unitary, which specialises in the use of AI to reduce the amount of harmful online content moderated by humans. These interviews seek to engage younger secondary students with these exciting fields and introduce them to career pathways they may not have considered before or even known existed.

Watch the videos and download the worksheets for free on the Royal Society website: **royalsociety.org/schoolexperiments**

I'm a Scientist Get me out of here

Hannah Higson, Education Lead at the I'm a Scientist, Get me out of here website, explains why text-based chat is a great way to level the playing field for children to engage with science.

imascientist.org.uk

Online engagement: why text is best

Audiovisual formats are often hailed as the pinnacle of online interaction. In our tech-based world, it's tempting to assume we should all be harnessing the power of Zoom and TikTok to prove 'science is cool'. Although young people like to consume video content, engagement is a two-way street. To create a comfortable, inclusive atmosphere that truly engages students, text is best.

I'm a Scientist has been connecting UK schools with scientists through text-based chats since 2008. Students kick off the experience by exploring profiles of scientists with diverse backgrounds, roles and interests. By browsing scientists' hobbies and photos alongside their careers, students find common ground and see scientists as real people, just like them. The text-based format widens participation, encouraging the view that anyone can be a scientist.

With the playing field levelled, lively 30-minute chats give every student an equal voice. A familiar text-based format reduces complex subjects to letters on a screen, empowering students to delve into their interests across classroom topics and beyond. Students receive insights into the world of science and see their own path within it.

One teacher commented in feedback: "It was really lovely to see the students feel able to ask such open and honest questions in a secure and comfortable environment – especially students who are less forthcoming."

Another observed that: "When you bring scientists into the classroom it's good but you don't have 100% engagement. [I'm a Scientist] takes that away: everybody's got questions."

Beyond curriculum-focused learning, I'm a Scientist makes science relevant to students. Through text-based online engagement, students discover science's breadth, its relevance to their world, and see it as something 'for them'.

Our pull-out section focuses on the physics of creating images – but before digital sensors, the process relied on chemistry too. Chemistry teacher Declan Fleming shares a creative way to demonstrate a photochemical reaction, from Education in Chemistry.

edu.rsc.org/eic

A blueprint for success

The blueprint, or cyanotype, reaction is one of the most famous and lasting demonstrations of a photochemical reaction. Simply put, it's triggered when light energy is absorbed by a substance's molecules. This slow-reacting and economical way to print images is perfect for science lessons.

This is a memorable activity, with plenty of room for learners to get creative. And the summer term is the perfect time of year for it, because strong sunlight will give better results. To demonstrate the reaction for your class, you'll first need to create light-sensitive paper. In a dim room, make up a Herschel cyanotype mixture (essentially citrate and iron(III) ions in the presence of potassium hexacyanoferrate(III)), paint it onto your paper and let that dry. A hairdryer may be useful to speed along the drying process.

To make the print itself, put the dry paper in direct sunlight and cover with objects, such as leaves. This makes a negative image. In strong sunlight, it'll take abut 20 minutes. Then wash off any unreacted chemicals in tap water and leave to dry.

If you prepare the paper ahead of time for students to use in their lessons, keep it in the dark, or there'll be no reaction for them to see.

Happy printing!

more...

For full instructions, health and safety information and a video, visit: **rsc.li/49CrwKH**

Find more powerful demonstrations on the Education in Chemistry website: **rsc.li/3W4R1Bv**

Introducing on-screen tools such as PhET simulations can enhance the teaching and learning of physics in the classroom. But using these pedagogical tools needs to be carefully considered so they have a meaningful impact on learning, writes Charley Phillips, Head of Teacher Support at the Ogden Trust.

ogdentrust.com

Applications for early career support are open now at: **ogdentrust.com/early-career**

Stimulating simulations

PhET Interactive Simulations are a suite of interactive teaching and learning tools. Developed at the University of Colorado, and originally named for 'Physics Education Technology', PhET simulations are used across physics, chemistry, earth science, biology and maths.

The Ogden Trust is currently supporting three projects researching the use of PhET simulations in the classroom. We are interested in how these on-screen resources can be effectively built into teaching approaches.

The 2023 Ofsted science report, 'Finding the optimum', noted that teaching models and clear explanations can help pupils to learn connected knowledge. PhET offers a range of models that can be introduced as part of the teaching toolkit to help make abstract concepts more tangible. For example, the circuit builder tool allows movement between the macroscopic and sub-microscopic features of electrical circuits.

These models and animations can be especially useful for early career teachers who are building their competence and confidence, but they do need to be used with caution. A guiding narrative from an experienced practitioner can provide the extra support needed to help use these resources to their best effect, developing clear explanations that reinforce learning.

Exploring pedagogical approaches, together with support from experienced physics mentors and an open forum for discussion, is a central component of our early career support, which guides teachers of physics from their initial teacher training through to their fifth year in the classroom. Introducing resources such as the PhET Interactive Simulations into teacher training and early career, especially with the expert narrative and guidance from a mentor, can help build classroom confidence and effective teaching approaches.

PhET simulations can be viewed and downloaded for free from **phet.colorado.edu/**

CLIMATE SCHOOLS PROGRAMME

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Free resources to explore solutions to climate change!

Sign up for free to EngineeringUK's popular Climate Schools Programme and get resources, lesson plans and case studies to inspire your students to explore solutions to climate change.

The curriculum-linked lesson plans cover English, science and geography and include everything you need to deliver the lesson, such as presentations, activity plans, case studies, curriculum alignments and worksheets. There are also Climate Action theme packs available to support existing extra-curricular clubs or new Climate Action Clubs.

Engineers are key to tackling climate change and this programme will provide you with the resources, knowledge, and confidence to address this modern issue, help stimulate debate and interest, and communicate a solutions-focused message of "we can do this!". It's been developed together with industry, contains useful facts and stats, and showcases a range of role models working in green jobs to help inspire your students.

Sign up to the Climate Schools Programme: climateschoolsprogramme.org.uk/sign-up

Lesson plans and resources will be sent out via email within a week of registering.

"The lessons are basically good to go, and for us that is a huge relief and it's really exciting for us because it's nice to have something that is ready made, but also that you can trust." **Geography teacher**

"The students really enjoyed the lesson, and they loved playing different roles." **Science teacher**

"The articles and resources were all accessible, and I was quite impressed the students wanted to read them. They were interested in and they understand it's their future so it's really important." **English teacher**

ASE ASSOCIATION FOR SCIENCE EDUCATION

INCLUSION IN SCIENCE

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Places are free to all IIS 23/24 participants and members of ASE. Join via **ase.org.uk/ase-membership** for only £45 a year.

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Upcoming events...

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

Experimental Extravaganzas

IOP Wales's annual summer conferences, with the RSC. A £165 STEM Learning subsidy is available for teachers at state-funded schools in Wales.

2 July
South Wales, Coleg Merthyr

bit.ly/EESouthWales

5 July
North Wales, Bangor University

bit.ly/EENorthWales

THE BLACKETT LAB FAMILY

Representing Physics 2024
Summer courses for students of Black heritage in Year 11 or 12.
12 August, online | 19–21 August, London (non-residential)
theblackettlabfamily.com/events/rp2024

Physics Partners

Physics Partners summer regional conferences

East Midlands Festival of Physics

29 June,
The Kimberley School

physicspartners.com/eastmidlands2024-2/

Winchester College Festival of Physics

6 July,
Winchester College

physicspartners.com/winchester2024/

THE ROYAL SOCIETY

The Royal Society's Partnership Grants scheme

The Royal Society's Partnership Grants scheme funds schools and colleges up to £3,000 to work in partnership with STEM professionals from academia or industry to devise and deliver an investigative project. Applications are open now for your physics-based proposals and support is available throughout the application process.

royalsociety.org/partnership

ASE
ASSOCIATION FOR SCIENCE EDUCATION

Summer/autumn events

ASE members receive up to 50% off. Full details at **ase.org.uk/events**

ASE Summer Technicians Conference 2024

5 July, Cambridge

An introduction to professional registration: technicians (2pm), science teachers (4pm)

24 September, online

ASE Northern Conference

16 November

Also running this summer/autumn:

- AI for science teachers (online)
- Technicians Leadership Programme (online)
- Technicians Supporting Physics/Chemistry/Biology and Students (online)

Seen elsewhere...

Your eyes are deceiving you

A video from PBS on optical illusions as the driver of all film and moving pictures.

bit.ly/PBSOpticalIllusions

Credit: PBS

The day after... never

A comprehensive take-down of the 'science' of *The Day After Tomorrow* by YouTuber Simon Clark.

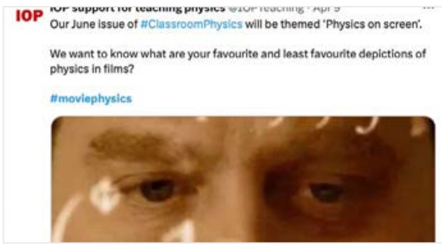
bit.ly/SCDayAfter

Credit: Simon Clark

Social media movie observations

Check out #MoviePhysics on X (Twitter) for some wry observations of how films have interpreted science over the years.

bit.ly/XMoviePhysics



Credit: IOP

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