PHYSICS NEWSLETTER #14

Hi everyone!
We are the new physics newsletter team from year 12. We hope to make this newsletter more accessible and therefore if you have any reasonable requests please contact one of the team and we'll see what adjustments we can make.

This month we will get started with a Halloween theme.
In this edition there is a competition to be featured in next month's article, a crossword, many interesting articles by different members of the team, and physics jokes.

Meet the team who will continue to write these monthly newsletters:
Mayuri Swaminathan 12S - 16swaminathan214@kechg.org.uk
Melyssa Bailey 12S -16baileymelyssa834@kechg.org.uk
Saki Khaki 12C - 16khaki921@kechg.org.uk
Saadiqah Bint-Monir12S - 16bintmonir152@kechg.org.uk
Zahra Saeed 12P - 16saeed252@kechg.org.uk
Chloe Chalkley12S - 16chalkleychloe532@kechg.org.uk

We'd also like to credit Cherry Black and Saadiqah for the pumpkin drawings.

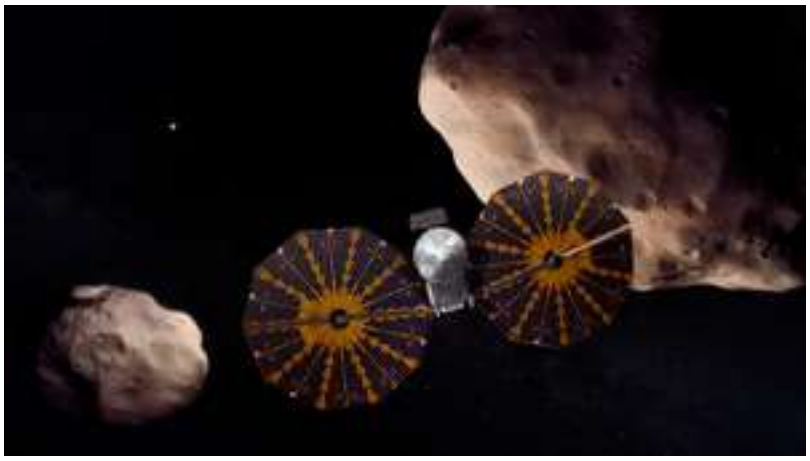
If you have any questions, jokes, physics memes, or suggestions, please send one of us an email. We hope you enjoy our first edition!

BepiColombo spacecraft reaches Mercury

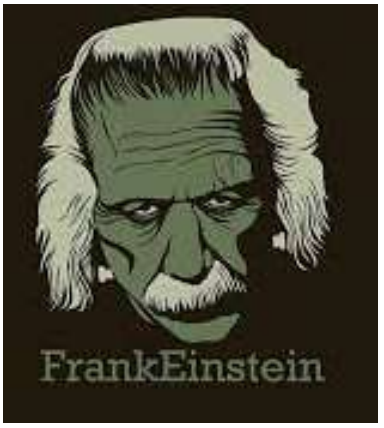
You may or may not have heard that the ESA and JAXA's spacecraft BepiColombo successfully completed its first flyby of mercury on October 1st. It set off from Earth in October 2018 on a mission to learn more about the solid and liquid core of mercury to help understand its formation, and therefore the early history of our solar system.

BepiColombo must complete six flybys of Mercury to lose enough speed to enter orbit. Unfortunately, due to the close proximity to the sun most of the spacecraft's features were not used in case they got damaged by heat.

However, the engineering camera (for keeping an eye on the spacecraft during its voyage) was used to take some pictures of the planet's surface, and when it enters orbit in 2025 all the instruments will be operational and scientists can start piecing together all kinds of unanswered questions, like how water can be present on a 450°c planet surface. - Melyssa



Physics jokes
Q: What do you call an undead physicist?
A: Frank-Einstein



My physics teacher told me I had potential. Then, she threw me off the roof.

Physics facts:
Assuming that an average pumpkin is 30cm tall, it would take a stack of 1,281,333,334 pumpkins to reach the moon

Dumb Questions with Saki
Welcome to "Dumb Questions with Saki" where I answer any silly physics questions you have! Today we're answering the question: how many slaps would it require to roast a pumpkin? According to Google, a pumpkin is roasted at 176°C so that's the temperature I

Lucy in the Sky with Diamonds

Lucy, which launched on 16 October on the Atlas V 401, is a NASA space probe which will visit seven Jupiter trojans, asteroids that orbit the Sun alongside Jupiter, as well as one main belt asteroid. Lucy was chosen in 2017 to be the 13th mission in NASA's Discovery Program, and is planned to last 12 years. This mission is named after the Lucy hominin skeleton, which was named after the 1967 Beatles song 'Lucy in the Sky with Diamonds' - Lucy itself is carrying diamonds as part of one of her instruments.

Lucy will receive two gravity assists from the Earth, in 2022 and 2024 and in 2025, it will fly by the asteroid 52246 Donaldjohanson, named after the discoverer of Lucy's skeleton. After this, the study of the Trojans will point to some clues about the early history of the Solar System, such as clumps of material that were present at the time, also described as the 'fossils of planet formation'. -Saadiqah

Primordial black holes

Hawking Radiation, which is a notion put forward by Stephen Hawking in 1975, suggests that black holes lose their mass over time, eventually leading to them exploding at the end of their life. The idea of primordial black holes proposes they formed during the Big Bang because of pockets of space that compressed on themselves and collapsed. In the present era, it may be possible to see these black holes exploding. Some scientists have estimated that these primordial black holes have an approximately equal mass to that of an asteroid (10^{16} to 10^{19}kg) packed into the radius of an atom. one theory suggests that dark matter may be

aimed for.

The specific heat capacity of a pumpkin is 3850J/(kg°C), the mass of this pumpkin 4.54kg. As the average velocity of a slap is 11m/s and the average mass of a hand is 0.4kg, the kinetic energy of a slap is 24.2J.

Assuming 100% energy transfer - no other energy such as sound or thermal dissipated into the surroundings, only thermal energy transferred to the pumpkin - 263958 slaps would do the trick (or treat).
Email me with any questions and I will answer them in future editions (:

Physics to save the planet: The North Sea Link

The longest subsea interconnector in the world, measuring 720

partly or entirely made up of these primordial black holes.

As primordial black holes could have been produced in huge numbers during the Big Bang, it is likely that many of them pass through the solar system, with some even hitting celestial bodies. Two scientists from the Canadian Institute for Theoretical Astrophysics, Matthew Caplan and Almog Yalinewich, want to use the moon as a detector for these black holes by studying its craters. Primordial black holes that hit the moon would create two very steep craters on either side, as their high mass and speed means that they would pass through extremely easily.

Caplan and Yalinewich want to use high resolution cameras to search the moon's surface for craters that fit these criteria, and estimate that they will see results in three years. In the future, these craters could be studied closer for evidence of churned up rock underground, which would be caused by the primordial black holes momentarily melting the rock inside as they pass through due to their extreme speed. -Saadiqah

The Nobel Prize in Physics 2021

The Nobel Prizes, awarded in five different categories, are awarded to 'those whom during the preceding year, have conferred the greatest benefit to humankind', as described in Sir Alfred Nobel's will in 1895. 120 years on from the receipt of the first set of awards, who has achieved this great honour in the field of Physics?

Sharing half a prize, Syukuro Manabe (USA) and Klaus Hasselmann (Germany) were rewarded 'for the physical modelling of Earth's climate,

kilometres, became operational on 1 October. The North Sea Link connects Norway and the United Kingdom and has a capacity of 1400 megawatts, which is equal to about the capacity of a nuclear reactor.

It runs from Kvilldal, a hydropower plant in Southern Norway, to Cambois, a village near Blyth, providing opportunities for both countries to share renewable energy - hydroelectric power from Norway and wind energy from the UK.

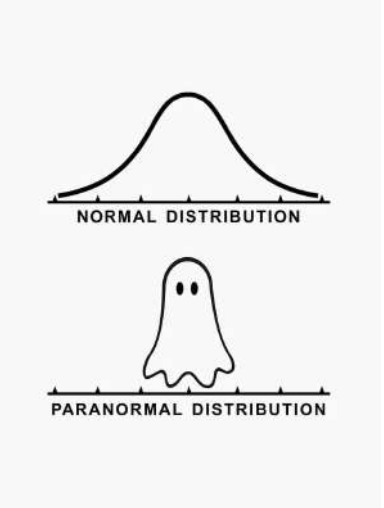
The cable's main use will be to import power from Norway, which will help manage demand and reduce energy costs, but if the UK produces excess power from its offshore windmills, it will also be used to export this energy.

quantifying variability and reliably predicting global warming'. How did they do it? During the 1960s and 1970s, both Manabe, now 90, and Hasselmann, now 89, raised deep rooted concerns on human-made climate change. 'Laying down the foundation for the development of current climate models', as stated by the Royal Academy of Sciences, Manabe worked on showcasing how increasing levels of carbon dioxide in the Earth's atmosphere is correlated to the temperature rise of our planet. Considering that Manabe worked on this 60 years ago, the pioneering nature of his demonstration has proven to be incredibly valuable as we can now see first-hand the importance of his discovery. Unleashing the calculating power of early computers, and applying it to climate, was truly revolutionary for the time. It is truly remarkable when we reminisce about what he was working with- room-sized computers that had only half a megabyte of memory (that is 5x10-4 GB – now picture that as a fraction of how much your phone can store)! His model, after countless hours of testing and perfecting, depicted that when the level of carbon dioxide in the atmosphere doubles, the average global temperature increases by 2 degrees Celsius. As Gunnar Ingelman - secretary of the Nobel physics community - said, 'he was the first scientist to do a thorough calculation that was reliable'. This extraordinary work, utilising the power of technology, is now the foundation of almost every climate model today.

Hasselmann's contribution takes shape as a 'model that links together weather and climate', created a decade after Manabe's work. In 1980, he found out how to answer the question of why climate models can be reliable despite the changeable and chaotic nature of weather. He developed a method for measuring ocean waves – this made use of

Physics phenomenon of the month:
Spooky action at a distance (a fun research task for you over the half term holiday?)

Physics meme



Halloween-y links
Here are some sciencey (yet Halloween-y) links that might interest you:
https://solarsystem.nasa.gov/resources/2553/sinister-sounds-of-the-solar-system/

https://exoplanets.nasa.gov/alien-worlds/universe-of-monsters/

https://solarsystem.nasa.gov/news/1546/sinister-solar-system/#sinister-facts

https://exoplanets.nasa.gov/alien-worlds/galaxy-of-horrors/

synthetic aperture radar (SAR) imaging, which is essentially a method in which instruments send a signal to the ground, and measure how much is reflected back. Such instruments are being used more than ever in satellites, which monitor the environment, with Hasselmann's technique also currently used on Earth-observing satellites, for instance the European Copernicus Sentinel-1 radar mission, which is highly beneficial for collecting data for ocean forecasting. It is safe to say that both Manabe and Hasselmann have helped shape our understanding of the Earth's climate dramatically.

Giorgio Parisi (Italy) won the other half of the prize 'for the discovery of interplay of disorder and fluctuations in physical systems from atomic to planetary scales'. Currently a professor at Sapienza University in Rome, Parisi commented on the timeliness of the award, stating that 'it is clear that for the future generations, we have to act now, in a very fast way'. Examining the changing landscape of the states of different materials, he was rewarded highly for his work due to its significance in aiding our understanding of the qualities of systems around us.

Linked by deepening our understanding of some of the world's most small, fundamental, and natural constituents in order to explain larger, more complex phenomena, Manabe, Hasselmann and Parsi were rewarded with the one and only Nobel Prize in Physics. Sharing $1.1 million, they truly have 'conferred the greatest benefit to humankind'. Perhaps, one day, it'll be you… -Zahra

Why don't electrons fall into the nucleus?

The short answer is: quantum theory.

https://solarsystem.nasa.gov/news/1546/sinister-solar-system/#ghastly-images

Competition time!
Some of our favourite Halloween phenomena involve levitation - from ghosts, to broomsticks. Here's a challenge for you all: can you make something levitate?

Send any of us any photos or videos of your levitation attempts, to be in for a chance of winning edible goodies! The deadline for this is Tuesday the 23rd of November - enjoy the levitation!

(If you're stuck, remember that indoor skydiving can be considered a type of levitation…)

Nobel prize sources:
https://www.nobelprize.org

https://edition.cnn.com/2021/10/05/health/nobel-prize-physics-winner-scn-2021/index.html

https://www.space.com/nobel-prize-physics-hasselmann-esa-earth-observation

Classical electrodynamics (a branch of physics that studies electromagnetic interactions) tells us that electric charges that accelerate will lose energy and emit electromagnetic radiation. At first, electrons seem to defy this law - they carry charge and move around a nucleus, but do not lose energy and spiral into the centre of the atom. Even if we ignore this, electrons are negatively charged, and protons are positively charged - surely the electrostatic forces of attraction will "pull" the electrons into the nucleus?

If we only consider electrostatic forces and classical mechanics, the behaviour of electrons seems erratic; we need quantum theory to explain why the electrons do not fall into the nucleus. Bohr's model of the atom tells us that electrons can only be found in shells, each with an absolute integer energy level. For an electron to move closer to the nucleus, it must lose energy, thus moving down an energy level. However, the first energy level has an absolute integer value of n=1: the lowest absolute integer. This means that an electron in the first energy level cannot lose more energy and move closer to the nucleus: it is "not allowed".

We can also justify the behaviour of electrons using conservation of energy. Whenever the force between two objects is attractive, the potential energy is negative. Due to the fact that electrostatic forces get stronger as the objects get closer, the potential energy of an electron would decrease as it gets closer to the nucleus, approaching negative infinity. To compensate for this fall in potential energy, the electron's kinetic energy also increases, approaching positive infinity. This divergence in kinetic energy and

Quantum theory - further resources

https://youtu.be/qwt6wUUD2QI

https://www.feynmanlectures.caltech.edu/III_01.html

https://youtu.be/41Jc75tQcB0

https://youtu.be/SDxzZHSBhw0

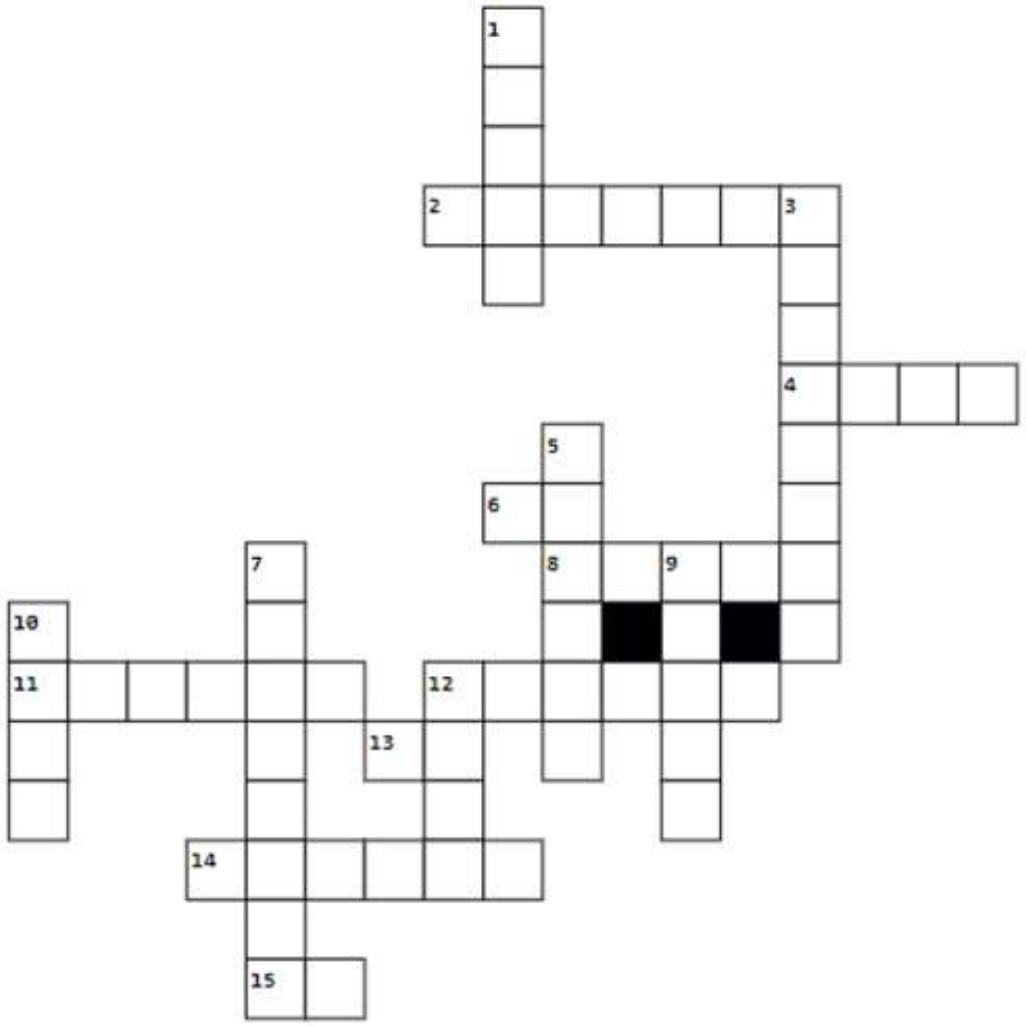
"In Search of Schrödinger's Cat" - John Gribbin

potential energy is like a tug of war that cannot be won, so the electron stays at a distance where neither the kinetic energy nor the potential energy approaches inconceivably large numbers.

This is further complicated by Heisenberg's uncertainty principle, which states that there are fundamental uncertainties in all objects: technically, no object has both a definite position and momentum simultaneously, though this is not noticeable on a macroscopic scale. This means that electrons are better described as a probability cloud, which means that we can't talk about them falling into the nucleus… Problem solved?

Technically, this means that matter is made of mostly empty space, surrounded by some electron densities - we are all made of empty space and probabilities. - Mayuri

Physics Crossword (answers below)

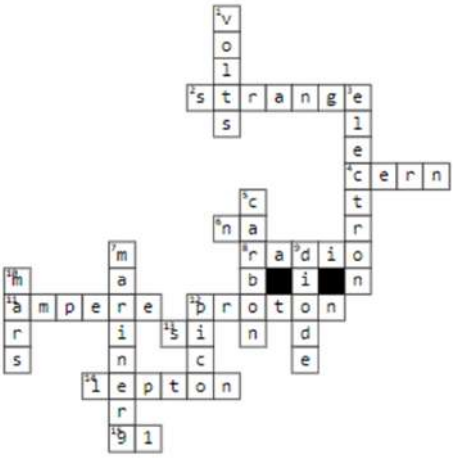


Across:

2) Up, down, top, bottom, charm, and…
4) European Organisation for Nuclear Research
6) Sodium
8) Longest type of EM wave
11) Watts/1 down
12) Positively charged subatomic particle
13) Standard units
14) Muons and neutrinos
15) Atomic number of Pa

Down:

1) Unit of voltage
3) Negatively charged subatomic particle
5) Element that makes up diamond
7) First spacecraft to orbit another planet
9) Only lets current flow in one direction
10) 4^{th} planet from the sun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