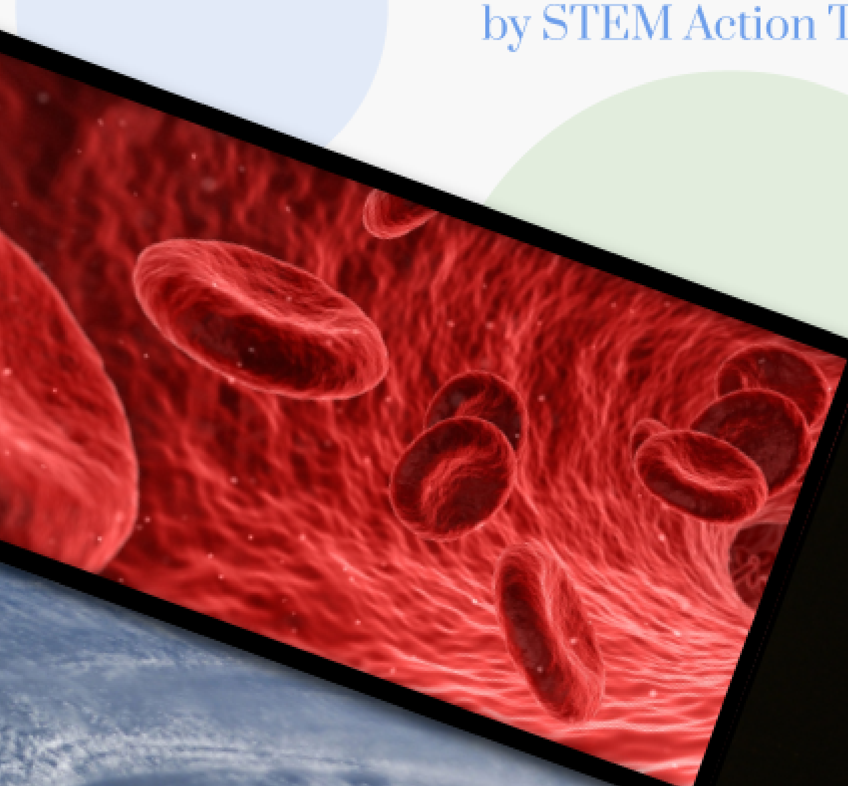
SEPTEMBER 4TH, 2023

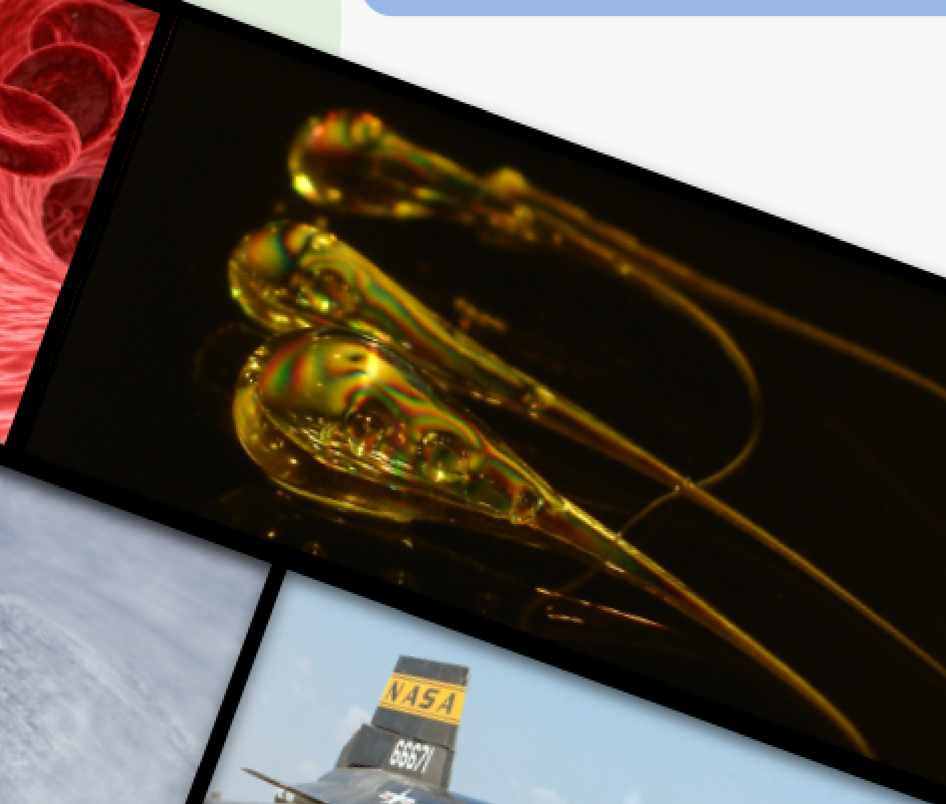
Seeking Science VOL 26

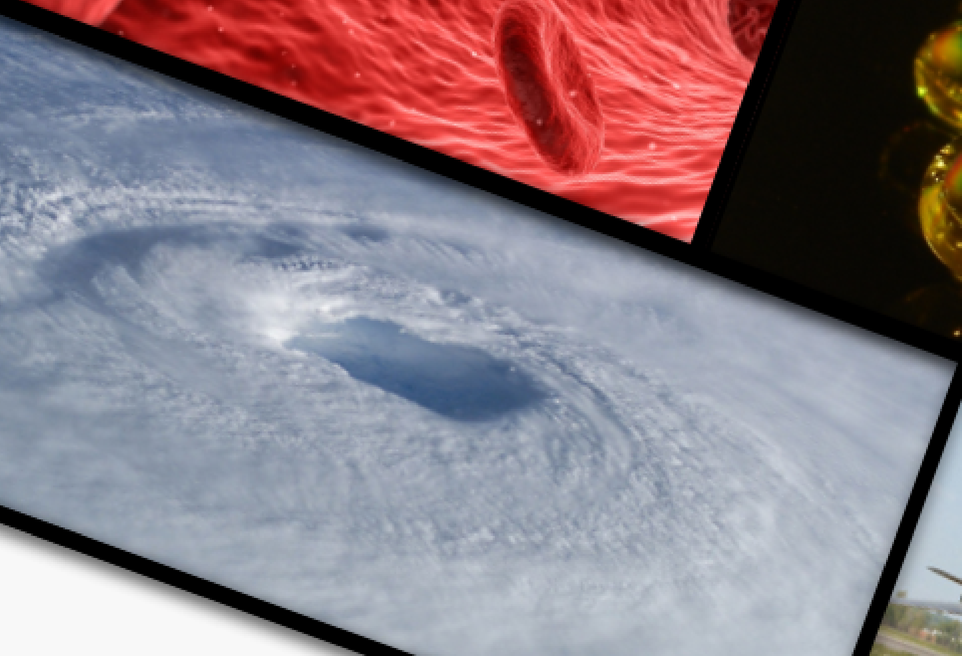
SEEKING SCIENCE

by STEM Action Teen Institution

A MONTHLY STEM NEWSLETTER







SUPERSONIC JETS

SEA TURTLES

GINGKO TREES

and more...

This Edition's Staff

Edward Huang	*President*
Stephen Hung	*Vice President*
Brian Wang	*Design Director*
Arthur Liang	*Lead Editor*
Anna Dai	*Graphics Director*
Kenny Wu	*Front Cover Designer*
Eddie Zhang	*Quality Control Manager*
Wilson Zhu	*Advertisement Manager*
Aidan Hong	*Advertisement Co-Manager*
Cody Duan	*Marketing Manager*
Owen Chen	*Marketing Co-Manager*
Aimee Fan	*Community Reporter*
Denise Lee	*Senior Designer*

Ryan Zhu	*Senior Designer*
Eason Fan	*Senior Graphics Editor*
Riley Lee	*Senior Graphics Editor*
Natalie Dai	*Senior Editor*
Jerry Yang	*Senior Editor*
Richard Wang	*Senior Editor*
Donia Cao	*Designer*
Angela Chin	*Graphics Editor*
Brandon Pian	*Graphics Editor*
Steven Lu	*Editor*
Xavier Cai	*Editor*
Arick Hong	*Editor*

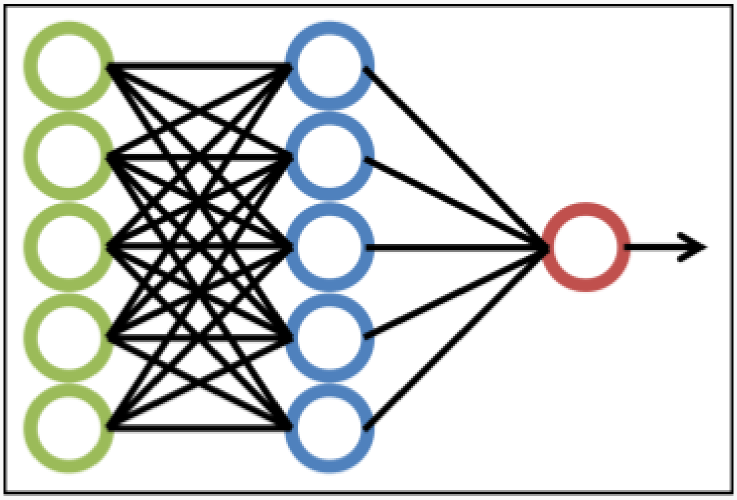
Table of Contents

The Art and Science of Matchmaking Algorithms in Video Games

Stephen Hung

Matchmaking algorithms are critical in providing players with compelling and balanced game experiences in the fast-paced and competitive world of online gaming. Behind the scenes, complex algorithms work diligently to pair people with comparable skill levels, resulting in exciting and challenging encounters for both newcomers and seasoned veterans. In this essay, we delve into the intriguing realm of video game matchmaking systems, investigating the science underlying their development as well as the art of balancing technological precision with player enjoyment.

Data is essential to modern matchmaking algorithms. They collect a wealth of information about players, such as their in-game behaviors, performance history, preferred playstyles, and social interactions. These systems construct thorough player profiles using machine learning and statistical analysis to evaluate individual strengths, limitations, and overall ability levels. The more data collected, the more precise the matchmaking.



Most modern matchmaking systems rely heavily on skill-based matchmaking (SBMM). SBMM matches players with opponents of comparable skill levels, fostering a competitive environment that challenges without overwhelming players. This delicate balancing act keeps veterans engaged with worthwhile adversaries while preventing novices from encountering insurmountable opponents.

The Elo rating system is one of the most commonly utilized in matchmaking. The Elo system, which was originally designed for chess, offers numerical ratings to players based on their performance against other players. This method is still the basis for many matchmaking algorithms. Each player starts with an initial rating, and the system determines the expected outcome based on their ratings prior to a match. The players' ratings are adjusted following the match based on the actual outcome and the difference between the expected and actual results. The process is iterative, with ratings becoming convergent to stable values as participants participate in more matches. The Elo system is adaptable and relevant to both one-on-one and team-based games, making it a critical tool in matchmaking systems across a wide range of competitive contexts. However, video game matchmaking has grown to include increasingly complex rating algorithms that adapt to various game genres and take into account numerous in-game criteria.

Achieving the correct mix between rapid matchmaking times and accurate skill-based pairings is critical for matchmaking systems. Longer player wait times might cause aggravation while compromising precision can result in uneven matches. Developers constantly adjust the trade-off between precision and speed, ensuring that gamers spend more time playing and less time waiting.

Forging Worlds from Scratch: Building a Complete Game Engine

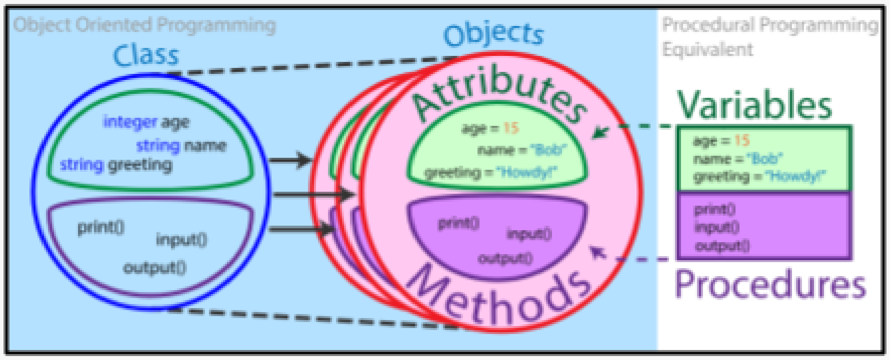
Brian Wang

While many of us look at websites, and YouTube videos, and even play video games for granted, the true nature behind how such creations came to be is a fascination. Not only do they require complex programming logic – both high and low level – built within them, but they also require rendering of both game components and physics. It generally boils down to gathering input, rendering output, and storing objects within classes.

Setting up a simple scene that defines our window of game development is the foremost topic, which could be achieved either through the creation of such by custom code, or using libraries out there such as SDL (Simple DirectMedia Layer). The overall goal of this library is to start up a renderer and window, though making such renders needs complex low-level programming specified on object buffers – which includes, in a more relatable sense, metadata within certain objects – that give items their properties. To help with rendering, you can also consider the DirectX library that is shown on the Microsoft website. Using libraries is much more efficient since you can simply drag in the game engine an OBJ file, and call a function from the library to render that object. When making your own graphics engine, it is important to consider your own screen

"Godot3.4" by SakuraMiyazono. Licensed by Wikimedia Commons under CC BY-SA 4.0. https://commons.wikimedia.org/wiki/File:Godot3.4.png dimensions, x-y-z coordinates, and their rotations, and how they will translate onto the screen (using game engines to draw certain lines).

Low-level languages that can build a game engine from scratch include C++, which has elements known as “classes”. These help organize certain objects and their properties together in a form of programming known as OOP (Object-Oriented Programming). You can create certain classes within your code, and make yet another class to correctly render and process these entities using the graphics engine. The final main component needed in a base engine is a physics engine. When making custom code, it is important to note the different positions of entities within their vertex buffers every single second and update the physics of that certain object accordingly – with gravity, for example. However, since this is time-consuming, it’s generally recommended to use a pre-made library for physics, such as PhysX. As for the rest of the game engine, certain elements can be created using a UI interface – as an interface for developers to make their own UI in their game – or a high-level programming language that builds off of C++, such as Python.



“CPT-Object-Var-Proc” by Milesjpool. Licensed by Wikimedia Commons under CC BY-SA 4.0.
https://commons.wikimedia.org/wiki/File:CPT-Object-Var-Proc.svg

Daisy - The Recycling Robot

Aidan Hong

One major source of e-waste is smartphones. Every year, smartphone manufacturers release a new phone, enticing many to buy a new one. However, there is an inherent problem with this – their old phone is left unused. In order to combat this issue, Apple created a robot known as “Daisy.”

“Daisy” is one of many robots Apple has created to combat e-waste. Before Daisy, Apple created two versions of Liam. However, Daisy is not only more compact than Liam, it is also more efficient. In fact, it can disassemble 200 iPhones an hour, or 1.2 million iPhones a year! The way Daisy works is it operates like a reverse production line. First, an iPhone is fed into the machine. Once it’s fed in, the screen is removed. This exposes all the components inside the phone. Then, it removes the battery. Since the battery is secured by adhesives, cold air is used to loosen up the adhesive. Then, the battery is removed. Afterwards, the screws are removed. In order to do so, it hits the phone 3 times. This had a higher success rate than manually unscrewing the phone, as well as being faster. Since the screws are removed, individual components can now be sorted. Unfortunately, these components need to be sorted manually. These parts are then sorted into boxes.

Daisy has many advantages over traditional e-waste recyclers. For starters, it can recover more than traditional e-waste recyclers. Additionally, it does so at a faster speed. However, it can only disassemble iPhones and only 9 versions of them. Still, it is a step forward from traditional e-waste recyclers and plays a pivotal role in not only combating e-waste but also recycling phone parts.

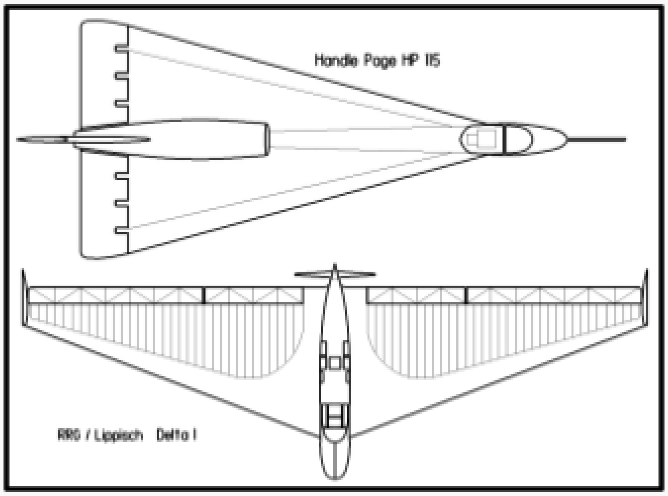
Faster Than Sound

Edward Huang

In 1947, the American Bell X-1 jet became the first plane to fly faster than the speed of sound, smashing the sound barrier at an amazing 958 miles per hour. As the first supersonic jet, the Bell X-1 blazed the trail for future development in supersonic technology, and more impressive milestones would be reached. Even more impressive than the insane speeds at which these planes fly, however, would be the complex science and optimization that goes into their design.

CC0 1.0 Universal (CC0 1.0)
Public Domain Dedication

One of the key problems that these planes face during the design process is combating air drag. The general shape of the plane, known as the airfoil, must be designed in a way that minimizes drag, which in turn maximizes the speed. Engineers have to consider the angle of the Mach cone, a pressure wave formed at the nose of the plane when it travels at supersonic speeds. By doing this, jets will minimize the formation of shockwaves at different points, reducing drag. Other consequences of supersonic air flow, such as wing sweep and the formation of vortexes surrounding the jet must also be factored, further complicating the design process. Over many decades of aerodynamics research, scientists and engineers have found that the optimal supersonic jet requires either a biconvex or double-wedge airfoil. Wing shapes are varied, but efficient designs include delta and ogive wings.



CC0 1.0 Universal (CC0 1.0)
Public Domain Dedication

Another problem that supersonic planes must face is heating, an unavoidable consequence of air drag. Supersonic jets are typically made from different materials from subsonic jets due to the immense heat generated by the friction of air molecules. While subsonic planes are usually made with aluminum alloys, supersonic jets are often built with titanium and stainless steel. Aluminum alloys like Duralumin are lightweight but deform under the immense heat at supersonic speeds, limiting their use to subsonic jets, while titanium and stainless steel are much stronger and can withstand being used for supersonic jets.

Of course, reaching such high speeds requires a strong and efficient engine. Typical supersonic jets usually have turbofan engines combined with afterburners. In a turbofan, a portion of the air bypasses the combustion chamber and turbines, increasing thrust and cooling the engine. Afterburners also increase the efficiency of the engine by burning extra fuel using the jet's own exhaust.

After years of research and development, jets have only become faster and faster. The fastest aircraft in the world, the X-15, has a maximum speed of 4520 miles per hour, many times faster than the X-1. The jet reaches a speed of Mach 6.72, making it "hypersonic", as its mach number is greater than 5. In conclusion, the remarkable journey from X-1 to X-15 highlights the complex interplay between science and engineering as scientists continue to push the realm of what is possible.

Mean Inequality Chain

Richard Wang

The mean inequality chain is a complex, yet intriguing part of math that relates four different means with inequalities. Before introducing the mean inequality chain, it is important to understand the four means involved in it: arithmetic mean, geometric mean, quadratic mean (also called rms), and harmonic mean. Arithmetic means taking the sum of the n numbers and dividing it by n: essentially taking the average. The geometric mean takes the n numbers, multiplies them, and takes the nth root of the product. The quadratic mean takes the square of each of n numbers, averages them, and takes the square root of it. Finally, the harmonic mean takes the average of the sum of the reciprocals of each number and then takes the reciprocal of the whole average.

At first glance, all these means look like a jumble of numbers. To simplify, all these means, like arithmetic mean, are measuring the central value from a set of numbers. For example, the idea behind the arithmetic mean was central with respect to the addition of numbers. For geometric mean, it is the same but with respect to multiplying the numbers. The quadratic mean is like taking the arithmetic mean but instead, we are taking the square of each number. Moreover, the harmonic mean is like the arithmetic mean but we are taking the reciprocals of the numbers.

Let some notation be established. AM will represent the arithmetic mean, GM will represent the geometric mean, QM will represent the quadratic mean, and HM will represent the harmonic mean. The mean inequality chain relates all of these means by saying that the QM >=AM >= GM >= HM. There are proofs behind these inequalities but they are beyond the scope of this essay.

One would ask themself - what are the practical uses of something as specific as the mean inequality chain? Well, the mean inequality chain is commonly used in proving complex inequalities. It is also used in statistical analysis. In Economics geometric means can calculate average growth rates and arithmetic means can calculate average returns. Then with the mean inequality chain, you can measure the differences between the different rates. QM and HM are also commonly used in physics and other areas of data analysis.

$$\sqrt{\frac{x_1^2 + x_2^2 + \cdots + x_n^2}{n}} \geq \frac{x_1 + x_2 + \cdots + x_n}{n} \geq \sqrt[n]{x_1 x_2 \cdots x_n} \geq \frac{n}{\frac{1}{x_1} + \frac{1}{x_2} + \cdots + \frac{1}{x_n}},$$

The Belousov-Zhabotinsky Reaction

Kenny Wu

To begin, the "Traffic Light Reaction," also known as the Belousov-Zhabotinsky (BZ) reaction, is a fascinating reaction of chemical kinetics that caught the interest of scientists. This rhythmic reaction displays a spectacular symphony of color changes, which resembles traffic lights changing colors in a hypnotic dance. As a classic example of a non-equilibrium chemical system, the BZ reaction shows the beauty of dynamic self-organization and the elegance of complex behaviors that build from simple chemical components.

Furthermore, the heart of the BZ reaction lies in the interaction of diverse chemicals, including bromine ions (BrO3-), malonic acid (CH2(COOH)2), and a catalyst like ferroin or cerium ions. These components are dissolved in water, and sulfuric acid is added to maneuver the acidity of the solution. When the reaction starts, a fascinating light show begins. The color changes follow a periodic pattern, creating a visual feast of blues, greens, reds, and yellows that smoothly transition from one hue to another, resembling a symphony of lights.

In addition, this fascinating reaction has important scientific significance rather than being just a visual marvel. The BZ reaction serves as an example of a non-equilibrium system, in which reactions are continuously modifying the chemical composition. The oscillations result from a precise balance between oxidation and reduction processes in the reaction mixture. Numerous fields benefit from the BZ reaction, including materials science, biology, and even meteorology, where dynamic behaviors are key to comprehending complicated phenomena.

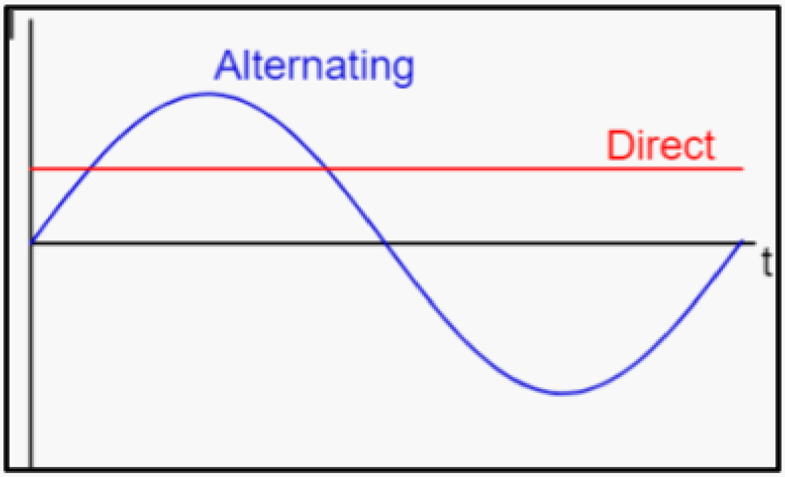
All in all, the Belousov-Zhabotinsky reaction is a fascinating demonstration of chemical kinetics, displaying the potential of non-equilibrium systems. With its rhythmic color changes and spectacular patterns, this reaction presents a visually engaging display that is both scientifically enlightening and artistically inspiring. The BZ reaction reminds scientists of the complex behavior that can be displayed from even the simplest of chemical components.

“Chemical traffic light experiment” by Yin may tun. Licensed by Wikimedia Commons under CC BY-SA 4.0. https://commons.wikimedia.org/wiki/File:Chemical_traffic_light_experiment.jpg

The Difference Between AC and DC Currents

Owen Chen

Electricity is the lifeblood of modern civilization, an indispensable force that drives our technological advancements and sustains our way of life. Despite its intangibility, humans have developed ingenious ways to harness and control electricity, and at the heart of this endeavor are two fundamental forms of electrical current: Direct Current (DC) and Alternating Current (AC).



DC is characterized by a steady and unidirectional flow of electric charge. Simply put, electrons move consistently in a single direction through a conductor. It was one of the earliest methods used for electricity distribution. Pioneered by Thomas Edison, DC powered some of the first electric systems, most notably the Pearl Street Station in New York City, which began operation in 1882. DC lies in its simplicity, making it ideal for low-voltage applications such as batteries and certain industrial processes. However, DC has its limitations, particularly when transmitting electricity over long distances, where voltage drop becomes a significant challenge.

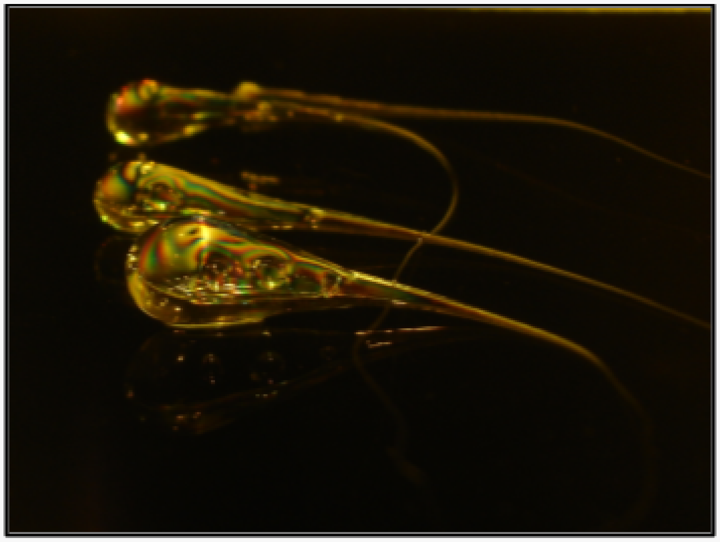
AC, in contrast, exhibits a constantly changing direction of electron flow. AC was developed to address the limitations of DC when it comes to long-distance power transmission. Figures like Nikola Tesla and George Westinghouse played pivotal roles in promoting AC power. AC's defining characteristic is the sinusoidal waveform it creates as charged particles oscillate between positive and negative charges. This waveform allows electricity to be transmitted efficiently over extensive distances without significant voltage loss. It is the backbone of electricity distribution, powering homes, industries, and a wide array of electrical devices.

In conclusion, DC and AC currents have shaped the modern world and its reliance on electricity. While DC offers simplicity and stability, AC's capacity for efficient long-distance transmission ensures that electricity can reach every corner of society. The interplay between these currents harnessed through innovative technologies, has facilitated the development of the electrified world we know today. As we continue to evolve in the realm of electrical power, the synergy between DC and AC currents remains a cornerstone of our technological progress.

Prince Rupert's Drop

Arthur Liang

Prince Rupert's Drops are a marvel of chemistry and physics that have puzzled scientists with their one-of-a-kind physical properties since they were discovered in the 1600s. The drops are named after Prince Rupert of the Rhine, who was the first to bring the drops to be examined at the British Royal Society in 1660 (though they may have already been discovered by Dutch glassmakers earlier in the century).



Public Domain Dedication

On the outside, the drops seem insubstantial. Just a piece of hardened glass molded in a teardrop/tadpole shape. They are also not considerably difficult to make. One can make these objects by just dropping molten glass into cold water. The outer layer of the glass cools quickly, while the inner layer remains tense due to the slower cooling. However, as a result, an object which is both incredibly strong and incredibly fragile is born. The tail end of the drop, the wide base, can withstand immense force. However, any pressure applied to the thin head of the drop will cause it to disintegrate entirely. The tension in the core of the drop is all released when the tail is disturbed, shattering the entire structure. This goes to show the power of energy release within materials, as the drop itself can even withstand bullets.

Researchers explore the chemical and atomic structure of the drop, hoping to somehow find a way to apply the drop’s reinforced structure to other materials. The drop also appeals to artists as well, as the drop also has a unique way of catching and refracting light, creating appealing optical effects. Overall, Prince Rupert's Drops serve as a reminder that the world of science and discovery is far from exhausted. If their properties can be explained and replicated, these tiny drops may just revolutionize the world as we know it.

The Amazing Sea Turtles

Riley Lee

Sea turtles are truly amazing and interesting ocean inhabitants. They are important protectors or defenders of marine ecosystems as they play a crucial role in marine ecosystems. From having to perceive biodiversity to preventing beach erosion to supporting coastal economies. One of their nicknames is called “Guardians of the Sea.” There are seven different species of sea turtles each with unique factors and behaviors. Sea turtles have been around for millions of years and have adapted to many different marine environments and ecosystems.

Sea turtles act like an ecosystem manager as they help maintain the health of marine habitats. They do this by preying on populations like jellyfish and sponges to prevent the overgrowth of these species. As they do this action more and more it helps support the diversity of marine life and improves the balance in the marine ecosystems. As sea turtles give birth, they help the beaches they are at because it prevents erosion when they dig up sand and helps nutrient cycling.

“Green Sea Turtle swimming” by RobertoCostaPinto. Licensed by Wikimedia Commons under CC BY-SA 4.0. https://commons.wikimedia.org/wiki/File:Green_Sea_Turtle_swimming.jpg

Although sea turtles are protectors and guardians of the sea, they are either endangered or threatened. This is because of habitat loss, pollution, climate change, and overfishing. Many sea turtles can also be endangered and threatened by being tangled in fishing gear, digestion of plastic, and poaching.

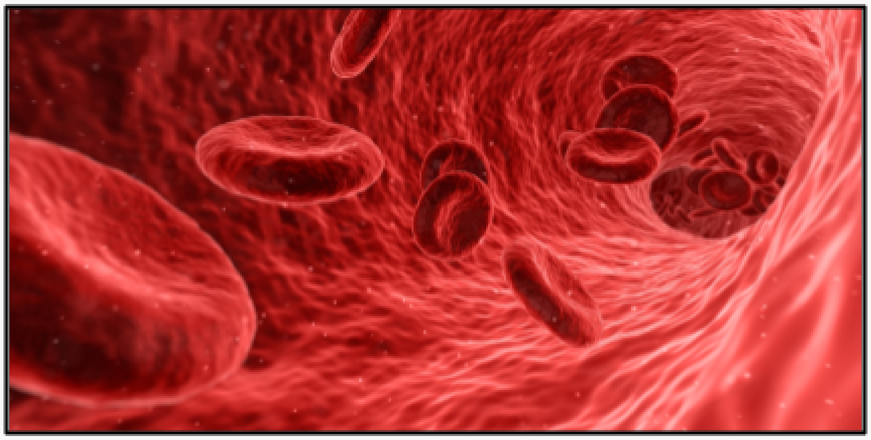
Without sea turtles, our marine ecosystem would be weaker than it would be today. In conclusion, sea turtles are an important and valuable part of marine ecosystems and coastal economies. Without sea turtles, our marine ecosystem would be weaker than it would be today. By working together to protect these creatures, we can help maintain the health and balance of our oceans for generations to come.

"Entangled green sea turtle" by NOAA Marine Debris Program. Licensed by Flickr under CC BY 2.0.
https://www.flickr.com/photos/noaamarinedebris/7656597150

Blood - The Essence of Human Life

Eddie Zhang

Blood, often symbolically referred to as the "river of life," assumes a central role in maintaining the delicate balance crucial for human existence. This complex and intricate fluid performs an array of essential functions that ensure the proper operation of our bodies. These functions encompass the transport of vital nutrients, the removal of waste products, temperature regulation, and hormonal regulation. The circulatory system, with blood at its core, coordinates these processes harmoniously, akin to an intricate symphony.



CC0 1.0 Universal (CC0 1.0)
Public Domain Dedication

One of the most well-known roles of blood is its function as a carrier for oxygen and nutrients throughout the body. Hemoglobin, a protein found within red blood cells, binds with oxygen in the lungs, forming oxyhemoglobin. This compound then travels through the arteries, delivering oxygen to tissues and organs, where it is released to facilitate cellular respiration. Additionally, blood serves as a conduit for crucial nutrients like glucose, amino acids, and fatty acids, which are essential for energy production, growth, and repair.

In the course of metabolizing nutrients and executing their functions, cells generate waste products. Blood plays a pivotal role in eliminating these waste materials, including carbon dioxide and urea, from tissues. Subsequently, it transports these byproducts to organs responsible for their disposal, primarily the lungs and kidneys. This meticulous waste elimination mechanism is indispensable in preventing the buildup of toxins and maintaining a state of equilibrium within the body.

Blood also acts as a regulator of body temperature, maintaining the body's internal environment within a narrow range. In response to elevated body temperature, blood vessels expand, promoting increased blood flow to the skin's surface. This enhances heat dissipation through radiation. Conversely, when the body's temperature drops, blood vessels constrict to minimize heat loss. This intricate interplay ensures optimal physiological functioning, irrespective of external temperature fluctuations.

Furthermore, blood functions as a carrier for hormones, serving as messengers that oversees a wide array of bodily functions. Hormones produced by the endocrine glands are released into the bloodstream and subsequently transported to specific target tissues and organs. This intricate communication network plays a pivotal role in regulating processes such as metabolism, growth, and reproduction.

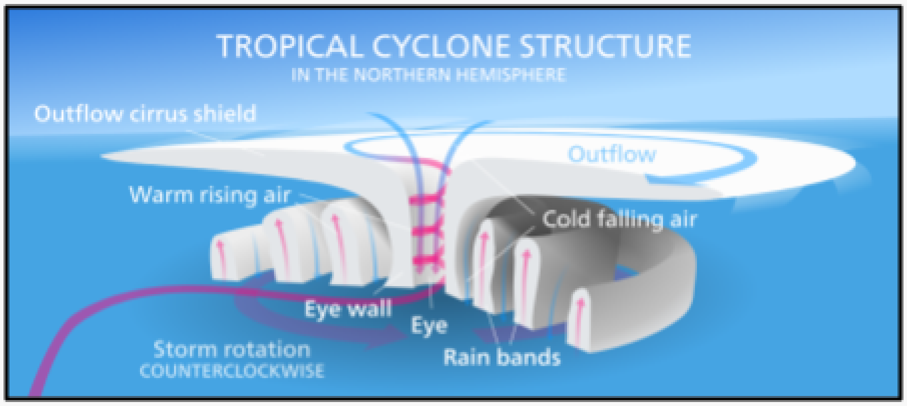
The roles of blood within the human body are indeed extraordinary. This life-sustaining fluid operates as a conduit for transporting oxygen, nutrients, and hormones to cells while concurrently eliminating waste products. Moreover, it actively participates in maintaining temperature, initiating immune responses, facilitating clotting, and ensuring hormonal balance. The orchestrated interactions of the circulatory system and blood underline the delicate equilibrium essential for human survival. As we contemplate the intricacies of this essential fluid, we foster a deeper appreciation for the remarkable mechanisms that perpetuate our lives.

Hurricanes: Nature's Fury

Cody Duan

Hurricanes are among the most destructive natural disasters causing up to 200 billion dollars in damages. These storms can sustain wind speeds of over 150 miles per hour and last about two weeks. During the two weeks, the area affected by the hurricane experienced heavy rainfall, strong winds, and mass flooding, but how does a hurricane form?

A hurricane is a low-pressure system. At the eye of the system, the air pressure is lower than its surroundings, resulting in the center sucking air toward it. A low-pressure system forms when air heats up by contact with land or water. As a result, the less dense air rises, lowering the air pressure. At the same time, water vapor condenses, causing cloud formation and precipitation.



"Hurricane-en" by Kelvinsong. Licensed by Wikimedia Commons under CC BY 3.0. https://commons.wikimedia.org/wiki/File:Hurricane-en.svg

Hurricanes are often categorized into five categories by wind speeds. The categories are sorted one through five, with one being the weakest. To be considered a hurricane, it must be in Category One with minimum wind speeds of 74 miles per hour and maximum wind speeds of 95 miles per hour. The next level, Category Two, has wind speeds of 96-110 miles per hour. A major hurricane starts at Category Three, with wind speeds ranging from 111-129 miles per hour, and Category Four hurricanes have wind speeds of 130-156 miles per hour. A Category Five hurricane causes the most destruction, with wind speeds of over 157 miles per hour, and according to https://oceanservice.noaa.gov/facts/hurricane.html, a majority of houses will collapse, resulting in an uninhabitable area for possibly months. Winds cause a lot of damage, yet it does not cause the most damage in a hurricane.

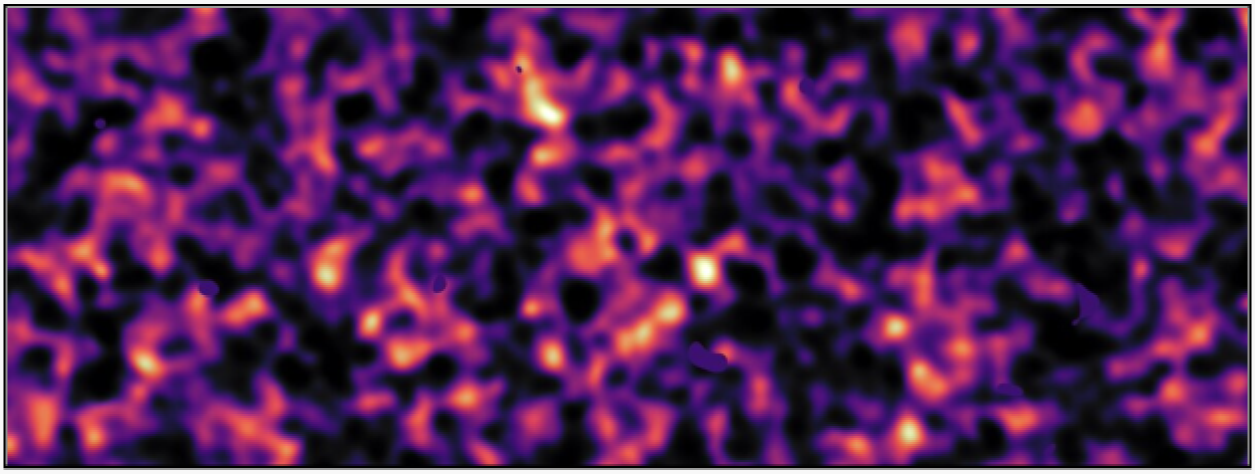
Winds are commonly believed to cause the most damage; however, it is actually the storm surge. A storm surge is the sudden rise of sea level associated with storms. Several factors influence the height, including wind and the structure of the continental shelf. Storm surges are primarily affected by wind speed, for the cyclonic motion of the wind forces water toward the shore. The angle the hurricane approaches also plays a crucial role. A hurricane approaching perpendicular to the shoreline will result in a much higher storm surge than if it closed in parallel to the coast. Another element that determines storm surge is the continental shelf, or according to National Geographic, "the edge of a continent that lies under the ocean." A steeper slope will block more water, while a shallower slope will result in a greater storm surge.

Hurricanes are frightening in that they cause immense loss. Houses can be lost and cities destroyed. There isn't much one can do to prevent the damage except to evacuate to a shelter with necessities and a few prized possessions. Hurricanes are, without a doubt, one of the most dangerous natural disasters to watch out for.

Dark Matter and Energy

Wilson Zhu

Dark matter is a hypothetical type of matter which is presumed to be approximately 27% of the entire universe. It is called dark matter since it does not interact with the electromagnetic field, which makes it not absorb, reflect, or emit light, making it difficult to detect. There are many astronomical observations that current theories cannot explain which implies that there is the possibility of dark matter. Numerous experts on the topic of dark matter believe that there is a plentiful amount of dark matter since there are many occasions that show that there is a possibility of dark matter existing in the universe.



"Dark matter map of KiDS survey region (region G12)" by Kilo-Degree Survey Collaboration/H. Hildebrandt & B. Giblin/ESO. Licensed by Wikimedia Commons under CC BY 4.0.
https://commons.wikimedia.org/wiki/File:Dark_matter_map_of_KiDS_survey_region_%28region_G12%29.jpg

There is some evidence that can show that dark matter might exist. For example, many calculations show that galaxies would behave differently if they did not contain a large amount of unseen matter. Also, observations of the structure of the observable universe show the possibility that dark matter exists. Scientists have also come up with the composition of the universe, where 68% is dark energy, 27% is dark matter, and 5% is normal matter. Although many scientists accept the evidence that dark matter exists, some do not because some cases are unable to be explained by the normal definition of dark matter.

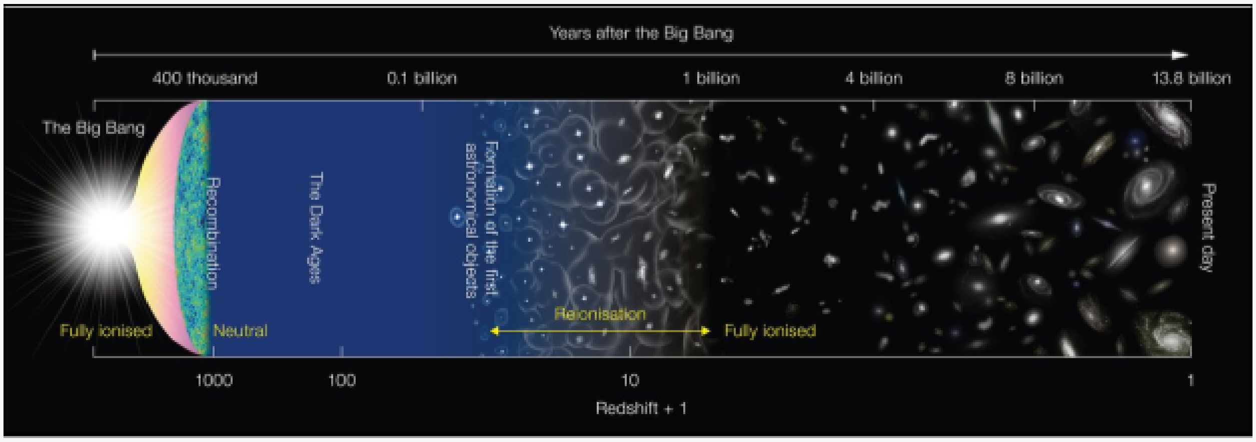
On the contrary, dark energy is an unknown form of energy that affects the universe greatly since it is responsible for the accelerating expansion of the universe. It makes up 68% of the universe compared to everything else. The energy is empty space or vacuum energy. It is equivalent to Albert Einstein's cosmological constant.

To summarize, dark energy and dark matter take up the majority of the universe. Dark matter is a type of matter that is hypothetical and is 27% of the entire universe. It does not interact with the electromagnetic field which makes it hard to detect. Dark energy on the other hand makes up 68% of the universe and causes the accelerating expansion of the universe.

The Dark Ages of the Universe

Brandon Pian

The Dark Ages is a period in the history of the universe that lasted from about 380,000 to 1 billion years after the Big Bang. It is called the Dark Ages because the universe was essentially dark, with no stars or galaxies to produce light. This is because the first stars and galaxies had not yet formed, and the gas that filled the universe was too diffuse to collapse under its own gravity. The Dark Ages began shortly after the recombination event when the universe cooled enough for electrons to recombine with protons to form neutral hydrogen atoms. This released a burst of photons, which we can see today as cosmic microwave background radiation.



"Schematic diagram of the history of the Universe" by NAOJ. Licensed by Wikimedia Commons under CC BY 4.0.
https://commons.wikimedia.org/wiki/File:Schematic_diagram_of_the_history_of_the_Universe.jpg

The Dark Ages ended when an epoch of reionization occurred. The epoch of reionization occurred 500 million years after the Big Bang. By the time the reionization occurred most of the hydrogen gas had been ionized again, releasing a lot of energy and heat into the universe leading to the formation of new stars and galaxies. After the reionization, the universe was filled with light.

The Dark Ages is a great mystery about the history of the universe that is waiting to be unlocked. One of the many challenges unlocking it is that the light from the first galaxies and stars is very faint. Also, it is very difficult to see through the fog of the neutral hydrogen gas. However, due to these setbacks, scientists are still finding ways to unlock the secrets of the history of the universe. Some strategies scientists use to unlock the mystery are looking at cosmic microwave background radiation, observations of distant galaxies that can tell scientists the conditions of when the universe was formed, and simulations of stars and galaxies. With these challenges and strategies, scientists are coming closer to unlocking the history of the universe.

The Biggest Pandemic in History

Denise Lee

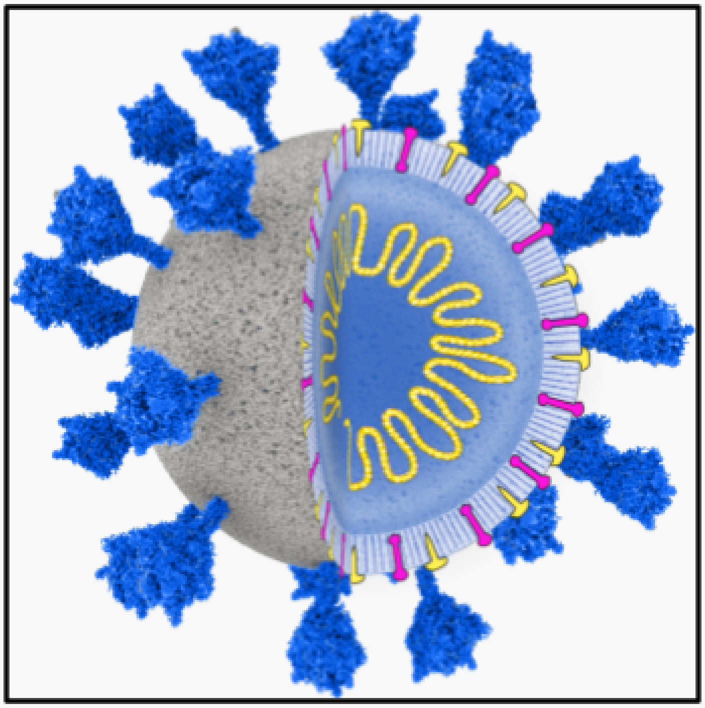
In 2019, the world experienced a pandemic called COVID-19, which lasted three years. About 770 million people were diagnosed with coronavirus, and only about 7 million of the 770 million died. In 1346, the world experienced the biggest pandemic in history, the Black Death, also known as the bubonic plague. It lasted till 1353. About 75-200 million people died.

"The Plague of Florence in 1348" by Wellcome Library. Licensed by Wikimedia Commons under CC BY-SA 4.0. https://commons.wikimedia.org/wiki/File:The_plague_of_Florence_in_1348,_as_described_in_Boccaccio%27s_Wellcome_L0004057.jpg

The bubonic plague is caused by the bacteria Yersinia pestis. It is caused by a bite of an infected flea. The Black Death was extremely contagious as it spread through the air. CDC (Centers for Disease Control and Prevention) says, "The incubation period of bubonic plague is usually 2 to 8 days. Patients develop fever, headache, chills, weakness, and one or more swollen, painful lymph nodes." Patients may cough up blood, have diarrhea, fatigue, and vomiting. The bubonic plague is called the Black Death because their fingers, hands, neck, and body would begin turning black until they died.

The Black Death began in Europe on October 1347, when 12 ships from the Black Sea arrived at Messina with dead and extremely sick sailors. According to the History Channel, "Over the next five years, the Black Death would kill more than 20 million people in Europe—almost one-third of the continent's population." The Bubonic Plague attacks the lymphatic system, causing swelling in the lymph nodes. If untreated, the infection can spread to the blood or lungs. People who were perfectly healthy when they went to bed at night could die by morning. In the 14th century, their science wasn't advanced enough to understand why so many people were dying, so many people believed that the Black Death was god's punishment. Since they believed that God was punishing them for their sins, they massacred Jews even though Jews were also infected by the plague. The Black Death doctors wore clothes that covered them completely and bird-like masks to avoid getting the plague. The doctors' jobs were to keep count of who and how many people died, and bloodlet the patients to get the toxins out. The doctors followed death around, so when patients saw them they knew it was their time to go.

The Black Death is the scariest period and the biggest pandemic in history. Hopefully, history won't repeat itself.



How Locomotives Work

Arick Hong

Many of us tend to order packages online on websites these days, and they come in a matter of hours, sometimes even on the same day. These packages take a long journey from the warehouse all the way to your doorstep. This journey would not be possible without locomotives, as they haul tons of cargo containers with these parcels to the next destination. They tend to carry around 65-200 cars full of items from cars to military equipment to scrap metal. This means that the locomotives need to have a lot of power, so how exactly do they get it?

First, there are different kinds of locomotives, each with different amounts of horsepower. We'll look at a GE C44 9W as it is a very common locomotive used on most trains. These locomotives have 4,400 hp and are capable of traveling up to 74 mph. The cargo these trains carry can be very heavy, and the train carries 65-200 cars with some of them weighing up to 3 tons. Now to explain how they carry such heavy loads, let's think about a very heavy box. You probably won't be able to lift the box, but perhaps you can push it a few inches. Now the train is just like that heavy box, but instead of pushing it, it travels on wheels (on a track of course). Because the train is so heavy, it takes a long time to speed up and slow down. For reference, it can take up to 1 mile to stop a train going at 50 mph. Now, do keep in mind that sometimes the cars are really heavy. For this, the company will usually send more than one locomotive for the job, including some locomotives in the middle and end to distribute the power. In case you're wondering how you control all the locomotives, GE C44 9Ws have a special

"union pacific freight train" by jefzila. Licensed by Flickr under CC BY 2.0. https://www.flickr.com/photos/jefzila/6692688169 function that allows one locomotive to control all locomotives on a train, so you don't need so many engineers in every single locomotive.

Now, every time you order items online, think about how they get here and how the trains play a vital part in it. Maybe next time you see a train, think about how amazing it is that just a few locomotives are able to pull such heavy freight.

Record Breaking Temperatures

Jerry Yang

This year's July has become the record-breaking temperature month ever recorded. Last month consisted entirely of chains of newly broken heat records, like the lingering heat wave located in Southwest U.S. The increasing temperature has put the human body to the test, with more than half a hundred thousand deaths from heat stroke in the years 2003 and 2022, and even more suffering from heat-related illness or injury.

Our bodies can adapt to heat, but only to certain limits, with a narrow range of temperature, the core body has to stay at. Continuously sustained heat waves strain ourselves, which cascades into effects leading to permanent injuries and at the worst, death. With climate change now a significant factor, days grow hotter, and cool nights that our bodies use to recover also grow more humid.

In order to stay cool, our bodies release heat by sweating, the process of our sweat glands releasing water out of pores, which absorbs heat. Meanwhile, the blood in our body also changes flow closer to the surface so it can disperse heat to the surrounding air, giving people the appearance of being flush when they're hot.

Now, even that backup system is becoming limited, as climate change causes humidity to rise, the sweat on our bodies cannot evaporate and instead continue to stick to the skin. If it continues to stay at a hot temperature, it reduces blood cells that are oxygen-rich and available to the heart, leading to oxygen shortage and eventual heart failure. Other issues like heat exhaustion, which kills off cells and interferes with the functions of our vital organs, and dehydration,

"TranspirationPerspirationCommonsFL" by Minghong. Licensed by Wikimedia Commons under CC BY-SA 3.0. https://commons.wikimedia.org/wiki/File:TranspirationPerspirationCommonsFL.jpg when we run out of water from sweating and force the heart to pump blood harder, are also common causes of injury and death.

All of this is avoidable if you hydrate well and find shelter from the heat with available air conditioning, whether you are at home or in public infrastructure.

How Cheese is Made

Anna Dai

Cheese originates from when sheep were first domesticated in around 8000 BCE. In current cultures, cheese is often enjoyed in various dishes such as pizza and pasta, or by itself with crackers and fruits. Cheesemaking has evolved to create over 2,000 types by alternating the recipe in different quantities and qualities.

It all starts with collecting fresh milk from farms, typically from cows, sheep, and goats. The final result of the cheese is impacted heavily by the quality of the milk used so it is important to use the best quality for best results.

The key ingredient in cheese making, rennet, is added to heated milk. Rennet is a substance usually extracted from the lining of the fourth stomach of goats, lambs, and calves that contains enzymes for coagulating milk proteins. When rennet is added, it interacts with casein, a milk protein, leading to the formation of curds.

"Adding rennet to the milk" by About Cheese. Licensed by Flickr under CC BY-NC-SA 2.0. https://www.flickr.com/photos/aboutcheese/4247929841

The liquid component of the curdled milk, whey, separates from the curds and is extracted more when the curds are cut and stirred. The curds are then pressed to remove additional whey. However, this whey is not thrown away. It can be used to help with the process of creating specific types of cheeses or used in other products.

Depending on the type of cheese, the working processes of the curd to cheese may vary. Some types may require the curds to undergo additional pressing or salting. Aging is another process that varies depending on the type of cheese. Hard cheeses such as cheddar and parmesan, age longer than soft cheeses such as brie and mozzarella.

In conclusion, the process of cheesemaking includes milk, curdling, and pressing in different variations. The science behind the important component, rennet, is what makes cheese possible by coagulating the milk. From simple cheeses to an array of flavors, cheese has expanded with time, making it one of the most enjoyed dairy products today.

Ginkgo Biloba

Angela Chin

Ginkgo biloba, also known as ginkgo trees, 'living fossils,' and maidenhair trees, live up to their title as fossils. They're the last remaining descendants of the Ginkgoaceae family, the earliest relatives dating as far back as the Permian period. Originally found in a Chinese monastery, they've now spread across the world and can most likely be found in a local botanical garden along with additional history and information on a plaque.

What makes these plants so distinct? The most noticeable feature is their leaves. Unlike any other tree, their leaves are fan-shaped and divided into two lobes. The trees grow in a pyramidal shape with golden or light green leaves in an alternate-simple pattern, which makes identifying them easy. Male trees sport catkin-like pollen sacs, while females produce malodorous plum-like fruit. Although males are usually planted throughout cities to avoid the females' fallen fruit, seeds from the fruit have long been used in medicine-making and are being researched as a cure for Alzheimer's.

"Ginkgo Tree with Autumn Color Kyoto | Japan" by Goat Tree Designs. Licensed by Flickr under CC BY 2.0. https://www.flickr.com/photos/188326905@N04/51716555429

Ginkgo trees and their lengthy past are fascinating for researchers and botanists alike. They're some of the world's oldest species and don't seem to be going extinct anytime soon

Glowing Frogs

Natalie Dai

Many animals have colorful patterns and traits to protect themselves or communicate with each other. Similar to how fish, corals, and penguins can glow under different types of light, it has been recently found that increasing amounts of frogs can also do the same. Some species are capable of producing a subtle green or orange glow, under the blue lights of nightfall, although it may not be visible to the human eye.

This glow is caused by a process known as biofluorescence. Frogs possess proteins in their skin and tissues that allow the energy absorbed from the sun to be re-emitted as different colors. Their bodies absorb short wavelengths of light, typically at higher amounts of energy, and, almost instantly after, it re-emits the absorbed light, at a lower amount of energy. This allows for the wavelengths of the re-emitted light to be longer.

"Hypsiboas punctatus fluorescente" by Casa Rosada. Licensed by Wikimedia Commons under CC BY 4.0 AR.
https://commons.wikimedia.org/wiki/File:Hypsiboas_punctatus_fluorescente.jpg

Researchers suspect that the frogs rely on fluorescent pigments to communicate with each other. Much of the fluorescence seems to be gathered around the underside of the frogs and their throats, which are used for mating and courting. With the green glow, helps make their mating calls more noticeable and attention-catching. While the green fluorescent glow is used to communicate with other frogs and attract mates, the orange glow may be intended for different uses. Researchers believe that the orange fluorescent glow may be intended to give off warning signals to predators, or used for camouflage.

In the fascinating world of nature, the discovery of frogs' biofluorescence adds yet another layer of intricacy to their complex behaviors. The ability of these amphibians to emit faint glows under specific light conditions reveals yet another fascinating method of communication and survival tactics.

Pluto

Donia Cao

Nestled at the far reaches of our solar system lies a celestial enigma that has intrigued astronomers and captivated our imaginations for decades: Pluto. Discovered by astronomer Clyde Tombaugh in 1930, Pluto was initially classified as the ninth planet in our solar system. However, in 2006, the International Astronomical Union (IAU) redefined the criteria for planetary status, relegating Pluto to the category of a "dwarf planet." Despite this reclassification, Pluto remains a source of fascination due to its unique characteristics, its role in our understanding of the outer solar system, and its connection to the ongoing exploration of space.

Pluto's distinctiveness is immediately evident. Its relatively small size, just two-thirds the diameter of Earth's moon, sets it apart from the more giant planets in our solar system. Its composition, primarily made up of rock and ice, hints at a complex history of formation and evolution. Additionally, Pluto's highly elliptical and tilted orbit deviates significantly from the flat, circular orbits of the eight classical planets. This unique orbit sometimes brings Pluto closer to the Sun than Neptune, challenging our conventional notions of planetary behavior.

"Pluto Eclipse" by PlanetUser. Licensed by Wikimedia Commons under CC BY-SA 4.0. https://commons.wikimedia.org/wiki/File:Pluto_Eclipse.jpg

One of Pluto's most captivating features is its five moons, the largest of which is Charon. The dynamic interaction between Pluto and Charon has intrigued scientists, offering insights into their shared history and the geological processes that have shaped their surfaces. Other moons, such as Nix, Hydra, Styx, and Kerberos, were discovered in the years following the New Horizons spacecraft's historic flyby of Pluto in 2015. This mission provided unprecedented close-up images and data, revolutionizing our understanding of the dwarf planet and its moons.

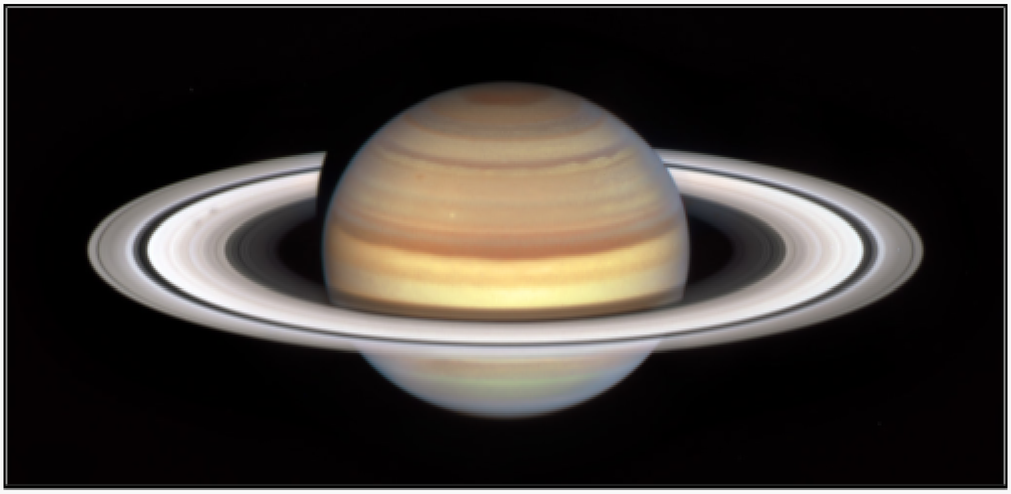
Pluto's reclassification as a dwarf planet sparked debates within the scientific community and ignited public interest in planetary definitions. While its change in status altered the way we categorize celestial bodies, it also prompted discussions about the nature of exploration and our evolving understanding of the cosmos. The New Horizons mission not only revealed Pluto's surface features in exquisite detail but also shed light on its thin atmosphere and icy plains. These discoveries challenged preconceptions and reinforced the idea that our solar system is a dynamic and diverse place.

In conclusion, Pluto's journey from a ninth planet to a dwarf planet symbolizes the fluid nature of scientific knowledge and the boundless mysteries of the universe. Its unique characteristics, including its size, composition, and orbital dynamics, have captured the imagination of astronomers and the general public alike. As space exploration continues to advance, Pluto will undoubtedly remain a subject of study, inviting us to uncover its secrets and expand our understanding of the distant reaches of our solar system. Just as Tombaugh's discovery sparked curiosity in the 20th century, Pluto continues to remind us that the universe is full of surprises waiting to be explored.

Saturn's Rings: A Dazzling Dance of Ice and Dust in the Universe

Ryan Zhu

Imagine a world where lanes of glittering ice and dust in the sky form celestial masterpieces unlike anything else in the solar system, Welcome to Saturn. This planet is often called the "Jewel of the Solar System" because of its amazing ring system. The beauty and mystery of these rings have fascinated astronomers for centuries.



"Hubble Captures the Start of a New Spoke Season at Saturn" by NASA's Marshall Space Flight Center. Licensed by Flickr under CC BY-NC 2.0. https://www.flickr.com/photos/nasamarshall/52776621547

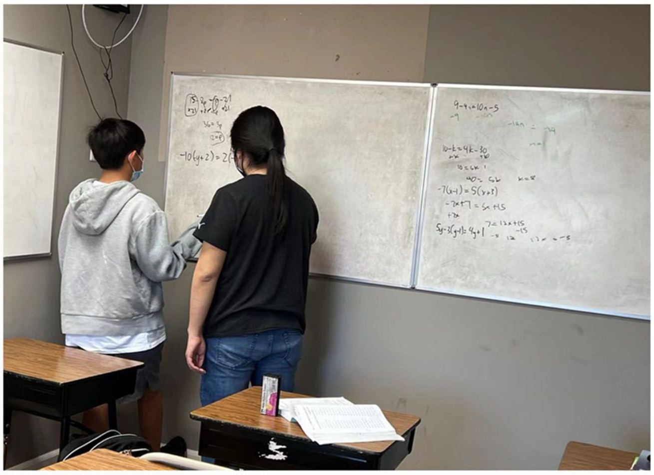
Saturn's rings are not solid rings, like diamond rings, but rather a collection of countless individual particles, ranging from tiny grains of dust to large chunks of ice. These particles are bound by Saturn's gravity and spread out over a wide area.

The rings of Saturn are also a dance of forces. Gravity from Saturn's many moons pulls particles and shapes Saturn's rings. Interactions between these moons and ring particles can also create phenomena like spirals, which create ripples in the ring system.

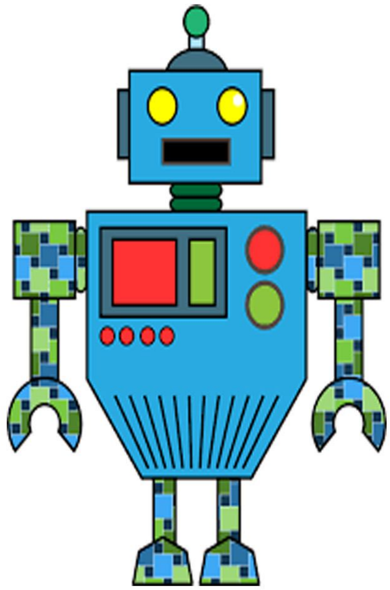
Of course, Saturn's rings are not uniform; they have a rich variety of patterns and textures. Some rings are filled with ice particles, while others are more diffuse. Variations in density and composition result in contrasting appearances, creating a new and unique visual spectacle.

Saturn's rings are also of great significance to astronomical research. According to research, they could be remnants of moons that broke up or material that never merged into moons. By studying the composition and structure of the rings, scientists can learn more about how the solar system formed.

Saturn’s rings are the grandeur of the universe. Their unique beauty ignites our imagination and calls us to explore further in our solar system and beyond. This cosmic gem will forever inspire new generations of stargazers and scientists.




週六下午就是數學大本營時間



2022年賽季將結束，每個小朋友都忙著完成自己的機器人組裝和編程