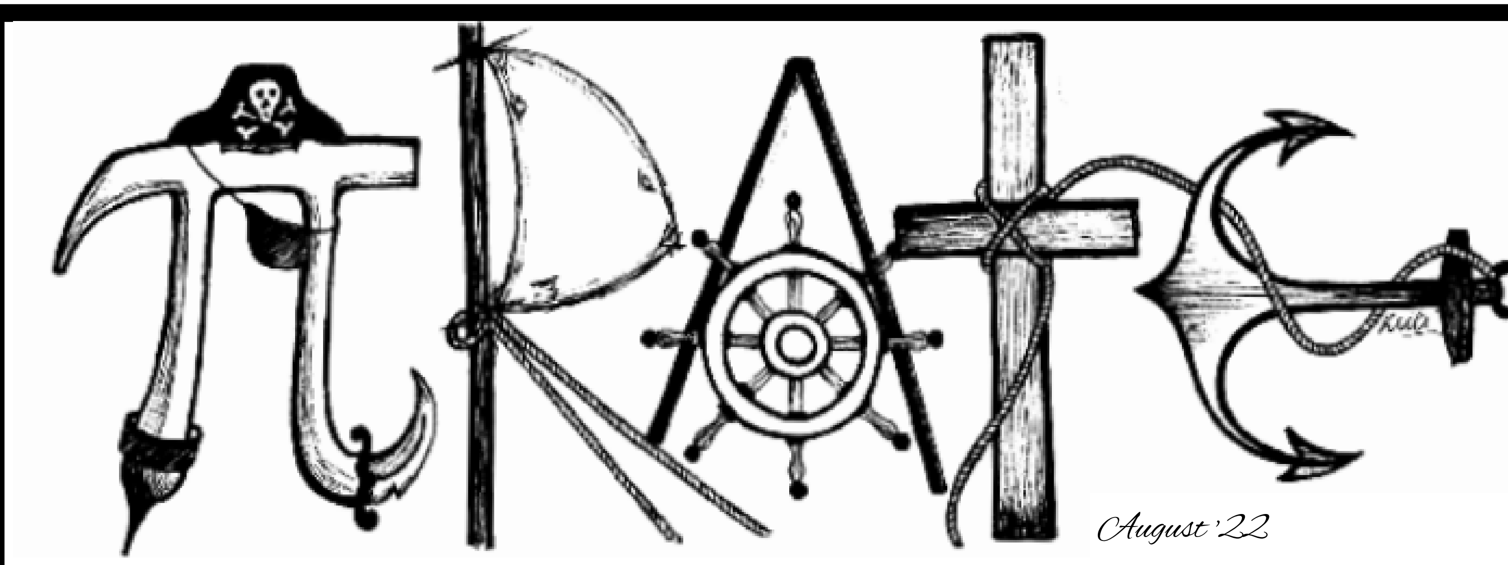

“Behind the cotton wool is hidden a pattern… the whole world is a work of art… there is no Shakespeare… no Beethoven… no God; we are the words; we are the music; we are the thing itself.”
- Virginia Woolf

Dear Reader,

My liking for Math has never been a constant- admittedly, it usually fluctuates depending on whether or not I could solve the question in front of me. To ease my (frequent) frustration over being stuck on a problem, my mother's voice would ring like a constant reminder, a repetitive alarm: "Mathematics helps to open up the mind." It's a notion that I hadn't fully understood until quite recently, unfortunately. How could Math - a subject that seemed to me so black and white - and its binary pile of solutions, scribbled down in well-worn students' registers, help to widen the horizon of cognition? After all, in Math, you're either right or exasperatingly wrong.

This mindset is not only propagated by the one-minded 'get good grades in the exam' style enforcement of education, but also by just how rigidly we divide different branches of learning. Just to pick the example closest to us, consider the segregation of streams - Science, Commerce and Arts. These barriers are further reinforced by the way society allocates us goals (and careers). And yes, the intersection of these barriers is gradually becoming all the rage (translation: Liberal Education) but that is not what we want to limit this to. Nor do we want to preach the mysticism in Math and Poetry. Instead, we just want you to understand the humanity in Math. In its errors, logic, format; in its search for meaning.

After all, Mathematics has its origins in philosophy. It is simply, by extension, a forum for discussion, exchange and contemplation. It stands true that even in school classes and courses, or in academic research conferences and gatherings, the main purpose always remains to further an insight or analyze its applications. It is not the secluded regime of numbers and formulas that we often make it out to be.

And, sure, Lieber or Einstein would be a great place to start exploring (and defying) these drawn-up boundaries, but, we hope, that this issue can serve as a good start too. In other words:

Happy Reading!

Yours infinitely,
Tanvi and Shubhika

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AN ALGORITHM TO CATCH A serial killer

Have you ever wondered why a crime took place where it did? Is it the killer's favourite ice cream spot or the victim's dance studio? Or is the place just random? The answer in most cases is no - a killer usually follows a predictable spatial pattern. Quite obviously, they avoid choosing areas too close to where they live in fear of getting recognized, leaving a buffer zone. Another phenomenon 'distance decay' suggests that they do not choose places too far from where they live either. The location of the crime also depends upon factors such as the neighbourhood, city, time, season, etc.

Taking all these factors into consideration Blim Rassno, a famous criminologist created an algorithm which focuses on the geographical aspects of the crime. This method is called Geospatial profiling, which is a crime analysis investigative technique for violent crime investigations. Blim captured the tension between the buffer zone and distance decay into a formula consisting of the two terms. This means that the probability of a crime first increases as we move to the buffer zone and then decreases as we move further away. This formula further incorporates the Manhattan distance formula in order to calculate the distance.

Rassno associates this technique to his favourite sprinkler analogy "If you know where enough drops are landing, you can infer the source". He has even incorporated this into a software system called *'Rigel',* named after the brightest star in the constellation 'The Hunter'. Its output is not an exact resistance- of course, but a colour geo profile depicting the most likely area where the criminal lives or works. The truth is that this technique was never really designed as an operational tool but merely a piece of academic research. Still, today it has popularly found applications in the police and military departments to narrow down searches in serial killer cases.

THE LINK BETWEEN MATH AND ART

Many core skills in Art and Mathematics are closely related- evidently, both fields require spatial skills and the ability to recognize patterns. In fact, mathematics has itself been described as art motivated by beauty. Artists and mathematicians extensively use geometry in their work, with parameters such as symmetry, proportion, and measurement, which adds mathematical concepts to arts like Music, Dance, Painting, and Architecture.

This brings us to the infamous Golden Ratio- defined as " the ratio of a line segment cut into two pieces of different lengths such that the ratio of the whole segment to that of the longer segment is equal to the ratio of the longer segment to the shorter segment." Since the discovery of the golden ratio, it has been widely applied by artists, designers, and architects to determine the most engaging properties to inculcate in their creations. There are many ways artists have used the golden ratio in art such as using the path of spiral in the golden rectangle.

Leonardo Da Vinci along with artists like Sandra Botticelli and Michelangelo used the proportion set by the Golden Ratio to construct many of his most acclaimed masterpieces. However, modernist art has seen a shift away from the strict use of the Golden ratio. Clean lines and shapes in primary colors, though, continue to populate paintings and graphics as evidenced by the Constructivist Movement, Suprematism and De Stijn.

Another artist known for his work with mathematics is M.C. Escher, who focused on the division of the plane and played with the 'impossible' spaces. He has even produced prototypes of drawings that cannot be replicated in the real world and can only be described using Mathematics.

Salvador Dali's painting, *'The Sacrament of The Last Supper'* is widely cited as utilizing the Golden Ratio. The painting can be broken into a dodecahedron, which is related to a golden rectangle in geometrical terms. The table and two disciples are positioned perfectly at sections of the Golden rectangle.

MATH-MADE MILLIONAIRES

Can you become a millionaire by *just* doing Mathematics? Well, it is certainly a tough job but certainly not impossible(although the problems have earned the reputation of being so). By any means, the Clay Mathematics Institute of Cambridge, Massachusetts established seven Prize Problems in 2000 to celebrate mathematics in the new millennium.

The primary objective of this problem-set is to reveal to the world that mathematics is a mysterious field with various unsolved problems and encourage mathematicians and researchers to work for solutions to these deeply difficult questions. A fund of 7 million U.S. dollars has been assigned to the program- with a million dollars allotted for the solution to each question.
These cover a variety of topics such as proofs for the Yang-Mills and Mass Gap, Navier-Stokes Equations, solutions for the P vs NP problem and a number of conjectures like the Birch and Swinnerton-Dyer conjecture.
The Riemann Hypothesis – considered to be the most important unsolved problem in pure mathematics, is included in this set. Concepts such as the fourth dimension (Hodge Conjecture) and fluid mechanics (Navier-Stokes Equations) which have fascinated humans for centuries are addressed as well.
Of the seven Millennium Prize Problems, one has actually been solved! In 2003, a Russian mathematician, Grigori Perelman, gave credible, plausible proof to the Poincare Conjecture. For this, in addition to the one million dollars, he was given the Fields Medal which he declined.
Who knows- if you keep up your passion for Math, maybe you will end up solving one of these unsolved mathematical mysteries someday. (And earn a million dollars in the process)!

PIES TO PIEMS

The Greek letter pi- named after this very magazine, is used to denote the constant ratio between the circumference and diameter of a circle. The universe of mathematical objects where pi exists is known as Flat or Euclidean geometry, a term you may have heard thrown around in mathematics classes. However, since the ancient Greeks only studied flat geometry, pi was a universal wonder for them- whose exact value they strived to determine. They were only able to reach a rough estimate as Archimedes could only place the value of pi between 3.140 and 3.142, while Ptolemy found the approximation to be 3.141.

Recently, though, with the invention of modern technology, the value of pi has been found up to 62.8 trillion digits. As the knowledge of the digits of pi expanded over the decades, people have tried to detect patterns- a rule that adheres definitively to the sequence. However, in the 1760s, the French-Swiss mathematician Johann Lambert proved that the decimal expansion of pi does not follow any simple rule for its digits; pi is irrational, i.e. its decimal expansion does not repeat or terminate.

With its literally ceaseless value, it became necessary for mathematicians to come up with a way to memorise these at least upto a certain number of digits. This has caused the field of Piphilology to come up which "comprises the creation and use of mnemonic techniques to remember many digits of the mathematical constant π", according to the website *academickids*. Thus, pi has generated an entire clierary style. Consider the following poem:

I wish I could determine pi,
Eureka cried the great inventor,
Christmas pudding, Christmas pie.
The problem's very central.

3.1415926535897932384626433832795
8841971693993751058209749445923 07
6406286208998628034825342117067 98
4808651328230664709384460955058 22

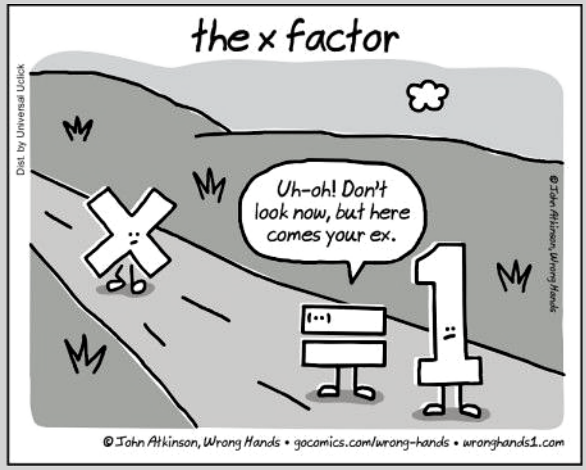
If you count the letters in each word, you'll get 3.14152653589793 23846, which is pi correct to 20 decimal places. This is an example of a "Piem"- a clever wordplay to memorize the digits of the pi. There are many such poems in English and other languages and this is only one example of a technique in Piphilology.

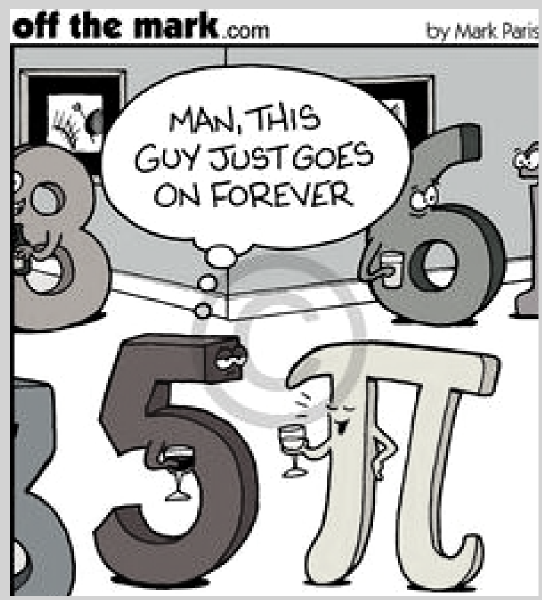
Pi day, since its numerous aspects certainly call for a celebration, falls on March 14th, or 3/14. It is celebrated by the recitation of pi's digits and enjoyment of round pies. As profound as eating pi (pie), the number pi captures a fundamental geometric fact. Often, we forget the struggles of the mathematicians who completed its value - to date, it cannot be fully captured by simple computers. These factors, though, contribute to the allure of pi and are sources of its ongoing influence in our culture.

Math Mirth

SUDOKO CHALLENGE!

		3			6			
				3			4	
4			7		2	6		
	5			9		2	3	
			4		7			
		7		1			6	
		9	2		5	1		
	2			7				
						7		





Jokes (the real mirth):

- **Why do plants hate math?**
  Because it gives them square roots.
- **How do you keep warm in a cold room?**
  You go to the corner because it's always 90 degrees.
- **How do you make seven an even number?**
  Just remove the "s!"

ANSWER:

5	1	3	8	4	6	9	7	2
7	6	2	9	3	1	5	4	8
4	9	8	7	5	2	6	1	3
1	5	4	6	9	8	2	3	7
9	3	6	4	2	7	8	5	1
2	8	7	5	1	3	4	6	9
3	7	9	2	6	5	1	8	4
8	2	5	1	7	4	3	9	6
6	4	1	3	8	9	7	2	5

MATH-A-GENIUS

The famous imposter behind Mathematics

In 1935, the great French mathematician, Élie Cartan, received a letter of introduction along with an article submitted on Nicolas Bourbaki's behalf for publication in the journal '*Comptes rendus de l'Académie des Sciences*'. Inspired by Bourbaki's work, Cartan launched himself into one of the greatest careers in mathematics, where, yes, the math was real but the mathematician was not.

I'll go on to explain- let's roll it back to the end of the first world war. Many great mathematicians lost their lives, which inevitably led to a downfall in the field at large. This is the time where independent thinking and hypothesis thrived. However, the lack of a basic shared aspect brought difficulty for various works to be connected. It was then- in 1934, that a small group of mathematicians particularly fed up with how vague and disjoint their calculus textbook were set out to write a better one.

From here, the group grew- and so did their ambition. The result was '*Éléments de mathématique*'- a [THE] treatise that omitted the 's' from mathematics by creating a consistent logical framework unifying every branch of the subject. The text began with a set of simple axioms used to build arguments. The authors were then able to deduce increasingly complex theorems corresponding to the work performed in this field. Their new systemic approach to form definitions was in sharp contrast to the previously held belief that over-dependence on logic would hinder creativity.

Nevertheless, the group of rebellious youngsters challenged society and decided to take up the biggest stunt possible: publishing their book *Éléments de mathématique* under the collective pseudonym of Nicolas Bourbaki. Over time, they went on to publish several papers that shaped mathematical activity in many parts of the world. Eventually, their books became standard references for many concepts and problems. Though Bourbaki did not referee a single major discovery, his work serves as the pioneer of many modern-day concepts including algebra, topology, and analysis among many others.

Shaping the subject into a non-existent scholar, Bourbaki's collaborators placed him in the complex mathematical-political world full of the incomprehensible terms and concepts of modern theory. Hence was born Nicolus Bourbaki, one of the greatest mathematicians in history (who never really existed)!

-Bhavya Sangal

ALBUMS AND NUMBER SYSTEMS

Numbers, evidently, play a significant role in music. Whether the notes, the verses, or just the chorus- they all follow a mathematical progression. Songs like "10,000 Hours" by Justin Bieber, "4 minutes" by Madonna, and Ed Sheeran's famous album '÷' have numerical components embedded in their titles themselves, making it safe to assume that math is ingrained within the music industry.

After a painfully long five-year silence, singer-songwriter Adele has once again taken over the music industry with her new album- '30'. Mathematicians, though, after looking back at her previous records, seem to be interested in the chronological order of the titles. It is interesting to note that her first album '19' was written when she was 19 years old and the succeeding albums- 21, 25, and the most recent addition- 30, were also written at the ages of 21, 25, and 30 respectively. The sequence has since been termed the Adele Sequence (A072666, to be exact) by mathematician David Patrick.

However, is this pattern a mere coincidence or does the singer have something in mind? I'll lay down the facts for you- she was 20 when 19 came out, 23 when 21 came out, 27 when 25 came out and 33 when 30 came out. Knowing this, do you think the singer is secretly a mathematical genius, encrypting her albums with sequences- waiting for another true genius (me) to uncover the true intentions behind her albums? It really just boils down to this: can you possibly, using simple math, predict what the singer's next album is going to be?

MATHEMATICS IN COSMETIC SURGERY

Getting cosmetic surgeries, especially with recent advancements in medicine, has evolved to become a common enough phenomenon- after all, improving your looks in whatever way or form you choose is definitely desirable to most of us. There are several examples and techniques to these surgeries such as face lifts, nose jobs, Botox, eyebrow lifts, breast augmentation, lip fillers etc.

Though most remain obsessed with the end result, hardly any heed is paid to the actual process used to procure such outcomes. Since this article has been featured in a mathematics magazine (and the title outright declares it), you may have guessed this by now: plastic surgeons, too, employ mathematics to take the guesswork out of the procedures of cosmetic surgeries. In order to ensure the live tissue segments that are selected to restore the damaged body parts have enough blood and oxygen to survive the surgical transfer, calculations are done by mathematical equations as well. According to a source, "cosmetic surgery is about symmetry, proportion, and aesthetics- that have been taught to students for a very long time." Even in lip augmentation, the 'Perfect Size' is decided by using a mathematical formula and checking the symmetry of the lips and proportion of the face with respect to it. Even the mathematical golden ratio is utilized in mammaplasty, abdominoplasty, and cheek shaping in plastic surgery.

Although Mathematics is used in many parts of our daily life, who knew that it could be used to cater to our whims- to make a 'Perfect' face, plump lips or whatever people deem desirable ?

WHY WE CAN'T DIVIDE BY ZERO

In math, we often come across a situation when we have to divide a number by zero (the ultimate travesty faced by PreSCs and SCs). Finding ourselves thrust into this scenario, we look to our mathematics teachers for much-needed help, who- in turn, offer us the kindest counsel- to simply assume that the answer is infinity. But in reality, what does it mean to divide by zero, and is it perhaps *possible*?

Division, in simple terms, is the splitting of a group of objects into equal parts. If you had to divide 12 chocolates between 3 people, each person would get four pieces. Now imagine dividing the same 12 chocolates among zero people. Is that achievable? To divide is to break something into piles of a certain number, and breaking something into piles of zero just doesn't make sense.

Another outlook on the same situation: dividing is just the opposite of multiplying. For example: 6 / 2 = x, means that

2 * x = 6. In this case, x is equal to 3.

Now let's take an equation with zero: 6 / 0 = x

means that 0 * x = 6

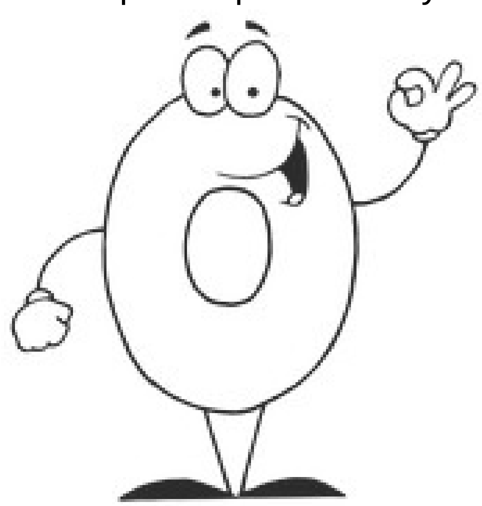
Since anything multiplied by zero equals zero, no number can possibly work for 'x', therefore 6 / 0 is undefined.

Still, there remains another lens to examine the issue. If we take the following equation: 0 / 0 = x; it means that 0 * x = 0.

For this, we can plug in zero as a correct answer, surely, but any other number that we plug in will also be right. Since we want things to have just one correct answer and 0 * x = 0 can have infinite answers, we can undeniably conclude that zero divided by zero remains undefined.

Bear with me, there remains yet another way to make sense of the expression 0/ 0 by using the principle of limits. The basic idea is to let both the numerator and the denominator become smaller and smaller, making the answer depend upon the way in which the numerator and denominator approach 0.

Confusing right? This phenomenon has also influenced an influx of memes on the internet- with any haphazard phenomenon followed by 'must have divided by zero'. The principle is accurate enough though, we really have no idea what will occur then.



ETYMOLOGY OF SINE

Today, the function '*sine*' is being frequently applied in various fields of physics and arithmetic. Rarely, though, does anybody question the reasoning behind naming this function: why, exactly, is it called that? We just know sine as the ratio of the perpendicular to the hypotenuse (longest side) of a right-angled triangle. Surprisingly, the meaning of the word does not, in the least, resemble the function it is associated with.

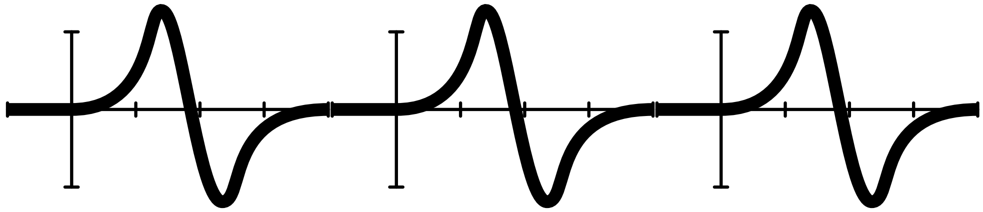
The journey of sine emerged from ancient India where it was named *jya-ardha* (chord-half). This concept of the Indian sine was quite different from today's sine for it was taken as directly equal to the side opposite the angle, instead of the side being divided by the hypotenuse, making it a length and not a ratio.

Entering mediaeval Europe, the word *jya* was translated into *jiba* which ended up being written as jyb (جيب).

Further, when this Arabic trigonometric work was being transliterated to Latin (during the 12th century) its Latin equivalent *sinus* emerged - which translates to bosom (meaning: opening of a woman's garment at the neck/bay or gulf). This Latin word *sinus* then gradually advanced to become our English 'sine.'

Other trigonometric functions, too, have similar origins. The word tangent, for example, is derived from the Latin *tangere (to touch)*. The 'co-' prefix in cosine and cotangent simply stands for co-angle (the complementary angle), which means the cosine of an angle is the sine of its complementary angle.

So, there we have it, *'sine'*. A Greek word, first translated into Sanskrit, then converted to Arabic, then mistranslated into Latin and, finally, promptly etched on every second page of our mathematics textbooks, as we find it today.



PUTTING A RING TO SEXISM IN MATHS

For the purpose of writing this article, we just spent 15 minutes going around our class, and asking people if they knew any female mathematicians, excluding the obvious answer Shakuntala Devi (though, if we're being honest, that too is because of her biopic). The only response we've received, so far, is, "No - but I could search it up?" Yes, you could; but why haven't you already? Perhaps this goes on to demonstrate the social reality that we have accustomed ourselves to, coupled with a general disinterest in Mathematics as a field. Again, this becomes especially applicable to women in STEM. The ignorance and systemic prejudice only further dissuade them from pursuing the subject and further perpetuate the cycle. Today, though, we aim to fix, at least to an extent, what has been inflicted, by introducing you to 'the most significant creative mathematical genius thus far produced, according to Einstein.

Amalie Emmy Noether was born in 1882 in Erlangen, Germany to a mathematician (no surprise there). In fact, she continued to be referred to as Max Noether's daughter even after her contribution to the field completely outweighed his (we will let you draw your own conclusions here). Despite this, Mathematics was not an obvious choice for her. In truth, she aimed to teach French and English because female students were generally barred from pursuing education beyond high school. However, with her academic rigour, the university was coerced into giving a degree to her, and she eventually took on the role of an unpaid guest lecturer at the University of Göttingen after mathematician David Hilbert lobbied her.

She utilized these years efficiently enough, as she conceptualized Noether's theorems. Basically, she proved that all physical laws hold true under a certain passage of time, or time frame, popularly termed *time symmetry* (this is a result of "energy symmetry" or the conservation of energy that you may have studied). This, in turn, helped further Einstein's theory of relativity and helped Peter Higgs predict Higgs Boson in 1964: a particle confirmed by the Large Hadron Collider only in 2012.

She had to escape to the US as a result of her Jewish identity. Fortunately for her, she was offered a teaching position at Bryn Mawr College. Here, she propositioned the Ring theory in 1921, a concept so advanced that it is still being built upon today. The ring in this case refers to a set of items you can add, subtract and multiply, the result of which will always be another object that is in the set.'

Despite making such major contributions to the field of mathematics, for most of her career (and even now) hardly anyone knew she was a woman! Most assumed she was a man because even conceptualizing that a woman could make such phenomenal discoveries seemed absolutely impossible. Her life was unexpectedly cut short in 1935, at the mere age of 53, four days after she underwent a surgery to remove an ovarian tumour.

With her contribution to both Mathematics and Physics, while overcoming rampant sexism (and Nazis), she truly has proven herself as a legend and deserves due recognition. Her legacy lives on in almost every aspect of modern Mathematics and Physics.

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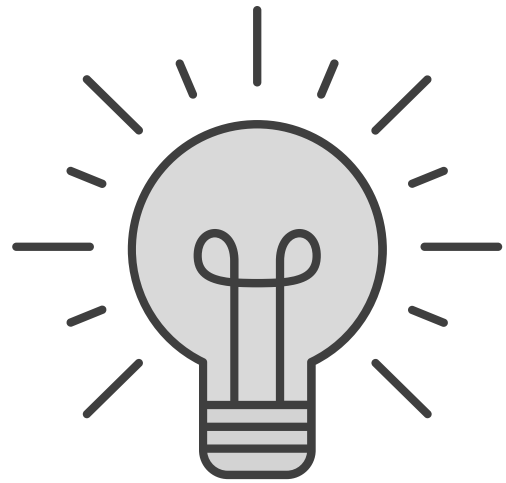

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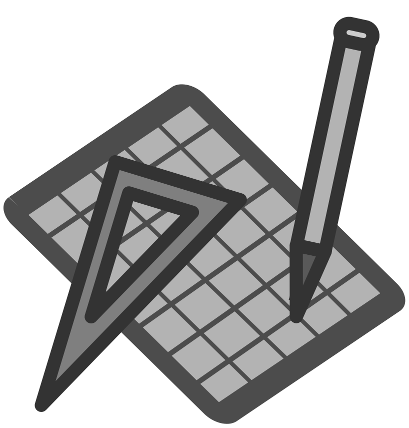

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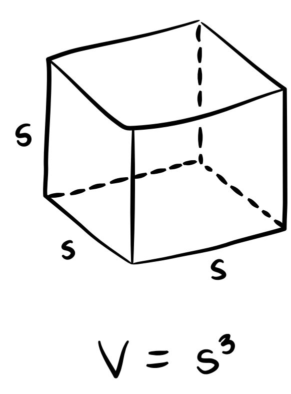

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