Pi-rate'24



"Mathematics is not about numbers, equations, or algorithms: it is about understanding." – William Paul Thurston

Dear Readers,

As I sit down to pen my final note for Pi-rate, nostalgia washes over me, reminding me of the incredible journey of producing the magazine. From a simple newsletter to a platform that has brought math to life in the most unexpected ways, the magazine has grown beyond what I had ever imagined. Over the years, I've heard countless voices ask, "When will I ever use this subject in my life?" or "This doesn't make sense." And yet, for me, mathematics has always stood out as the most practical and applicable subject in our daily lives. We may not always notice it, but we are constantly using math.

This issue, themed 'Math in the Mundane', is an effort to show exactly that: how mathematics is woven into the fabric of our everyday lives, often without us realizing it. From the early morning routine of a Welhamite to the late-night banter with friends, math is quietly there, shaping the world around us.

We begin with something as simple as tying our shoelaces before morning sports and then we move through the day, touching on the classroom challenges that sometimes make us wonder why we even chose math. The magazine takes you on a journey through interdisciplinary connections, everyday activities, and even those seemingly small moments, like scrambling to get an umbrella when rain strikes. We even touch upon more exciting topics like the use of math in cinemas, as well as how bank officials ensure the smooth working of social service. Through it all, we hope to help you see math from a new perspective — one that is intertwined with your daily life.

I cannot end this note without expressing my deepest gratitude to everyone who has contributed to this magazine, especially the Editorial Board and all the teachers of the Mathematics Department. Each article, each thought shared, has added a layer to what Pi-rate has become.

I hope this issue ignites your curiosity just a little more and makes you see math not just as something you study, but as something you live.

Signing off, Aaruni Garg Editor-in- Chief

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Equation of a Shoelace

Tying shoelaces is seemingly a simple task, one that we do unconsciously. It does not take much thinking, does it? But if you delve deep, you will discover it involves an interplay of various mathematical concepts.

On a mundane day at Welham, getting late for sports is nothing out of the ordinary. What makes it all the more ironic is when your shoelaces get undone on the way. Then, you hurriedly bend down to tie them and within a fraction of a second, it is done! But have you ever thought about the mathematical concepts that came into play while doing so? At the heart of tying shoelaces is the knot theory, a branch of topology that delves into various types of knots that relate to the geometry of position (and essentially, symmetry also). Loop the laces and consider each loop a circle. Then, when you cross the loops over each other, it showcases the idea of "twists" in knot theory. Furthermore, the laces need to be tied at a specific angle because of which they will actually hold up instead of slipping away.

And let us not forget the sheer number of ways you can tie laces. The classic "bunny ear" method is not the only one. A typical shoe has twelve eyelets, thus you have 24 ways to start tying your laces. As you keep on passing the lace through more and more eyelets, the possibilities keep on increasing. Thus, the total number of paths the laces can have will be represented by the formula – paths = $n! \times 2n$.

Taking 'n' as the number of eyelets -

12!x212 = 1,961,990,553,600,

you end up with almost 2 trillion ways to lace your shoes, which is more than the number of galaxies in our universe!

Whether you are a mathematician or just a tardy Welhamite, the next time you bend down to tie your shoelaces, give yourself a second to realize the intricacy and complexity of such a simple task and how it includes Math in daily life.

> -Paavni Mahendra AII



You have ₹125 to order your tuck. What is the maximum number of food items you can buy given the following conditions?

- You can buy a maximum of 6 Doreos, but the number must be even.
- The number of Chips you buy must be one more than the number of Doreos.
- You must buy at least one of each item.

NO MORE BELLYFLOPPING

Virat Kohli is at the crease. The tension in the air is optimal angle of entry, to minimize splashing, palpable. Everyone is on the edge of their seats. He watches the bowler closely, thinking about his next move. With a powerful swing of his bat, he hits perfectly. It is a sixer! And the crowd goes wild, "Wow, he is so talented!' Well, no offence to Mr. Kohli, but cricket is not only a game of talent but also the trigonometrical angles between the bat and the ball and the predicted parabolic path of the ball.

It might come as a surprise to you but math does actually haS a purpose besides making your brain hurt. (Shocking! I know). In our own very school, math is used in a vast array of sports; from calculating the windage and elevation in shooting, to the player formation in hockey and even evaluating players' performance in basketball through Player Efficiency Rating (PER).

And if you think that is interesting just wait until you dive into the pool. Diving into the school pool is something which terrifies most of the inexperienced (yours welhamites interhouse during truly included).

However, I (along with help from the math department) figured out a simple way to overcome such fears. After all, what is diving but math in a practical form? All you have to do is measure the

calculate the trajectory and motion (so that bellyflopping is prevented) and ensure that your body makes a perfect line while diving. It is that simple!

While discussing trajectories, let us not forget the crucial role that math plays in calculating the perfect angles for the racket to connect with the ball for optimal placement on the TT table. Mix that with well-analysed spin-mechanics and some raw talent and you get a perfect table tennis player (with or without the famous hexagon racket).Whether it is inside the classroom or outside, math acts as a powerful tool to make your life better and easier(even though it may not seem so while sitting in the classroom).

> -Amaya Marwah PreSc







In the game of chess, every move holds the weight of a tactic. This is where mathematics interlinks its intertwined threads, molding every fabric to a gameplay. The pieces advance and enthrall in a clash of intelligence and strategy.

The game of chess is one of finite options, with each movement and interplay being synchronized by a set of rules. Think about the primary move in a chess game when players try to advance their pieces and gain power at the centre of the board. Every move that looks like child's play is the repercussion of convoluted calculations.

Every piece on the board has a numerical value. Pawns are usually worth one point, knights and bishops are for three points, rooks are worth five points, and queens are worth nine points. By calculating the value of pieces, players can determine if a given exchange or sacrifice will be beneficial in the long run.

Yet, the most brilliant time for mathematics in chess is during the endgame. Accurate tally is essential as the board clears, and fewer pieces are left. During the intricacy of the endgame, ideas like king's opposition, triangulation, and the square of the pawn come into play and help players reach dominant placements.

The basic calculation of where to move your piece and when are present throughout the game, providing a clear structure for players to explore. Whether played for leisure among associates or learned at a prominent level of competition, chess keeps on bewailing minds with its blend of numerical accuracy with key intelligence, which helps us to recall the maintenance through potency of instinct and evaluation.

Chess is a clear example of how math is complementary to various fields and is the key factor in winning a match of chess. Whether played nonchalantly among companions or learned at the most significant levels of rivalry, math is essential if you want to win a game of chess.

-Jasmira Chandhok AI



CRUELLA CODES AND COMBINATIONS

Have you ever wondered how a simple string of characters keeps your account safe from the prying eyes of cybercriminals? Or how you secure your belongings by entering a few digits to lock a safe or even a building? Well, it is not just technology that binds it all together, but a powerful mathematical concept — permutations and combinations.

Permutation refers to the arrangement of objects in a definite order, whereas combinations are selections where the order does not matter. Both of these together play a significant role in our day-today lives and impact our daily experiences. Whether it is securing our online presence on various social media platforms or enhancing learning environments, the mathematical principles of permutations and combinations guarantee that everything from vehicle number plates to account passwords operates with precision and security. For example, consider Cruella De Vil's iconic car number plate, "DE VIL."

While her chaotic personality contrasts with the the strategic world of mathematics, the arrangement of characters on her nameplate symbolizes how no two number plates are alike. Similarly, combinations are used to generate unique passwords or passcodes, making sure that security systems, like those in schools, function without repetition. This guarantees that every password is distinct, much like the distinct license plate that makes Cruella's car stand out.

Mathematically speaking, permutations and combinations are not just about numbers or characters. They extend to various real-world applications. Consider data encryption, where permutations ensure that even a slight change in the input string, such as changing the order of characters, results in a completely different output, enhancing security. Similarly, combinations help in optimizing resource allocation, where choosing a set of items without regard to order maximises efficiency.

Overall, in such an evolving world where every detail counts, as we navigate through the principles of permutations and combinations, we observe that they serve as our guiding framework. Most importantly, they empower us to make informed decisions, whether we are selecting the perfect combination of subjects for our studies, crafting a strong password to protect our online presence, or assembling a diverse team for a project.



An Escape for the Sportless Community

Every morning at 5:30 a.m., as the harsh reality of the day sets in, a thought arises at the back of every Welhamite's mind—how many more red A's can I afford on the sports register? While didi is trying to wake us up, we are secretly calculating the number of sleep-ins we can afford before the Captains paste us up. Worry not, because I bring a solution to this generational problem: Bayes' theorem.

Now, Bayes' theorem is not as intimidating as it sounds. In fact, it might just be the math we need in this chaos. The theorem essentially calculates the probability of an event occurring, based on prior knowledge of conditions related to that event. The formula is as follows:

P(A/B) = [P(B/A) P(A)] / P(B).

Here:

P(A | B) is the probability of event A happening given that event B has occurred.

 $P(B \mid A)$ is the probability of event B happening given that event A has occurred.

P(A) is the initial probability of event A happening. P(B) is the probability of event B occurring.

This formula allows for the adjustment of probabilities based on new information, making it essential for reasoning under uncertainty. At Welham, where chaos often reigns, this theorem might just save the day.

Imagine yourself returning to the dorm after hours of Founders' practice. You are exhausted, feeling like you have aged twenty years, and you stare at the pile of assignments.

Now comes the real dilemma: should you sleep and finish it the next day?

By applying Bayes' theorem, you can weigh your past behaviour (procrastination) against your current lack of sleep and predict the rare event of actually completing your assignment on time. (you are going to choose sleep).



Picture this: you wake up late, and the realization hits you-you have already missed breakfast. Your stomach grumbles as you rush to class, hoping to grab a quick snack before morning assembly. But, as fate would have it, the school's supply of cornflakes has vanished, leaving only dry chocos. This is where Bayes' theorem comes into play. By evaluating our past breakfast habits-like how many times we have slept in rather than waking up early-we can also calculate the likelihood of future breakfast success based on our current choices. The theorem reflects our daily decisions: if we keep skipping breakfast, the probability of scoring those delicious muffins the next day diminishes. Perhaps setting an alarm just fifteen minutes earlier could improve our odds of scoring breakfast and tackling that pile of assignments with more energy.

In a life filled with red A's, endless practices, and piles of homework, Bayes' theorem can be your secret weapon. It helps to get ahead of outcomes based on your history and current situation. It is not just math. It is survival. And while Bayes' might not help us dodge all those red marks on the register, it can certainly give you an insight you need for the madness!

> -Simrit Kaur Pre Sc

Feel the Beat

When you think of Indian classical music, the thought of a melodious singer or perhaps an intense rhythm produced by the tabla may come to your mind. However, lurking beneath the beautiful melodies is the hidden partner in crime, mathematics. Yes, the same numbers that terrify students during exams also have a well-established relationship with taals and ragas.

Math is significantly involved in ragas. For example, the mood of a raga can vary dramatically based on the prahav it is performed in. Mathematics is akin to this because a mathematical equation may have multiple solutions depending upon the condition provided. It is almost as if composers with their own emotions try to infuse a musical equation.

Taals are rhythmic repetitions of certain beats that give Indian classical music their essence and have a precise mathematical structure. One of the most know taals is teental.

It consists of 16 beats divided into groups of four. It can be compared to finding the square root of 256, but in a more engaging and less stressful manner. Musicians experiment with various beats to provide complex pattern that can be compared to a mathematicians equation. It is almost as if you are playing a musical sudoku.

Believe it or not mathematics also plays a crucial part in Indian classical dances. Let us dive into the connection between the two. Movements are often geometrical in nature. They create innovative shapes and formations like *pataka* and *tripataka* in Kathak. Imagine Bharatnatyam dancers performing unique shapes like triangles or the geometry in the *mudra mayura*.

To conclude the next time you are enjoying a toe-tapping tabla recital or a captvating Kathak performance, remember that beneath the beauty lies a number of mathematical intricacies. Who knew that every *chakar* in Kathak and every raaga is merely a manner to embrace your inner mathelete?

Did Yaı knav

• Mozart loved math so much that he created a game where

Pythagoras described how the planets' movements create a kind of cosmic harmony based on mathematical ratios.
Studies have shown that learning music helps improve

you could compose music by rolling dice!

-Himakshika Jain

AIII

math skills.

Since the era of Tadpoles

THE HEART OF WELHAM

Nasreen, the nerve centre of Welham, the first building constructed in this establishment, has played a key role in the lives of innumerable Welhamites who have spent time within its premises. The Nasreen originally a dormitory was converted to a library to accommodate both the senior and junior school and into a conference room for meetings. The interiors of the Nasreen were brought back to their pleasant mood with fireplaces, woodwork and tiles being brought into focus by restoration. The timber framed balcony with folding windows made the rooms even cozier, ensuring a warm atmosphere in the whole building.

Geometry is a part of the design since its inception. This has been opted by architects while analysing and partitioning the space as well as drafting detailed architectural blueprints. Builders and engineers defend the structures with the use of geometric methods. Graphics (geometrical textures, colours and formats) have been used in the interior spaces for their beauty. It is simply impossible to avoid geometry in design. Besides the classical geometry, non-Euclidean geometry can also be applied to Nasreen's work. This geometry broadens up the conception of space as it incorporates bent surfaces within which straight lines can either meet or part. It also facilitates the architecture to evolve new shapes, accommodating thousands of angles, rather than mere rectangles, which can sometimes restrict a trend of a structure. As it becomes more and more obvious here, forms of architecture may be found in Nasreen's works where classical outlines will be imperceptibly blended with non-Euclidean ones producing the play of light and shadow dramatically. As we climb the stairs of the Nasreen every morning, we may remember the lasting impact of why the

building has endured and stood strong.

-Riyanshi Bansal Pre-sc Pi-rate'24

ights As the clock ticked down to the last Sunday night before the math half-yearly on Monday morning, the AI dorms were crowded with some Welhamites who were sleeping comfortably wrapped in their warm bed covers. There were some that had slept accidentally while studying, but there were some diligent students that sat awake tirelessly struggling to solve quadratic equations. Suddenly, amidst this scene of sleepy mathematical mayhem, someone jolted upright, stepping off the bed with all the grace of a malfunctioning robot. "I got it!" she exclaimed, as if they had just discovered the meaning of life rather than the solution to $x^2+5x+6=0$. The others stared blankly, their expressions a mix of confusion and mild concern. Was this a breakthrough or just a caffeinefuelled hallucination? 'Eureka' is an expression of joy or satisfaction when someone discovers something. The term comes from the ancient Greek, word meaning "I have found it." It can be understood in two phases. First, a person faces a problem that causes frustration and confusion; then, after some distraction or relaxation, the solution often appears out of the blue, as if emerging from the subconscious. In fact the most 'Eureka' moments usually occur unexpectedly in the middle of sleep or while taking a stimulating bath or shower. In a Welhamite's painfully busy life, we can rely on are our unforeseen Eureka moments. It can be something as simple as realising how to balance your schedule after lunch or as complex as understanding upper quartiles in Statistics. All these moments interplay with our lives to enlighten us with profound moments of realization of something that has been glaringly obvious all along. After all, if one can survive the trials of math at Welham, one can surely navigate the complexities of life... even if it means occasionally praying to God before an exam so that you too get an

epiphanic Eureka moment in the middle of your paper and miraculously pass mathematics. P.S. Dear God, this is my prayer. Please help me come out stronger from the trials of Mathematics (pass math exam).

> -Aanya Gupta AI

-MATH-A-GEN/VS-

Leonhard Euler, who lived from April 15, 1707, to September 18, 1783, is one of the most famous mathematicians known today. Euler was a mathematician, astronomer, physicist, geographer, logician, and engineer. He contributed significantly to the studies of topology and graph theory. He was a multitalented figure who revolutionized the mathematics we use today. In fact, the symbol π (Pi), which is now used in all our classes, was introduced by him. His journey started in 1727 when he joined the St. Petersburg Academy of Sciences, and through his many books, he developed the theory of trigonometric and logarithmic functions used today. Without him, we probably would not be able to do even basic algebra. After Euler's death, many great mathematicians recognized and praised his work. Pierre-Simon Laplace, a French scholar whose work was important to the development of engineering, mathematics, statistics, physics, astronomy, and philosophy, said, "Read Euler, read Euler, he is the master of us all."

-Amayra Gambhir AIII

THE GINEMATIC RATIO

Are you aware of the golden ratio (phi) which is known to have allegedly inspired artists like Michelangelo and Leonardo da Vinci. Also known as the golden proportion or divine proportion, it is the ratio of two numbers that goes on forever but can be rounded off to around 1.618. It is the ratio of a line segment divided into two parts of different lengths, so that the ratio of the entire segment (AB) to the longer segment (BC) is equal to the ratio of the longer segment to the shorter segment (AB).

AB/BC = BC/AC. This mathematical concept of the Divine Proportion appears in nature and various iconic pieces of art. It is also widely employed in filmmaking to continue the management as

in filmmaking to capture the moment as we experience it in nature and showcase the theme in a way that creates a lasting impact on the audience. This mathematical equation improves frame shots

by taking into account the foreground, middle ground, and backdrop, focusing just enough attention to the objects in each layer of the frame.

Balancing the aspect ratio is an essential issue in cinematography, regardless of how effectively one manipulates the colours or spatial depth. There are

certain points in a film's intensity which are greatly influenced

by the utilization of the Golden Ratio.

When focusing on a character's eyes, the height of the frame is frequently divided according to the Golden Ratio proportions, which results in the optimum location of the eyes. It also allows us to place the main object in the focus of attention while distributing the other objects in the foreground and background in a spiral-like pattern. This helps the viewer absorb the full plot in the scene, increasing the impact. The human psyche always follows deepest point. without even realizing it.

Using the Golden Ratio allows editors to produce a natural, compelling flow that enhances storytelling. Filmmakers can increase emotional resonance and keep audiences interested in the picture by deliberately inserting cuts that follow this mathematical theory.

Using the Golden Ratio in film composition can improve visual narrative, increase emotional resonance, and result in more compelling films. While not a rigorous rule, it is definitely a useful tool for filmmakers aiming to create visually appealing narratives.

The Golden Ratio helps us find order in the midst of chaos. It is necessary to capture the essence of the subject when expression and art can be found in everything ranging from the symmetry of the timeless pyramids to the merciless abstract of fantasy realms with warped realities.

-Arshia Aneja AII

the spiral

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As the weather gods make efforts to stall the tormenting rains, the damage has already been done and dusted. With umbrellas flapping about like lost souls, one question looms large among the students of Welham Girls' School: Who stole my umbrella? But fear not! We shall unravel this mystery using the delightful lens of probability.

Picture a lively late afternoon at Welham, where students rush to their classes, each clutching her own umbrella. As you sip your refreshing tang in the mess, you notice several umbrellas that look suspiciously similar to yours. Now, which one is yours? Let us denote these umbrellas as A, B, C, and D.

To solve this mystery, we need to consider the sample space of possible outcomes:

S= {A, B, C, D} Calculating Probability:

Let E be the event that your umbrella is among those seen. The probability of your umbrella being one of these three is:

P(E)=34=0.75P(E)=43 =0.75

This means, of course, that 75% of one of those similar umbrellas will belong to you!

Conditional Probability:

What if a classmate, P, seems overly interested in your umbrella? If P has two umbrellas (one being yours), then: P(A | P)=12=0.5P(A | P)=21=0.5This indicates there's a 50% chance that if classmate P is holding an umbrella, it could be yours!

Engaging the Community:

Why not seek peer help? Maybe you can ask classmates if they have ever seen a parasol that resembles yours. Then if 3 out of 10 report that they have, then: P (E | Community) =3/10=0.3

This means there is a 30% chance that your umbrella is among those spotted by your fellow students! With their sly moves resembling those of professional ninjas, Welhamites have mastered the art of umbrella acquisition to such an extent that even the finest mathematical calculation may not be apt enough to lead you to your beloved umbrella.

Hence, as we wrap up our thrilling escapade through the mystery of the missing umbrella at Welham, let us take a moment to appreciate the true heroes of this story: probability and our fellow Welhamites! So dear reader, keep your umbrellas close and embrace the chaos that comes with life at Welham. And in case you are to part with your beloved umbrella, let math come to your rescue (or at least try to).

Also the next time you see an umbrella lying in the corridor or on someone's desk, please DON'T take it.

A sincere request from a fellow theft victim -Nabhya Shekhar Pre-Sc

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Never in the 67 years of Welham has its sacred grounds been turned into a battlefield. However that changed this year. The reason? Three of the biggest music events of the year: the concerts of Diljit Dosanjh, Karan Aujla, and Coldplay turned a normal day in the life of Welhamites into a war of clicks and screen refreshes as if their lives depended on the ticket sales.

Welhamites switched between Wi-Fi connections (factoring the probability of signal strength), refreshed pages with near-perfect timing (measuring latency to the millisecond), and invoked the law of large numbers, hoping for some stroke of luck through repeated calls home. They dived headfirst for Karan Aujla. With 49 students competing, 41 triumphed, resulting in a staggering 83.7% success rate. Probability was on their side, with many getting tickets on their first try, while a few unlucky ones missed out entirely.

Then came Diljit Dosanjh. Here the stakes rose even higher. Out of 149 eager fans, only 91 emerged victorious. AIII's faced a brutal reality: 63 students went in, and only 21 survived with tickets, leaving them with a grim 33.3% success rate. Pre-Scs, however, rode high, pulling off an almost mythical 95.7% success. As the rest watched their friends, who felt like they were "Born to Shine", score tickets, they could only hum "Do you Know" with tears in their eyes!

Neither of the two concerts could prepare us for the madness that came with Coldplay. The total number of students attempting to get these tickets resembled a complex combination problemselecting a limited number of successful attempts. Out of the several students (more than 150) who dared to try, only 18 emerged victorious. For those who did not make it, it felt like they were stuck in a real-life version of "Viva La Vida," reminiscing about a time when getting tickets did not feel like trying to reach for the stars(or solving a Compound and Multiple angles question).

The 2024 Welham concert craze perfectly illustrated the Pigeonhole Principle: which states that if you have more pigeons (excited students) than pigeonhole (concert tickets), at least one hole must contain more than one pigeon.

For the lucky ones who snagged those high-in demand tickets, victory felt sweeter than a surprise encore. Others were left singing "A Sky full of Stars" with the hope of miraculously getting tickets still. But, it was not just about the concerts. It was about the thrill, the chase, and the unforgettable stories of the year Welham turned into one big concert craze. Here's to those who made itand to those still waiting, for their next chance at musical glory. -Prangya Singh

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BANKEE BACK IN BUSINESS

Every Wednesday, every Welhamite's heart is filled with the joy of getting social service food, thanks to the operations of the Welham Bank. Previously, the cheque system was the norm, and many remember senior bank officials tearing their cheques, marking the learning process of how to fill one correctly. Interestingly, every torn cheque was also part of an unseen mathematical count!

Math plays a pivotal role in our school bank. Every note is counted and safely bundled into defined currency groups. These transactions are meticulously recorded in ledger accounts, which are then relayed to

the school's finance and administration department. Almost like an actual bank,

right? From counting plates of honey chilli potatoes to managing coupons and savings for the next week's social service, Welhamites constantly apply mathematical principles to avoid financial shortfalls. The math involved includes basic arithmetic, algebra, and financial mathematics.

The amount lent or borrowed by students is termed the principal, and it forms the foundation for calculating interest, repayments, and lending dynamics. The Welham Bank also employs statistics to measure risk, such as the default probability, allowing for accurate predictions on students' likelihood of defaulting on borrowed money.

For instance, if the bank incurs a loss, it can be computed as:

Loss Given Default (LSD) = Principal- Recovery Amount and

Expected loss (for school bank) = Principal x Probability of default x LSD.

Additionally, the bank utilises Probability Distributions to forecast when students are likely to use or default on funds, which can depend on the popularity of certain food items like tandoori momos or honey chilli potatoes. These predictions are supported by analysing historical data. This system not only teaches budgeting but also offers students hands-on financial education.

So, the next time you wait in line for Welham bucks, remember that for every torn cheque, another is already accounted for, waiting to feed a hungry Welhamite!

-Nimrat Kaur Mehram Sc

The Secret Superpower to everyday survival In Welham

Scan this code to unlock the hidden math magic at Welham! From sneaking shortcuts to figuring out how much time we have to procrastinate and with a fun twist on the mundane life of a Welhamite, this video will show how math is a part of our everyday adventures. It is a take on how we balance life, one equation at a time!





