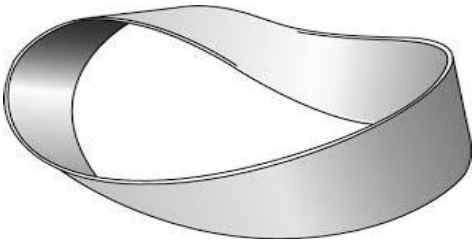
Mathematics at Lister Community School

# The Möbius Strip



**January 2022**

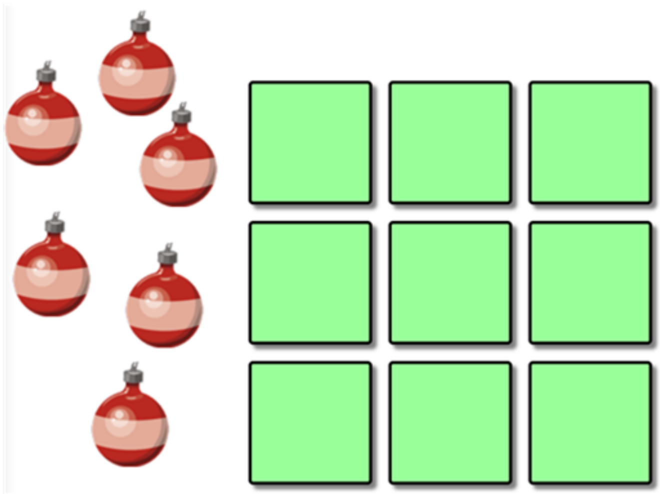
### *The Möbius Strip*

*The Möbius strip has only one side. You can travel indefinitely in a loop on the surface of the strip. This mathematics newsletter got its name because of the infinite nature of learning and the resilience required to improve.*

### Hello Lister Community School!

I hope you are all well. Let's do some puzzles! Let's learn new stuff! If you want to write an article for *The Möbius strip,* email me,
Mr Sozomenou.

Arrange all the baubles so that no more than two are in any line vertically, horizontally or diagonally.



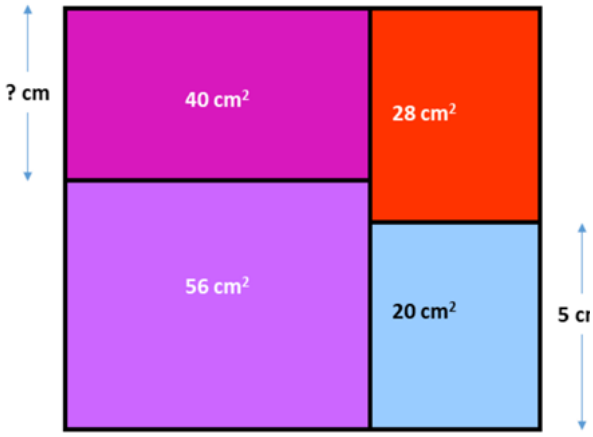
It has just turned 22:22. How many minutes are there until midnight?

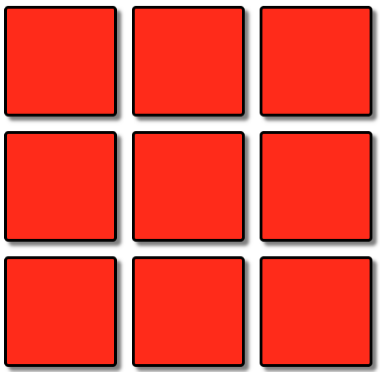
A 178 B 138 C 128 D 108 E 98

ABC, CBA and CAB are three-digit numbers; that is, they are numbers between 100 and 999. If ABC – CBA = CAB, what are the values of A, B and C?

### Who was the inventor of fractions?
### Henry the Eighth.

Find the value of the question marks in the following diagrams. All of the shapes are rectangles but are not drawn to scale. Your working should only contain whole numbers.



Place all the digits 1 to 9, in the grid so that the sum of each row and each column make a prime number.

In 1770, Joseph-Louis Lagrange proved that every positive integer can be written as the sum of four squares. For example, $13 = 0^2 + 0^2 + 2^2 + 3^2$.
How many of the first 15 positive integers can be written as the sum of *three* squares?



A 11 B 12 C 13 D 14 E 15

## Katherine Johnson

*Before you read this you need to appreciate that her huge achievements took place in the early 1950s in the USA. Racism was everywhere; segregation was legal. Sexism was blatant e.g., "no women in meetings", women were not trusted to do what was seen as "man's work". So, as a black African American female at that time, she didn't stand a chance being given an opportunity, let alone of being successful.*

She was an American ***mathematician*** who calculated and analysed the flight paths of many spacecraft during her more than three decades with the U.S. space program. Her work helped send astronauts to the Moon.

***Her intelligence and skill with numbers became apparent when she was a child; by the time she was 10 years old***, she had started attending high school. In 1937, at age 18, she graduated with highest honours from what is now West Virginia State University, earning bachelor's degrees in mathematics and French. She subsequently moved to Virginia to take a teaching job.

In 1939, however, ***she was selected to be one of the first three African American students to enrol in a graduate program at West Virginia University.*** She studied mathematics there but soon left after marrying James Goble and deciding to start a family. He died in 1956, and 3 years later she married James Johnson.

In 1953 she began working at the National Advisory Committee for Aeronautics (NACA)'s West Area Computing unit, a group of African American women who ***manually* performed complex mathematical calculations** for the program's engineers. The women, known as the West Computers, analysed test data and provided mathematical computations that were essential to the success of the early U.S. space program. During this time, NACA was ***segregated***, and the West Computers had to use ***separate bathrooms and dining facilities.*** That changed in 1958 when NACA was incorporated into the newly formed National Aeronautics and Space Administration (NASA), which banned segregation.

At NASA Johnson was a member of the Space Task Group. In 1960 she ***co-authored a paper with one of the group's engineers about calculations for placing a spacecraft into orbit***. It was the first time a woman in her division received credit as an author of a research report. Johnson authored or co-authored 26 research reports during her career.

Johnson also played an important role in NASA's Mercury program (1961–63) of crewed spaceflights. ***In 1961 she calculated the path for Freedom 7, the spacecraft that put the first U.S astronaut in space***, Alan B. Shepard, Jr. The following year, at the request of John Glenn, ***Johnson verified that the electronic computer had planned his flight correctly.***

***Johnson was also part of the team that calculated where and when to launch the rocket for the Apollo 11 mission of 1969, which sent the first three men to the Moon***. Johnson later worked on the space shuttle program. She retired from NASA in 1986.
***What a woman!!***

***Below is a tiny fraction of the types of calculations Katherine Johnson had to do. You think YOU have difficulties in maths lessons!***

Since $w_{1,d} - w_1 = w_{2,d} - w_2$ and $\frac{w_1}{w_{1,d}}\frac{y_d}{y} = \frac{w_{2,d}}{w_2}$, this expression may be written in the form:

$$A\left\{e^{\frac{-2C_D}{C_L}\sqrt{c}} \log_e \frac{w_{1,d}}{w_1} + e^{\frac{2C_D}{C_L}\sqrt{c}} \log_e \frac{w_1}{w_{1,d}}\frac{y_d}{y} + \frac{2C_D}{C_L}\left(w_{1,d} - w_1\right)\left[e^{\left(\frac{2C_D}{C_L}\sqrt{c}\right)} + e^{\left(\frac{-2C_D}{C_L}\sqrt{c}\right)}\right]\right\}$$

or

$$A\left[2 \sinh \frac{2C_D}{C_L}\sqrt{c} \log_e \frac{w_1}{w_{1,d}} + \frac{C_D}{C_L}\left(w_{1,d} - w_1\right)\left(4 \cosh \frac{2C_D}{C_L}\sqrt{c}\right) + e^{\frac{2C_D}{C_L}\sqrt{c}} \log_e \frac{y_d}{y}\right]$$

Johnson received numerous awards and honours for her work. Katherine Johnson, died recently in February 2020.

Margot Lee Shetterly published the book Hidden Figures. A film based on the book was also released in 2016 called "**Hidden Figures**". ***I thoroughly recommend you watch it.***

***She was an incredibly talented person.***

Text (edited) from brittanica.com. Thank you.

# Prime Numbers

Prime Numbers. What is all the fuss about? Please read on – *I PROMISE* it gets very interesting! **Primes are special numbers that have just two factors**. Those factors are the number 1 and the number itself. For example: 2, 3, 7, 17, 23 31. The number 1 is not considered to be a prime number. Two is the only even prime number. **There are an infinite number of prime numbers (we think).**

The largest prime number known has around 13 million digits! The Greek mathematician Euclid studied prime numbers in 300BC. The number 379009 is a prime number. It also looks like the word Google if you type it into a calculator and look at it upside down!

Prime numbers seem to become more spread out as you get further along the number line. There are 4 prime numbers from 1 to 10, while there are only 25 primes from 1 to 100, 168 primes from 1 to 1000, 1229 primes from 1 to 10000, and 9592 primes between 1 and 100000. As you would observe from this pattern, prime numbers are getting rarer, and average prime gaps are becoming greater.

**Prime numbers also have an amazing presence in nature.** If you have ever been to a very hot country, you would have heard a distinct sound emanating from trees. This sound comes from cicadas. **Cicadas** are known for their buzzing and clicking noises, which can be amplified by multitudes of insects into an overpowering, hypnotic, hum. Males produce this species-specific noise with vibrating membranes on their abdomens. The sounds vary widely, and some species are more musical than others. The cicada life cycle has three stages: eggs, nymphs, and adults. Female cicadas can lay up to 400 eggs, generally in twigs and branches. After six to 10 weeks, young cicada nymphs hatch from their eggs and dig themselves into the ground to suck the liquids of plant roots. They spend their entire developmental period in these underground burrows before moulting their shells and surfacing as adults to mate and lay eggs. Broods emerge in synchrony depending on the year and soil temperature. They wait for the right conditions for breeding, which are when the ground thaws to 18°C. It's not clear why these cicadas have such distinct and oddly timed cycles, though some scientists theorize it has to do with **avoiding predators.**

**Cicadas appear periodically but only emerge after a prime number of years.**

In the case of a brood in Nashville in the USA which emerged in 2011. The forests were quiet for 13 years since the last invasion of these mathematical bugs in 1998 and the locals won't be disturbed by them again until 2024.

**Here is a cicada; in its prime.**

This choice of a 13-year cycle doesn't seem too arbitrary. There are another two broods across north America that also have this 13-year life cycle, appearing in different regions and different years. In addition, there are another 12 broods that appear every 17 years! (Yes, a prime.)

You could just dismiss these numbers as random. But it's very curious that there are no cicadas with 12, 14, 15, 16 or 18-year life cycles. However, look at these cicadas through the mathematician's eyes and a pattern begins to emerge.

Because 13 and 17 are both indivisible this gives the cicadas an evolutionary advantage as primes are helpful in avoiding other animals with periodic behaviour. Suppose for example that a predator appears every six years in the forest. Then a cicada with an eight or nine-year life cycle will coincide with the predator much more often than a cicada with a seven-year prime life cycle.

**So how do the cicadas know how to calculate prime numbers?**

*They don't. They're cicadas.*

The cicadas discovered the primes using evolutionary tactics. Humans have understood that these numbers are not just the key to survival but are the very building blocks of the code of mathematics.

# Mathematicians Read 2

**Little Trotty Wagtail** by John Clare (1793-1864)

Little trotty wagtail he went in the rain,
And tittering, tottering sideways he ne'er got straight again,
He stooped to get a worm, and looked up to get a fly,
And then he flew away ere his feathers they were dry.

Little trotty wagtail, he waddled in the mud,
And left his little footmarks, trample where he would.
He waddled in the water-pudge, and waggle went his tail,
And chirrupt up his wings to dry upon the garden rail.

Little trotty wagtail, you nimble all about,
And in the dimpling water-pudge you waddle in and out;
Your home is nigh at hand, and in the warm pig-stye,
So, little Master Wagtail, I'll bid you a good-bye.

*If you want to share a poem that you like let me know,*
*Mr Sozomenou*

*The start of a short story…*

**Metamorphosis** by Franz Kafka 1883-1924
(Translated from German)

As Gregor Samsa awoke one morning from uneasy dreams he found himself transformed in his bed into a gigantic insect. He was lying on his hard, as it were armour-plated, back and when he lifted his head a little he could see his dome-like brown belly divided into stiff arched segments on top of which the bed quilt could hardly keep in position and was about to slide off completely. His numerous legs, which were pitifully thin compared to the rest of his bulk, waved helplessly before his eyes….

*Check out the Library for this book.*

## Why I like Maths by Hassan Murshed (Year 11)

A +10 for this excellent article by Hassan Murshed

I'd say one of the main reasons I love maths so much is the seemingly endless possible things that can come out of it. For example, one of the very first things that we learn in lessons is that you simply can't put an end to numbers. Count as long as you want, and no matter how far you get, the end will never be in sight. Numbers are infinite, and because of this, we can do some pretty cool things with them. Who would have thought?

The sky really is the limit here, and the only thing stopping us from doing anything is ourselves.

With maths, every answer is clear as day. There's no ambiguity, no "might be", or "maybe". It is, or it isn't. And you can't simply say something without proving it either. There is always a concrete solution, and evidence to prove it. It's too bad this is one of the only subjects with this concept.

One other thing I love about maths is how I can use it to solve many problems. It's not all mundane tasks like gas bills and paving slabs. Pilots need to use their maths skills to navigate, doctors and pharmacists use ratio to calculate doses of medicine. Mathematics is everywhere, there's simply no denying it. No wonder it's considered a core subject in world of education. Because our daily lives simply wouldn't be able to function without it, no matter how simple or complex the task is.

*Let me know if you want to write an article about why you like maths. Mr Sozomenou*

## Solutions

**C** Thirteen of the first fifteen integers may be written as the sum of three squares, as shown below.
$1 = 0^2 + 0^2 + 1^2$; $2 = 0^2 + 1^2 + 1^2$; $3 = 1^2 + 1^2 + 1^2$; $4 = 0^2 + 0^2 + 2^2$; $5 = 0^2 + 1^2 + 2^2$;
$6 = 1^2 + 1^2 + 2^2$; $8 = 0^2 + 2^2 + 2^2$; $9 = 0^2 + 0^2 + 3^2$; $10 = 0^2 + 1^2 + 3^2$; $11 = 1^2 + 1^2 + 3^2$;
$12 = 2^2 + 2^2 + 2^2$; $13 = 0^2 + 2^2 + 3^2$; $14 = 1^2 + 2^2 + 3^2$.
However, it is not possible to find any three-number combination chosen from 0, 1, 4, 9 to sum to 7, or to 15.

"Just turned midnight" E 98 mins. Rectangle areas ?=5