

Meet the world's largest known prime number

How important are prime numbers? The largest known prime number has just been discovered by an engineer from Tennessee. It is 23 million characters long and is known simply as M77232917.



Mysterious: There is no known simple formula which separates prime numbers from other numbers.

They start small and regular: 2, 3, 5, 7. Then they become slightly more sparsely spread: 10,009, 10,037. But though it seems unlikely, there are prime numbers (numbers only divisible by one and themselves) stretching to lengths which can scarcely be imagined.

Last week the largest known prime number was discovered. It was found after six full days of nonstop computing on a PC owned by Jonathan Pace, a 51-year-old electrical engineer from Tennessee. He can now collect a \$3,000 reward.

Known as M77232917, the figure is arrived at by calculating 2 to the power of 77,232,917 and subtracting 1, leaving an enormous string of 23,249,425 digits. By way of comparison, the Bible contains about 3.5 million letters, not including spaces. Writing the whole number down would take up a bookshelf.

The number belongs to a rare group of **Mersenne** prime numbers, named after a French monk. These function like normal primes, but all are derived by multiplying twos together over and over before taking away one.

One example is 31: 2 to the power of 5 is 32, then subtract 1.

The previous record-holding number was the 49th Mersenne prime ever found, making the new one the 50th.

Asked about mathematicians' fascination with such mammoth numbers, Chris Caldwell, a professor who runs a website on the largest primes, said: "They are exciting to those of us who are interested in them. It's like asking why do you climb a mountain." This is maths for the purists.

But primes have real-world uses too, especially in computer science. For example: the bank card that you might carry is protected by an access code. This cannot be stored openly on the card, so **encryption** is used to store it instead. This encryption uses multiplications, divisions, and remainders of large prime numbers.

Or, think of the **cicada**. This is an insect which lives in the ground and comes out after 7, 13 or 17 years: all prime numbers. Because cicadas only emerge at these times, predators

cannot **adapt** and kill them.

But does finding the largest known prime really matter?

Number theory

Of course, say maths lovers. It matters because it adds to the store of human knowledge, like the discovery of faraway galaxies. No knowledge is useless, but prime numbers are especially useful. They are the fundamental **building blocks** of all numbers, which are themselves the building blocks of our understanding of the universe.

Understanding relatively low prime numbers is useful, but the latest discovery is too big to be either comprehensible by ordinary people or useful in the real world. Chris Caldwell compares prime numbers to diamonds, where the small ones are useful in industry and the large ones simply serve as showpieces.

Q & A

Q: What do we know?

A: We know that there are higher prime numbers than M77232917, and that there are lots of undiscovered primes that are lower than the new discovery. The number recently found

is nearly one million digits longer than the previous record holder, which was found 2016. The new number is the 50th Mersenne prime ever found.

Q: What do we not know?

A: One area of mystery is the question of twin primes: numbers which have just one number

between them, like 5 and 7. The twin primes conjecture is that there are infinitely many pairs of twin primes among the infinitely many prime numbers. While prime numbers get rarer as numbers get larger, most number theorists think that twin prime pairs should still pop up from time to time. However, this has not yet been proven.

YOU DECIDE

1. Do you care about the discovery of the world's largest known prime number?
2. Do you see the world in mathematical terms?

WORD WATCH

Mersenne – As well as being a monk, Marin Mersenne was a polymath. He lived from 1588 until 1648. He has been called "the centre of the world of science and mathematics during the first half of the 1600s".

Encryption – Encryption is how WhatsApp messages remain secret. Encryption does not

ACTIVITIES

1. In one minute, list as many prime numbers as possible.
2. Now it gets harder. List as many Mersenne primes as you can. There are seven under one million.

itself prevent interference, but stops the encrypted content from being understood by someone without a key. The study of encryption is called cryptography.

Cicada – Cicadas are distinctive for their prominent eyes set wide apart, their short antennae, and their exceptionally loud song. They typically live in trees.

Adapt – For example, imagine the cicadas

SOME PEOPLE SAY...

"Pure mathematics is, in its way, the poetry of logical ideas."
Albert Einstein

WHAT DO YOU THINK?

came out every 12 years instead. This way, the predators that emerged every two, three and four years could all adapt to the cicadas' life cycles, and kill them. Emerging in prime number years makes this impossible.

Building blocks – The fundamental theorem of arithmetic states that any number can be factored into a unique list of primes. For example $12 = 2 \times 2 \times 3$, $50 = 5 \times 5 \times 2$ and $69 = 3 \times 23$.

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