# Prime numbers: What they are and how they show up in nature

By Gale, Cengage Learning, adapted by Newsela staff on 01.25.18
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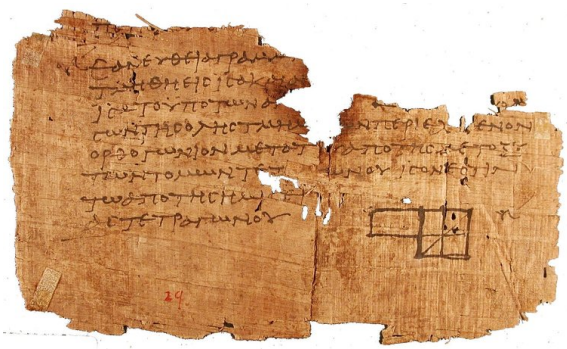
Image 1. A Magicicada in Logan, Ohio. The Magicicada is a kind of cicada that spends 17 years of its life underground. After that, it comes out to find a mate. Scientists don't think it's a coincidence that 17 is a prime number. They think this makes it easier for the cicada to avoid animals that would eat it. Photo by: dankeck/Wikimedia.

A prime number can only be divided evenly by itself and by the number 1. The number 2 is prime because it can only be divided by 1 or 2 to give a whole number. An example that is not prime is the number 6. It can be divided by 2, which gives the number 3. Other examples of prime numbers are 3, 5, 7, 11, 13, 17, 19, 23 and 29.

## Discovering Prime Numbers



People have found prime numbers interesting for a very long time. About 2,300 years ago, the Greek mathematician Euclid wrote a book called "The Elements." In this book, Euclid showed that prime numbers did not just stop at a certain value. He showed that there are infinitely many of them.

About 100 years later, another Greek mathematician came up with a way of finding prime numbers. His name was Eratosthenes. His method was called the Sieve of Eratosthenes. A sieve is a tool that drains water. Eratosthenes' mathematical sieve drains away non-prime numbers from prime numbers. Here's how it works.

• Write down all the numbers from 1 to 100.

• Cross out 1, since it's not a prime number. A prime number can be divided by exactly two numbers. The number 1 can only be divided by 1.

• Circle 2, the smallest prime number, then cross out every multiple of two. These are the numbers 4, 6, 8, etc. In other words, cross out every second number.

• Circle 3, the next prime number. Then cross out all the multiples of 3, which are 6, 9, 12, 15, etc. Some have already been crossed out.

**Sieve of Eratosthenes** $(10 \times 10)$

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
| 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 |
| 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |

Primes:
2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97

• Circle the next number not circled or crossed out, which is 5, then cross out the multiples of 5, which are 10, 15, 20, 25, etc. Some have already been crossed out.

• Continue doing this until all the numbers have been circled or crossed out. The circled numbers are the prime numbers from 1 to 100.

Christian Goldbach was a historian and mathematician. He made another discovery about prime numbers in the 1600s, about 400 years ago. He said that every even number could be written by adding two prime numbers together. For example, 6 can be written as 3 + 3. The number 20 can be written as 17 + 3.

Even today, we are still not sure if Goldbach's idea is true. But scientists do know that it's true for every even number between 2 and 400,000,000,000,000.

## An Example In Nature

Cicadas are plant-eating insects. They spend almost all their lives underground before coming out as adults. For some kinds of cicada, this happens after 13 or 17 years.

Note that 13 and 17 are prime numbers. Scientists who have studied these cicadas think there's a reason for this. Certain predators wait for the cicadas to come out in order to eat them. The cicadas are their prey. Scientists have used computers and math to understand the relationship between predators and prey.

When there are many predators and prey at the same time, it is bad news for the prey. If the cicadas come out when there aren't many predators, there is a better chance they will live long enough to find a mate. The scientists found out that the best number of years for the cicadas to come out are prime numbers, like 13 and 17. These are the cicadas' life cycles. Predators have a life cycle too, which is the number of years after which there are the most predators.

Let's look at what would happen if the cicada's life cycle was 12 years long. If cicadas came out every 12 years, any predators that had a life cycle of 1, 2, 3, 4, 6 or 12 years would be there to eat them. These are all the numbers that divide 12 evenly. If a life cycle is 17 years long, a predator's life cycle also has to be 1 or 17 years too. That is not as likely to happen.

## Quiz

1 Read the introductory paragraph.

> *A prime number can only be divided evenly by itself and by the number 1. The number 2 is prime because it can only be divided by 1 or 2 to give a whole number. An example that is not prime is the number 6. It can be divided by 2, which gives the number 3. Other examples of prime numbers are 3, 5, 7, 11, 13, 17, 19, 23 and 29.*

What inference can the reader make based on this paragraph?

(A) The number 6 is the smallest non-prime number because it can be divided by 2 and 3.

(B) The smallest prime number is the number 1 because it can be divided evenly by itself.

(C) Prime numbers are basically the same as odd numbers, like 3, 5, 7, 11, 13, 17, 19, 23, and 29.

(D) The numbers 3, 5, 7, 11, 13, 17, 19, 23, and 29 can be divided by exactly two numbers.

2 Read the section "Discovering Prime Numbers."

Select the sentence from the article that suggests that Goldbach's idea about prime numbers is likely correct.

(A) He made another discovery about prime numbers in the 1600s, about 400 years ago.

(B) He said that every even number could be written by adding two prime numbers together.

(C) But scientists do know that it's true for every even number between 2 and 400,000,000,000,000.

(D) Now, we know the greatest prime number is 23 million digits long.

3 According to the section “An Example In Nature,” how do the prime numbers like 13 or 17 help cicadas to survive?

(A) Because the life cycle of a cicada is every 13 or 17 years, they are more successful at mating because they come out at the same time as most of their predators.

(B) Because the life cycle of a cicada is every 13 or 17 years, they are safer from predators that are not likely to have life cycles that will match up with the cicadas.

(C) Because the life cycle of a cicada is every 13 or 17 years, they are able to become stronger underground and fight off predators that have shorter life cycles.

(D) Because the life cycle of a cicada is every 13 or 17 years, they are likely to find more prey when they are hungry and this means they will be able to mate.

4 What is MOST LIKELY the reason why the author included the information about using the Sieve of Eratosthenes?

(A) to show how Greek mathematicians were the first to discover prime numbers

(B) to explain how Eratosthenes proved that there are infinite prime numbers

(C) to illustrate how mathematicians today usually find the next greatest prime number

(D) to describe a method that separates prime numbers from non-prime numbers

## Answer Key

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