Prime Numbers and Prime Factorization

Definition of a Prime Number

A prime number is a natural number that has no factors other than 1 and itself.

The first few prime numbers are:

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, 101, 103, 107, 109, 113, 127, 131, 137, 139, 149, 151, 157, 163, 167 …

- A composite number is a natural number greater than 1 that is not prime.
- The natural number 1 is neither prime nor composite.
- The natural number 2 is the only even number that is prime.
- There are infinitely many prime numbers.

Examples of Prime and Composite Numbers		
Number 7 is a prime number, because it has only two factors: 1 and 7. (In other words, it divides only by 1 and by 7.)	Number 13 is a prime number, because it has only two factors: 1 and 13. (In other words, it divides only by 1 and by 13.)	Number 29 is a prime number, because it has only two factors: 1 and 29. (In other words, it divides only by 1 and by 29.)
Number 12 is a composite number, because it has more than two factors: 1, 2, 3, 4, 6 and 12. (In other words, it divides by 1, 2, 3, 4, 6, and 12.)	Number 25 is a composite number, because it has more than two factors: 1, 5 and 25. (In other words, it divides by 1, 5 and 25.)	Number 42 is a composite number, because it has more than two factors: 1, 2, 3, 6, 7, 14, 21, and 42. (In other words, it divides by 1, 2, 3, 6, 7, 14, 21 and 42.)

Prime Factorization

A composite number written as a product of prime numbers
is called prime factorization of a number.

To find the prime factorization of a number,
you need the list of the prime numbers handy, and a few divisibility rules.

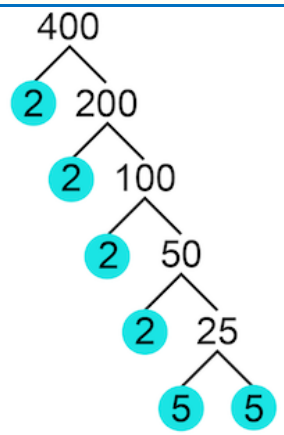
Prime Numbers

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, 101, 103,
107, 109, 113, 127, 131, 137, 139,
149, 151, 157, 163, 167 …

The Divisibility Rules

- A number is divisible by 2 if the last digit is 0, 2, 4, 6, or 8.
- A number is divisible by 3, if the sum of its digits is divisible by 3.
- A number is divisible by 5, if the number ends with 0 or 5.

Examples of Prime Factorization



The prime factorization is:

$$400 = 2^4 \cdot 5^2$$

Start by dividing by prime numbers in order from the smallest to the largest:

400 is even, therefore divide 400 by 2.

$$400 \div 2 = 200$$

200 is even, therefore divide 200 by 2.

$$200 \div 2 = 100$$

100 is even, therefore divide 100 by 2.

$$100 \div 2 = 50$$

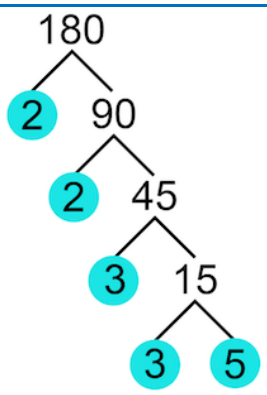
50 is even, therefore divide 50 by 2.

$$50 \div 2 = 25$$

25 does not divide by 2 or by 3. 25 divides by 5.

$$25 \div 5 = 5$$

Write the product of the prime numbers, and if some of them repeat, use exponents.



The prime factorization is:

$$180 = 2^2 \cdot 3^2 \cdot 5$$

Start by dividing by prime numbers in order from the smallest to the largest:

180 is even, therefore divide 180 by 2.

$$180 \div 2 = 90$$

90 is even, therefore divide 90 by 2.

$$90 \div 2 = 45$$

45 does not divide by 2.

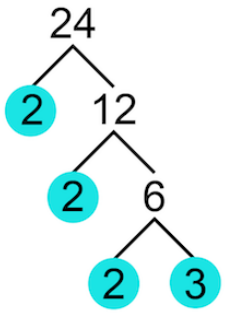
45 divides by 3 (because $4 + 5 = 9$ is divisible by 3), therefore divide 45 by 3.

$$45 \div 3 = 15$$

15 divides by 3.

$$15 \div 3 = 5$$

Write the product of the prime numbers, and if some of them repeat, use exponents.



The prime factorization is:

$$24 = 2^3 \cdot 3$$

Start by dividing by prime numbers in order from the smallest to the largest:

24 is even, therefore divide 24 by 2.

$$24 \div 2 = 12$$

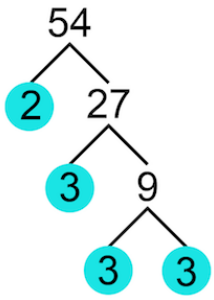
12 is even, therefore divide 12 by 2.

$$12 \div 2 = 6$$

6 is even, therefore divide 6 by 2.

$$6 \div 2 = 3$$

Write the product of the prime numbers, and if some of them repeat, use exponents.



The prime factorization is:

$$54 = 2 \cdot 3^3$$

Start by dividing by prime numbers in order from the smallest to the largest:

54 is even, therefore divide 54 by 2.

$$54 \div 2 = 27$$

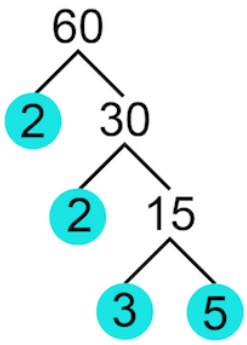
Divide 27 by 3.

$$27 \div 3 = 9$$

Divide 9 by 3.

$$9 \div 3 = 3$$

Write the product of the prime numbers, and if some of them repeat, use exponents.



The prime factorization is:

$$60 = 2^2 \cdot 3 \cdot 5$$

Start by dividing by prime numbers in order from the smallest to the largest:

60 is even, therefore divide 60 by 2.

$$60 \div 2 = 30$$

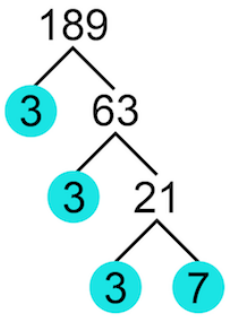
30 is even, therefore divide 30 by 2.

$$30 \div 2 = 15$$

Divide 15 by 3.

$$15 \div 3 = 5$$

Write the product of the prime numbers, and if some of them repeat, use exponents.



The prime factorization is:

$$189 = 3^3 \cdot 7$$

Start by dividing by prime numbers in order from the smallest to the largest:

189 divides by 3 (because $1 + 8 + 9 = 18$ is divisible by 3), therefore divide 189 by 3.

$$189 \div 3 = 63$$

63 divides by 3 (because $6 + 3 = 9$ is divisible by 3), therefore divide 63 by 3.

$$63 \div 3 = 21$$

21 divides by 3 (because $2+1 = 3$ is divisible by 3), therefore divide 21 by 3.

$$21 \div 3 = 7$$

Write the product of the prime numbers, and if some of them repeat, use exponents.