

Euclid's Elements

Book VII

Definitions:

- 1 A unit is that by virtue of which each of the things that exist is called one
- 2 A number is a multitude composed of units. (not one)
- 3 A number is part of a number, the less of the greater, when it measures the greater
- 11 A prime number is that which is measured by a unit alone.
- 12 Numbers prime to one another are those which are measured by a unit alone as a common measure
- 15 A number is said to multiply a number when that which is multiplied is added to itself as many times as there are units in the other, and thus some number is produced.
- 20 Numbers are proportional when the first is the same multiple, or the same part, or the same parts, of the second that the third is of the fourth.

As long as algebra and geometry have been separated, their progress have been slow and their uses limited; but when these two sciences have been united, they have lent each mutual forces, and have marched together towards perfection.

Joseph-Louis Lagrange
(1736 to 1813)



Table of Contents, Chapter 7

1	Determine if two numbers are relatively prime	10	If $B = (p/q) \cdot A$ and $D = (p/q) \cdot C$, and If $B = (r/s) \cdot D$, then $A = (r/s) \cdot C$	21	If A,B are relatively prime, then A,B are the smallest whole numbers that can be used to describe the ratio A:B
2	Find the greatest common divisor for two numbers	11	If $A:B = C:D$, then $(A-C):(B-D) = A:B$	22	If A,B are the smallest whole numbers that can be used to describe the ratio A:B, then A,B are relatively prime
3	Find the largest common divisor for three numbers	12	If $A:B = C:D$, then $(A+C):(B+C) = A:B$	23	If A,B are relatively prime and if $A = n \cdot C$, then B,C are relatively prime
4	Given two natural numbers, A and B, either B is part of A, or there exists a natural number (a part) that can measure both A and B	13	If $A:B = C:D$, then $A:C = B:D$	24	If A,C are relatively prime and B,C are relatively prime then the $A \times B$ is relatively prime to C
5	If $B = (1/q) \cdot A$ and $D = (1/q) \cdot C$, then $(B+D) = (1/q) \cdot (A+C)$	14	If $A:B = D:E$ and $B:C = E:F$, then $A:C = D:F$	25	If A,B are relatively prime then A^2, B are relatively prime
6	If $B = (p/q) \cdot A$ and $D = (p/q) \cdot C$, then $(B+D) = (p/q) \cdot (A+C)$	15	If $B = i \cdot 1$ and $E = i \cdot D$, and if $D = j \cdot 1$ then $E = j \cdot B$	26	If A is relatively prime to C and D, and if B is also relatively prime to C and D, then $A \times B$ is relatively prime to $C \times D$
7	If $B = A/q$ and $D = C/q$, $B > D$, then $(B-D) = (A-C)/q$	16	$A \times B = B \times A$	27	If A,B are relatively prime, then A^2, B^2 are relatively prime, and A^3, B^3 are relatively prime, and so on
8	If $B = (p/q) \cdot A$ and $D = (p/q) \cdot C$, $B > D$, then $(B-D) = (p/q) \cdot (A-C)$	17	If $D = A \times B$ and $E = A \times C$ then $D:E = B:C$		
9	If $B = (1/q) \cdot A$ and $D = (1/q) \cdot C$, and If $B = (r/s) \cdot D$, then $A = (r/s) \cdot C$	18	If $D = B \times A$ and $E = C \times A$ then $D:E = B:C$		
		19	If $A:B = C:D$ then $A \times D = B \times C$ If $A \times D = B \times C$ then $A:B = C:D$		
		20	Given the ratio A:B and C,D are the smallest numbers such that $A:B = C:D$ then $A = n \cdot C$ and $B = n \cdot D$		



Table of Contents, Chapter 7

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|----|--|----|---|
| 28 | If A,B are relatively prime, then A,(A+B) are relatively prime | 37 | If $A = p \cdot B$, then $A = q \cdot C$ where $C = p \cdot 1$ |
| 29 | If A is prime, and $B \neq n \cdot A$, then A,B are relatively prime | 38 | If $A = (1/c) \cdot B$ and $C = c \cdot 1$ then $A = n \cdot C$ |
| 30 | If $C = A \times B$ and $C = i \cdot D$ where D is prime, then either $A = j \cdot D$ or $B = j \cdot D$ | 39 | Find the smallest number that has the fractions $1/a$, $1/b$, $1/c$ |
| 31 | If $A = B \times C$, then $A = j \cdot D$ where D is prime | | |
| 32 | If A is a number then it is either prime, or $A = j \cdot D$ where D is prime | | |
| 33 | Find the smallest numbers X,Y,Z where the ratio X:Y:Z is equal to the given ratio A:B:C | | |
| 34 | Find the lowest common denominator of 2 numbers | | |
| 35 | If E is the lowest common denominator of A,B, and if $C = n \cdot A = m \cdot B$, then $C = i \cdot E$ | | |
| 36 | Find the least common multiple of 3 numbers | | |



Proposition 31 of Book VII

Any composite number is measured by some prime number



Proposition 31 of Book VII

Any composite number is measured by some prime number



A

$$A = i \times j$$

In other words

Let A be a number that is constructed by multiplying two other numbers



Proposition 31 of Book VII

Any composite number is measured by some prime number

—————● A

$$A = i \times j$$

$$A = q \cdot D$$

D is prime

In other words

Let A be a number that is constructed by multiplying two other numbers

Then A will be a multiple of some prime number



Proposition 31 of Book VII

Any composite number is measured by some prime number



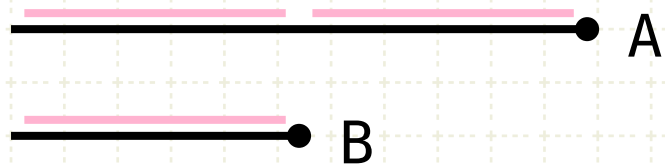
$$A = i \times j$$

Proof



Proposition 31 of Book VII

Any composite number is measured by some prime number



$$A = i \times j$$

$$A = r \cdot B$$

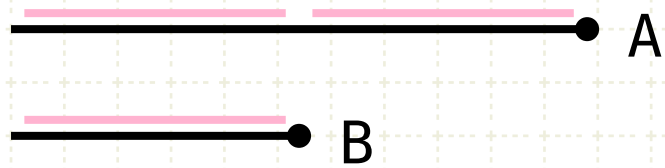
Proof

Since A is composite, it is measured by some number. Let that number be B



Proposition 31 of Book VII

Any composite number is measured by some prime number



$$A = i \times j$$

$$A = r \cdot B$$

Proof

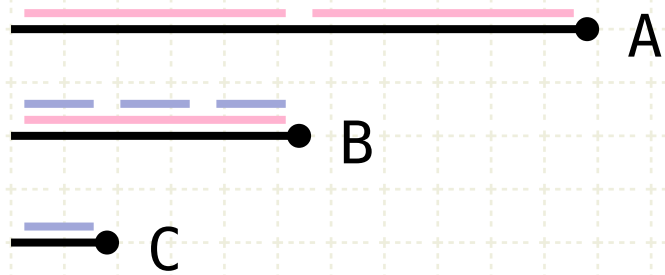
Since A is composite, it is measured by some number. Let that number be B

If B is prime, then A is measure by a prime number



Proposition 31 of Book VII

Any composite number is measured by some prime number



$$A = i \times j$$

$$A = r \cdot B$$

$$B = s \cdot C$$

Proof

Since A is composite, it is measured by some number. Let that number be B

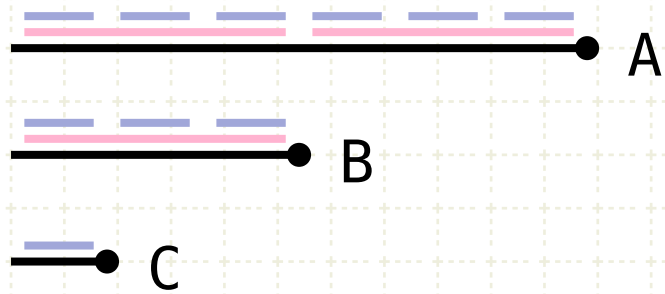
If B is prime, then A is measure by a prime number

If B is not prime, then let some number measure B. Let that number be C



Proposition 31 of Book VII

Any composite number is measured by some prime number



$$A = i \times j$$

$$A = r \cdot B$$

$$B = s \cdot C$$

$$A = r \cdot (s \cdot C)$$

Proof

Since A is composite, it is measured by some number. Let that number be B

If B is prime, then A is measure by a prime number

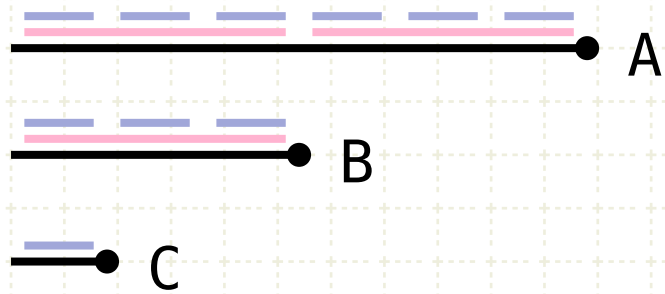
If B is not prime, then let some number measure B. Let that number be C

Since C measures B, and B measures A, C also measures A



Proposition 31 of Book VII

Any composite number is measured by some prime number



$$A = i \times j$$

$$A = r \cdot B$$

$$B = s \cdot C$$

$$A = r \cdot (s \cdot C)$$

Proof

Since A is composite, it is measured by some number. Let that number be B

If B is prime, then A is measure by a prime number

If B is not prime, then let some number measure B. Let that number be C

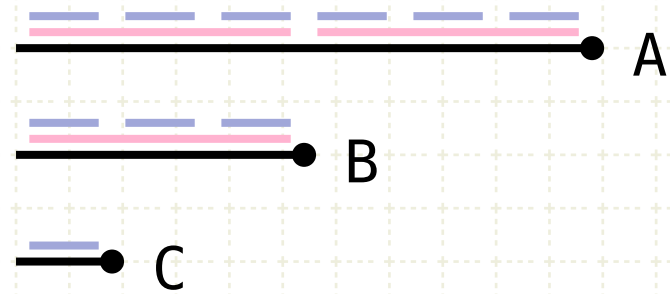
Since C measures B, and B measures A, C also measures A

If C is prime, then A is measure by a prime number



Proposition 31 of Book VII

Any composite number is measured by some prime number



$$A = i \times j$$

$$A = r \cdot B$$

$$B = s \cdot C$$

$$A = r \cdot (s \cdot C)$$

Proof

Since A is composite, it is measured by some number. Let that number be B

If B is prime, then A is measure by a prime number

If B is not prime, then let some number measure B. Let that number be C

Since C measures B, and B measures A, C also measures A

If C is prime, then A is measure by a prime number

And if C is not a prime, we continue the process until we reach a prime number that measures A

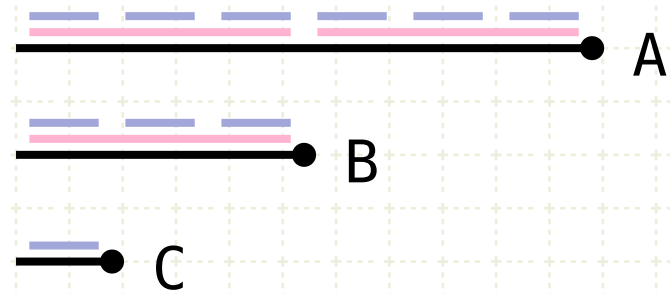
For, if it is not found, an infinite series of numbers will measure the number A, each of which is less than the other: which is impossible in numbers.(*)

** By numbers, Euclid means the set of integers $\{2,3,\dots\}$*



Proposition 31 of Book VII

Any composite number is measured by some prime number



$$A = i \times j$$

$$A = r \cdot B$$

$$B = s \cdot C$$

$$A = r \cdot (s \cdot C)$$

Proof

Since A is composite, it is measured by some number. Let that number be B

If B is prime, then A is measure by a prime number

If B is not prime, then let some number measure B. Let that number be C

Since C measures B, and B measures A, C also measures A

If C is prime, then A is measure by a prime number

And if C is not a prime, we continue the process until we reach a prime number that measures A

For, if it is not found, an infinite series of numbers will measure the number A, each of which is less than the other: which is impossible in numbers.(*)

** By numbers, Euclid means the set of integers $\{2,3,\dots\}$*

Therefore a prime number measures A



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