

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 $B = n \cdot D$		



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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 26 of Book VII

If two numbers be prime to two numbers, both to each, their products also will be prime to one another



Proposition 26 of Book VII

If two numbers be prime to two numbers, both to each, their products also will be prime to one another



In other words

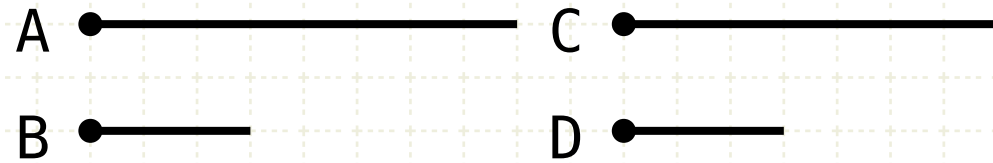
If A is relatively prime to C and to D, and B is also relatively prime to C and to D

$$\begin{aligned} \gcd(A, C) &= 1 \\ \gcd(A, D) &= 1 \\ \gcd(B, C) &= 1 \\ \gcd(B, D) &= 1 \end{aligned}$$



Proposition 26 of Book VII

If two numbers be prime to two numbers, both to each, their products also will be prime to one another



In other words

If A is relatively prime to C and to D, and B is also relatively prime to C and to D

Then the product of A and B will be relatively prime to the product C and D

$$\gcd(A, C) = 1$$

$$\gcd(A, D) = 1$$

$$\gcd(B, C) = 1$$

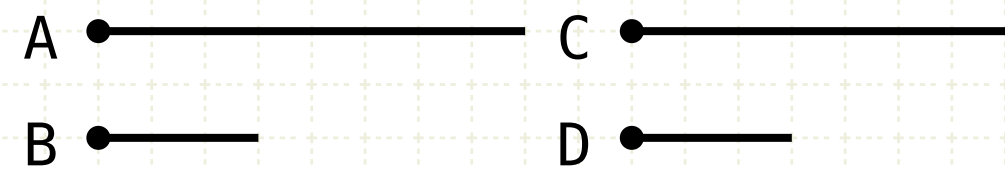
$$\gcd(B, D) = 1$$

$$\gcd(A \times B, C \times D) = 1$$



Proposition 26 of Book VII

If two numbers be prime to two numbers, both to each, their products also will be prime to one another



$$\begin{aligned} \gcd(A, C) &= 1 \\ \gcd(A, D) &= 1 \\ \gcd(B, C) &= 1 \\ \gcd(B, D) &= 1 \end{aligned}$$

In other words

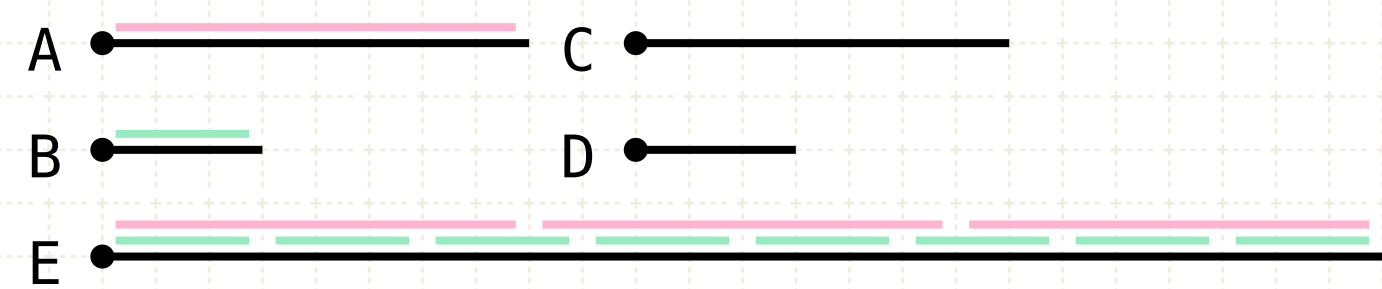
If A is relatively prime to C and to D, and B is also relatively prime to C and to D
Then the product of A and B will be relatively prime to the product C and D

Proof



Proposition 26 of Book VII

If two numbers be prime to two numbers, both to each, their products also will be prime to one another



$$\begin{aligned} \gcd(A, C) &= 1 \\ \gcd(A, D) &= 1 \\ \gcd(B, C) &= 1 \\ \gcd(B, D) &= 1 \end{aligned}$$

$$E = A \times B$$

In other words

If A is relatively prime to C and to D, and B is also relatively prime to C and to D
Then the product of A and B will be relatively prime to the product C and D

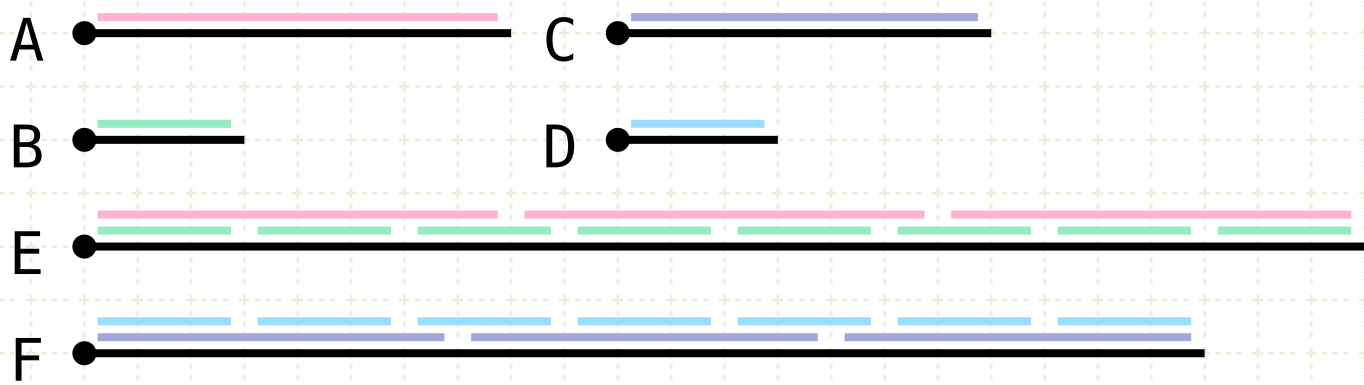
Proof

Let E be the product of A and B



Proposition 26 of Book VII

If two numbers be prime to two numbers, both to each, their products also will be prime to one another



$$\begin{aligned} \gcd(A, C) &= 1 \\ \gcd(A, D) &= 1 \\ \gcd(B, C) &= 1 \\ \gcd(B, D) &= 1 \end{aligned}$$

$$\begin{aligned} E &= A \times B \\ F &= C \times D \end{aligned}$$

In other words

If A is relatively prime to C and to D, and B is also relatively prime to C and to D
Then the product of A and B will be relatively prime to the product C and D

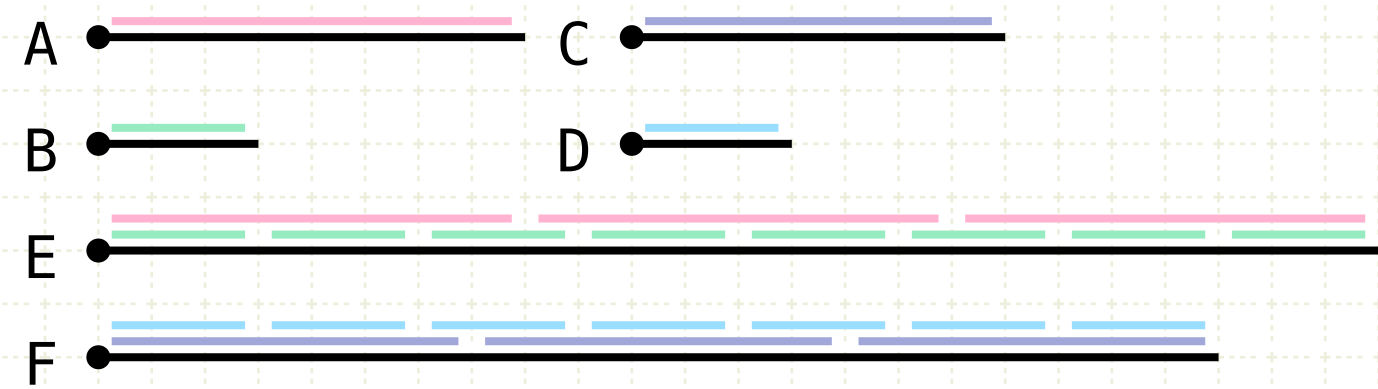
Proof

Let E be the product of A and B
Let F be the product of C and D



Proposition 26 of Book VII

If two numbers be prime to two numbers, both to each, their products also will be prime to one another



$$\gcd(A, C) = 1$$

$$\gcd(A, D) = 1$$

$$\gcd(B, C) = 1$$

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$$F = C \times D$$

$$\gcd(A \times B, C) = 1$$

In other words

If A is relatively prime to C and to D, and B is also relatively prime to C and to D

Then the product of A and B will be relatively prime to the product C and D

Proof

Let E be the product of A and B

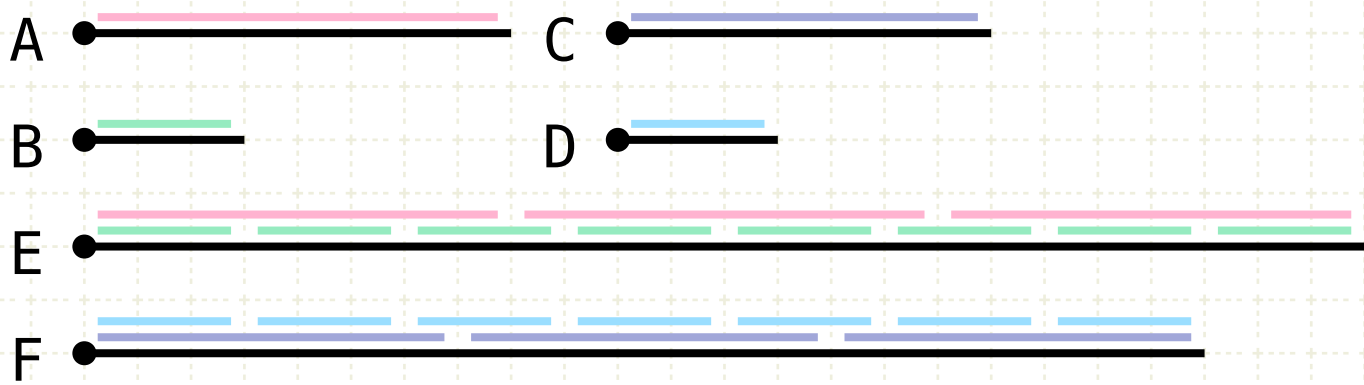
Let F be the product of C and D

Since A and B are prime to C, then the product A and B will also be prime to C (VII·24)



Proposition 26 of Book VII

If two numbers be prime to two numbers, both to each, their products also will be prime to one another



$$\begin{aligned} \gcd(A, C) &= 1 \\ \gcd(A, D) &= 1 \\ \gcd(B, C) &= 1 \\ \gcd(B, D) &= 1 \end{aligned}$$

$$\begin{aligned} E &= A \times B \\ F &= C \times D \\ \gcd(A \times B, C) &= 1 \\ \gcd(E, C) &= 1 \end{aligned}$$

In other words

If A is relatively prime to C and to D, and B is also relatively prime to C and to D
Then the product of A and B will be relatively prime to the product C and D

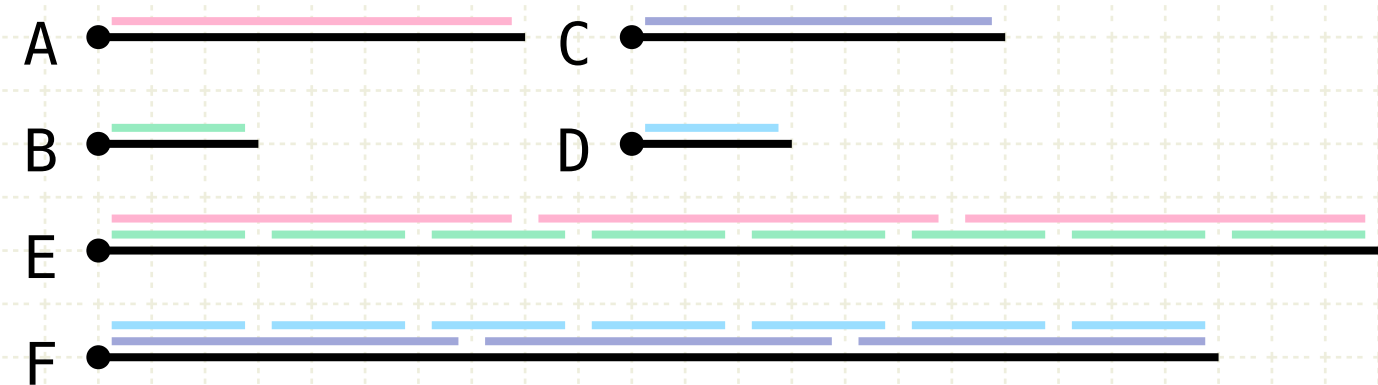
Proof

Let E be the product of A and B
Let F be the product of C and D
Since A and B are prime to C, then the product A and B will also be prime to C (VII·24)
But E is equal to the product of A and B, so E is relatively prime to C



Proposition 26 of Book VII

If two numbers be prime to two numbers, both to each, their products also will be prime to one another



$$\gcd(A, C) = 1$$

$$\gcd(A, D) = 1$$

$$\gcd(B, C) = 1$$

$$\gcd(B, D) = 1$$

$$E = A \times B$$

$$F = C \times D$$

$$\gcd(A \times B, C) = 1$$

$$\gcd(E, C) = 1$$

$$\gcd(E, D) = 1$$

In other words

If A is relatively prime to C and to D, and B is also relatively prime to C and to D

Then the product of A and B will be relatively prime to the product C and D

Proof

Let E be the product of A and B

Let F be the product of C and D

Since A and B are prime to C, then the product A and B will also be prime to C (VII·24)

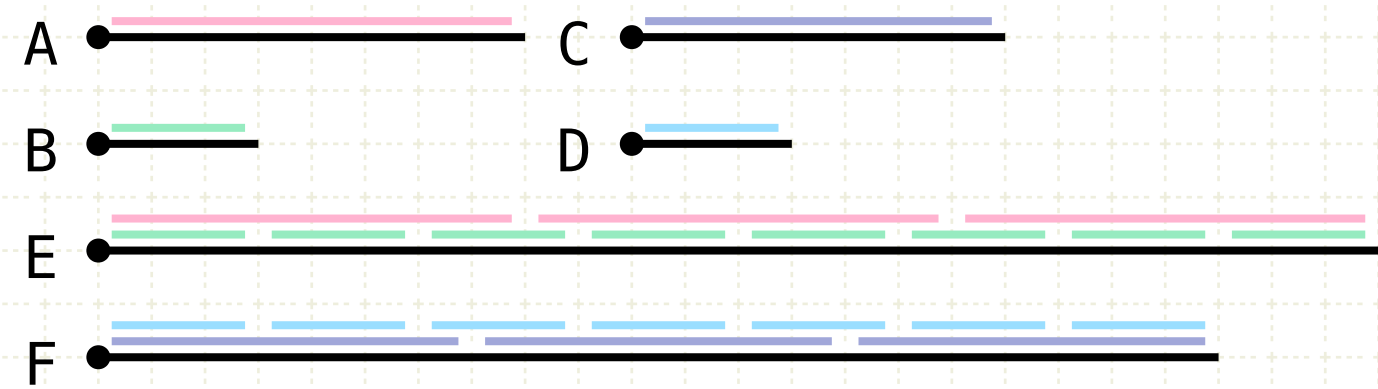
But E is equal to the product of A and B, so E is relatively prime to C

Since A and B are prime to D, then the product A and B will also be prime to D (VII·24)



Proposition 26 of Book VII

If two numbers be prime to two numbers, both to each, their products also will be prime to one another



$$\gcd(A, C) = 1$$

$$\gcd(A, D) = 1$$

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$$E = A \times B$$

$$F = C \times D$$

$$\gcd(A \times B, C) = 1$$

$$\gcd(E, C) = 1$$

$$\gcd(E, D) = 1$$

In other words

If A is relatively prime to C and to D, and B is also relatively prime to C and to D

Then the product of A and B will be relatively prime to the product C and D

Proof

Let E be the product of A and B

Let F be the product of C and D

Since A and B are prime to C, then the product A and B will also be prime to C (VII·24)

But E is equal to the product of A and B, so E is relatively prime to C

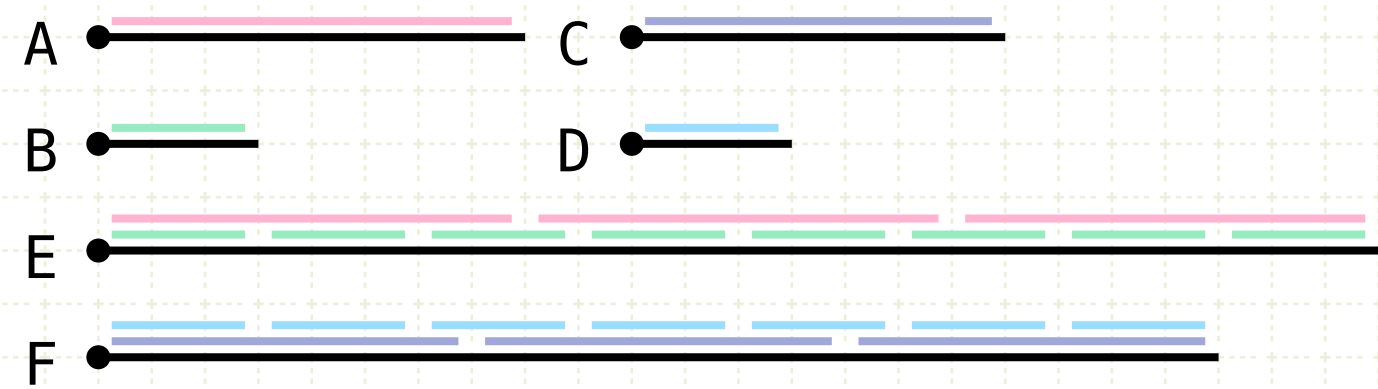
Since A and B are prime to D, then the product A and B will also be prime to D (VII·24)

Therefore C and D are prime to E



Proposition 26 of Book VII

If two numbers be prime to two numbers, both to each, their products also will be prime to one another



$$\gcd(A, C) = 1$$

$$\gcd(A, D) = 1$$

$$\gcd(B, C) = 1$$

$$\gcd(B, D) = 1$$

$$E = A \times B$$

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$$\gcd(E, D) = 1$$

$$\gcd(E, C \times D) = 1$$

In other words

If A is relatively prime to C and to D, and B is also relatively prime to C and to D

Then the product of A and B will be relatively prime to the product C and D

Proof

Let E be the product of A and B

Let F be the product of C and D

Since A and B are prime to C, then the product A and B will also be prime to C (VII·24)

But E is equal to the product of A and B, so E is relatively prime to C

Since A and B are prime to D, then the product A and B will also be prime to D (VII·24)

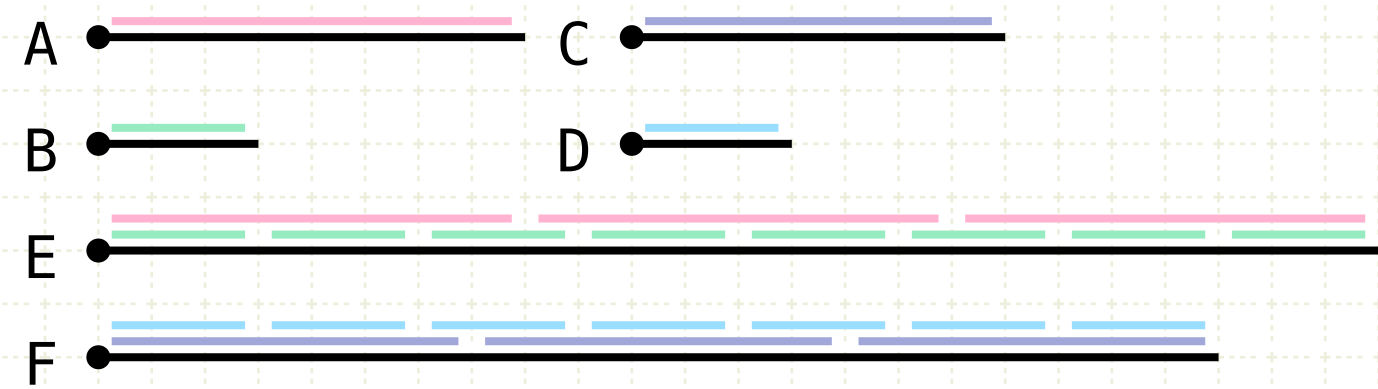
Therefore C and D are prime to E

Therefore the product of C and D are prime to E (VI·24)



Proposition 26 of Book VII

If two numbers be prime to two numbers, both to each, their products also will be prime to one another



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$$\gcd(E, F) = 1$$

In other words

If A is relatively prime to C and to D, and B is also relatively prime to C and to D

Then the product of A and B will be relatively prime to the product C and D

Proof

Let E be the product of A and B

Let F be the product of C and D

Since A and B are prime to C, then the product A and B will also be prime to C (VII·24)

But E is equal to the product of A and B, so E is relatively prime to C

Since A and B are prime to D, then the product A and B will also be prime to D (VII·24)

Therefore C and D are prime to E

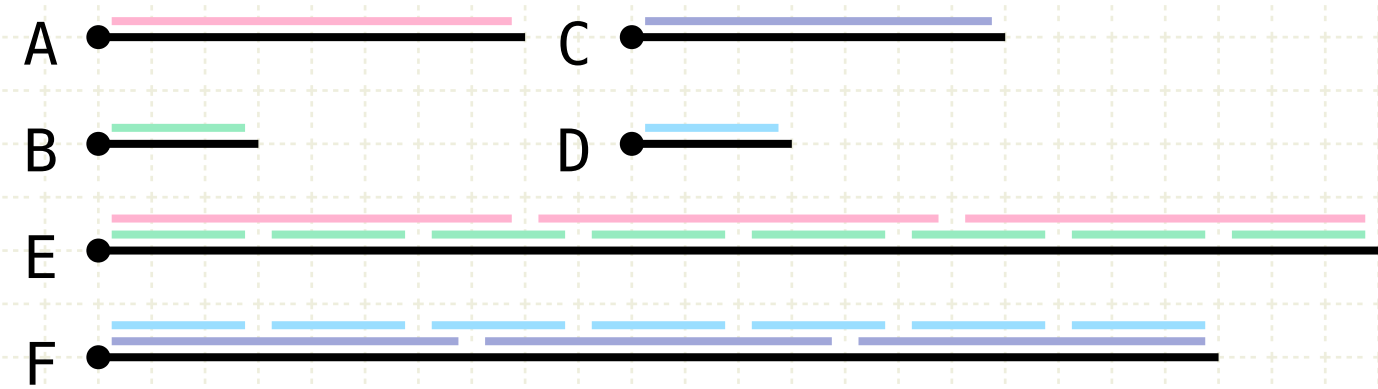
Therefore the product of C and D are prime to E (VI·24)

But F is equal to the product of C and D, so F is relatively prime to E



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If two numbers be prime to two numbers, both to each, their products also will be prime to one another



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In other words

If A is relatively prime to C and to D, and B is also relatively prime to C and to D

Then the product of A and B will be relatively prime to the product C and D

Proof

Let E be the product of A and B

Let F be the product of C and D

Since A and B are prime to C, then the product A and B will also be prime to C (VII·24)

But E is equal to the product of A and B, so E is relatively prime to C

Since A and B are prime to D, then the product A and B will also be prime to D (VII·24)

Therefore C and D are prime to E

Therefore the product of C and D are prime to E (VI·24)

But F is equal to the product of C and D, so F is relatively prime to E



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