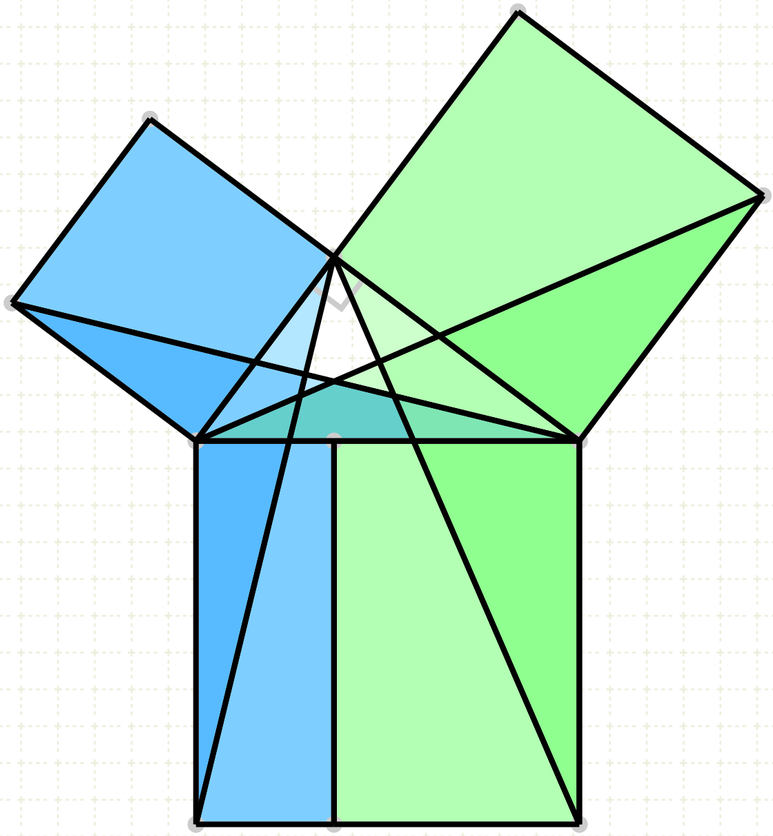
Euclid's Elements

Book I



If Euclid did not kindle your youthful enthusiasm, you were not born to be a scientific thinker.

Albert Einstein

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Proposition 28 of Book I

If a straight line falling on two straight lines makes the exterior angle equal to the interior and opposite angle on the same side,
or the sum of the interior angles on the same side equal to two right angles, then the straight lines are parallel to one another.

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Definition - Parallel Lines

Parallel straight lines are straight lines which, being in the same plane and being produced indefinitely in both directions, do not meet one another in either direction.

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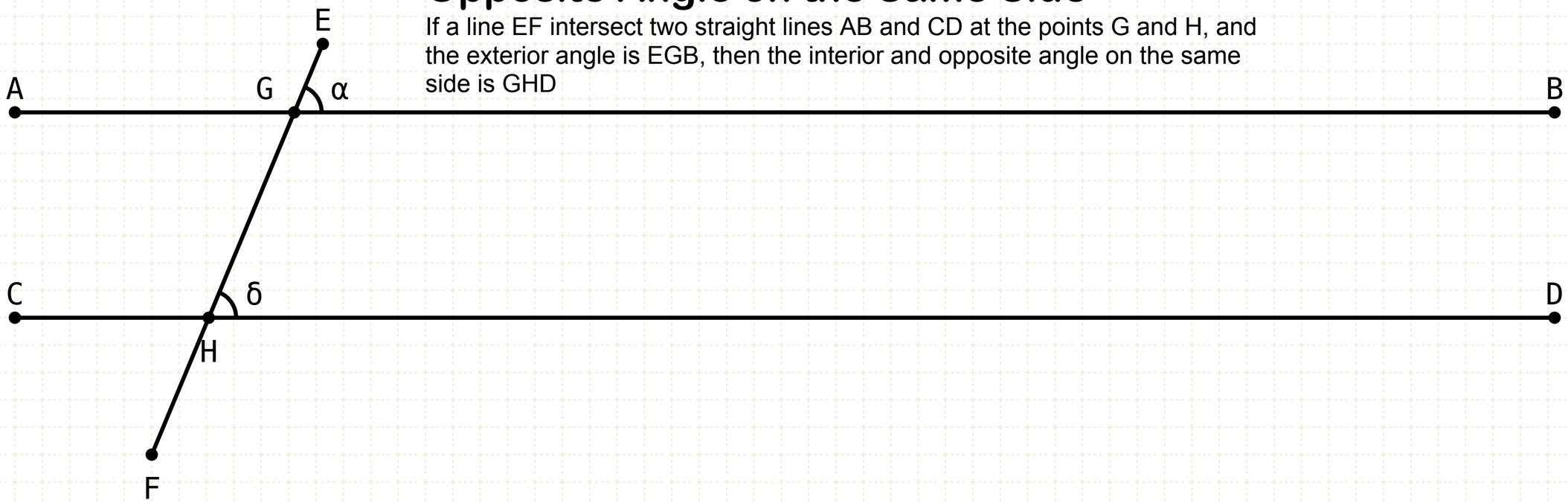
If a straight line falling on two straight lines makes the exterior angle equal to the interior and opposite angle on the same side, or the sum of the interior angles on the same side equal to two right angles, then the straight lines are parallel to one another.

Definition - Exterior to Interior and Opposite Angle on the Same Side

If a line EF intersect two straight lines AB and CD at the points G and H, and the exterior angle is EGB, then the interior and opposite angle on the same side is GHD



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In other words

Given two straight lines AB and CD

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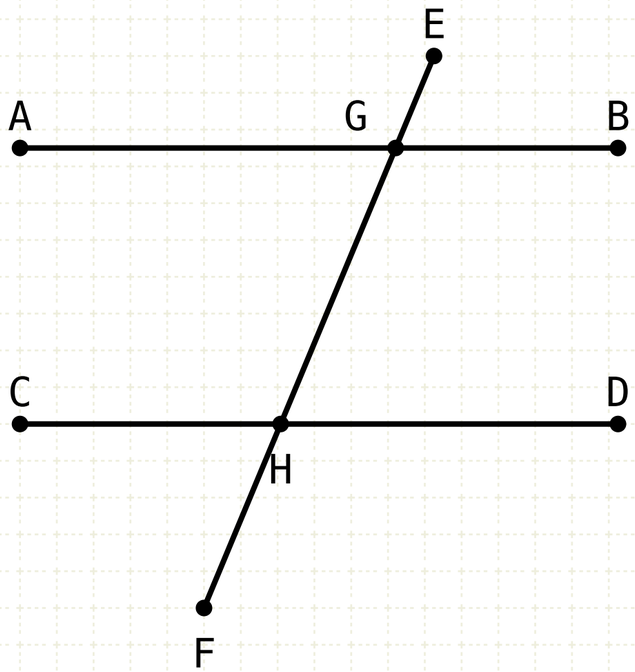

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And a third line EF that intersects lines AB and CD at points G and H

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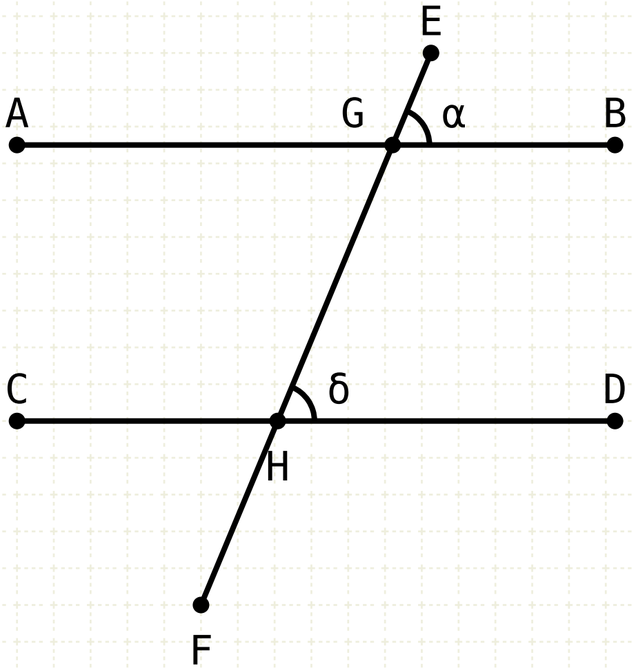


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if α = δ
=> AB || CD
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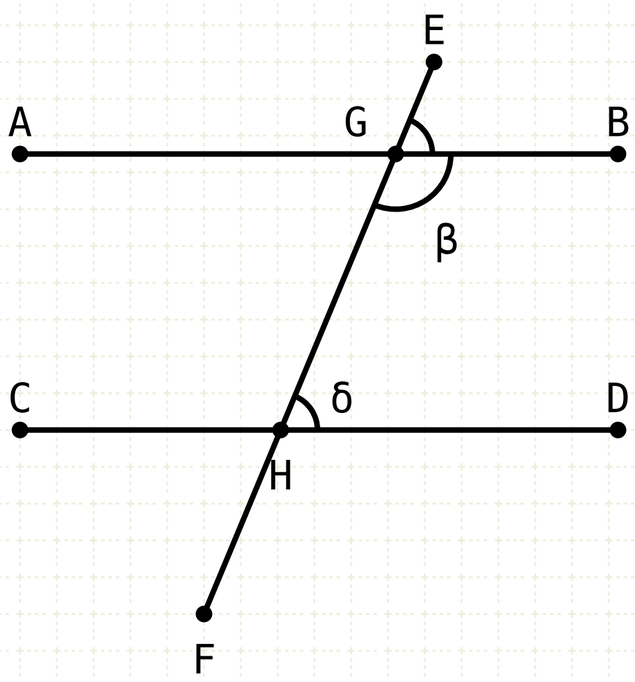


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if α = δ
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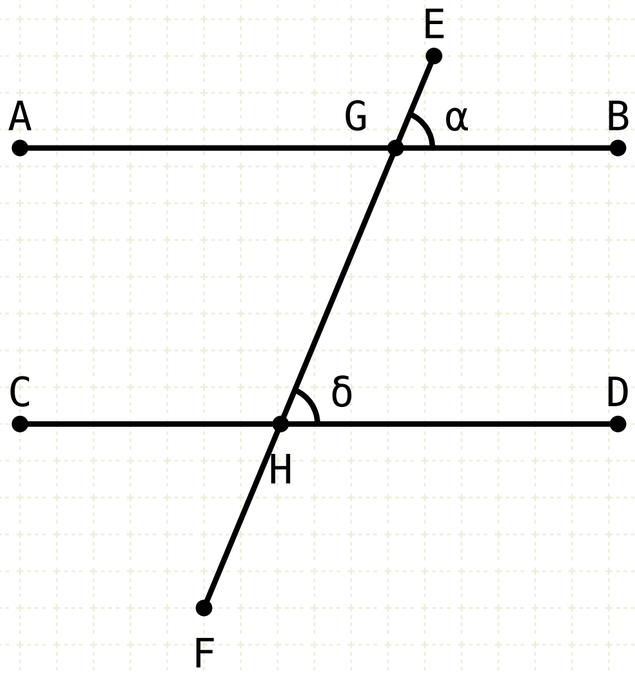
$\alpha = \delta$



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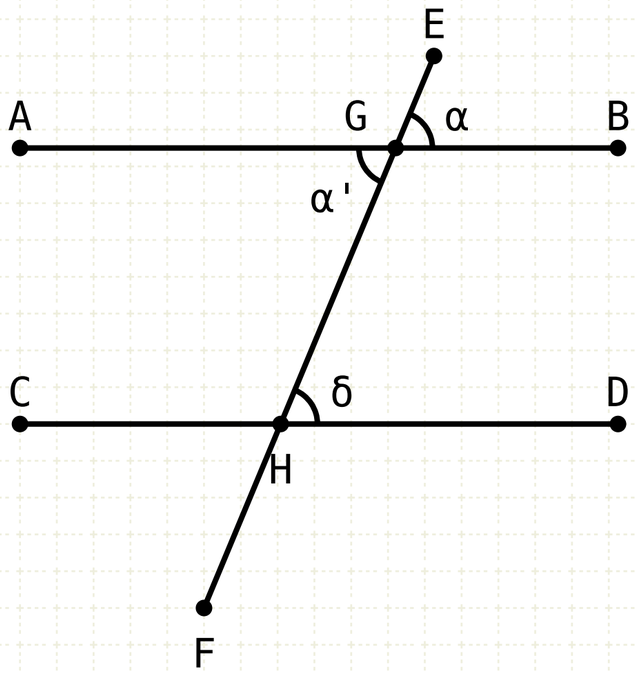

$\alpha = \delta$

$\alpha' = \alpha$

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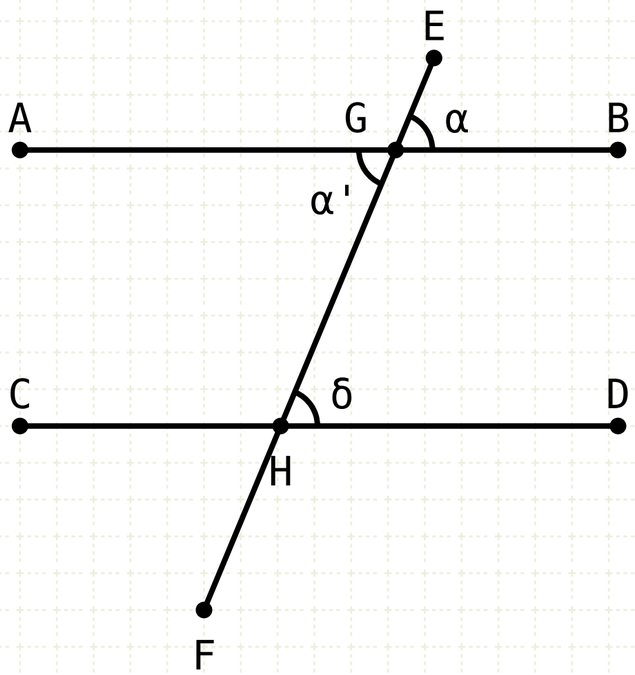

$\alpha = \delta$

$\alpha' = \alpha$

$AB \parallel CD$

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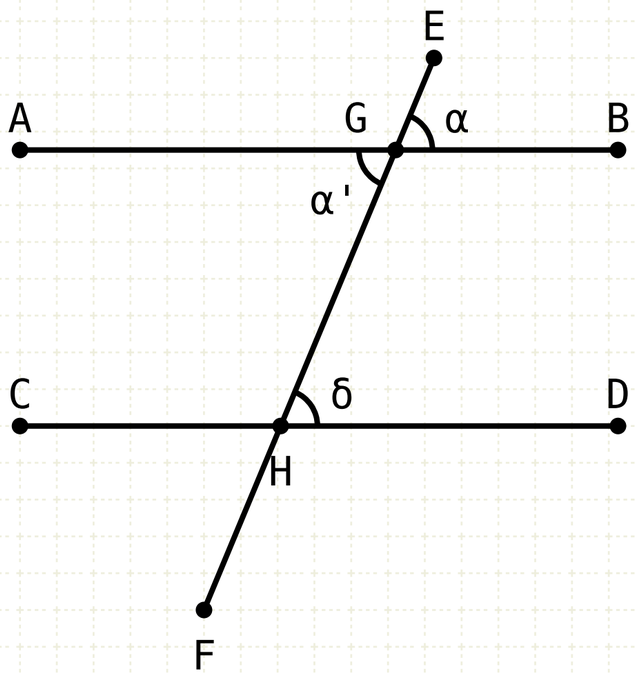

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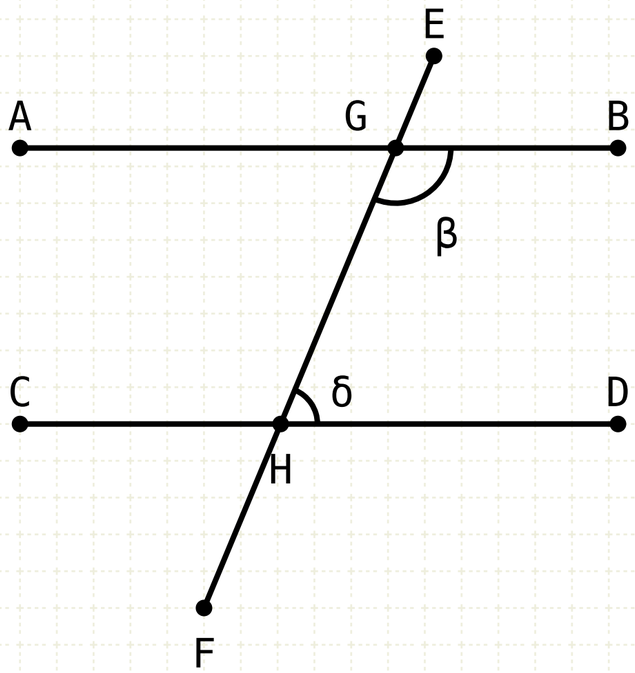
δ + β = ∟+∟



In other words

Given two straight lines AB and CD

And a third line EF that intersects lines AB and CD at points G and H

1. If angles EGB and GHD are equal, then the lines AB and CD are parallel

2. If angles BGH and GHD added together equal two right angles, then the lines AB and CD are parallel

Proof 1

Angle AGH equals EGB (I·15), equals GHD

Since AGH and GHB are opposite interior angles, and they are equal, lines AB and CD are parallel (I·27)

Proof 2

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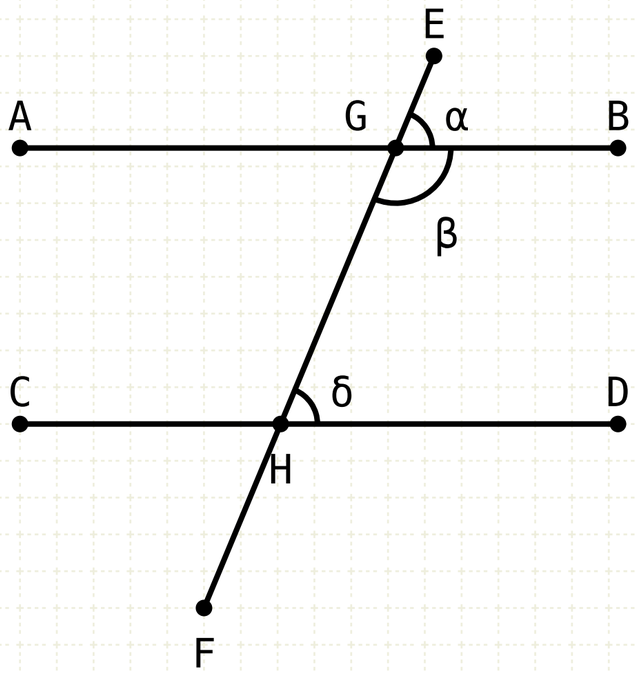

δ + β = ∟+∟

α + β = ∟+∟

In other words

Given two straight lines AB and CD

And a third line EF that intersects lines AB and CD at points G and H

1. If angles EGB and GHD are equal, then the lines AB and CD are parallel

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Proof 1

Angle AGH equals EGB (I·15), equals GHD

Since AGH and GHB are opposite interior angles, and they are equal, lines AB and CD are parallel (I·27)

Proof 2

The sum of the EGB and BGH are two right angles (I·13)

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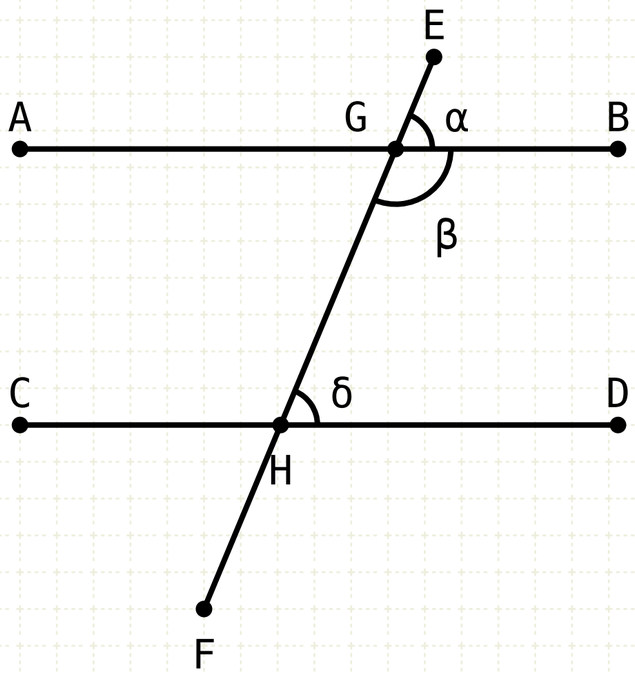

δ + β = ∟+∟

α + β = ∟+∟

α + β = δ + β

In other words

Given two straight lines AB and CD

And a third line EF that intersects lines AB and CD at points G and H

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2. If angles BGH and GHD added together equal two right angles, then the lines AB and CD are parallel

Proof 1

Angle AGH equals EGB (I·15), equals GHD

Since AGH and GHB are opposite interior angles, and they are equal, lines AB and CD are parallel (I·27)

Proof 2

The sum of the EGB and BGH are two right angles (I·13)

Since the sum of GHD and GHD are also two right angles, the sum of EGB and DGH are equal

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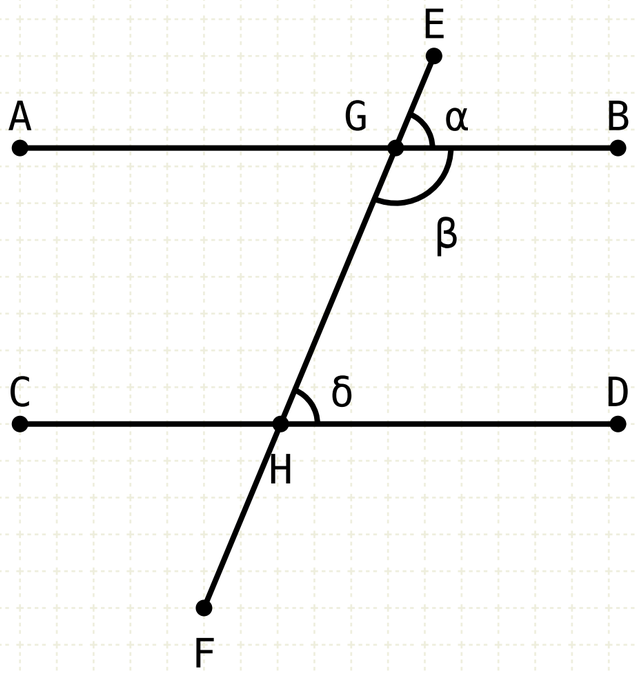

δ + β = ∟+∟

α + β = ∟+∟

α + β = δ + β

α = δ

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Proof 2

The sum of the EGB and BGH are two right angles (I·13)

Since the sum of GHD and GHD are also two right angles, the sum of EGB and DGH are equal

Remove the common angle DGH and we have angle EGB equal to GHD

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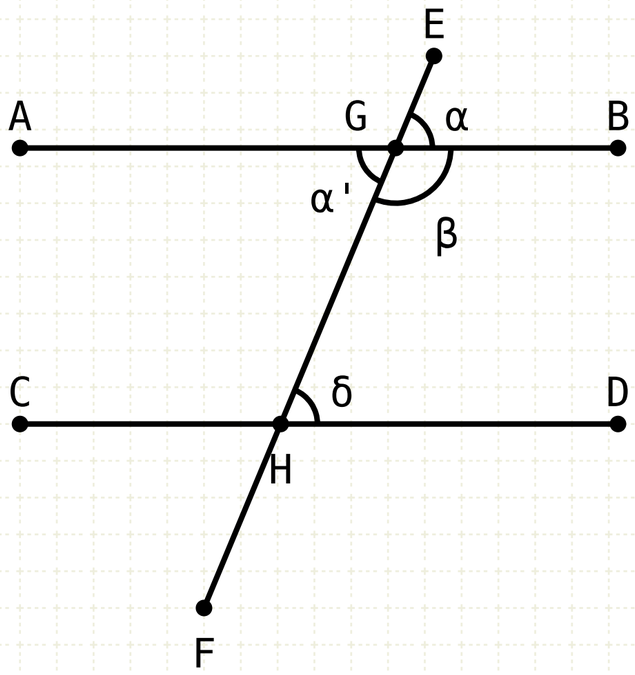

δ + β = ∟+∟

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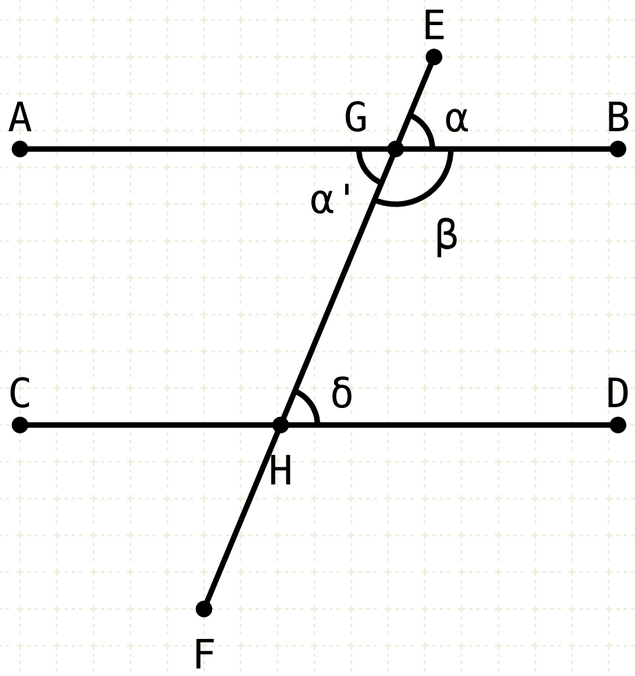

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AB || CD

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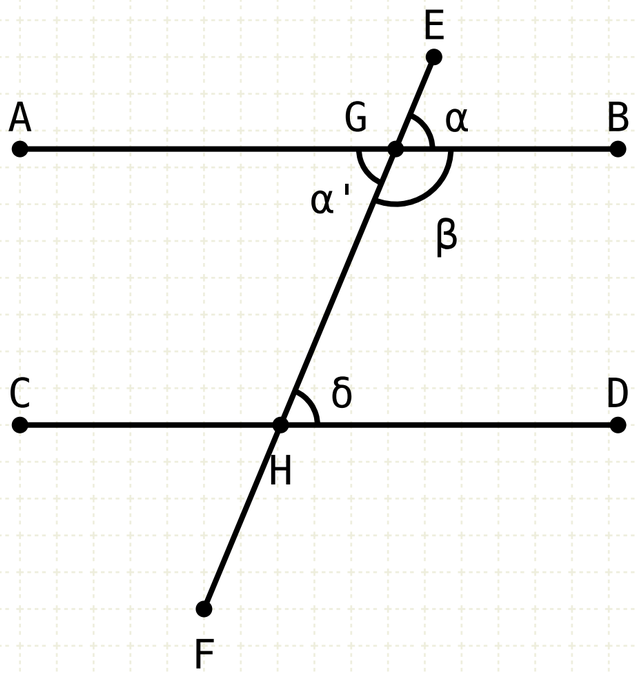

δ + β = ∟+∟

α + β = ∟+∟

α + β = δ + β

α = δ

α ' = α = δ

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Since the sum of GHD and GHD are also two right angles, the sum of EGB and DGH are equal

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