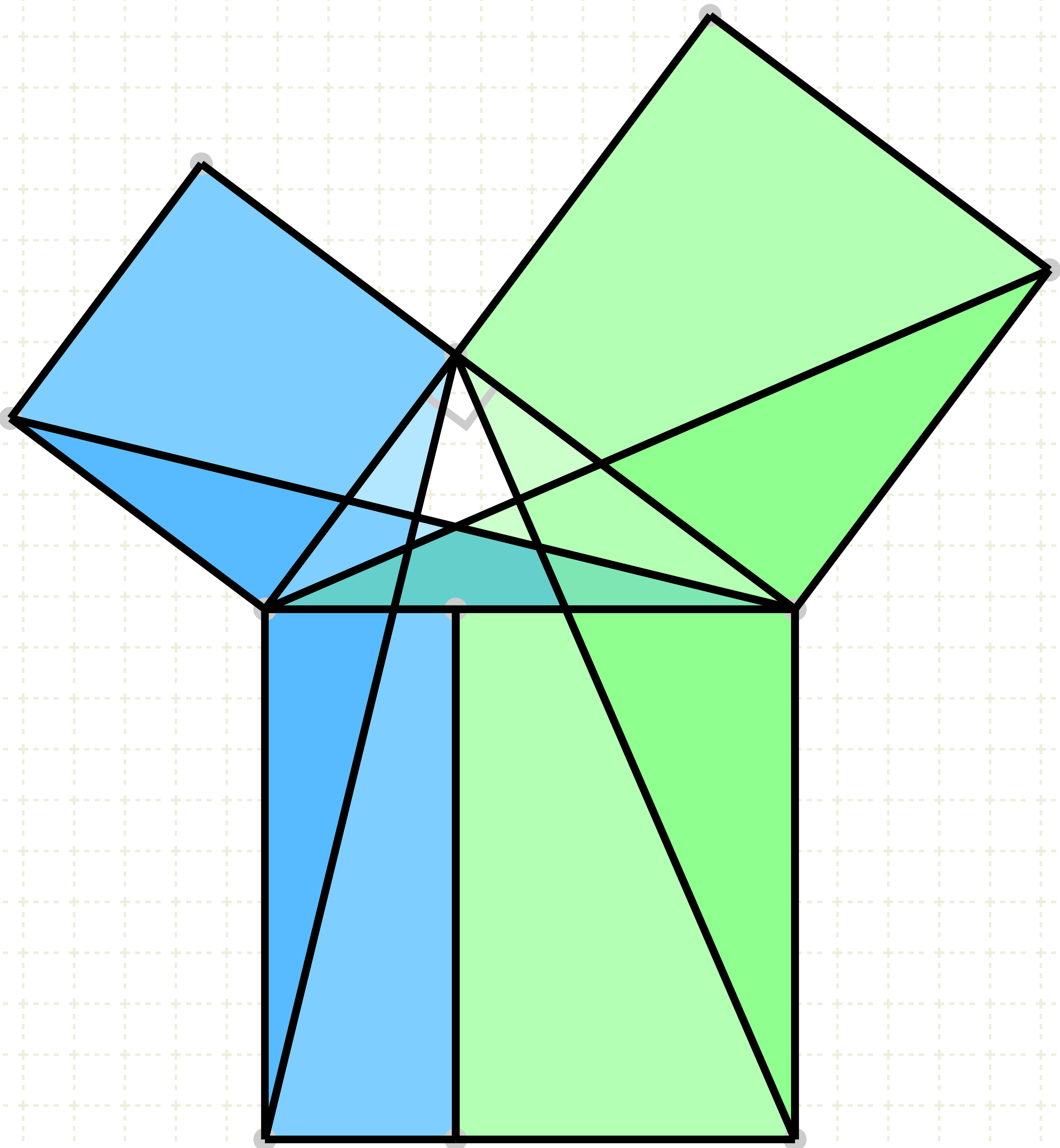
Euclid's Elements

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 16 of Book I

In any triangle, if one of the sides is produced, then the exterior angle is greater than either of the interior and opposite angles.

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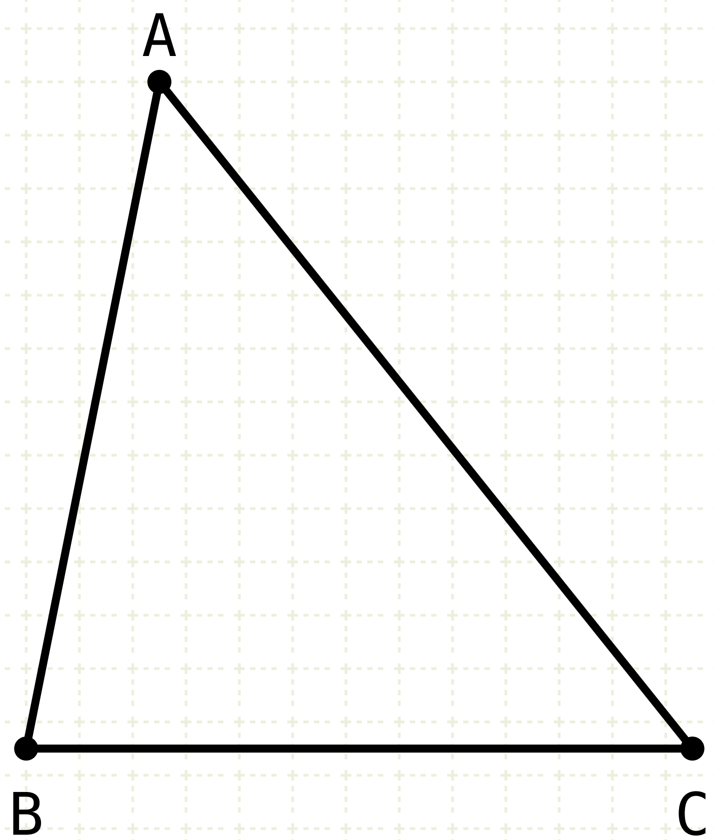
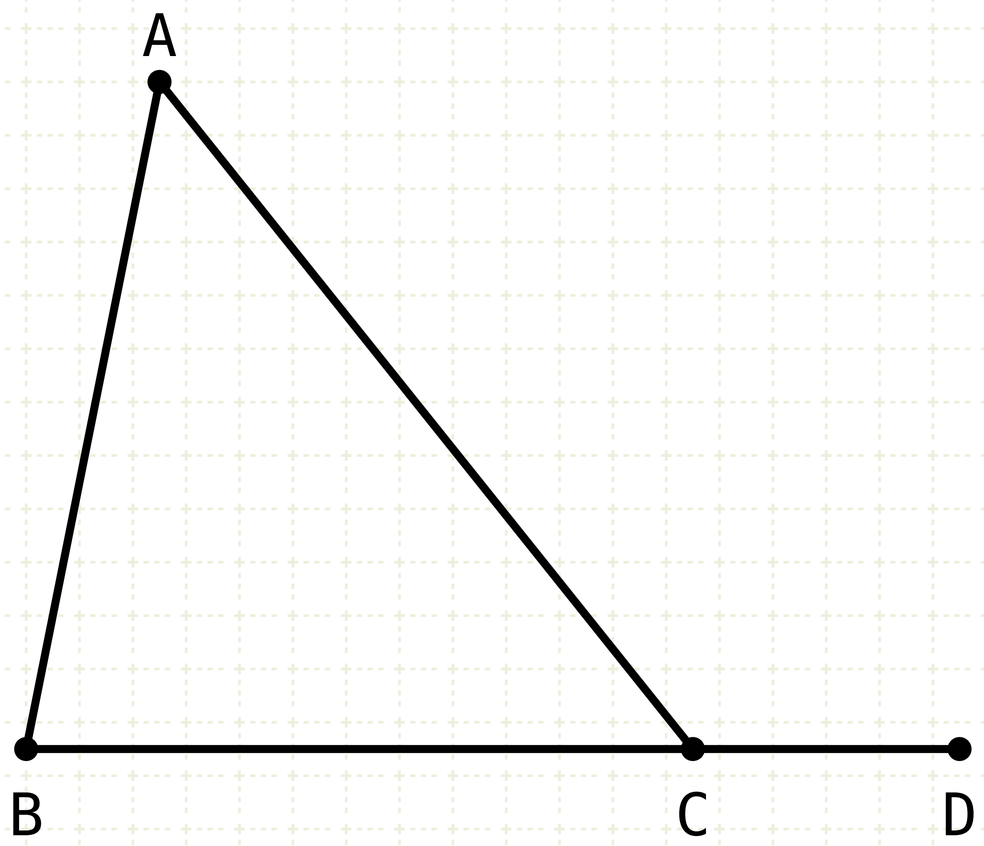


In other words

Start with a triangle ABC

Proposition 16 of Book I

In any triangle, if one of the sides is produced, then the exterior angle is greater than either of the interior and opposite angles.



In other words

Start with a triangle ABC

Extend line BC to point D

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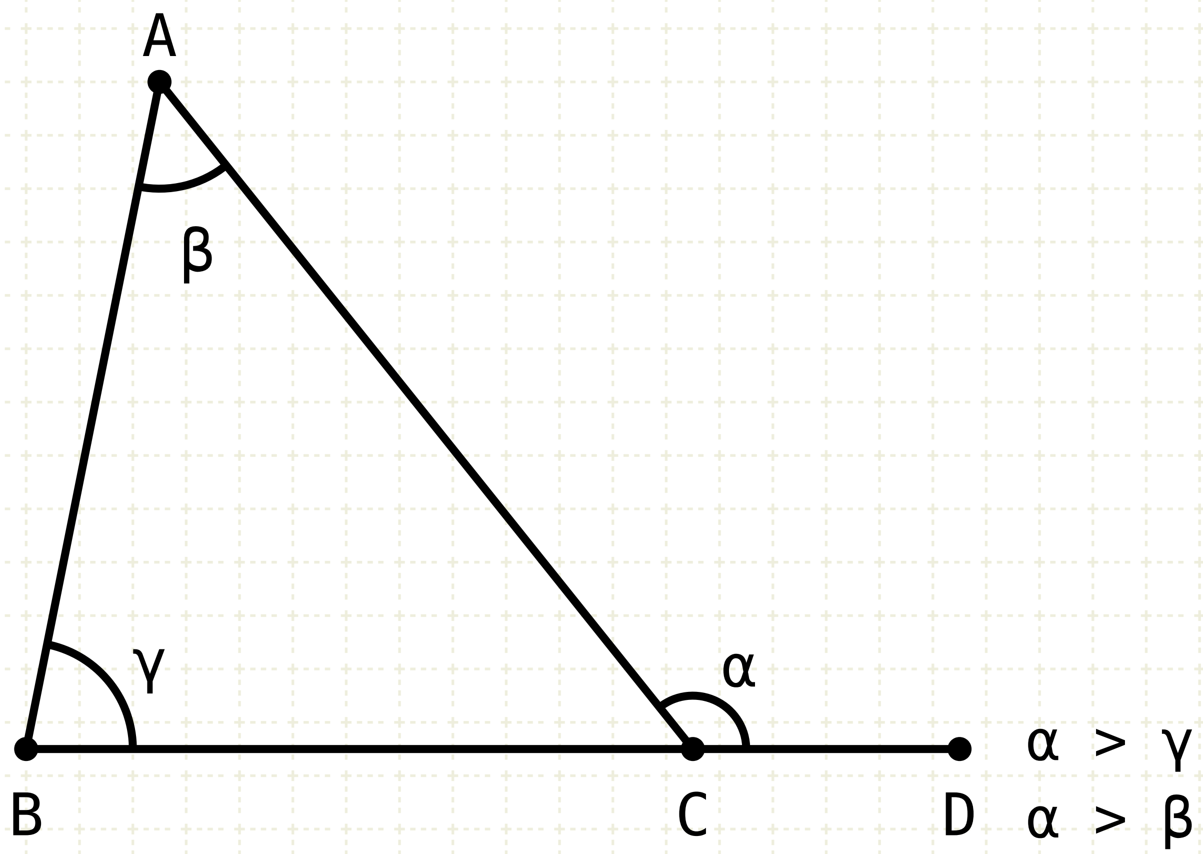

In other words

Start with a triangle ABC

Extend line BC to point D

The angle ACD is larger than either ABC or CAB

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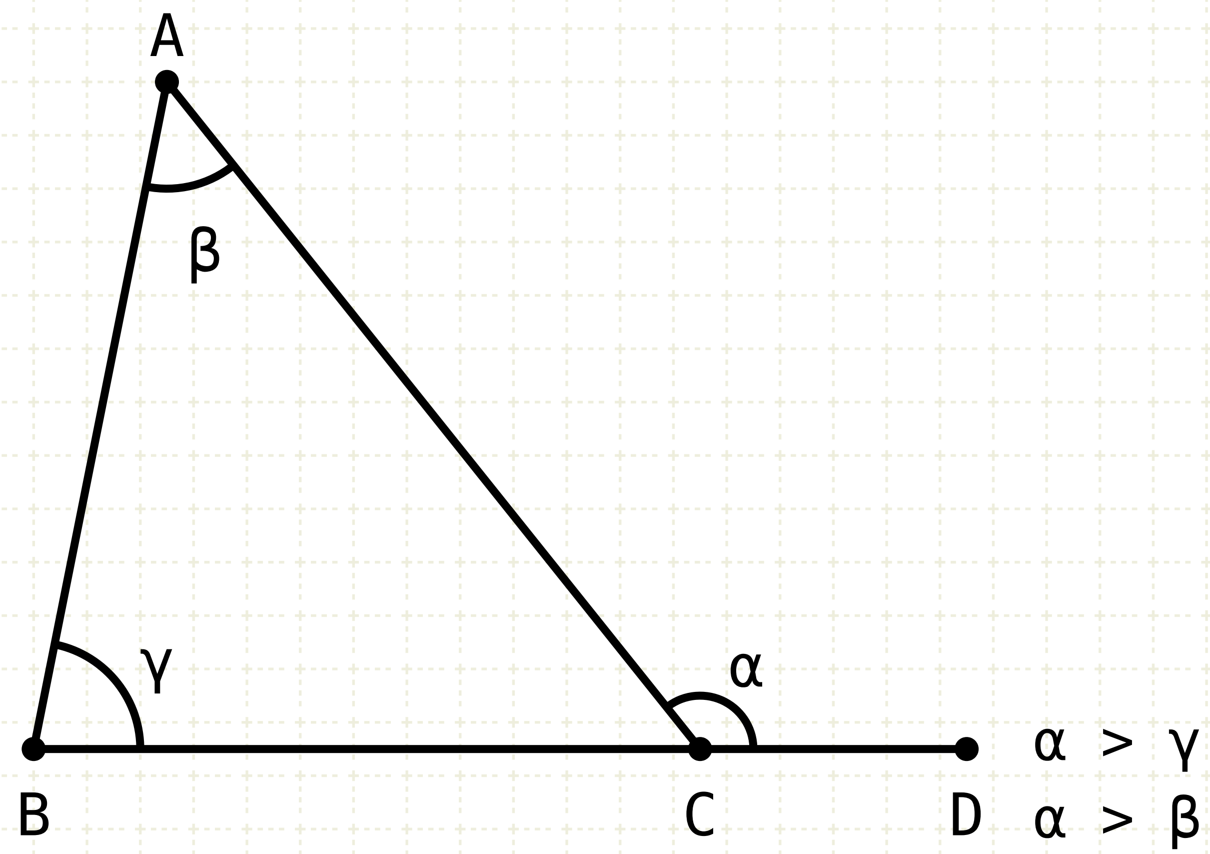

Proof

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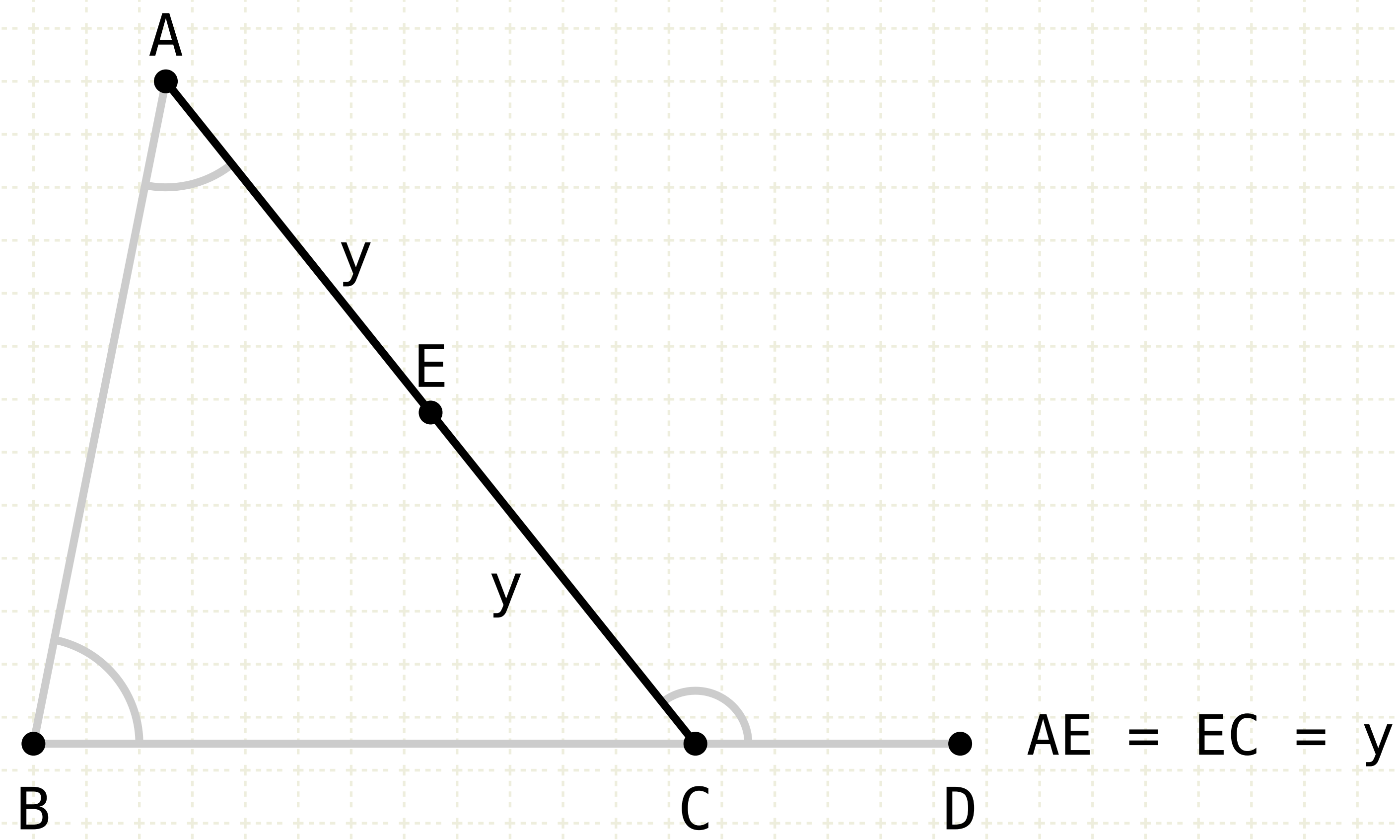

Proof

Bisect line AC at point E (I·10)

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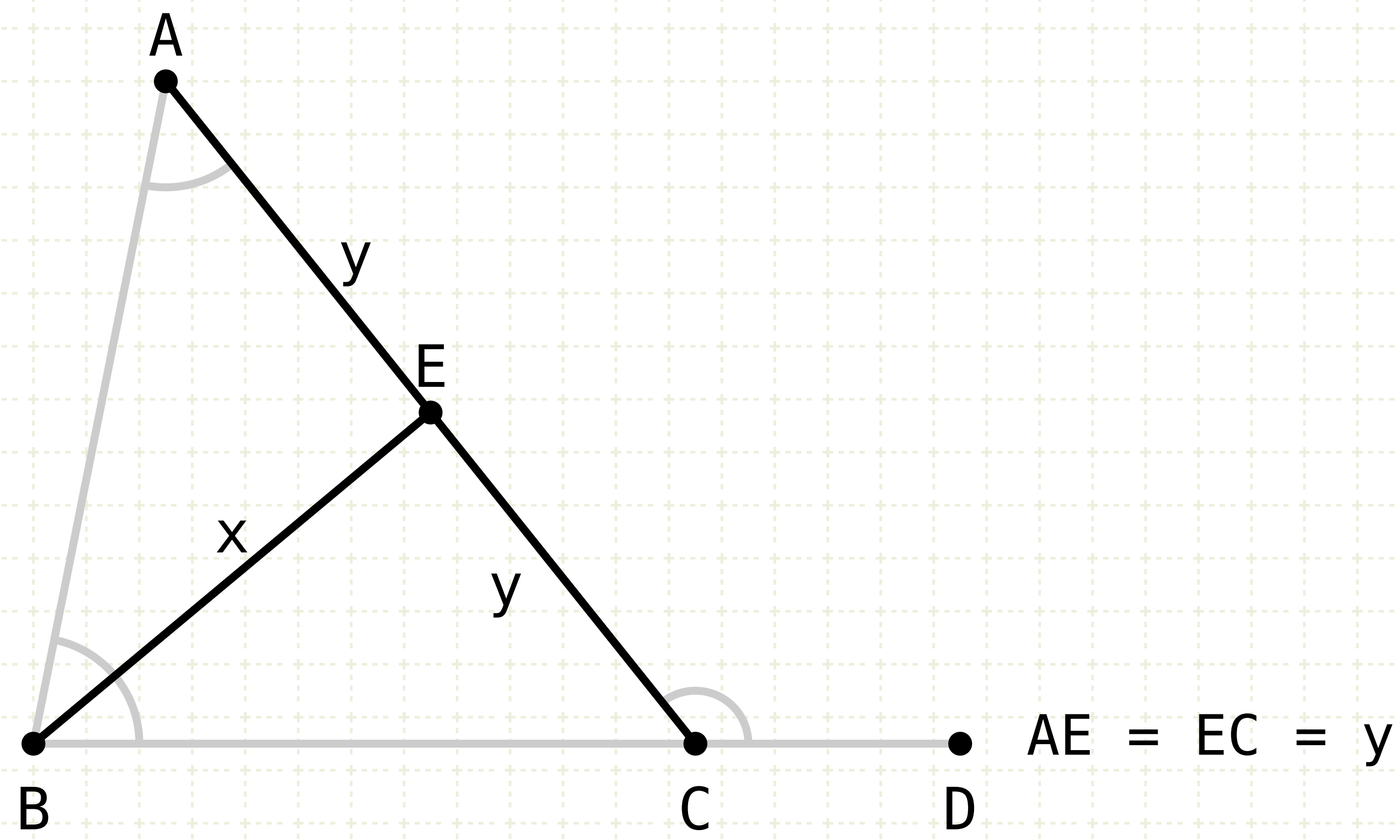

Proof

Bisect line AC at point E (I·10)

Create line segment BE

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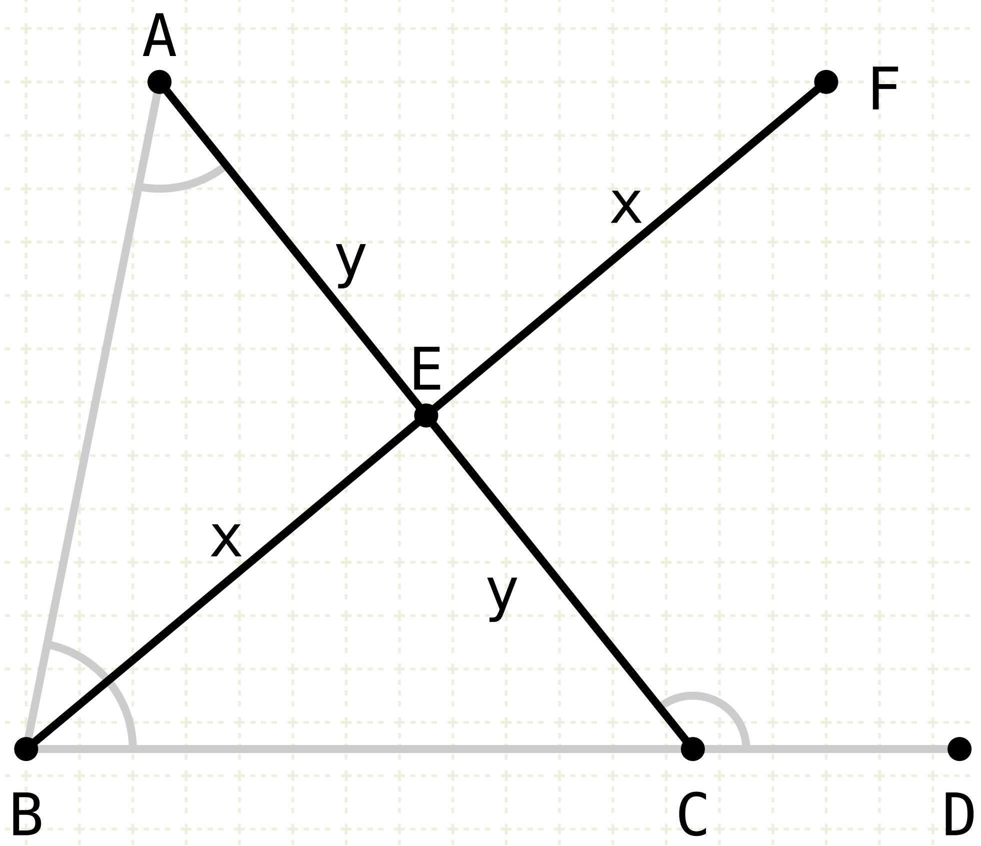

AE = EC = y
BE = EF = x

Proof

Bisect line AC at point E (I·10)

Create line segment BE

Extend line BE to line F, where EF equals BE

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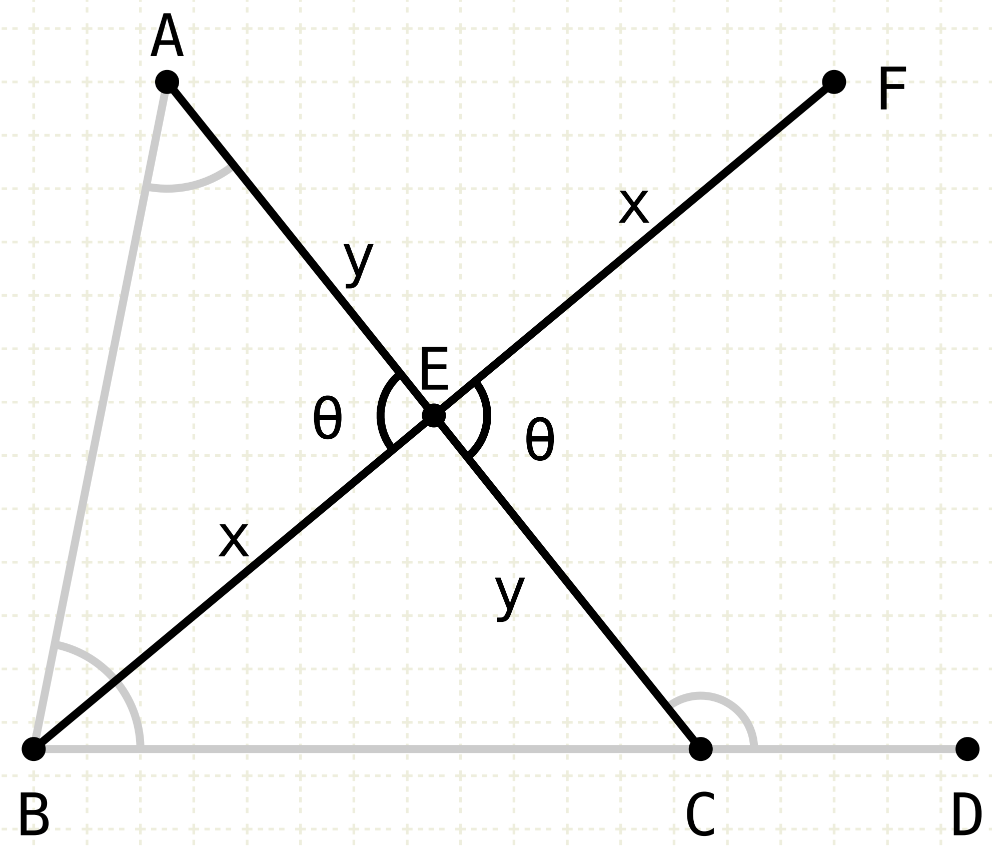

$AE = EC = y$

$BE = EF = x$

$\angle AEB = \angle CEF = \theta$

Proof

Bisect line AC at point E (I·10)

Create line segment BE

Extend line BE to line F, where EF equals BE

Angles AEB and CEF are vertical to each other, hence they are equal (I·15)

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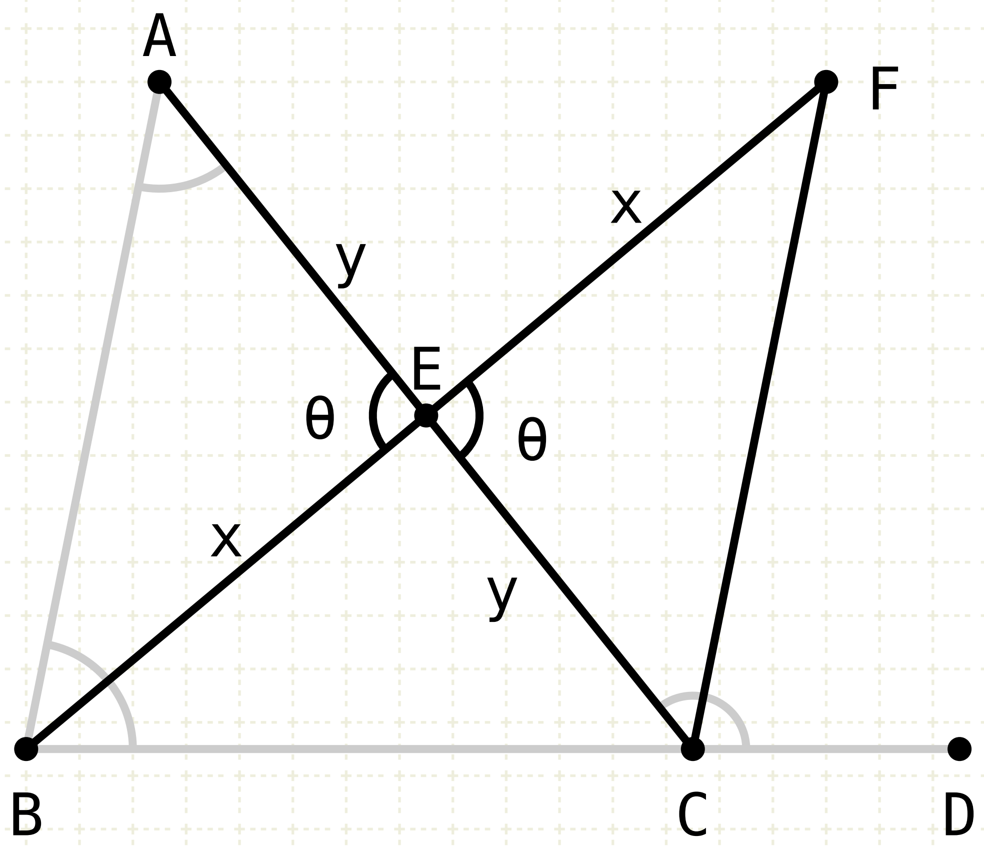

AE = EC = y

BE = EF = x

∠AEB = ∠CEF = θ

Proof

Bisect line AC at point E (I·10)

Create line segment BE

Extend line BE to line F, where EF equals BE

Angles AEB and CEF are vertical to each other, hence they are equal (I·15)

Create line CF

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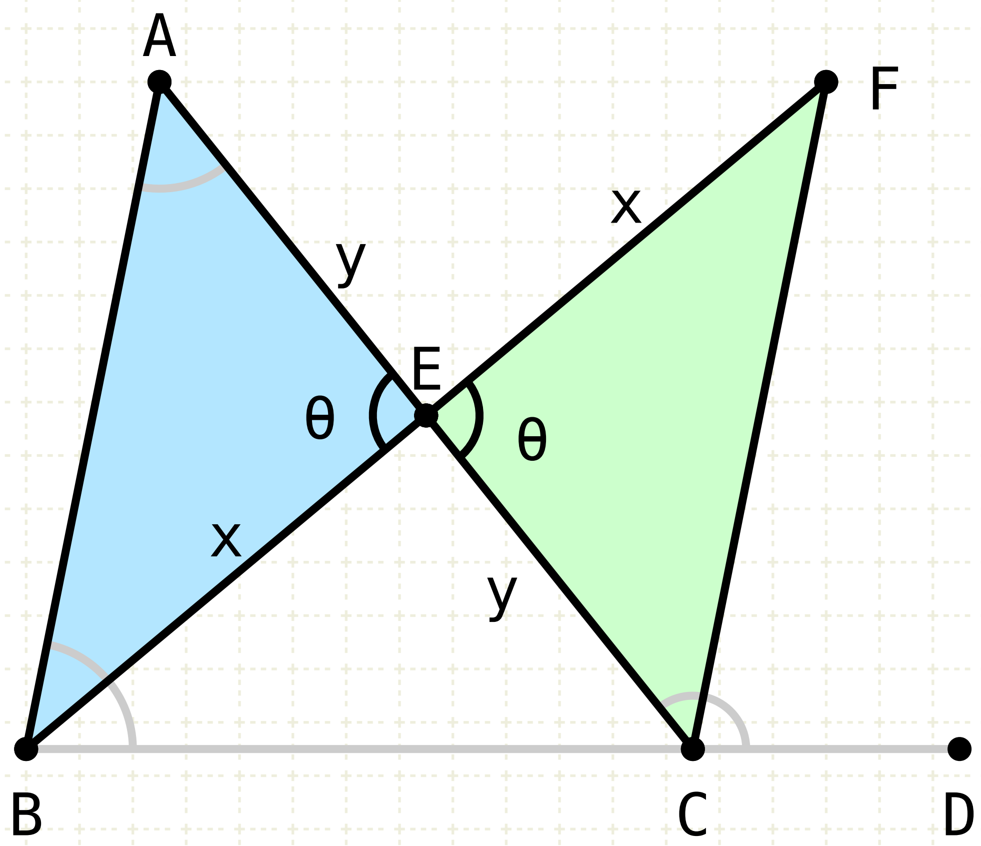

$AE = EC = y$

$BE = EF = x$

$\angle AEB = \angle CEF = \theta$

Proof

Bisect line AC at point E (I·10)

Create line segment BE

Extend line BE to line F, where EF equals BE

Angles AEB and CEF are vertical to each other, hence they are equal (I·15)

Create line CF

Triangles ABE and FEC are equivalent since they have two equal sides, with an equal angle AEB and FEC

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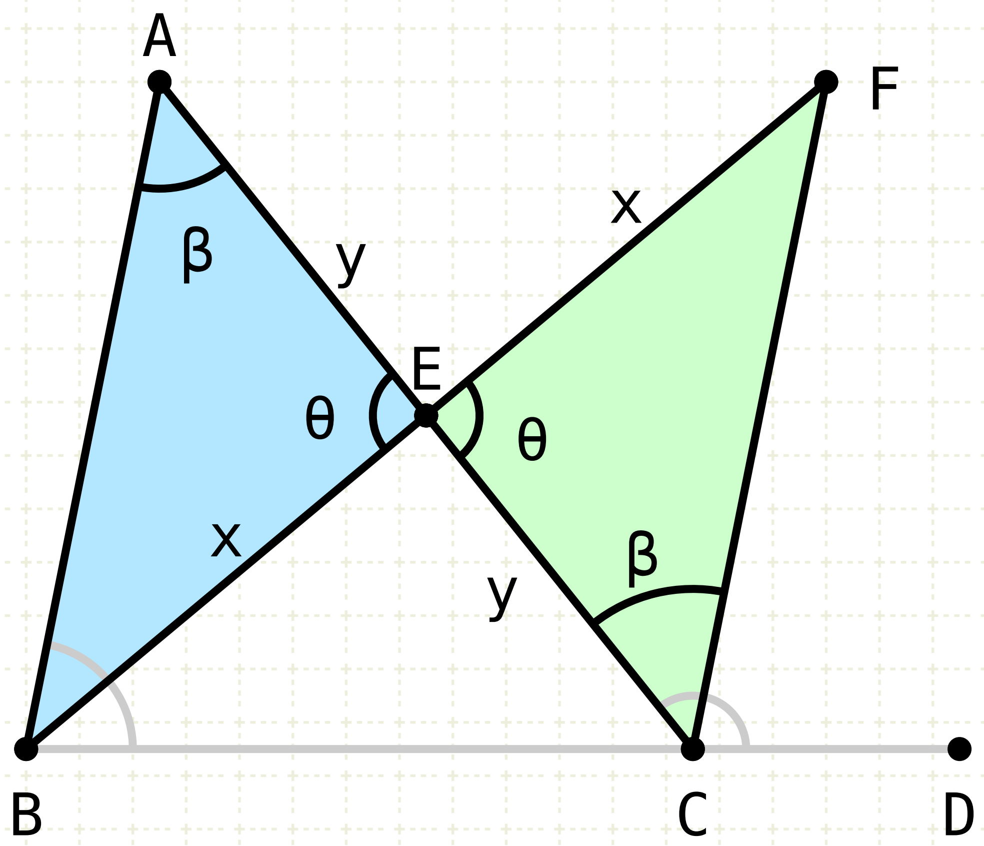

AE = EC = y

BE = EF = x

∠AEB = ∠CEF = θ

∠BAE = ∠ECF = β

Proof

Bisect line AC at point E (I·10)

Create line segment BE

Extend line BE to line F, where EF equals BE

Angles AEB and CEF are vertical to each other, hence they are equal (I·15)

Create line CF

Triangles ABE and FEC are equivalent since they have two equal sides, with an equal angle AEB and FEC

Thus, angles BAE and ECF are equal (I·4)

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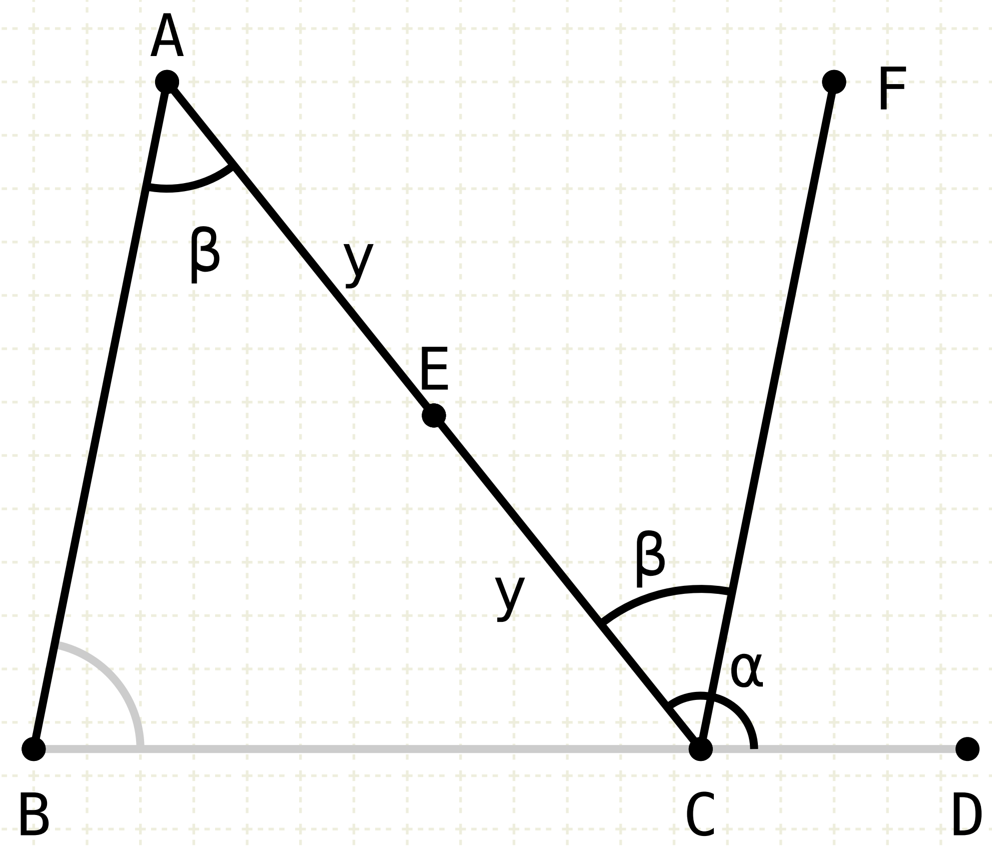

$AE = EC = y$

$BE = EF = x$

$\angle AEB = \angle CEF = \theta$

$\angle BAE = \angle ECF = \beta$

$\angle ECF = \angle BAC < \angle ACD$

$\alpha > \beta$

Proof

Bisect line AC at point E (I·10)

Create line segment BE

Extend line BE to line F, where EF equals BE

Angles AEB and CEF are vertical to each other, hence they are equal (I·15)

Create line CF

Triangles ABE and FEC are equivalent since they have two equal sides, with an equal angle AEB and FEC

Thus, angles BAE and ECF are equal (I·4)

As can be seen angle ECF, which is equals to angle BAC, is less than angle ACD

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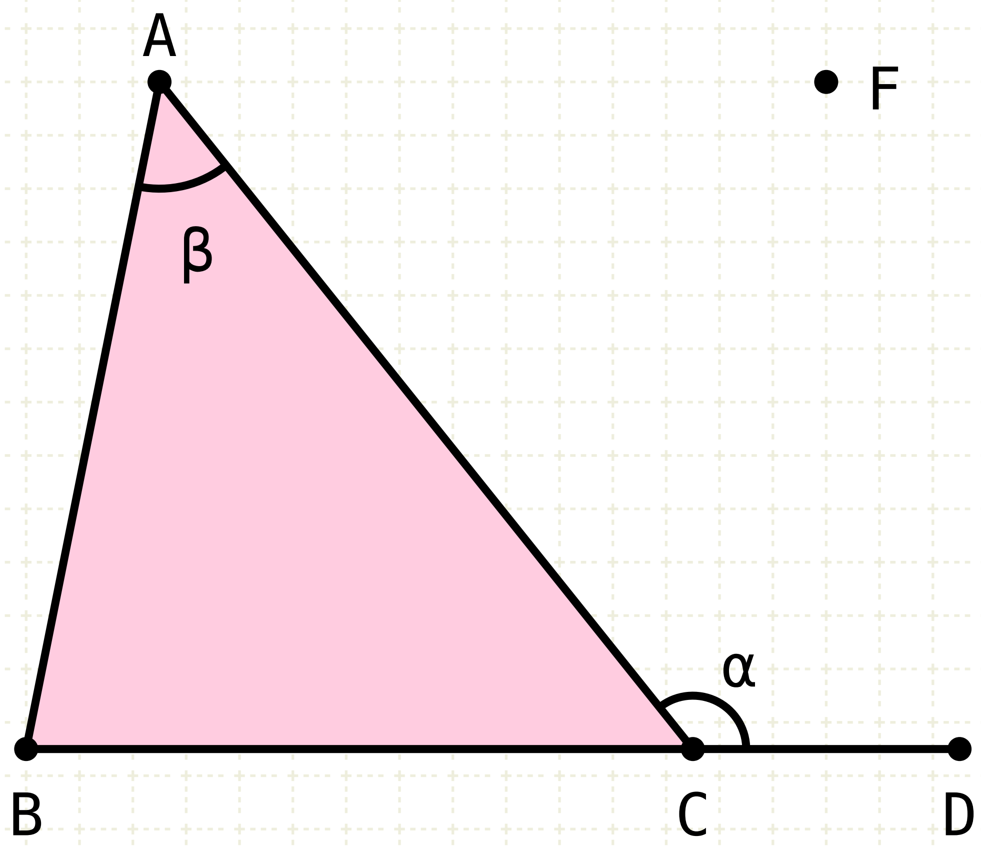

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$\angle BAE = \angle ECF = \beta$

$\angle ECF = \angle BAC < \angle ACD$

$\alpha > \beta$

Proof

Bisect line AC at point E (I·10)

Create line segment BE

Extend line BE to line F, where EF equals BE

Angles AEB and CEF are vertical to each other, hence they are equal (I·15)

Create line CF

Triangles ABE and FEC are equivalent since they have two equal sides, with an equal angle AEB and FEC

Thus, angles BAE and ECF are equal (I·4)

As can be seen angle ECF, which is equals to angle BAC, is less than angle ACD

Thus it has been shown that the exterior angle ACD is larger than the interior angle BAC

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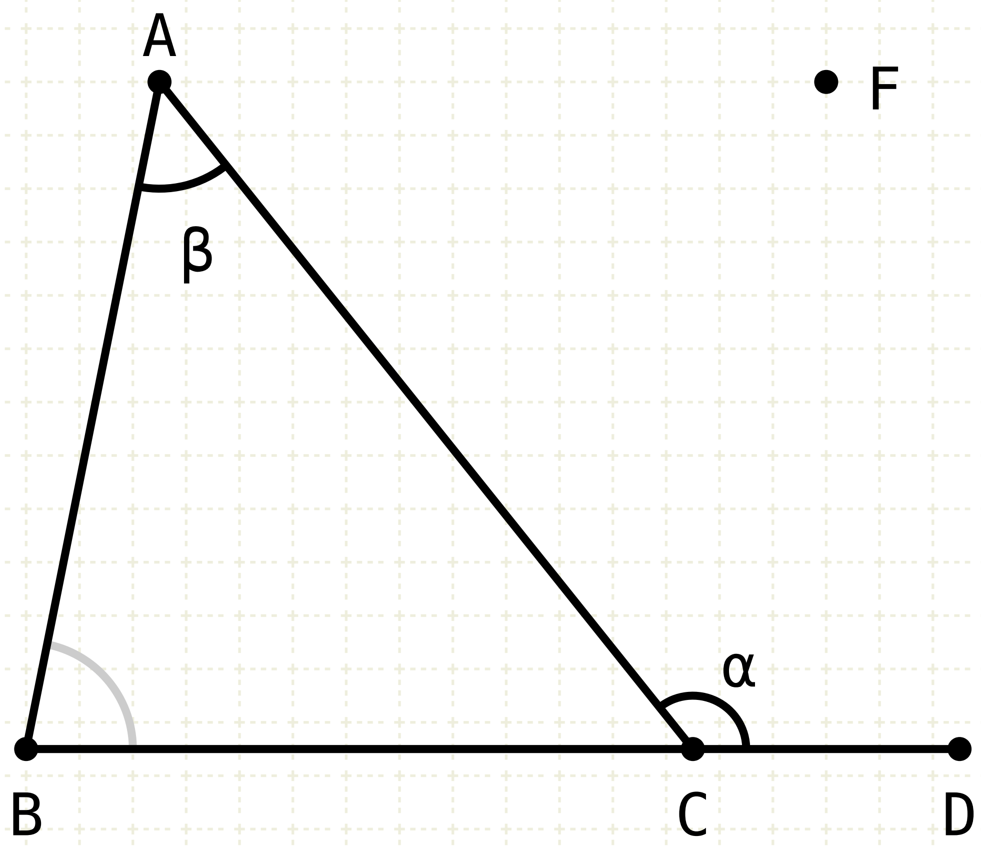

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Proof

Bisect line AC at point E (I·10)

Create line segment BE

Extend line BE to line F, where EF equals BE

Angles AEB and CEF are vertical to each other, hence they are equal (I·15)

Create line CF

Triangles ABE and FEC are equivalent since they have two equal sides, with an equal angle AEB and FEC

Thus, angles BAE and ECF are equal (I·4)

As can be seen angle ECF, which is equals to angle BAC, is less than angle ACD

Thus it has been shown that the exterior angle ACD is larger than the interior angle BAC

Using the same method as before, we can prove that angle BCG is greater than ABC

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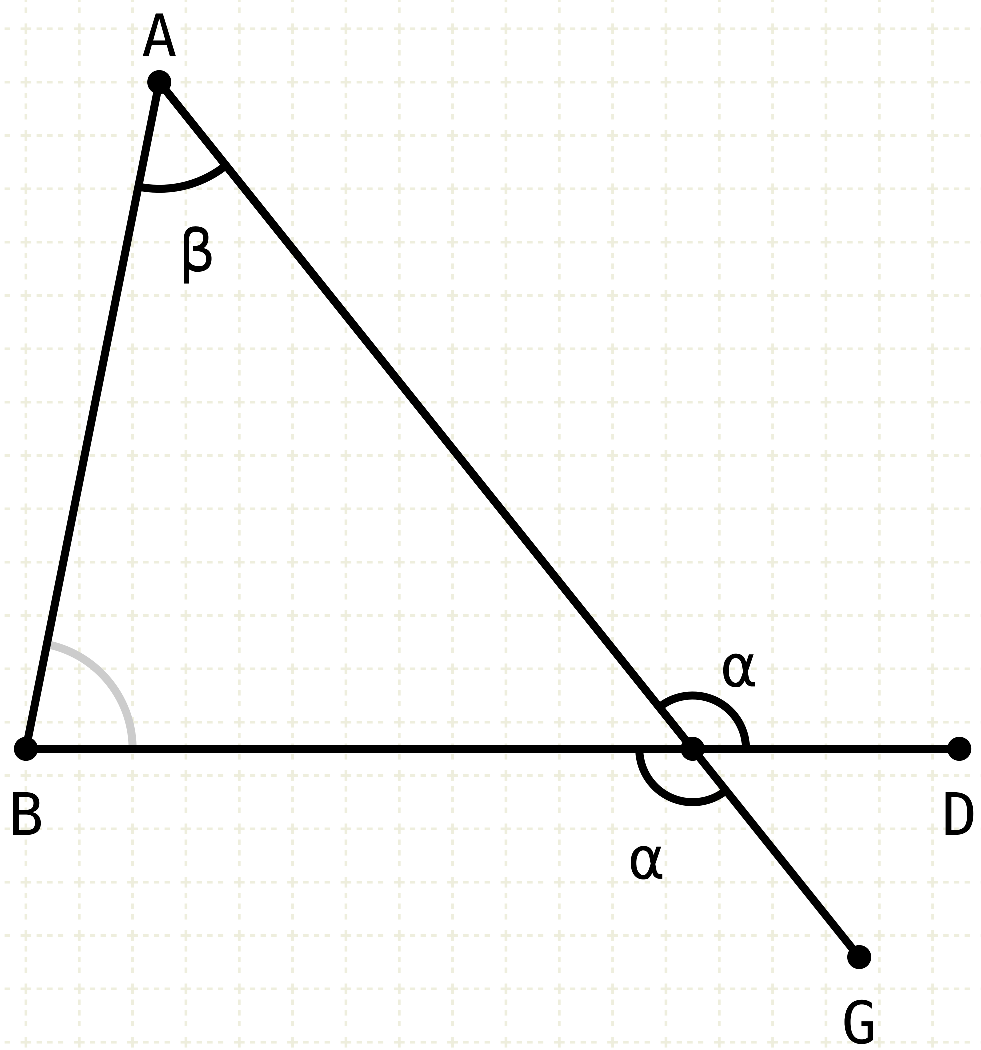
In any triangle, if one of the sides is produced, then the exterior angle is greater than either of the interior and opposite angles.



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$\alpha > \beta$

Proof

Bisect line AC at point E (I·10)

Create line segment BE

Extend line BE to line F, where EF equals BE

Angles AEB and CEF are vertical to each other, hence they are equal (I·15)

Create line CF

Triangles ABE and FEC are equivalent since they have two equal sides, with an equal angle AEB and FEC

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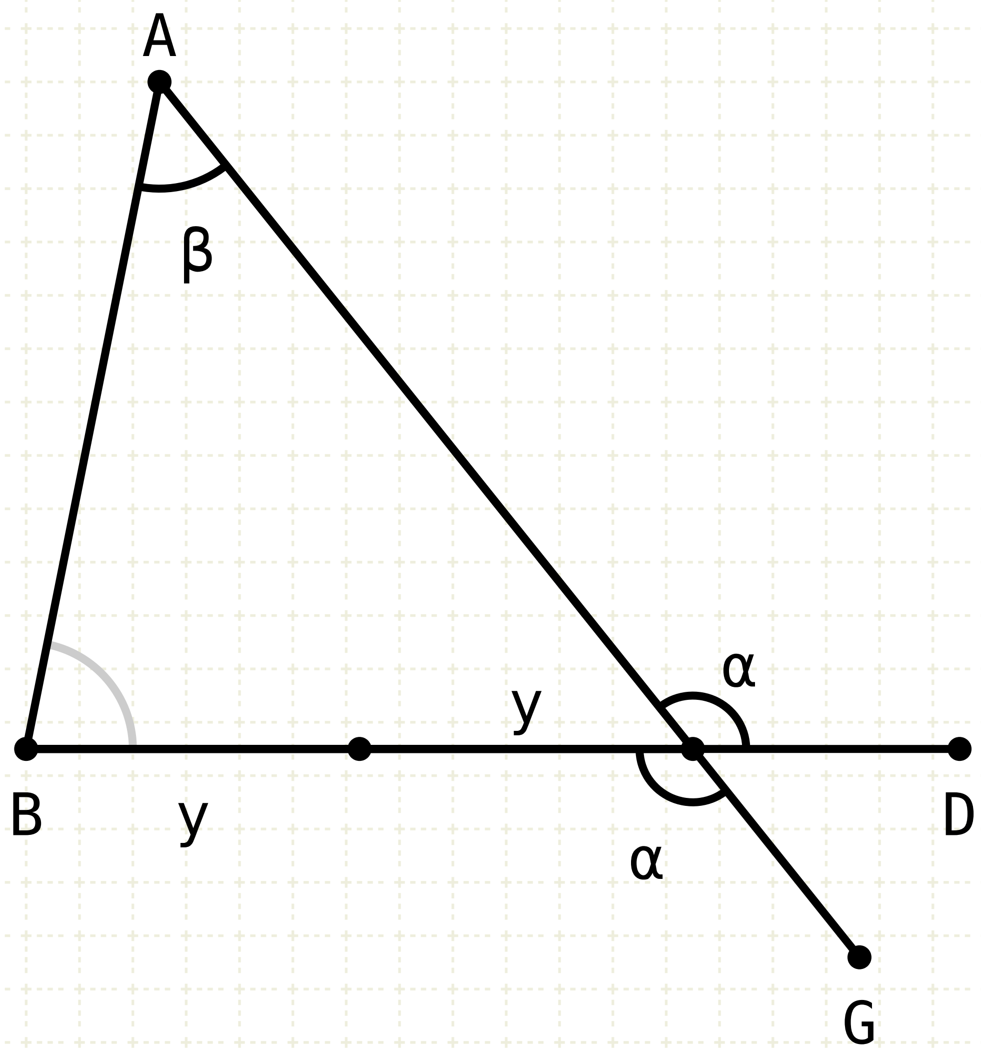

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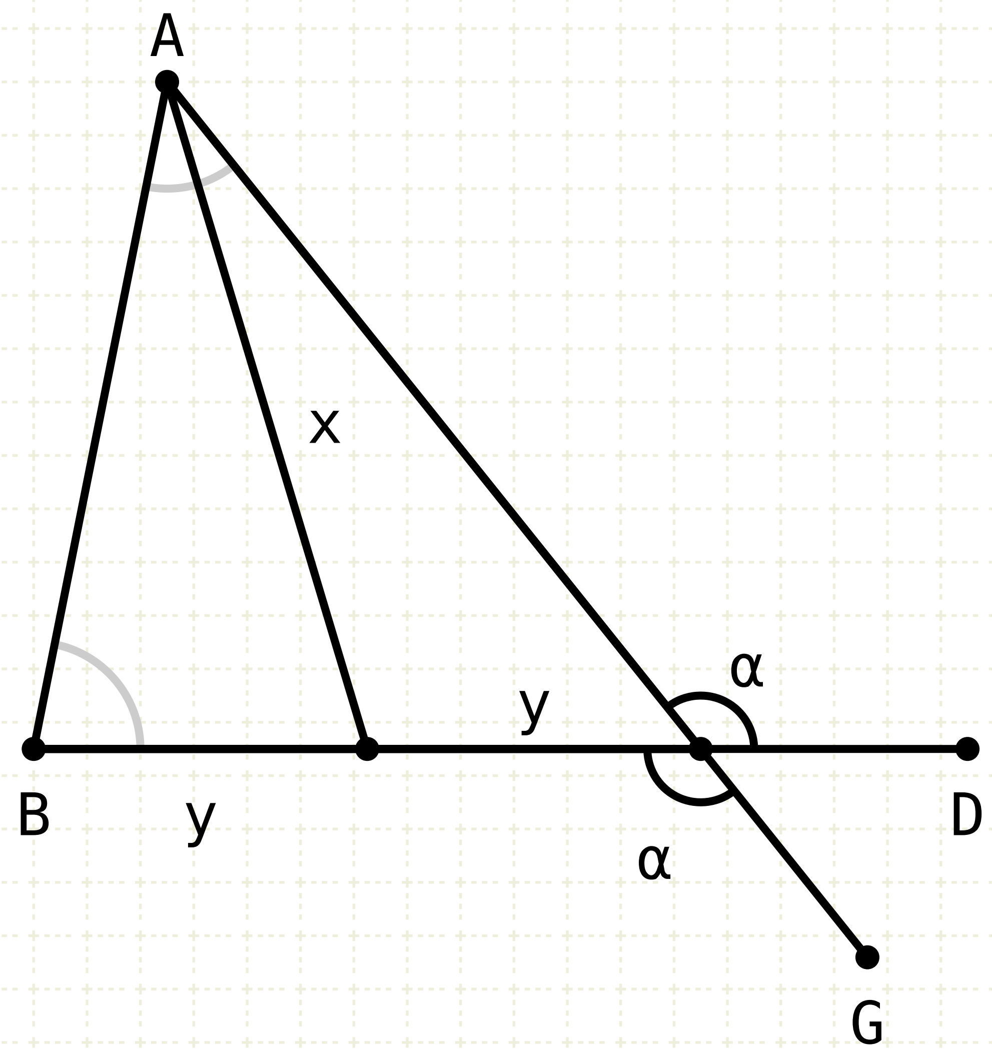

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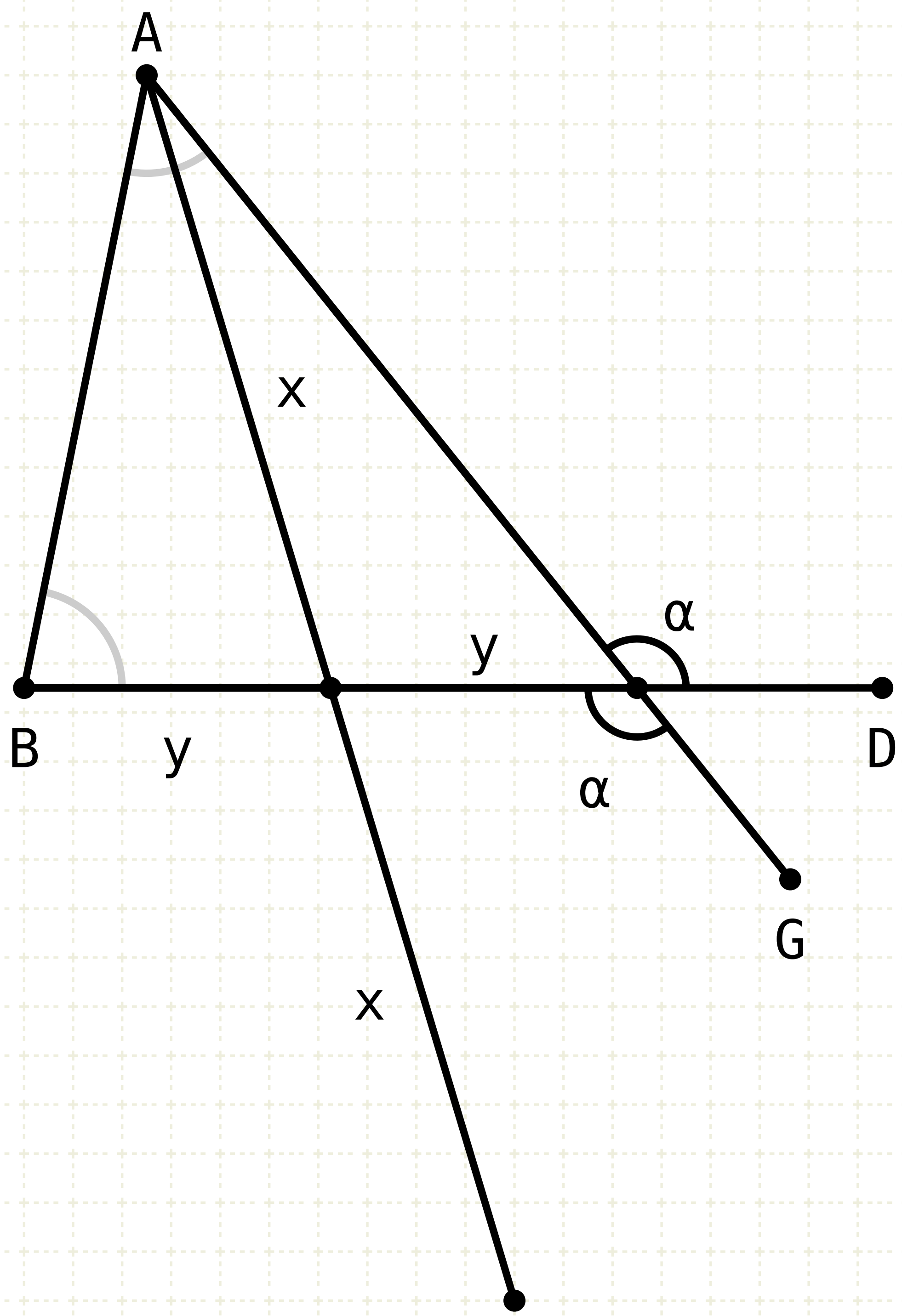

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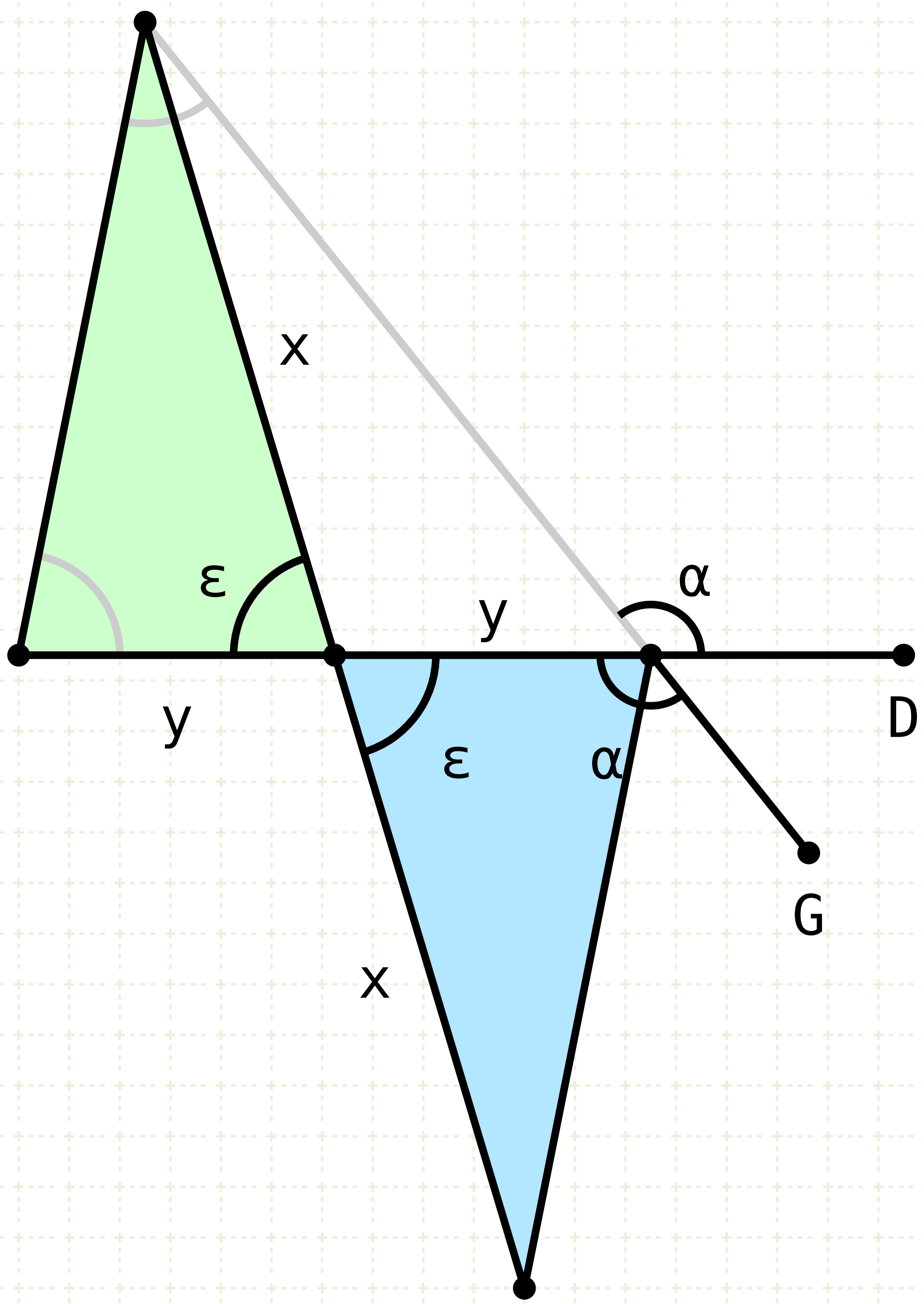

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∠ECF = ∠BAC< ∠ACD

α > β

Proof

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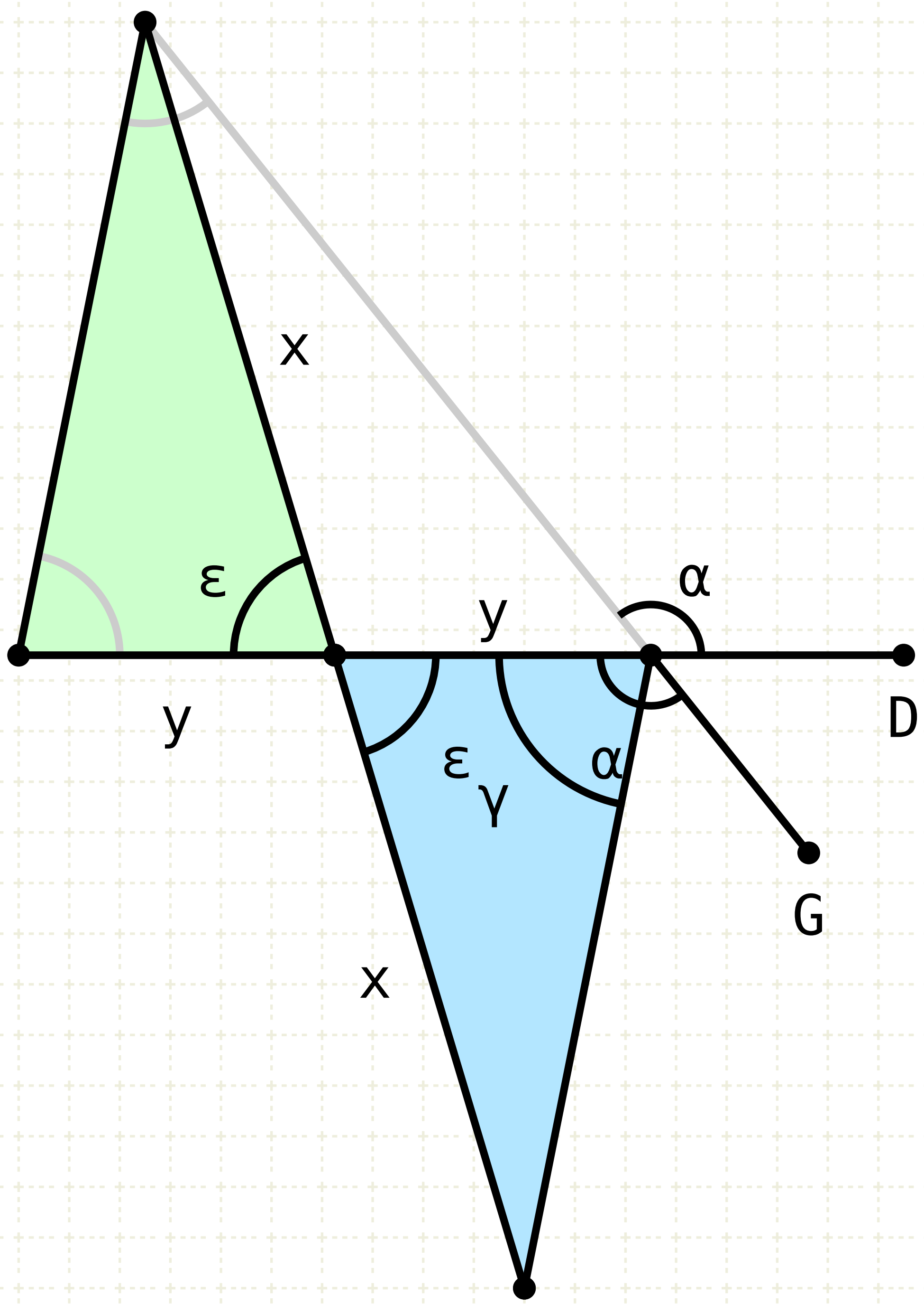

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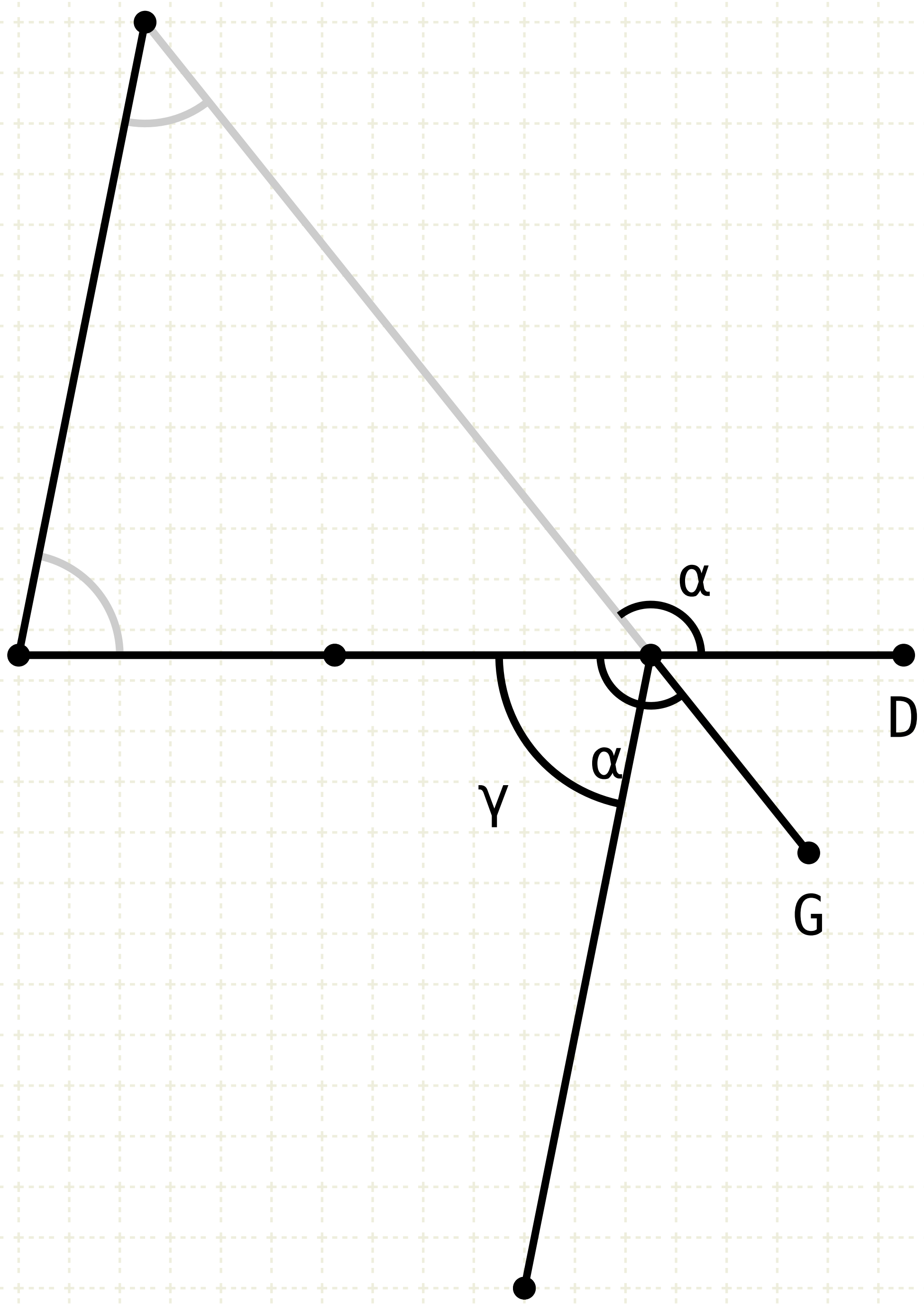

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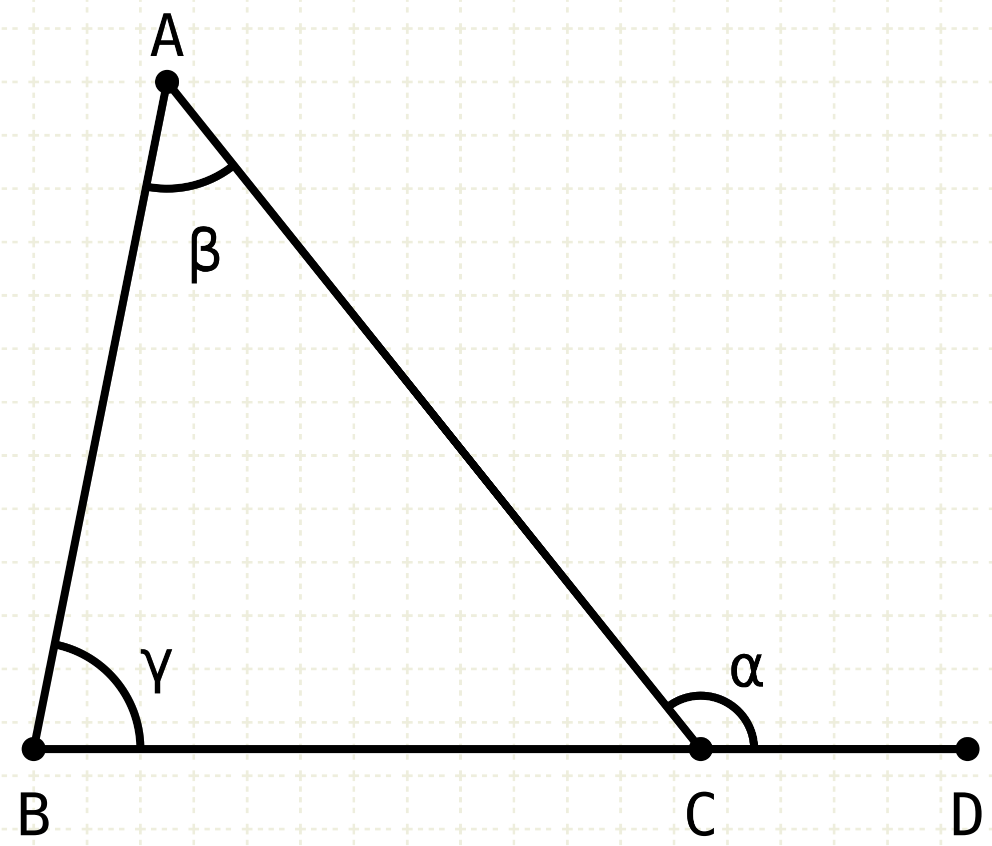

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