Precalculus
Find the area of a triangle from two sides and an angle between them

Todor Milev

2019

Triangle area = $\frac{1}{2}$base · height

Proposition (Triangle area)

$$\color{red}{Area(\triangle ABC) = \textbf{?}}$$

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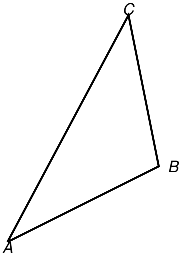

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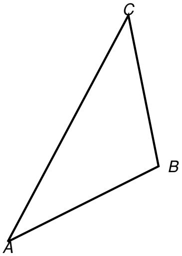

Triangle area = $\frac{1}{2}$base · height

Let $\triangle ABC$ have side length a and height length h_a, as indicated - side a is opposite to vertex A and h_a starts at A

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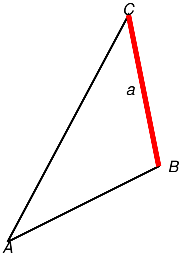
$$Area(\triangle ABC) = \frac{1}{2} height \cdot base = \frac{1}{2} h_a a \quad .$$



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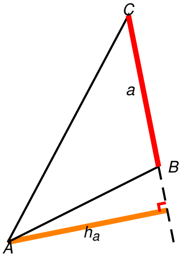

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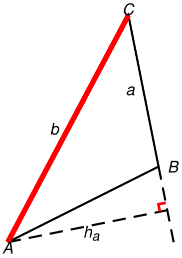

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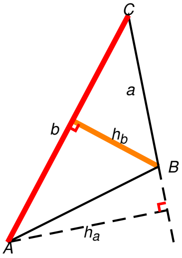

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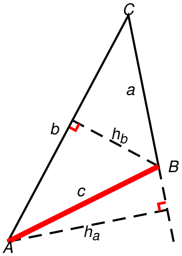

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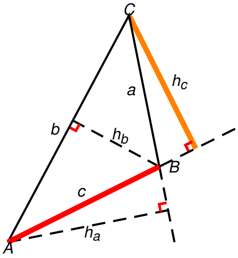


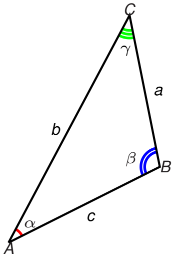
Triangle area from two sides and angle between them

Let $\triangle ABC$ have sides lengths a, b, c angles α, β, γ, as indicated: α is opposite to a, β is opposite to b, γ is opposite to c.

Proposition ($\triangle$ area from two sides and angle between them)

The area of a triangle is half the product of the lengths of two of its sides times the sine of the angle between them. In other words,

$$Area(\triangle ABC) = \frac{ab\sin\gamma}{2} = \frac{bc\sin\alpha}{2} = \frac{ca\sin\beta}{2}$$



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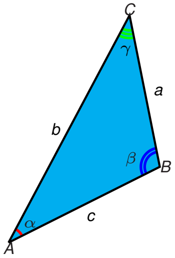

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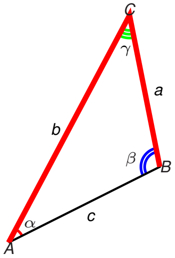

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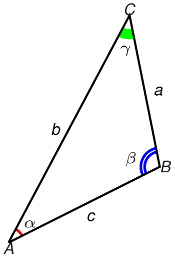

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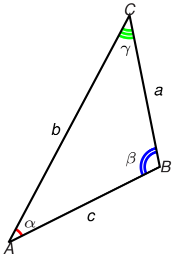

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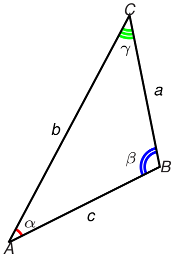

Proof.

$$\text{Area}(\triangle ABC) = \frac{\text{base}\cdot\text{height}}{2}$$

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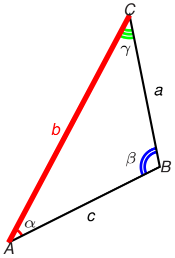

Proof.

$$\text{Area}(\triangle ABC) = \frac{\text{base} \cdot \text{height}}{2} = \frac{bh_b}{2}$$

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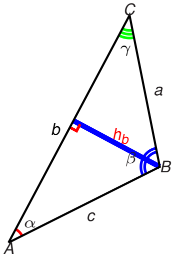

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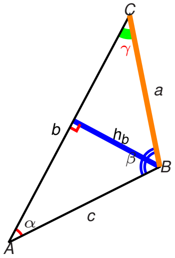

Proof.

$$\begin{aligned} \text{Area}(\triangle ABC) &= \frac{\text{base} \cdot \text{height}}{2} = \frac{b h_b}{2} \\ &= \frac{b a \sin\gamma}{2}. \end{aligned}$$

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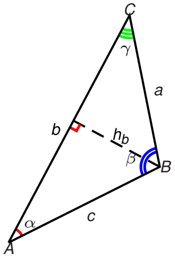

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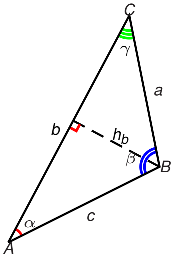

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The proof of the other two cases is similar. □