

# Proof: Trigonometric identities

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## Summary

Explanations as to why certain trigonometric identities are true.

*Before reading this proof sheet, it is recommended that you read [Guide: Trigonometric identities \(degrees\)](#) or [Guide: Trigonometric identities \(radians\)](#).*

## Proof of Pythagorean identities

Remember from [Guide: Trigonometric identities \(degrees\)](#) or [Guide: Trigonometric identities \(radians\)](#) that the **Pythagorean identities** are:

$$\cos^2(\theta) + \sin^2(\theta) = 1$$

$$1 + \tan^2(\theta) = \sec^2(\theta)$$

$$\cot^2(\theta) + 1 = \csc^2(\theta)$$

### **i** Proof of $\sin^2(\theta) + \cos^2(\theta) = 1$

You know from [Guide: Trigonometry \(degrees\)](#) or [Guide: Trigonometry \(radians\)](#) that

$$\sin(\theta) = \frac{\text{opposite}}{\text{hypotenuse}} \quad \text{and} \quad \cos(\theta) = \frac{\text{adjacent}}{\text{hypotenuse}}.$$

You can shorten these to  $O$  for opposite,  $A$  for adjacent and  $H$  for hypotenuse. Rearranging gives  $A = H \cos(\theta)$  and  $O = H \sin(\theta)$ .

From Pythagoras' Theorem, you also know that  $A^2 + O^2 = H^2$ .

Replacing  $A$  and  $O$  with the expressions above, you get

$$(H \cos(\theta))^2 + (H \sin(\theta))^2 = H^2$$

Using the laws of indices (see [Guide: Laws of indices](#)), and using the standard notation  $(\cos(\theta))^2 = \cos^2(\theta)$  and  $(\sin(\theta))^2 = \sin^2(\theta)$  you can write

$$H^2 \cos^2(\theta) + H^2 \sin^2(\theta) = H^2$$

Divide everything by the non-zero  $H^2$  to get:

$$\frac{H^2 \cos^2(\theta)}{H^2} + \frac{H^2 \sin^2(\theta)}{H^2} = \frac{H^2}{H^2}$$

Therefore  $\cos^2(\theta) + \sin^2(\theta) = 1$ .

## Proof of sum identities

## Further reading

[Guide: Trigonometric identities \(degrees\)](#)

[Questions: Trigonometric identities \(degrees\)](#)

## Version history

v1.0: created in 04/24 by tdhc.