# **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

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

You can shorten these to  ${\cal O}$  for opposite,  ${\cal A}$  for adjacent and  ${\cal H}$  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

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

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.