MATHEMATICS · GRADES 10-12

Special angles: 30 degrees, 45 degrees, and 60 degrees

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you work out exact heights and distances, like the height of a roof or the length of a ramp, for the three angles builders and designers meet most often, without reaching for a calculator. Thirty, forty five, and sixty degrees show up again and again in roofs, ramps, and frames, and their values are exact numbers you can know by heart. Knowing them means you can work out the height or length on the spot, with no calculator and no rounding. That exact answer is what a builder needs when a measurement has to be right the first time.



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Worked examples

EXAMPLE 1

Q Find sin 60 degrees from the 30-60-90 triangle.

angle	sin	cos	tan
30°	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{3}}{3}$
45°	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{2}}{2}$	1
60°	**?**	$\frac{1}{2}$	$\sqrt{3}$

SOLUTION

This is a special-angle question, so do not reach for a calculator. The one rule to remember is that the values come from the special triangles, and the 30-60-90 triangle has sides 1, $\sqrt{3}$, and 2.

Take an equilateral triangle with side 2 and cut it in half. The half has a short side 1, a long side, $\sqrt{3}$, and the hypotenuse 2. The angle opposite the long side is 60 degrees.

Sine is opposite over hypotenuse, so sin 60 degrees is $\frac{\sqrt{3}}{2}$.

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EXAMPLE 2

Q Find tan 45 degrees.

SOLUTION

This is a special-angle question, so use the 45-45-90 triangle, whose two equal legs are both 1 and whose hypotenuse is $\sqrt{2}$.

Tangent is opposite over adjacent. For the 45 degree angle, the opposite and the adjacent are the same leg, so tan 45 degrees is $\frac{1}{1}$.

So tan 45 degrees is 1.

Practice questions

1 **What is sin 30 degrees?**

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2 What is cos 30 degrees?

A $\frac{\sqrt{3}}{2}$

B $\frac{1}{2}$

C $\frac{\sqrt{2}}{2}$

D $\frac{\sqrt{3}}{3}$

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3 What is tan 30 degrees?

A $\frac{1}{2}$

B $\frac{\sqrt{3}}{3}$

C $\frac{\sqrt{3}}{2}$

D 1

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4 What is sin 45 degrees?

A $\frac{1}{2}$

B $\frac{\sqrt{2}}{2}$

C $\frac{\sqrt{3}}{2}$

D 1

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5 What is cos 60 degrees?

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6 What is tan 60 degrees?

A 1

B $\frac{\sqrt{3}}{2}$

C $\sqrt{3}$

D 2

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7 Work out sin 30 degrees + cos 60 degrees.

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8 Work out 2 × sin 30 degrees.

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9 Which special angle has its sine equal to its cosine?

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10 Is sin 60 degrees the same as cos 30 degrees?

A. Yes, both are $\frac{\sqrt{3}}{2}$

B. No, sin 60 degrees is $\frac{1}{2}$

C. No, cos 30 degrees is $\frac{1}{2}$

D. Yes, both are $\frac{1}{2}$

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ANSWER KEY

1. $\frac{1}{2}$

2. $\frac{\sqrt{3}}{2}$

3. $\frac{\sqrt{3}}{3}$

4. $\frac{\sqrt{2}}{2}$

5. $\frac{1}{2}$

6. $\sqrt{3}$

7. 1

8. 1

9. 45

10. Yes, both are $\frac{\sqrt{3}}{2}$

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