MATHEMATICS · GRADES 10-12

Rationalizing denominators

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you tidy a fraction so its bottom is a plain number, like giving a measurement as a clean length a builder can actually mark on a board. A fraction with a square root on the bottom is hard to use, since no ruler is marked in square roots. A carpenter needs a plain number they can measure, and a clean denominator gives them one. It is a small tidy up that turns a correct but awkward answer into one someone can actually use.



Rule

To rationalize a denominator, multiply the top and bottom by the same thing so the bottom becomes a whole number.

For a single square root, multiply by that root. For a sum or difference with a root, multiply by its conjugate, the same expression with the sign flipped.

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Worked examples

EXAMPLE 1

Q What is $\frac{1}{\sqrt{3}}$ written with a rational denominator?

SOLUTION

Multiply the top and bottom by $\sqrt{3}$: $\frac{(1 \times \sqrt{3})}{(\sqrt{3} \times \sqrt{3})}$.

Simplify the bottom: $\sqrt{3} \times \sqrt{3} = 3$.

Write the result: $\frac{\sqrt{3}}{3}$

EXAMPLE 2

Q What is $\frac{1}{(\sqrt{3} + 1)}$ written with a rational denominator?

SOLUTION

Multiply the top and bottom by the conjugate, $\sqrt{3} - 1$.

Simplify the bottom as a difference of squares: $3 - 1 = 2$.

Write the result: $\frac{(\sqrt{3} - 1)}{2}$

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Practice questions

1 $\frac{1}{\sqrt{2}}$. Write it with a rational denominator.

- **A** $\frac{\sqrt{2}}{2}$
- **B** $\frac{2}{\sqrt{2}}$
- **C** $\sqrt{2}$
- **D** $\frac{\sqrt{2}}{4}$

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2 Write $\frac{1}{\sqrt{8}}$ with a rational denominator, in simplest form.

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

B $\frac{\sqrt{8}}{8}$

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

D $\frac{\sqrt{8}}{4}$

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3 Write $\frac{\sqrt{5}}{\sqrt{3}}$ with a rational denominator.

A $\frac{\sqrt{15}}{3}$

B $\frac{\sqrt{5}}{3}$

C $\frac{\sqrt{15}}{5}$

D $\frac{\sqrt{8}}{3}$

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4 Write $\frac{2}{3\sqrt{2}}$ with a rational denominator, in simplest form.

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

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

C $\frac{\sqrt{2}}{6}$

D $\frac{2\sqrt{2}}{6}$

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5 Write $\frac{1}{(\sqrt{5}+2)}$ with a rational denominator.

A $\sqrt{5}-2$

B $\sqrt{5}+2$

C $\frac{\sqrt{5}-2}{2}$

D $\sqrt{5}-1$

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6 Write $\frac{3}{\sqrt{2}+1}$ with a rational denominator.

A $3\sqrt{2}-3$

B $\sqrt{2}-1$

C $3\sqrt{2}+3$

D $\frac{\sqrt{2}-1}{3}$

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7 Write $\frac{1}{\sqrt{6}+\sqrt{2}}$ with a rational denominator.

A $\frac{\sqrt{6}-\sqrt{2}}{4}$

B $\sqrt{6}-\sqrt{2}$

C $\frac{\sqrt{6}+\sqrt{2}}{4}$

D $\frac{\sqrt{6}-\sqrt{2}}{2}$

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8 What is the conjugate of $\sqrt{7} - 3$?

A $\sqrt{7} + 3$

B $-\sqrt{7} + 3$

C $\sqrt{7} - 3$

D $7 - 3$

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9 A garden bed has area $2\sqrt{3}$ m² and length $\sqrt{3}$ m. Divide and rationalize to find its width.

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10 **Which expression already has a rational denominator?**

A $\frac{1}{\sqrt{2}}$

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

C $\frac{2}{\sqrt{5}+1}$

D $\frac{5}{\sqrt{7}}$

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ANSWER KEY

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

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

3. $\frac{\sqrt{15}}{3}$

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

5. $\sqrt{5} - 2$

6. $3\sqrt{2} - 3$

7. $\frac{\sqrt{6} - \sqrt{2}}{4}$

8. $\sqrt{7} + 3$

9. 2

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

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