

Simplifying surds

A LEVEL LINKS

Scheme of work: 1a. Algebraic expressions – basic algebraic manipulation, indices and surds

Key points

- A surd is the square root of a number that is not a square number, for example $\sqrt{2}$, $\sqrt{3}$, $\sqrt{5}$, etc.
- Surds can be used to give the exact value for an answer.
- $\sqrt{ab} = \sqrt{a} \times \sqrt{b}$
- $\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$
- To rationalise the denominator means to remove the surd from the denominator of a fraction.
- To rationalise $\frac{a}{\sqrt{b}}$ you multiply the numerator and denominator by the surd \sqrt{b}
- To rationalise $\frac{a}{b + \sqrt{c}}$ you multiply the numerator and denominator by $b - \sqrt{c}$

Examples

Example 1 Simplify $\sqrt{50}$

$\begin{aligned}\sqrt{50} &= \sqrt{25 \times 2} \\ &= \sqrt{25} \times \sqrt{2} \\ &= 5 \times \sqrt{2} \\ &= 5\sqrt{2}\end{aligned}$	<ol style="list-style-type: none"> 1 Choose two numbers that are factors of 50. One of the factors must be a square number 2 Use the rule $\sqrt{ab} = \sqrt{a} \times \sqrt{b}$ 3 Use $\sqrt{25} = 5$
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Example 2 Simplify $\sqrt{147} - 2\sqrt{12}$

$\begin{aligned}\sqrt{147} - 2\sqrt{12} \\ &= \sqrt{49 \times 3} - 2\sqrt{4 \times 3} \\ \\ &= \sqrt{49} \times \sqrt{3} - 2\sqrt{4} \times \sqrt{3} \\ &= 7 \times \sqrt{3} - 2 \times 2 \times \sqrt{3} \\ &= 7\sqrt{3} - 4\sqrt{3} \\ &= 3\sqrt{3}\end{aligned}$	<ol style="list-style-type: none"> 1 Simplify $\sqrt{147}$ and $2\sqrt{12}$. Choose two numbers that are factors of 147 and two numbers that are factors of 12. One of each pair of factors must be a square number 2 Use the rule $\sqrt{ab} = \sqrt{a} \times \sqrt{b}$ 3 Use $\sqrt{49} = 7$ and $\sqrt{4} = 2$ 4 Collect like terms
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Practice questions

1 Simplify.

a $\sqrt{45}$

c $\sqrt{48}$

e $\sqrt{300}$

g $\sqrt{72}$

b $\sqrt{125}$

d $\sqrt{175}$

f $\sqrt{28}$

h $\sqrt{162}$

Hint

One of the two numbers you choose at the start must be a square number.

2 Simplify.

a $\sqrt{72} + \sqrt{162}$

c $\sqrt{50} - \sqrt{8}$

e $2\sqrt{28} + \sqrt{28}$

b $\sqrt{45} - 2\sqrt{5}$

d $\sqrt{75} - \sqrt{48}$

f $2\sqrt{12} - \sqrt{12} + \sqrt{27}$

Watch out!

Check you have chosen the highest square number at the start.

Answers

1 a $3\sqrt{5}$

c $4\sqrt{3}$

e $10\sqrt{3}$

g $6\sqrt{2}$

b $5\sqrt{5}$

d $5\sqrt{7}$

f $2\sqrt{7}$

h $9\sqrt{2}$

2 a $15\sqrt{2}$

c $3\sqrt{2}$

b $\sqrt{5}$

d $\sqrt{3}$

e $6\sqrt{7}$

f $5\sqrt{3}$