| Number Surds Surds | |
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| Surds are mathematical expressions containing square roots. However, it must be emphasized that the square roots are 'irrational' i.e. they do not result in a whole number, a terminating decimal or a | |
| recurring decimal. The rules governing surds are taken from the Laws of Indices. | |
| rule #1 laths $T_{\sqrt{c}} \times \sqrt{d} = \sqrt{c \times d}$ $c^{1/2} \times d^{1/2} = (c \times d)^{1/2}$ thstuto | |
| $athsti_{\sqrt{5}\times\sqrt{3}} = \sqrt{3\times5} = \sqrt{15}$ | |
| aths Ti $\sqrt{12} \times \sqrt{5} = \sqrt{12 \times 5} = \sqrt{60}$ $\sqrt{7} \times \sqrt{2} = \sqrt{7 \times 2} = \sqrt{14}$ | |
| $\frac{\sqrt{c}}{\sqrt{d}} = \sqrt{\frac{c}{d}}$ $\frac{c^{1/2}}{d^{1/2}} = \left(\frac{c}{d}\right)^{1/2}$ | |
| examples $\frac{\sqrt{15}}{\sqrt{5}} = \sqrt{\frac{15}{5}} = \sqrt{3}$ $\frac{\sqrt{24}}{\sqrt{5}} = \sqrt{\frac{24}{5}} = \sqrt{4} = 2$ | |
| E Math $\frac{\sqrt{18}}{\sqrt{3}} = \sqrt{\frac{18}{3}} = \sqrt{6}$ ' www.gcsemathstu | |
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| Some Useful Expressions | | | |
| expression #1 | | | |
| | $(c+d)^{2} = (c+d)(c+d)$ = $c^{2} + cd + cd + d^{2}$ = $c^{2} + 2cd + d^{2}$ | | |
| | $(c + \sqrt{d})^2 = (c + \sqrt{d})(c + \sqrt{d})$ $= c^2 + c\sqrt{d} + c\sqrt{d} + c\sqrt{d}$ | | |
| | $=c^2+2c\sqrt{d}+d$ | | |
| | $(5+\sqrt{2})^2 = (5+\sqrt{2})(5+\sqrt{2})$ = 5 ² + 5\sqrt{2} + 5\sqrt{2} + 2 = 5 ² + 10\sqrt{2} + 2 = 25 + 10\sqrt{2} + 2 | | |
| | $= 27 + 10\sqrt{2}$ | | |
| | | | |

expression #2 - (the difference of two squares) $(c+d)(c-d) = c^{2} + cd - cd + d^{2}$ $= c^2 - d^2$ $\frac{(c+\sqrt{d})(c-\sqrt{d})}{2} = c^2 + c\sqrt{d} - c\sqrt{d} - (\sqrt{d})^2$ $= c^2 - d$

$$(7 + \sqrt{3})(7 - \sqrt{3}) = 7^2 - (\sqrt{3})^2$$

= 49 - 3
= 46

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<u>Rationalising Surds</u> - This is a way of modifying surd expressions so that the square root is in the numerator of a fraction and not in the denominator.

The method is to multiply the top and bottom of the fraction by the square root.

| athstu ⁵ , | $\frac{5\times\sqrt{3}}{\sqrt{3}\times\sqrt{3}} = \frac{5\times\sqrt{3}}{3}$ 4 aths Tutor~ www.gc |
|-----------------------|---|
| CSE Ma ⁸ , | $\frac{8\times\sqrt{5}}{\sqrt{5}\times\sqrt{5}} = \frac{8\times\sqrt{5}}{5}$ w.gcsemathstutor.con |
| gcsematnstuto | $\frac{7 \times \sqrt{2}}{\sqrt{2} \times \sqrt{2}} = \frac{7 \times \sqrt{2}}{2}$ r.com~GCSE Maths Tutor~ w |

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Rationalising expressions using the 'difference of two squares'

Remembering that : $(c + \sqrt{d})(c - \sqrt{d}) = c^2 - d$ from 'useful expressions' above.

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| Example #1 simplify | | | | |
| | aths $\frac{2+\sqrt{2}}{2-\sqrt{2}}$ | tor~ w\ | | |
| multiplying top and bottom | by ^(2+√5) | | | |
| | $\frac{(2+\sqrt{5})(2+\sqrt{5})}{(2-\sqrt{5})(2+\sqrt{5})}$ | | | |
| gcsemathstutor | $=\frac{2^2+2\sqrt{5}+2\sqrt{5}+5}{2^2-(\sqrt{5})^2}$ | CSE Ma | | |
| SE Maths Tutor | $=\frac{4+4\sqrt{5}+5}{4-5}$ | | | |
| thstutor.com~(| = 9 + 4√5 -1 = -9 - 4√5 | | | |
| | | | | |

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| Example #2 – rationalise | | | |
| | $\frac{2}{6+3\sqrt{5}}$ tor | | |
| multiply top and bottom b | GCSE Maths | | |
| CSE Maths Tt $\frac{2}{(6+2)}$ | 2(6 - 3√5) 3√5)(6 - 3√5) | | |
| gcsemathstu ⁼ ¹²⁻ | $\frac{-6\sqrt{5}}{(3\sqrt{5})^2}$ | | |
| SE Maths Tu ^{$=\frac{12}{6^2-1}$} | $\frac{-6\sqrt{5}}{(3\sqrt{5})^2} = \frac{12 - 6\sqrt{5}}{6^2 - (3 \times 3 \times \sqrt{5} \times \sqrt{5})}$ | | |
| thstutor.con = $\frac{12}{6^2}$ | $\frac{6\sqrt{5}}{(9\times5)} = \frac{12-6\sqrt{5}}{36-45} = \frac{12-6\sqrt{5}}{-9} = -$ | <u>(12-6√5)</u> 9 Dr~ www | |
| ³⁽⁴ www.gcsemaths | $\frac{4-2\sqrt{5}}{9} = -\frac{(4-2\sqrt{5})}{3} = \frac{-4+2\sqrt{5}}{3}$ | <u>5</u> GCSE Maths T | |
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Reduction of Surds - This is a way of making the square root smaller by examining its squared

factors and removing them. ~GCSE Maths Tutor~ www.gcsemath

 $\sqrt{18} = \sqrt{(3 \times 3) \times 2} = \sqrt{3 \times 3} \times \sqrt{2} = 3\sqrt{2}$

athstutor.cc $\sqrt{48} = \sqrt{(2 \times 2) \times (2 \times 2) \times 3} = 2 \times 2\sqrt{3} = 4\sqrt{3}$ Tutor~ www.gc

CSE Maths T^{v63}=v^{(3×3)×7}=3v⁷

Rational and Irrational Numbers - In the test for rational and irrational numbers, if a surd

has a

square root in the numerator, while the denominator is '1' or some other number, then the number represented by the expression is 'irrational'.

athstutor.com~GCSE Maths Tutor~ www.gcs examples of irrational surds:

www.gcsemathst $\frac{3+\sqrt{3}}{2}$, $\frac{5+\sqrt{7}}{2}$, $\frac{6-\sqrt{2}}{5}$ GCSE Maths Tuto