**Surds and rationalising the denominator**

**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  etc.
* Surds can be used to give the exact value for an answer.
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* To rationalise the denominator means to remove the surd from the denominator of a fraction.
* To rationalise you multiply the numerator and denominator by the surd 
* To rationalise  you multiply the numerator and denominator by 

Examples

**Example 1** Simplify 

|  |  |
| --- | --- |
|  | **1** Choose two numbers that are factors of 50. One of the factors must be a square number  **2** Use the rule  **3** Use |

**Example 2** Simplify 

|  |  |
| --- | --- |
|  | **1** Simplify  and . 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  **3** Use  and  **4** Collect like terms |

**Example 3** Simplify 

|  |  |
| --- | --- |
| =  = 7 – 2  = 5 | **1** Expand the brackets. A common mistake here is to write  **2** Collect like terms: |

**Example 4** Rationalise 

|  |  |
| --- | --- |
| =  =  = | **1** Multiply the numerator and denominator by  **2** Use |

**Example 5** Rationalise and simplify 

|  |  |
| --- | --- |
| =  =  =  = | **1** Multiply the numerator and denominator by  **2** Simplify  in the numerator. Choose two numbers that are factors of 12. One of the factors must be a square number  **3** Use the rule  **4** Use  **5** Simplify the fraction:  simplifies to |

**Example 6** Rationalise and simplify 

|  |  |
| --- | --- |
| =  =  =  =  = | **1** Multiply the numerator and denominator by  **2** Expand the brackets  **3** Simplify the fraction  **4** Divide the numerator by −1  Remember to change the sign of all terms when dividing by −1 |

Practice

**1** Simplify.

**Hint**

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

**a**  **b** 

**c**  **d** 

**e**  **f** 

**g**  **h** 

**2** Simplify.

**Watch out!**

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

**a**  **b** 

**c**  **d** 

**e  f** 

**3** Expand and simplify.

**a**  **b** 

**c**  **d** 

**4** Rationalise and simplify, if possible.

**a**  **b** 

**c**  **d** 

**e**  **f** 

**g**  **h** 

**5** Rationalise and simplify.

**a**  **b**  **c** 

# **Extend**

**6** Expand and simplify 

**7** Rationalise and simplify, if possible.

**a**  **b** 

Answers

**1 a**  **b** 

**c**  **d** 

**e**  **f** 

**g**  **h** 

**2 a**  **b** 

**c**  **d** 

**e**  **f** 

**3 a** −1 **b** 

**c**  **d** 

**4 a**  **b** 

**c**  **d** 

**e**  **f** 

**g**  **h** 

**5 a**  **b**  **c** 

**6** *x* − *y*

**7 a**  **b** 