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Expanding brackets and 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 $b-\sqrt{c}$

Example 1 Simplify $\left(\sqrt{7}+\sqrt{2}\right)\left(\sqrt{7}-\sqrt{2}\right)$

$\left(\sqrt{7}+\sqrt{2}\right)\left(\sqrt{7}-\sqrt{2}\right)$ $= \sqrt{49} - \sqrt{7}\sqrt{2} + \sqrt{2}\sqrt{7} - \sqrt{4}$ $= 7 - 2$ $= 5$	**1** Expand the brackets. A common mistake here is to write $\left(\sqrt{7}\right)^2 = 49$ **2** Collect like terms: $-\sqrt{7}\sqrt{2} + \sqrt{2}\sqrt{7}$ $= -\sqrt{7}\sqrt{2} + \sqrt{7}\sqrt{2} = 0$

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Practice questions

1 Expand and simplify.

a $(\sqrt{2}+\sqrt{3})(\sqrt{2}-\sqrt{3})$

b $(3+\sqrt{3})(5-\sqrt{12})$

c $(4-\sqrt{5})(\sqrt{45}+2)$

d $(5+\sqrt{2})(6-\sqrt{8})$

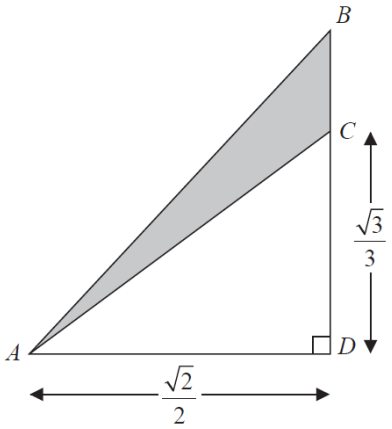
2 Expand and simplify $\left(\sqrt{x}+\sqrt{y}\right)\left(\sqrt{x}-\sqrt{y}\right)$

3 Work out the value of $\left(\sqrt{2}+\sqrt{8}\right)^2$

4 Expand $(1+\sqrt{2})(3-\sqrt{2})$

Give your answer in the form $a+b\sqrt{2}$ where a and b are integers.

5 ABD is a right angled triangle.



All measurements are given in centimetres.

C is the point on BD such that $CD = \dfrac{\sqrt{3}}{3}$

$AD = BD = \dfrac{\sqrt{2}}{2}$

Work out the exact area, in cm^2, of the shaded region.

6 The diagram shows a triangle *DEF* inside a rectangle *ABCD*.

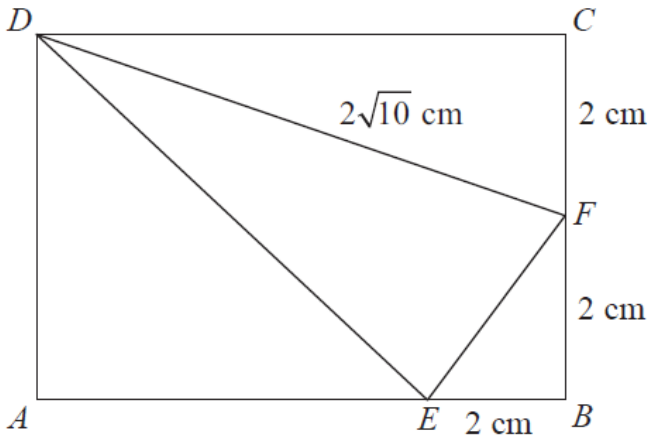


Diagram **NOT** accurately drawn

Show that the area of triangle *DEF* is 8 cm^2.
You must show all your working.

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7 The diagram shows a triangle *DEF* inside a rectangle *ABCD*.

$a = \sqrt{8} + 2$

$b = \sqrt{8} - 2$

$T = a^2 - b^2$

Work out the value of T.

Give your answer in the form $c\sqrt{2}$ where c is an integer.

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Answers

1 **a** -1 **b** $9-\sqrt{3}$

c $10\sqrt{5}-7$ **d** $26-4\sqrt{2}$

2 $x-y$

3 18

4 $1+2\sqrt{2}$

5 $\frac{1}{4}-\frac{\sqrt{6}}{12}$

Method:

$\frac{1}{2}\times\frac{\sqrt{2}}{2}\times\frac{\sqrt{2}}{2}$ or $\frac{1}{2}\times\frac{\sqrt{2}}{2}\times\frac{\sqrt{3}}{3}$

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

$\frac{1}{4}-\frac{\sqrt{6}}{12}$ oe

OR

(BC =) $\frac{\sqrt{2}}{2}-\frac{\sqrt{3}}{3}$

$\frac{1}{2}\times\left\{\frac{\sqrt{2}}{2}-\frac{\sqrt{3}}{3}\right\}\times\frac{\sqrt{2}}{2}$

$\frac{1}{4}-\frac{\sqrt{6}}{12}$ oe

6 8

Method:

$(2\sqrt{10})^2-2^2$ (= 36)

(*CD* =) 6

'6' × 4 – $\frac{1}{2}$ × '6' × 2 – $\frac{1}{2}$ × 2 × 2 – $\frac{1}{2}$ × ('6' – 2) × 4

7 $16\sqrt{2}$