

Exercise walk-through

E1.18

Surds

IGCSE Mathematics

You must be able to

- simplify a surd by taking out the largest square factor
- add, subtract and multiply surds, leaving the answer in exact form
- rationalise a denominator of the form $\sqrt{a}$

1

The method

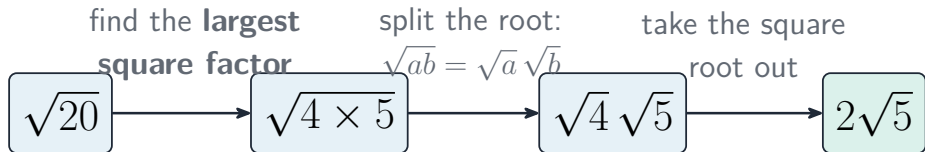
Method — Pull out the largest square factor, then collect like surds

- **Simplify:** $\sqrt{50} = \sqrt{25 \times 2} = 5\sqrt{2}$. Take the **largest** square factor, or you will have to simplify twice.
- **Add and subtract:** only **like** surds combine. $\sqrt{12} + \sqrt{27} = 2\sqrt{3} + 3\sqrt{3} = 5\sqrt{3}$.
- **Multiply:** $(\sqrt{5})^2 = 5$, and $(2 + \sqrt{3})(2 - \sqrt{3}) = 4 - 3 = 1$ — the surd disappears.
- **Rationalise:** multiply top and bottom by the surd. $\frac{6}{\sqrt{3}} = \frac{6\sqrt{3}}{3} = 2\sqrt{3}$.

Answer shapes (marked by **method marks** — M1 for a correct method, A1 for the correct answer): the line splitting the root into a square factor times the rest is the method mark. A decimal answer earns nothing — surd questions want **exact** form.

Method — Pull out the largest square factor, then collect like surds

Answer shapes (marked by method marks — M1 for a correct method, A1 for the correct answer): the line...

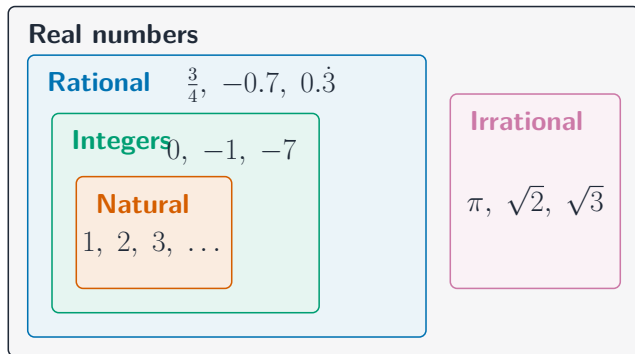


picking a smaller square factor ($\sqrt{20} = \sqrt{2 \times 10}$) gets stuck -
always take out the **largest** square: 4, 9, 16, 25, ...

Simplifying a surd by splitting off a square factor

Method — Pull out the largest square factor, then collect like surds

Answer shapes (marked by method marks — M1 for a correct method, A1 for the correct answer): the line...



The number sets: natural, integer, rational and real

2

Practice

Practice 2.1 ■ 2 marks

Simplify $\sqrt{75}$.

Solution 2.1

Method: Pull out the largest square factor, then collect like surds — p.4

Worked steps

- $75 = 25 \times 3$ and 25 is a square M1

$$\sqrt{75} = 5\sqrt{3}$$

A1

Practice 2.2 ■ 2 marks

Simplify $\sqrt{8} + \sqrt{18}$.

Solution 2.2

Method: Pull out the largest square factor, then collect like surds — p.4

Worked steps

■ $\sqrt{8} = 2\sqrt{2}$ and $\sqrt{18} = 3\sqrt{2}$ **M1**

$$2\sqrt{2} + 3\sqrt{2} = 5\sqrt{2}$$

A1

Practice 2.3 ■ 2 marks

Rationalise the denominator of $\frac{10}{\sqrt{5}}$, giving your answer in its simplest form.

Solution 2.3

Method: Pull out the largest square factor, then collect like surds — p.4

Worked steps

■ multiply top and bottom by $\sqrt{5}$: $\frac{10\sqrt{5}}{5}$ **M1**

$$= 2\sqrt{5}$$

A1

3

Exam-style

Exam-style 3.1 (a) ■ 2 marks

Expand and simplify $(3 + \sqrt{2})(3 - \sqrt{2})$.

Solution 3.1 (a)

Method: Pull out the largest square factor, then collect like surds — p.4

Worked steps

■ expand: $9 - 3\sqrt{2} + 3\sqrt{2} - 2$ — the middle terms cancel M1

$$= 7$$

A1

Exam-style 3.1 (b) ■ 2 marks

Write $\sqrt{48} - \sqrt{12}$ in the form $a\sqrt{3}$, where a is an integer.

Solution 3.1 (b)

Worked steps

■ $\sqrt{48} = 4\sqrt{3}$ and $\sqrt{12} = 2\sqrt{3}$ (M1)

$$4\sqrt{3} - 2\sqrt{3} = 2\sqrt{3}$$

(A1)

Exam-style 3.2 ■ 2 marks

Rationalise the denominator of $\frac{8}{\sqrt{6}}$ and simplify your answer.

Solution 3.2

Method: Pull out the largest square factor, then collect like surds — p.4

Worked steps

■ multiply top and bottom by $\sqrt{6}$: $\frac{8\sqrt{6}}{6}$ **M1**

■ divide top and bottom by 2

$$= \frac{4\sqrt{6}}{3}$$

A1

Exam-style 3.3 ■ 2 marks

A square has an area of 18 cm^2 . Find the exact length of one side, in the form $a\sqrt{b}$ where a and b are integers.

Solution 3.3

Method: Pull out the largest square factor, then collect like surds — p.4

Worked steps

■ side = $\sqrt{18}$, and $18 = 9 \times 2$ M1

$$= 3\sqrt{2} \text{ cm}$$

A1