Your notes

GCSE Maths: revision notes

Surds

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What surds are (Higher)

- A **surd** is a square root (or other root) that cannot be written as a whole number or a fraction, such as $\sqrt{2}$ and $\sqrt{3}$.
- **Surds** are **exact values**. Leaving an answer as a **surd** is more accurate than rounding a decimal.

Simplifying surds (Higher)

- Use $\sqrt{(ab)} = \sqrt{a} \times \sqrt{b}$, looking for a square number factor: $\sqrt{12} = \sqrt{4} \times \sqrt{3} = 2\sqrt{3}$ and $\sqrt{50} = \sqrt{25} \times \sqrt{2} = 5\sqrt{2}$.
- $\sqrt{a} \times \sqrt{a} = a$, so $\sqrt{3} \times \sqrt{3} = 3$ and $(\sqrt{5})^2 = 5$.
- $\sqrt{a} \times \sqrt{b} = \sqrt{(ab)}$: $\sqrt{2} \times \sqrt{8} = \sqrt{16} = 4$.

Adding and expanding (Higher)

- Only **like surds** can be added: $3\sqrt{5} + 2\sqrt{5} = 5\sqrt{5}$. Simplify first: $\sqrt{18} + \sqrt{8} = 3\sqrt{2} + 2\sqrt{2} = 5\sqrt{2}$.
- Expand brackets as normal: $(2 + \sqrt{3})^2 = 4 + 2\sqrt{3} + 2\sqrt{3} + 3 = 7 + 4\sqrt{3}$.
- $(a + \sqrt{b})(a - \sqrt{b}) = a^2 - b$, with no **surd** left: $(1 + \sqrt{2})(1 - \sqrt{2}) = 1 - 2 = -1$.

Rationalising the denominator (Higher)

- To remove a **surd** from the denominator, multiply the top and bottom by that **surd**: $1/\sqrt{3} = \sqrt{3}/3$ and $6/\sqrt{2} = 6\sqrt{2}/2 = 3\sqrt{2}$.
- If the denominator is like $3 - \sqrt{5}$, multiply the top and bottom by $3 + \sqrt{5}$: $4/(3 - \sqrt{5}) = 4(3 + \sqrt{5})/(9 - 5) = 3 + \sqrt{5}$.

Worked examples

Simplify √48

Find the biggest square number that goes into 48. **48 = 16 × 3**

Split the root. **√48 = √16 × √3**

√16 = 4. **4√3**

Answer: 4√3

Rationalise the denominator of 6 ÷ √3

Multiply the top and bottom by √3. **(6 × √3) ÷ (√3 × √3)**

√3 × √3 = 3. **6√3 ÷ 3**

Simplify. **2√3**

Answer: 2√3

Key terms

Surd	A root that can't be written as a whole number or fraction, such as √2.
Simplify a surd	Write it with the smallest possible number under the root, such as √12 = 2√3.
Like surds	Surds with the same number under the root, which can be added.
Rationalise the denominator	Rewrite a fraction so there is no surd on the bottom.
Exact value	An answer given without rounding, such as 5√2.

Quick questions

Cover the answers and test yourself: remembering is what makes it stick.

1. Simplify √12. (Higher)
2. Simplify √50. (Higher)
3. What is √3 × √3? (Higher)
4. What is √2 × √8? (Higher)
5. What is 3√5 + 2√5? (Higher)
6. Rationalise the denominator of 1/√3. (Higher)
7. What is $(\sqrt{5})^2$? (Higher)
8. Expand (1 + √2)(1 – √2). (Higher)

Answers

1. 2√3
2. 5√2
3. 3
4. 4

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5. 5√5
6. √3/3
7. 5
8. –1

What to do next

Practise 12 questions on this topic

Try 7 exam questions, with mark schemes

Read the lesson, one step at a time

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