

1.4 Surds

Name: _____ Class: _____ Date: _____

Total: 19 marks

KEY WORDS surd • rationalising the denominator

Surds

Objective

Understand surds as exact irrational roots, simplify them, add like surds and rationalise denominators using conjugates (objectives Higher 1.4 A–B).

1 Key knowledge and worked examples

Simplifying. $\sqrt{ab} = \sqrt{a} \sqrt{b}$: extract squares – $\sqrt{50} = 5\sqrt{2}$, $\sqrt{72} = 6\sqrt{2}$. Like surds add: $3\sqrt{2} + 5\sqrt{2} = 8\sqrt{2}$; $\sqrt{2} + \sqrt{3}$ does not simplify.

Rationalising. Multiply top and bottom by the root (or the conjugate $a + \sqrt{b}$ for $a - \sqrt{b}$): $\frac{6}{\sqrt{3}} = 2\sqrt{3}$ and $\frac{5}{3 - \sqrt{2}} = \frac{5(3 + \sqrt{2})}{9 - 2} = \frac{5(3 + \sqrt{2})}{7}$ – a difference of two squares clears the root exactly. The June 2024 paper's Q17 family rationalises a $2 - \sqrt{3}$ denominator to the $\frac{7(2 + \sqrt{3})}{4}$ family.

2 Practice

2.1 Simplify $\sqrt{50}$ [2]

2.2 Simplify $\sqrt{72}$ [2]

2.3 Simplify $3\sqrt{2} + 5\sqrt{2}$ [1]

2.4 Expand and simplify $2(3 - \sqrt{5})$ [2]

2.5 Rationalise $\frac{6}{\sqrt{3}}$ [2]

3 Exam-style questions

3.1 (*Original.*) Rationalise and simplify $\frac{5}{3 - \sqrt{2}}$, showing the difference-of-two-squares step. [4]

3.2 (*Edexcel 4MA1 1HR June 2024 Q17 family, adapted.*) Show that $\frac{7}{4(2 - \sqrt{3})} = \frac{7(2 + \sqrt{3})}{4}$. [3]

3.3 (*Original.*) A rectangle has sides $(2 + \sqrt{3})$ cm and $(2 - \sqrt{3})$ cm. Find its exact area. [3]

Solutions

2.1 $\sqrt{25 \times 2} = 5\sqrt{2}.$

2.2 $\sqrt{36 \times 2} = 6\sqrt{2}.$

2.3 $8\sqrt{2}.$

2.4 $6 - 2\sqrt{5}.$

2.5 $\frac{6\sqrt{3}}{3} = 2\sqrt{3}.$

3.1 Multiply by the conjugate: $\frac{5(3 + \sqrt{2})}{(3 - \sqrt{2})(3 + \sqrt{2})} = \frac{5(3 + \sqrt{2})}{9 - 2} = \frac{5(3 + \sqrt{2})}{7}.$

3.2 $(2 - \sqrt{3})(2 + \sqrt{3}) = 4 - 3 = 1$, so $\frac{7}{4(2 - \sqrt{3})} = \frac{7(2 + \sqrt{3})}{4 \times 1} = \frac{7(2 + \sqrt{3})}{4}.$ ✓

3.3 $(2 + \sqrt{3})(2 - \sqrt{3}) = 4 - 3 = 1 \text{ cm}^2$ exactly.

Local review guidance: the conjugate multiplier shown; exact forms with the root in the numerator only; the difference-of-two-squares step visible. This is authored classroom guidance.