*Surds - Lesson 4*

# Rationalising the Denominator 1

LI

- Rationalise a simple denominator.

SC

- Simplify surds.
- Simplify (fully) fractions.

Rationalising the denominator of a fraction means writing the fraction without a surd in the denominator (bottom)

Reminder

Multiplying numerator and denominator of a fraction by the same quantity does not change the fraction (because it's the same as multiplying the fraction by the number 1).

# Rationalising a Simple Denominator

A 'simple' denominator is one that has a term of the form :

$$\sqrt{b}$$

How to rationalise a simple denominator :

- Multiply top and bottom of fraction by the surd in the bottom.
- Simplify fully any surds on the top; simplify fully any fractions.

Example 1

Rationalise the denominator :

$$\frac{2}{\sqrt{3}} \quad \begin{matrix} \times \sqrt{3} \\ \times \sqrt{3} \end{matrix}$$

$$= \boxed{\frac{2\sqrt{3}}{3}}$$

## Example 2

Rationalise the denominator, and simplify fully :

$$\frac{6}{\sqrt{2}} \quad \begin{matrix} \times \sqrt{2} \\ \times \sqrt{2} \end{matrix}$$

$$= \frac{6\sqrt{2}}{2}$$

$$= \boxed{3\sqrt{2}}$$

## Example 3

Rationalise the denominator :

$$\frac{7}{9\sqrt{5}} \quad \begin{matrix} \times \sqrt{5} \\ \times \sqrt{5} \end{matrix}$$

$$= \frac{7\sqrt{5}}{9 \times 5}$$

$$= \boxed{\frac{7\sqrt{5}}{45}}$$

## Example 4

Rationalise the denominator :

$$\frac{\sqrt{7}}{\sqrt{3}} \quad \begin{matrix} \times \sqrt{3} \\ \times \sqrt{3} \end{matrix}$$

$$= \boxed{\frac{\sqrt{7}\,\sqrt{3}}{3}}$$

## Example 5

Rationalise the denominator (and simplify fully) :

$$\frac{6}{\sqrt{12}} \quad \begin{matrix} \times \sqrt{12} \\ \times \sqrt{12} \end{matrix}$$

$$= \frac{6\sqrt{12}}{12}$$

$$= \frac{\sqrt{12}}{2}$$

$$= \frac{\sqrt{4}\,\sqrt{3}}{2}$$

$$= \boxed{\sqrt{3}}$$

## Example 6

Express in simplest form with a rational denominator :

$$\frac{4}{\sqrt{72}} \quad \begin{matrix} \times \sqrt{72} \\ \times \sqrt{72} \end{matrix}$$

$$= \frac{4\sqrt{72}}{72}$$

$$= \frac{\sqrt{72}}{18}$$

$$= \frac{\sqrt{9}\,\sqrt{8}}{18}$$

$$= \frac{3\,\sqrt{4}\,\sqrt{2}}{18}$$

$$= \boxed{\frac{\sqrt{2}}{3}}$$

## Questions

**1** Rationalise the denominators of these expressions.

**a** $\frac{1}{\sqrt{5}}$ **b** $\frac{1}{\sqrt{2}}$ **c** $\frac{6}{\sqrt{3}}$ **d** $\frac{8}{\sqrt{2}}$

**e** $\frac{1}{3\sqrt{2}}$ **f** $\frac{5}{2\sqrt{7}}$ **g** $\frac{\sqrt{12}}{\sqrt{7}}$ **h** $\frac{6}{5\sqrt{3}}$

**2** Express each of the following in its simplest form with a rational denominator.

**a** $\frac{\sqrt{5}}{\sqrt{3}}$ **b** $\frac{1}{4\sqrt{2}}$ **c** $\frac{4}{5\sqrt{5}}$ **d** $\sqrt{\frac{1}{7}}$

**e** $\sqrt{\frac{5}{2}}$ **f** $\frac{1}{\sqrt{3}}$ **g** $\frac{6}{\sqrt{5}}$ **h** $\frac{2}{3\sqrt{7}}$

**i** $\frac{4}{5\sqrt{2}}$ **j** $\frac{10}{\sqrt{40}}$ **k** $\frac{3\sqrt{5}}{\sqrt{8}}$ **l** $\frac{4}{\sqrt{18}}$

# Answers

| | | | | | |
|---|---|---|---|---|---|
| 1 | a | $\frac{\sqrt{5}}{5}$ | 2 | a | $\frac{\sqrt{15}}{3}$ |
| | b | $\frac{\sqrt{2}}{2}$ | | b | $\frac{\sqrt{2}}{8}$ |
| | c | $2\sqrt{3}$ | | c | $\frac{4\sqrt{5}}{25}$ |
| | d | $4\sqrt{2}$ | | d | $\frac{\sqrt{7}}{7}$ |
| | e | $\frac{\sqrt{2}}{6}$ | | e | $\frac{\sqrt{10}}{2}$ |
| | f | $\frac{5\sqrt{7}}{14}$ | | f | $\frac{\sqrt{3}}{3}$ |
| | g | $\frac{2\sqrt{21}}{7}$ | | g | $\frac{6\sqrt{5}}{5}$ |
| | h | $\frac{2\sqrt{3}}{5}$ | | h | $\frac{2\sqrt{7}}{21}$ |
| | | | | i | $\frac{2\sqrt{2}}{5}$ |
| | | | | j | $\frac{\sqrt{10}}{2}$ |
| | | | | k | $\frac{3\sqrt{10}}{4}$ |
| | | | | l | $\frac{2\sqrt{2}}{3}$ |