

## Let's be rational about this

use the screen!

$$\begin{aligned} 5 &= \sqrt{25} \\ &= \sqrt{16+9} \\ &\neq 4 + 3 \\ &= 7 \end{aligned}$$

**What about multiplying:**

**Does**  $\sqrt{16} \times \sqrt{9} = 4 \times 3$  ?

**What about**  $\sqrt{25} \times \sqrt{100} = \sqrt{2500} = 5 \times 10 = 50$

Work out:

$$1. \sqrt{2 \times 2} = \sqrt{4} = 2$$

$$2. \sqrt{9 \times 9} = 9$$

$$3. \sqrt{25 \times 36} = 5 \times 6 = 30$$

$$4. \sqrt{81 \times 100} = 9 \times 10 = 90$$

$$5. \sqrt{121 \times 4} = 11 \times 2 = 22$$

$$6. \sqrt{484} = \sqrt{121 \times 4} = 22$$

$$7. \sqrt{8100} = 9 \times 10 = 90$$

$$8. \sqrt{36 \times 100} = 6 \times 10 = 60$$

$$9. \sqrt{3600} = 6 \times 10 = 60$$

$$10. \sqrt{14400} = 12 \times 10 = 120$$

$$11. \sqrt{180} = \sqrt{9 \times 20}$$

$$12. \sqrt{4900} = \sqrt{49 \times 100} = 7 \times 10 = 70$$

$$13. \sqrt{4 \times 9 \times 25} = \sqrt{2 \times 3 \times 5} = 30$$

$$14. \sqrt{16 \times 81 \times 100} = 4 \times 9 \times 10 = 360$$

$$15. \sqrt{576} = \sqrt{4 \times 144} = 24$$

$$16. \sqrt{44100} =$$

$$= \sqrt{4 \times 11025}$$

$$= \sqrt{4 \times 441 \times 25}$$

$$= \sqrt{4 \times 25 \times 49 \times 9}$$

$$= 2 \times 5 \times 7 \times 3$$

$$= 210$$

### Expressing numbers in surd form

You can express a number as a number multiplied by a root eg

$$\sqrt{8} = \sqrt{4 \times 2} = 2\sqrt{2}$$

$\sqrt{2}$  is an irrational number.

It is expressed here as a surd.

Do the same for  $\sqrt{20}$

$$\begin{aligned} &= \sqrt{4 \times 5} \\ &= 2\sqrt{5} \end{aligned}$$

Express in surd form:

1.  $\sqrt{45} = \sqrt{9 \times 5} = 3\sqrt{5}$

2.  $\sqrt{60} = \sqrt{4 \times 15} = 2\sqrt{15} \quad 3\sqrt{2}$

3.  $\sqrt{50} = \sqrt{25 \times 2} = 5\sqrt{2}$

4.  $\sqrt{27} = \sqrt{9 \times 3} = 3\sqrt{3}$

5.  $\sqrt{63} = \sqrt{7 \times 9} = 3\sqrt{7}$

6.  $\sqrt{200} = \sqrt{2 \times 100} = 10\sqrt{2}$

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$$\begin{aligned} &3 \times \sqrt{5} \times \sqrt{5} \times \sqrt{20} \\ &= 3 \times 5 \times \sqrt{20} \\ &= 15\sqrt{4 \times 5} \\ &= 15 \times 2 \times \sqrt{5} = 30\sqrt{5} \end{aligned}$$

$$\begin{aligned} \sqrt{27} &= \sqrt{3 \times 9} \\ &= 3\sqrt{3} \end{aligned}$$

## Multiplying out brackets

Multiply out the brackets and simplify:

1.  $3x(x - 5) = 3x^2 - 15x$

2.  $7a(3b - 4a)$

3.  $(x + 4)(x - 6)$

4.  $(2x - 1)(x + 3)$

5.  $(x - 4)(x + 4)$

6.  $(x - 3)^2$

Now try :

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

Write down an irrational number between 7 and 8.

$5\sqrt{2}$     $\sqrt{53}$     $\sqrt{49} = 7$     $\sqrt{51}$   
 $\sqrt{63.5}$     $\sqrt{50}$     $\sqrt{64} = 8$

Without using a calculator put these cards in order, starting with the smallest.

$\sqrt{5} \times \sqrt{5} \times \sqrt{5}$   
 $\frac{5}{5} \sqrt{5}$

2	$\sqrt{5}$	$\sqrt{5} + \sqrt{5}$	$3\sqrt{5}$	$\sqrt{5^3}$
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Multiply out and simplify:

$$\sqrt{2}\sqrt{2} = 2$$

$$\sqrt{2}(\sqrt{2}+3) = 2 + 3\sqrt{2}$$

$$(\sqrt{3}+5)(\sqrt{3}+4) = 3 + 5\sqrt{3} + 4\sqrt{3} + 20 = 23 + 9\sqrt{3}$$

$$(3-\sqrt{3})(4-\sqrt{3}) = 12 - 4\sqrt{3} - 3\sqrt{3} + 3 = 15 - 7\sqrt{3}$$

$$\begin{aligned}(8-\sqrt{5})^2 &= (8-\sqrt{5})(8-\sqrt{5}) \\ &= 64 - 8\sqrt{5} - 8\sqrt{5} + 5 \\ &= 69 - 16\sqrt{5}\end{aligned}$$

$$\begin{aligned}(5+\sqrt{3})(5-\sqrt{3}) &= 25 + 5\sqrt{3} - 5\sqrt{3} - 3 \\ &= \underline{\underline{22}}\end{aligned}$$

Simply (ab)surd

Simplify:

$$\begin{aligned}
 1. \frac{\sqrt{20}}{2} &= \frac{\sqrt{5 \times 4}}{2} = \frac{2\sqrt{5}}{2} = \sqrt{5} \\
 2. \frac{\sqrt{200}}{20} &= \frac{\sqrt{2 \times 100}}{20} = \frac{10\sqrt{2}}{20} = \frac{\sqrt{2}}{2} \\
 3. \frac{7}{\sqrt{7}} &= \frac{7}{\sqrt{7}} \times \frac{\sqrt{7}}{\sqrt{7}} = \frac{7\sqrt{7}}{7} = \sqrt{7} \\
 4. \frac{\sqrt{10}}{\sqrt{5}} &= \sqrt{\frac{10}{5}} = \sqrt{2} = \sqrt{2} \\
 5. \sqrt{\frac{4}{20}} &= \sqrt{\frac{1}{5}} = \frac{1}{\sqrt{5}} = \frac{1}{\sqrt{5}} \times \frac{\sqrt{5}}{\sqrt{5}} = \frac{\sqrt{5}}{5}
 \end{aligned}$$

$\frac{\sqrt{4}}{\sqrt{100}} = \frac{2}{10} = \frac{2}{10}$   
 $\frac{\sqrt{4}}{\sqrt{100}} = \frac{2}{10} = \frac{2}{10}$   
 $\frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}}$

Rationalising the denominator

$$\begin{aligned}
 \frac{5}{\sqrt{5}} &= \frac{5}{\sqrt{5}} \times \frac{\sqrt{5}}{\sqrt{5}} = \frac{5\sqrt{5}}{5} = \sqrt{5} \\
 \frac{12}{\sqrt{3}} &= \frac{12}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{12\sqrt{3}}{3} = 4\sqrt{3}
 \end{aligned}$$

$$\begin{aligned}
 \frac{\sqrt{20}}{\sqrt{8}} &= \frac{\sqrt{20}}{\sqrt{8}} \times \frac{\sqrt{8}}{\sqrt{8}} = \frac{\sqrt{160}}{8} \\
 &= \frac{\sqrt{16 \times 10}}{8} \\
 &= \frac{4\sqrt{10}}{8} = \frac{\sqrt{10}}{2}
 \end{aligned}$$

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## Rationalizing the denominator

$$\frac{\sqrt{15}}{\sqrt{5}}$$

$$\frac{\sqrt{15}}{\sqrt{3}}$$

$$\frac{\sqrt{15}}{\sqrt{7}}$$

Express  $\frac{\sqrt{100}}{\sqrt{5}}$  in the form  $p\sqrt{q}$

Show that  $\frac{2}{\sqrt{3}} + \frac{\sqrt{3}}{4} = \frac{11\sqrt{3}}{12}$

A\*!

Show that

$$\frac{4}{2-\sqrt{2}} = 2(2+\sqrt{2})$$