

Index (exponent)

$$a^m \times a^n$$



$$a^m \div a^n$$

$$(a^m)^n$$



Why is $a^0 = 1$?

Can you combine $2^3 \times 3^2$?



$$a^{-n}$$

$$2^{-3}$$



a^{m+n} (same base: add the powers)

the small raised number that says how many times the base is multiplied



a^{mn} (power of a power: multiply)

a^{m-n}



no: the index laws need the same base

$a^n \div a^n = 1$ and also $a^{n-n} = a^0$



$\frac{1}{8}$

$1 \div a^n$: a negative index is a reciprocal



$$\left(\frac{2}{3}\right)^{-2}$$

$$a^{\frac{1}{n}}$$

$$9^{\frac{1}{2}} \text{ and } 27^{\frac{1}{3}}$$

$$a^{\frac{m}{n}}$$

$$8^{\frac{2}{3}}$$

Pattern showing negative indices

If $a^x = a^y$ then...

Solve $2^x = 32$

the nth root of a

flip then square: $(\frac{3}{2})^2 = \frac{9}{4}$



$(\sqrt[n]{a})^m$: root first, then power

3 and 3



$$2^3 = 8, 2^2 = 4, 2^1 = 2, 2^0 = 1, 2^{-1} = \frac{1}{2}$$

$$(\sqrt[3]{8})^2 = 2^2 = 4$$



$$32 = 2^5, \text{ so } x = 5$$

$$x = y \text{ (same base, } a > 0 \text{ and } a \neq 1)$$



Solve $9^x = 27$

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Solve $2^x = \frac{1}{8}$

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Solve $4^{x+1} = 2^{x+7}$

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Simplify $\sqrt{12}$

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Simplify $\sqrt{50}$

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

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Can you simplify $\sqrt{2} + \sqrt{3}$?

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$$\frac{1}{8} = 2^{-3}, \text{ so } x = -3$$

$$\text{write as } 3^{2x} = 3^3, \text{ so } x = \frac{3}{2}$$

an irrational root left exact, e.g. $\sqrt{2}$ or $\sqrt{12}$

$$2^{2x+2} = 2^{x+7}, \text{ so } 2x + 2 = x + 7 \text{ and } x = 5$$

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

$$\sqrt{4} \times \sqrt{3} = 2\sqrt{3} \text{ (use the largest square factor)}$$

no: they are unlike surds

$$8\sqrt{2} \text{ (like surds only)}$$

$$\sqrt{a} \times \sqrt{a}$$

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$$2\sqrt{3} \times 3\sqrt{2}$$

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

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$$\text{Expand } (1 + \sqrt{3})^2$$

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**Rationalise a
denominator**

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$\frac{1}{\sqrt{2}}$ rationalised

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Conjugate

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$$(a + \sqrt{b})(a - \sqrt{b})$$

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$$6\sqrt{6}$$

$$a$$

$$1 + 2\sqrt{3} + 3 = 4 + 2\sqrt{3}$$

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

$$\frac{\sqrt{2}}{2}$$

remove the surd from the denominator by
multiplying numerator and denominator by
the same thing

$$a^2 - b, \text{ which is rational}$$

the same terms with the opposite sign: the
conjugate of $3 + \sqrt{2}$ is $3 - \sqrt{2}$

Rationalise $1/(3 + \sqrt{2})$

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Why does rationalising keep the value?

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$\sqrt{2}$, $\sqrt{8}$, $\sqrt{18}$ simplified

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you multiply by a fraction equal to 1

$$(3 - \sqrt{2})/(9 - 2) = \frac{3 - \sqrt{2}}{7}$$



$\sqrt{2}$, $2\sqrt{2}$, $3\sqrt{2}$: arithmetic with $d = \sqrt{2}$

