

Helping Your Child with Indices & Scientific Notation

Number & Algebra · Year 7 to Year 10 · Australian Curriculum Mathematics

An **index** (also called a power or exponent) is a shorthand way to show repeated multiplication. Instead of writing $3 \times 3 \times 3 \times 3$, we write 3^4 . This idea makes very large and very small numbers manageable. **Scientific notation** uses powers of 10 to write numbers like the distance to the sun ($150,000,000 \text{ km} = 1.5 \times 10^8 \text{ km}$) or the size of a virus ($0.0000001 \text{ m} = 1 \times 10^{-7} \text{ m}$) in a compact form.

Year	What your child learns	What this looks like at home						
Year 7	Index notation and integer exponents index / exponent — the small raised number showing how many times to multiply: $2^5 = 2 \times 2 \times 2 \times 2 \times 2 = 32$ base — the number being multiplied: in 2^5 , the base is 2 Your child writes numbers using index notation: $8 = 2^3$, $100 = 10^2$, $1,000 = 10^3$	'What is 2^3 ?' $(2 \times 2 \times 2 = 8)$ 'How many zeros in 10^6 ?' (Six zeros — 1,000,000) 'Which is bigger, 3^4 or 4^3 ?' $(3^4 = 81, 4^3 = 64$ — so 3^4 is bigger!) Computer/phone storage: 1 GB = 10^9 bytes. 'What is 10^9 as a normal number?'						
Year 8	Index laws and zero index zero index : any number to the power zero is equal to 1. $7^0 = 1$, $100^0 = 1$ They apply index laws: Multiply same base: add indices $\rightarrow 3^2 \times 3^4 = 3^6$ Divide same base: subtract indices $\rightarrow 5^6 \div 5^2 = 5^4$ Power of a power: multiply indices $\rightarrow (2^3)^4 = 2^{12}$	'What is 5^0 ?' (Any number to the power 0 = 1, so $5^0 = 1$) What is $8^7 \div 8^4$? What is $4^3 \times 4^4$? What is $(5^4)^2$?						
Year 9	Negative indices, scientific notation and index laws with algebra negative index — means 'one over': $2^{-3} = \frac{1}{2^3} = \frac{1}{8}$ scientific notation — a number between 1 and 10 multiplied by a power of 10: Large: $4,500,000 = 4.5 \times 10^6$ Small: $0.000034 = 3.4 \times 10^{-5}$ Your child converts between scientific notation and normal numbers and performs calculations using it (e.g. speed of light = 3×10^8 m/s). Your child applies all index laws to algebraic expressions: <table><tr><td>$a^m \times a^n = a^{m+n}$</td><td>$a^m \div a^n = a^{m-n}$</td></tr><tr><td>$(a^m)^n = a^{mn}$</td><td>$a^0 = 1$</td></tr><tr><td>$a^{-n} = \frac{1}{a^n}$</td><td></td></tr></table> They simplify expressions like: $x^3 \times x^5 = x^8$, $(y^2)^3 = y^6$	$a^m \times a^n = a^{m+n}$	$a^m \div a^n = a^{m-n}$	$(a^m)^n = a^{mn}$	$a^0 = 1$	$a^{-n} = \frac{1}{a^n}$		'What is 3^{-2} as a fraction?' $\frac{1}{3^2} = \frac{1}{9}$ 'The Earth is 1.5×10^8 km from the sun. Write that as a normal number.' (150,000,000 km) Look at a virus size online — often given in nanometres (nm) or in scientific notation. 'Simplify: $a^4 \times a^3$ ' (Add the indices: a^7) 'Simplify: $(x^2)^5$ and $(2x^2)^5$ ' (Multiply indices: x^{10} , $32x^{10}$) Discuss: 'Why does $a^0 = 1$?' (Dividing same base: $a^2 \div a^2 = a^0 = 1$)
$a^m \times a^n = a^{m+n}$	$a^m \div a^n = a^{m-n}$							
$(a^m)^n = a^{mn}$	$a^0 = 1$							
$a^{-n} = \frac{1}{a^n}$								
Year 10	Index laws in financial and scientific contexts exponential growth — when a quantity multiplies by the same amount each period: Population, compound interest, bacteria doubling exponential decay — when a quantity shrinks by the same ratio each period: Depreciation, radioactive decay, medicine in the bloodstream Your child models real-world situations with indices: Compound interest: $A = P(1 + r)^n$ uses indices Depreciation: $V = P(1 - r)^n$ Population: $P = P_0 \times P = P_0 \times 2^t$ (doubling each time period) They compare models and use digital tools to evaluate them.	'A bacteria colony doubles every 3 hours. Starting with 100, how many after 12 hours? ' (4 doublings: $100 \times 2^4 = 1,600$) 'A car worth \$25,000 depreciates 15% per year. What is it worth after 4 years? ' ($25,000 \times 0.85^4 \approx \$13,050$) 'If a disease spreads and cases triple every 5 days, use indices to estimate spread.'						

★ Index laws — quick reference card

Law	Rule	Example
Multiply (same base)	$a^m \times a^n = a^{m+n}$	$3^2 \times 3^4 = 3^6 = 729$, $x^6 \times x^2 = x^8$
Divide (same base)	$a^m \div a^n = a^{m-n}$	$5^6 \div 5^2 = 5^4 = 625$, $x^6 \div x^2 = x^4$
Power of a power	$(a^m)^n = a^{mn}$	$(2^3)^4 = 2^{12} = 4,096$, $(t^6)^2 = t^{12}$
Zero index	$a^0 = 1$	$7^0 = 1$, $1,000,000^0 = 1$, $(2xt)^0 = 1$
Negative index	$a^{-n} = \frac{1}{a^n}$	$2^{-3} = \frac{1}{8}$, $10^{-2} = 0.01$, $y^{-4} = \frac{1}{y^4}$

Scientific notation: write as $A \times 10^n$ where $1 \leq A < 10$. To convert $340,000 \rightarrow 3.4 \times 10^5$. To convert $0.00006 \rightarrow 6 \times 10^{-5}$.

Helping at Home — Indices & Scientific Notation

Worked examples and questions to ask · Year 7 to Year 10

How it works — worked examples

Year 7 — Squares, square roots and powers of 10

Work out: (a) 6^2 (b) $\sqrt{49}$ (c) 1,000 as a power of 10

(a) Square	$6^2 = 6 \times 6 = 36$
(b) Square root	$\sqrt{49} = 7$ (because $7 \times 7 = 49$)
(c) Power of 10	$1,000 = 10^3$ ($10 \times 10 \times 10 = 1,000$)

Year 8 — Using index laws

Simplify: (a) $3^2 \times 3^5$ (b) $4^6 \div 4^2$ (c) $(5^2)^3$

(a) Multiply	$3^2 \times 3^5 = 3^{2+5} = 3^7$ (add the indices)
(b) Divide	$4^6 \div 4^2 = 4^{6-2} = 4^4$ (subtract the indices)
(c) Power of a power	$(5^2)^3 = 5^{2 \times 3} = 5^6$ (multiply the indices)

Year 9 — Scientific notation

(a) Write 0.0000045 in scientific notation.
(b) Write 6.2×10^4 as a normal number.

(a) Small number	0.0000045 — write a number between 1 and 10 (4.5) and multiply by the appropriate power of 10. Check your answer.
Answer (a)	4.5×10^{-6} (negative power = small number)
(b) Large number	6.2×10^4 — move the decimal point 4 places to the right. Check your answer.
Answer (b)	62,000 (positive power = large number)

Year 10 — Exponential decay (depreciation)

A laptop costs \$1,500. It loses 20% of its value each year. What is it worth after 3 years?

Formula	$V = P \times (1 - r)^n$
After 1 year	$1,500 \times 0.80 = \$1,200$
After 2 years	$1,200 \times 0.80 = \$960$
After 3 years	$1,500 \times (0.80)^3 = 1,500 \times 0.512 = \768

Questions to ask your child

You don't need to solve these. Ask them and let your child explain their thinking!

7 Year 7

- What is 2^4 ? How do you work it out?
- Write 10,000 as a power of 10.
- Which is larger: 2^5 or 5^2 ? Work it out without a calculator.

8 Year 8

- What is 8^0 ? What is any number to the power zero?
- Simplify $5^3 \times 5^2$.

9 Year 9

- Write 370,000 in scientific notation.
- Write 5.6×10^{-3} as a normal number.
- What is 2^{-4} ? Write it as a fraction.
- Simplify: $y^4 \times y^{-2}$
- Simplify: $(x^3)^2$
- Show me how to get from $a^2 \div a^2 = a^0 = 1$.

10 Year 10

- A city's population is 50,000 and grows by 2% per year. What is the population after 10 years?
- A medicine halves in the body every 6 hours. After 24 hours, what fraction is left?
- When does exponential growth become dangerous? Can you think of a real example?
- Compare simple and compound interest on \$1,000 at 5% for 10 years.

Things to try at home

Year 7: Computer storage — '1 GB = 10^9 bytes. How many bytes is 64 GB?' ($64 \times 10^9 = 6.4 \times 10^{10}$)	Year 7: Use a calculator to compare 2^{10} (1,024) to 10^3 (1,000). Which is bigger? By how much?
Year 8: Simplify $2^3 \times 2^4$ together without a calculator, then check the answer with one. ($2^7 = 128$)	Year 8: Ask what 9^0 equals — any number (except 0) to the power zero is always 1.
Year 9: Find the size of a red blood cell online (about 8×10^{-6} m). Write as a normal number.	Year 9: Calculator: type in 5.4E6 on your phone. What number does it show?
Year 10: Bacteria problem: if bacteria double every 2 hours, starting with 10, how many after 8 hours?	Year 10: Research a savings account. Use the compound interest formula to predict growth over 5 years.

Key words to learn together

index / exponent: the small raised number showing how many times to multiply: 2^5 — the index is 5	base: the number being multiplied: in 3^4 , the base is 3
index notation: writing a number as a base raised to a power: $8 = 2^3$	scientific notation: a number written as $A \times 10^n$ where $1 \leq A < 10$: $4,500,000 = 4.5 \times 10^6$
zero index: any number to the power 0 equals 1: $5^0 = 1$	negative index: means 'one divided by': $2^{-3} = 1 \div 2^3 = \frac{1}{8}$
exponential growth: a quantity that keeps multiplying by the same number: 2, 4, 8, 16, 32...	exponential decay: a quantity that keeps dividing by the same number: 1000, 500, 250, 125...
depreciation: decrease in value over time: car, phone, or equipment losing value each year	compound interest: interest calculated on both principal and accumulated interest: $A = P(1 + r)^n$