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 × 3 × 3 × 3, we write $\mathbf{3^4}$. 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 km = 1.5×10^8 km) or the size of a virus (0.0000001 m = 1×10^{-7} 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: **$8 = 2^3$ | $100 = 10^2$ | $1{,}000 = 10^3$** They apply index laws: Multiply same base: add indices → $3^2 \times 3^4 = 3^6$ Divide same base: subtract indices → $5^6 \div 5^2 = 5^4$ Power of a power: multiply indices → $(2^3)^4 = 2^{12}$	'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	**Zero and negative indices, scientific notation** **zero index** — any number to the power zero = 1: $7^0 = 1$ | $100^0 = 1$ **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 = 4.5×10^6** **Small: 0.000034 = 3.4×10^{-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).	'What is 5^0?' (Any number to the power 0 = 1, so $5^0 = 1$) **'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.
Year 9	**Fractional indices and index laws** **fractional index** — means a root: $9^\wedge(\frac{1}{2}) = \sqrt{9} = 3$ | $8^\wedge(\frac{1}{3}) = \sqrt[3]{8} = 2$ Your child applies all index laws to algebraic expressions: **a^m × a^n = a^(m+n) | a^m ÷ a^n = a^(m−n)** **(a^m)^n = a^(m×n) | $a^0 = 1$ | a^(−n) = 1/a^n** **a^(1/n) = $\sqrt[n]{a}$ (the nth root of a)** They simplify expressions like: $x^3 \times x^5 = x^8$ | $(y^2)^3 = y^6$ | $z^\wedge(\frac{1}{2}) = \sqrt{z}$	**'What does $25^\wedge(\frac{1}{2})$ mean? What is the answer?'** **(Square root of 25 = 5)** **'Simplify: $a^4 \times a^3$'** **(Add the indices: a^7)** **'Simplify: $(x^2)^5$'** **(Multiply indices: x^{10})** Discuss: 'Why does $a^0 = 1$?' (Dividing same base: $a^2 \div a^2 = a^0 = 1$)
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: $P = P_0 \times 2$^(t/d) (doubling time d) 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)	$a^m \times a^n = a^{m+n}$	$3^2 \times 3^4 = 3^6 = 729$
Divide (same base)	$a^m \div a^n = a^{m-n}$	$5^6 \div 5^2 = 5^4 = 625$
Power of a power	$(a^m)^n = a^{mxn}$	$(2^3)^4 = 2^{12} = 4{,}096$
Zero index	$a^0 = 1$	$7^0 = 1$ | $1{,}000{,}000^0 = 1$
Negative index	$a^{-n} = 1/a^n$	$2^{-3} = \frac{1}{8}$ | $10^{-2} = 0.01$
Fractional index	$a\text{^}(1/n) = \sqrt[n]{a}$	$25\text{^}(\frac{1}{2}) = \sqrt{25} = 5$

Scientific notation: *write as $A \times 10^n$ where $1 \le A < 10$. To convert 340,000 → move decimal 5 places left → 3.4×10^5. To convert 0.00006 → move decimal 5 places right → 6×10^{-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 — 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 power	$(5^2)^3 = 5^{2\times3} = 5^6$ (multiply the indices)

Year 8 — Scientific notation

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

(a) Small number	0.0000045 — move decimal 6 places right
Answer (a)	**4.5×10^{-6} (negative power = small number)**
(b) Large number	6.2×10^4 — move decimal 4 places right
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 × 0.80 = $1,200
After 2 years	1,200 × 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.
→ Simplify $5^3 \times 5^2$.
→ Which is larger: 2^5 or 5^2? Work it out without a calculator.

8 Year 8

→ Write 370,000 in scientific notation.
→ Write 5.6×10^{-3} as a normal number.
→ What is 8^0? What is any number to the power zero?
→ What is 2^{-4}? Write it as a fraction.

9 Year 9

→ What does $16^\wedge(\frac{1}{2})$ mean? What is the answer?
→ 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: Find the size of a red blood cell online (about 8×10^{-6} m). Write as a normal number.	**Year 8:** Calculator: type in 5.4E6 on your phone. What number does it show?
Year 9: 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 $1 \le A < 10$: $4{,}500{,}000 = 4.5 \times 10^6$
zero index: any number to the power 0 equals 1: $5^0 = 1$	**negative index:** means 'one divided by': $2^{-3} = 1 \div 2^3 = \frac{1}{8}$
fractional index: means a root: $9\wedge(\frac{1}{2}) = \sqrt{9} = 3$ | $8\wedge(\frac{1}{3}) = \sqrt[3]{8} = 2$	**square root:** the number that multiplied by itself gives the original: $\sqrt{25} = 5$ because $5 \times 5 = 25$
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: $A = P(1 + r)^n$