# A New Family That Multiplies

Lines add the same amount every step (constant difference). Exponentials multiply by the same number every step (constant ratio). Exponents write the multiplying; anything to the zero power is 1.

1 THE VOCABULARY

## Words we use

Exponent how many times the base is multiplied: in $2^5$, the 5.

Base the number multiplied over and over: in $2^5$, the 2.

Power the whole thing, $2^5 = 32$.

Constant difference same amount added each step: subtract to check. The line pattern.

Constant ratio same number multiplied each step: divide to check. The exponential pattern.

Zero power any base to the 0 is 1: the do-nothing number.

- Watch out for these.
- $2^3$ is not $2 \times 3$. It is $2 \times 2 \times 2 = 8$.
- $2^3$ and $3^2$ are different: 8 and 9.
- Checking only differences. If they change, divide for ratios before saying neither.
- Thinking $2^0$ is 0. Walk backward: it is 1.

2 THE METHOD

## Add or multiply?

1. CHECK x GOES UP BY EQUAL STEPS the test needs equal steps.
2. SUBTRACT each output minus the one before. All the same: linear, constant difference.
3. IF NOT, DIVIDE each output over the one before. All the same: exponential, constant ratio.
4. NEITHER differences and ratios both change: another family.
5. READ A POWER base multiplied exponent times. Walk left to get the zero and negative powers.

WHY THE ZERO POWER IS 1

Each step right multiplies by the base; each step left divides by it. From the first power, one step left divides the base by itself: 1. Nothing has been multiplied yet.

3 WALK THE TABLE

## Powers of 2, both directions

| | |
|---|---|
| $2^3 = 2 \times 2 \times 2 = 8$ | three 2s |
| $2^2 = 8 \div 2 = 4$ | one step left divides by 2 |
| $2^1 = 4 \div 2 = 2$ | again |
| $2^0 = 2 \div 2 = 1$ | the zero power: the do-nothing number |
| $2^{-1} = 1 \div 2 = 12$ | a negative exponent: a fraction, small but not 0 |

ADDS OR MULTIPLIES

4, 12, 36, 108: differences 8, 24, 72 (not constant); ratios 3, 3, 3 (constant). Exponential, multiplying by 3.

SAY IT OUT LOUD

Lines add, exponentials multiply. Subtract for a difference, divide for a ratio. Anything to the zero is 1.