TEACHER GUIDE

Teaching Orders of Magnitude

A practical companion to the two-page student worksheet and interactive powers-of-ten journey.

Age / level	Ages 11-16 / KS3-KS4. Adaptable for maths, physics and general science.
Time	25-35 minutes.
Set-up	One worksheet per student; one connected device per pair where available.
Core ideas	Orders of magnitude; powers of ten; standard form; exponent differences; multiplicative reasoning; dimensional intuition.

LEARNING OBJECTIVES

- Recognise that one order of magnitude is specifically a factor of ten.
- Compare and order real lengths written in scientific notation.
- Estimate a nearest power of ten and explain the estimate.
- Convert an exponent difference into an approximate multiplier.

SUGGESTED LESSON FLOW

5 min	10 min	10 min	5-10 min
Model one whole 10x step. Contrast exponent difference with multiplier.	Students estimate and order before opening any links.	Complete exponent and standard-form tasks; check with the journey.	Discuss errors, measurement choices and the big question.

KEY TEACHING POINTS

- An order of magnitude is not a synonym for "much bigger"; it is a 10x change.
- A difference of 3 orders means about 10^3 = 1,000 times, not 3 times.
- Negative exponents do not mean negative size: 10^-6 m is a positive length smaller than 10^-3 m.
- Scientific notation states magnitude compactly; the coefficient must be at least 1 and less than 10.
- Width, height, diameter and distance can place the same subject in different orders of magnitude.

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Answers, differentiation and discussion

Accept sensible rounding where students state their chosen measurement and work consistently.

ANSWER GUIDANCE

1. Nearest powers	Human 10^0; Human hair 10^-4; Bacterium 10^-6; Football pitch 10^2; Mount Everest 10^4; Earth 10^7; Sun 10^9. Boundary answers may vary when a value lies near the geometric midpoint.
2. Order	Virus < Bacterium < Human hair < Human < Blue whale < Mount Everest < Earth < Sun.
3. Orders and multipliers	DNA (10^-9) to hair (10^-4): 5 orders, about 100,000x. Earth (10^7) to Sun (10^9): 2 orders, about 100x. Burj Khalifa (10^3) to Everest (10^4): 1 order, about 10x. Actual ratios need not equal the rounded power exactly.
4. Standard form	70 µm hair: 7 x 10^-5 m; 2 µm bacterium: 2 x 10^-6 m; Football pitch: 1.05 x 10^2 m; Mount Everest: 8.849 x 10^3 m; Earth: 1.274 x 10^7 m; Sun: 1.391 x 10^9 m.
5. Estimates	DNA 10^-9 m; virus 10^-7 m; blue whale 10^1 m; Saturn 10^8 m; Everest 10^4 m; Earth-Sun distance 10^11 m. Credit reasoning and an adjacent power where justified.
6. Big question	Six exponent steps represent 10^6 = 1,000,000 times. Strong answers discuss repeated multiplication and why direct experience is limited at microscopic and astronomical scales.

DIFFERENTIATION

Support	Stretch
Provide the powers-of-ten reference, unit prefixes and a number line. Let students compare only exponent parts first. Use three objects before expanding to eight.	Convert units before comparing; estimate actual ratios from coefficients; introduce log10 as the exponent; explain why logarithmic scales make wide ranges readable.

DISCUSSION PROMPTS

- Which scale was hardest to estimate, and what reference could improve the estimate?
- Why can two objects in the same order of magnitude still differ substantially?
- When would diameter be more useful than height or length?
- Why are logarithmic scales useful when values span many powers of ten?

MEASUREMENT CAUTIONS

Examples use selected dimensions from Just How Big?. DNA is helix diameter; Everest is elevation above mean sea level; Solar System is the diameter of Neptune's orbit. Cells, viruses, people and galaxies vary, so answers describe representative values and approximate orders.