Chapter 15

Scientific notation

Learn the ideas below, follow each worked example, then attempt the practice before checking the answers.

15.1 The standard form convention

Scientific notation writes a nonzero number as $a \times 10^n$, where $1 \le |a| < 10$ and n is an integer. For positive numbers, $1 \le a < 10$. It makes very large and very small values easier to compare and calculate. The coefficient must satisfy the convention.

Worked example $4{,}700{,}000 = 4.7 \times 10^6$. The expression 47×10^5 has the same value but is not normalised scientific notation because 47 is at least 10.

15.2 Large numbers and positive powers

Count how many places the decimal point moves to obtain a coefficient between 1 and 10. For numbers of at least 10, the exponent is positive. Check by expanding the power of ten. Keep the original significant digits unless rounding is requested.

Worked example $62{,}300 = 6.23 \times 10^4$ because $6.23 \times 10{,}000 = 62{,}300$. A population of 8,140,000 can be written 8.14×10^6.

15.3 Small numbers and negative powers

A positive number smaller than 1 has a negative exponent in scientific notation. A negative exponent means repeated division by ten, not a negative value. Leading zeros help count place shifts but are not significant figures.

Worked example $0.000508 = 5.08 \times 10^{-4}$. Expanding gives $5.08 \div 10{,}000 = 0.000508$. The value remains positive even though its exponent is negative.

15.4 Multiplying and dividing

Multiply or divide coefficients separately and use index laws for powers of ten. Normalise the result afterwards. Include units if the calculation represents a measurement. Check the order of magnitude to catch exponent errors.

Worked example $(3 \times 10^5)(4 \times 10^{-2}) = 12 \times 10^3 = 1.2 \times 10^4$. Also, $(8 \times 10^7) \div (2 \times 10^3) = 4 \times 10^4$.

15.5 Adding subtracting and comparing

To add or subtract, express both terms with the same power of ten first. Then combine coefficients and normalise. For positive normalised values, compare exponents first and coefficients second. Round the coefficient only after completing a calculation.

Worked example $5.2 \times 10^6 + 7 \times 10^5 = 5.2 \times 10^6 + 0.7 \times 10^6 = 5.9 \times 10^6$. Also, 2.1×10^4 is greater than 9.8×10^3.

Chapter 15 practice

Work in your notebook. Show your method and include units where needed.

1. Write 92,000 in scientific notation.
2. Write 0.000063 in scientific notation.
3. Expand 4.08×10^3.
4. Calculate $(6 \times 10^4) \div (3 \times 10^{-2})$.
5. Calculate $3.4 \times 10^5 + 2 \times 10^4$.

Answers with methods

1. 9.2×10^4.

2. 6.3×10^{-5}.

3. $4.08 \times 1{,}000 = 4{,}080$.

4. 2×10^6, because $4 - (-2) = 6$.

5. $3.4 \times 10^5 + 0.2 \times 10^5 = 3.6 \times 10^5$.

Common mistake to avoid

Adding exponents is a multiplication rule. It does not apply when adding two scientific notation values.