What Are Significant Digits?

Significant digits are the digits in a number that carry meaning. Measurements are accurate only to a certain number of digits, depending on the tool used. If you were to measure the mass of a carbon sample on a top loading balance, you might get a mass of 42.04 g. The same sample on an analytical balance might record the mass as 42.0388 g. Because we know the value of more digits in the measurement from the analytical balance, this number is more accurate. It has more significant digits. The top loading balance has fewer significant digits, resulting in more uncertainty.

Here is a simple set of rules to help you determine which digits are significant in a number:

Significant Digits Rules

1. Any digit between 1-9 is significant.
2. The first significant digit cannot be zero.
   In the number **0.00619**, the first significant digit will be "**6**".
3. Look for a decimal in the number.
   a. If there is a decimal anywhere in the number, all zeroes at the end of the number will be significant.
      In the number **2040.00**, **all six digits** are significant.
   b. If there is no decimal in the number, zeroes at the end of the number are not significant.
      In the number **204 000**, the "**2**", "**0**", and "**4**" at the start of the number are significant. The three zeroes at the end are not.

Why Are Only Some Zeroes Significant?

Zeroes serve multiple roles in measurements:

- Some zeroes tell us the actual value of a digit. The molar mass of carbon is 12.011 g/mol. We know that the zero in that number is actually a "0", it can't be any other digit. Zeroes that indicate value are significant digits.
- Some zeroes only tell us that a number is either very large or very small (e.g. the diameter of a carbon atom: 0.000 000 17 mm). These zeroes represent placeholders, the actual values may not be "0". Placeholder zeroes are not significant, because we can't say for certain that they represent values of "0".

Rounding Answers to Significant Digits

Your **final answers** must have the correct number of significant digits. How you round off your answer depends on the calculation performed.

Adding/Subtracting

- Round answers off to the fewest number of **decimal places**.

Examples:

2.**65** cm + 4.**839** cm = 7.**48**9 cm

2 d.p. | 3 d.p. | Answer will have 2 d.p. = 7.**49** cm

19.**14** g – 0.**8** g = 18.**3**4 g

2 d.p. | 1 d.p. | Answer will have 1 d.p. = 18.**3** g

Logarithms/Antilogs

- Round answers off to the fewest number of **places after the decimal**.

Examples:

pH = -log(**2.74** × 10^{-5}) = 4.**562**249437

3 s.d. | Answer will have 3 d.p. = 4.**562**

[OH^-] = $10^{-10.28}$ = **5.2**48074603×10^{-11} M

2 d.p. | Answer will have 2 s.d. = **5.2** x 10^{-11} M

Multiplying/Dividing

- Round answers off to the lowest number of **significant digits.**

Examples:

1.3 cm x 0.0**528** cm = 0.0**68**64 cm^2

2 s.d. | 3 s.d. | Answer will have 2 s.d. = 0.06864 cm^2

20 800 g ÷ **1**0 g/mL = **2**080 mL

3 s.d. | 1 s.d. | Answer will have 1 s.d. = **2**000 mL

Multi-step Calculations

1. **Complete all steps of the calculation**, recording results of each operation.

   Example:

   73.2 g ÷ (50.00 mL – 12.25 mL)

   50.00 mL – 42.2 mL = 7.8 mL

   73.2 g ÷ 7.8 mL = 9.3846153 g/mL
2. Review the calculation and **apply the appropriate rounding rule to each step**:

   50.**00** mL – 42.**2** mL = 7.**8** mL (round to 1 d.p.)

   73.2 g ÷ **7.8** mL = **9.3**846153 (round to 2 s.d.) = **9.4** g/mL

For practice with significant digits or rounding answers, visit SALS ONLINE – Chemistry in DC Connect.

For help with significant digits or any chemistry concept, email sals@durhamcollege.ca to request an appointment with the chemistry specialist.