

Stage 1 

Understanding number: significant figures and rounding

Introduction

Scientists need to record measurements and calculations to an appropriate level of precision. Writing every calculator digit suggests false accuracy, while rounding too much loses important information. We will build on rounding skills from maths and learn to use significant figures.

Learning objectives

1. Understand what rounding means and why it is used in science.
2. Understand what significant figures are and why they matter in science.
3. Round numbers to a given number of significant figures.
4. Choose an appropriate number of significant figures when recording measurements and carrying out calculations.

Lesson question

During this session we will cover the maths skills needed to answer the following question:

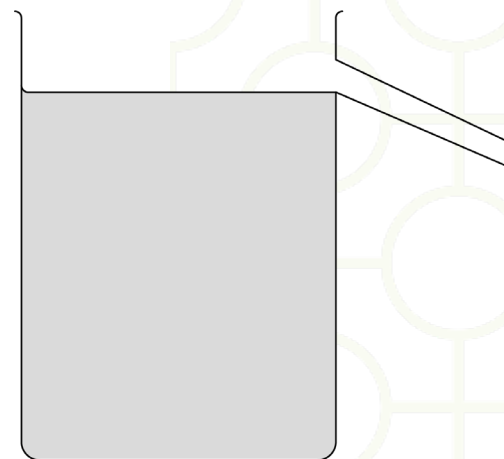
A student wants to find the density of a block of pine wood. They measure the mass on a balance: 15.8 g.

To find the volume, they lower the block into a eureka can filled with water and collect the displaced water in a measuring cylinder. The measuring cylinder reads 52.0 cm³.

They calculate the density using a calculator:
 $15.8 \div 52.0 = 0.30384615384$

How should the student record the density?

Explain why.



Rounding recap

Rounding makes numbers simpler and easier to work with. In science, we also round because our measurements have limited precision. Our answer should match the precision of the equipment we used.

In maths, you have been taught how to round to the nearest 10, 100, and to decimal places. The same process is used in science.

Round the following numbers:

- a) 3.456 to 1 decimal place
- b) 7.823 to 2 decimal places
- c) 0.0483 to 2 decimal places

Rounding recap – answers

Round the following numbers:

a) 3.456 to 1 decimal place

Look at the 2nd decimal place digit: 5. This is 5 or more, so round up.

Answer: 3.5

b) 7.823 to 2 decimal places

Look at the 3rd decimal place digit: 3. This is less than 5, so round down.

Answer: 7.82

c) 0.0483 to 2 decimal places

Look at the 3rd decimal place digit: 8. This is 5 or more, so round up.

Answer: 0.05



The problem with decimal places in science

Rounding to decimal places works well for some numbers. But what happens with very small numbers?

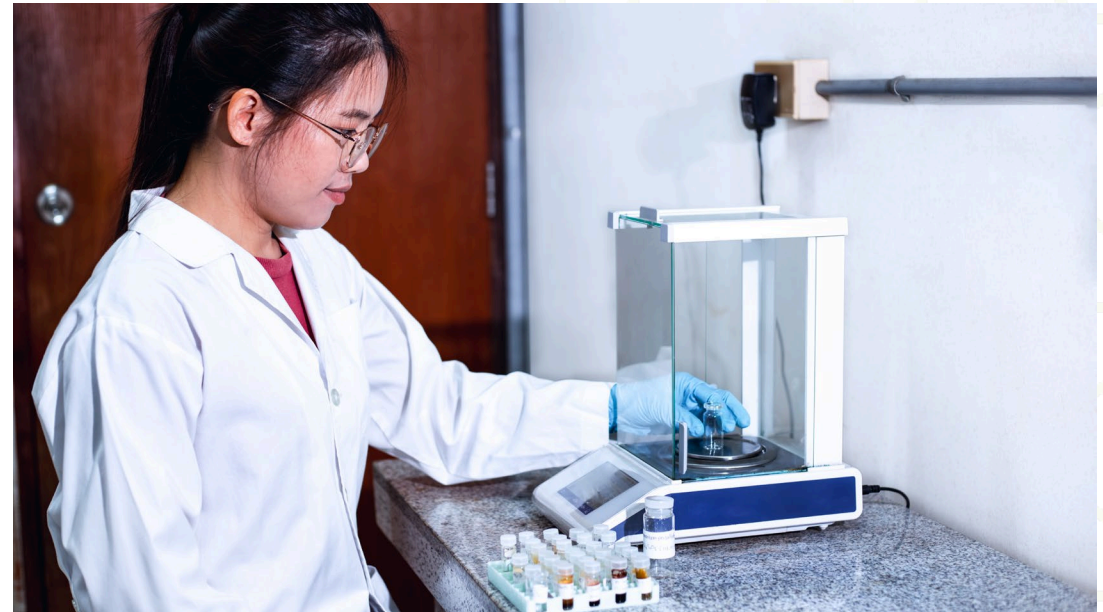
A scientist uses a sensitive balance to measure 0.00247 g of a chemical in a lab.

1. What would happen if they rounded the number to 1 decimal place?

0.0 g

2. What if they round to 2 significant figures instead?

0.0025 g





What are significant figures?

Significant figures (s.f.) tell us how **precise** a number is. They count the meaningful digits (the significant digits), regardless of where the decimal point is.

So, how do we work out which digits are significant?

Rule 1: All non-zero digits are significant.

247 is to 3 s.f.

Rule 2: Zeros between non-zero digits are significant.

204 is to 3 s.f.

Rule 3: Leading zeros **are not** significant digits.

0.003 is to 1 s.f.

Rule 4: Trailing zeros after a decimal point **are** significant.

2.50 is to 3 s.f.

How many significant figures?

For each value, identify the number of significant figures and which rule(s) have been applied:

Value	Number of significant figures	Which rule(s)?
45		
3.07		
0.025		
1.00		
0.0040		

How many significant figures? – Answers

For each value, identify the number of significant figures and which rule(s) have been applied:

Value	Number of significant figures	Which rule(s)?
45	2 s.f.	Rule 1
3.07	3 s.f.	Rules 1 and 2
0.025	2 s.f.	Rules 1 and 3
1.00	3 s.f.	Rules 1 and 4
0.0040	2 s.f.	Rules 1, 3 and 4

Round 0.04572 to 2 s.f.	Your turn
Step 1: Find the first significant figure First significant figure = 4 Step 2: Count to the required number of significant figures and identify the decider digit Decider digit = 7 Step 3: Round Round up as decider digit is greater than 5 Answer = 0.046	a) Round 67.83 to 2 s.f. b) Round 0.00361 to 2 s.f. c) Round 4.997 to 3 s.f. d) Round 25480 to 2 s.f.

Round 0.04572 to 2 s.f.	Your turn
Step 1: Find the first significant figure First significant figure = 4 Step 2: Count to the required number of significant figures and identify the decider digit Decider digit = 7 Step 3: Round Round up as decider digit is greater than 5 Answer = 0.046	a) 68 b) 0.0036 c) 5.00 d) 25000



Why do significant figures matter in chemistry?

In science, significant figures tell us how precise the measurement was.

Balance reads: 12.35 g which is 4 s.f.	Measuring cylinder reads: 25 cm ³ which is 2 s.f.	Thermometer reads 21.5 °C which is 3 s.f.
--	--	---

Give the answer to the same number of significant figures as the least precise measurement used in the calculation.

Example:

A student measures a mass of 5.42 g and a volume of 25 cm³.
They calculate density on their calculator = $5.42 \div 25 = 0.2168$

Give the answer to an appropriate number of significant figures.



Do I use significant figures or decimal places?

It depends on the type of calculation and the mathematical operation that you are using:

Multiplication or division	Addition or subtraction
E.g. calculating density or concentration Give your answer to the same number of significant figures Example: $45.2 \text{ g} \div 38 \text{ cm}^3 = 1.189\dots$ 45.2 is 3 s.f., 38 is 2 s.f. Answer = 1.2 g/cm^3 (2 s.f.)	E.g. calculating a mean or finding a difference in mass Give your answers to the same number of decimal places Example: $(21.5 + 22.0 + 21.5) \div 3 = 21.6667$ Thermometer reads to 1 d.p. Answer 21.7°C (1 d.p.)



Recurring numbers

In maths, when you get a recurring number like 0.33333333 you write it using dot notation: $0.\dot{3}$. This is because mathematically the number is infinitely precise and the dot is an exact way to represent it.

In science, we can't do this. Our measurements come from equipment like balances and measuring cylinders, which can only measure to a certain level of precision. Our answer can't be more precise than the equipment we used, so we always round instead.

A student dissolves 1.0 g of salt in 3.0 cm³ of water and calculates the concentration:

$$1.0 \div 3.0 = 0.333333 \dots$$

They write $0.\dot{3}$ g/cm³. What should they write instead?

Returning to the lesson question:

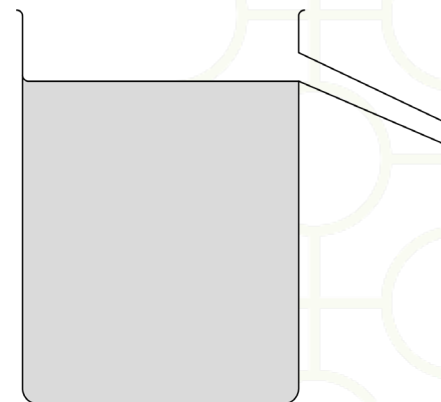
A student wants to find the density of a block of pine wood. They measure the mass on a balance: 15.8 g.

To find the volume, they lower the block into a eureka can filled with water and collect the displaced water in a measuring cylinder. The measuring cylinder reads 52.0 cm³.

They calculate the density using a calculator:
 $15.8 \div 52.0 = 0.30384615384$

How should the student record the density?

Explain why.



Returning to the lesson question – answers

How should the student record the density?

Explain why.

The correct answer is 0.304 g/cm^3 (3 significant figures).

The answer should be given to 3 s.f. because this is a division and the rule is to match the least number of significant figures from the data.

The mass (15.8 g) is 3 s.f. and the volume (52.0 cm^3) is 3 s.f., so the answer should be 3 s.f.

To round 0.30384615384 to 3 s.f.: the first three significant figures are 3, 0 and 3 (leading zeros are not significant, but the trapped zero is). The decider digit is 8 (≥ 5), so round up to give 0.304 g/cm^3 .

Acknowledgements

Image on slide 3 and 15 © Royal Society of Chemistry

Image on slide 6 © S. Singha/Shutterstock

