Significant Figures

Other Handouts:
- Scientific notation • Units
- Ratio and Proportion • Logarithms
- Review of Number • Graphing

The number of **significant figures** in a measurement tells us how precise the measurement is.

A tree is four metres tall. If our accuracy in measuring the tree is to the nearest centimetre, then writing its height as 4m does not convey this; rather it should be written as 4.00m to show that even to hundredths of a metre the measurement is accurate. We would say that 4m has only 1 significant figure, while 4.00m has 3 significant figures – i.e. they are all "significant' in the measuring process.

Non-zero digits always count as significant figures (s.f.), as do zeros at the end of decimals. The accuracy of a measurement cannot be determined in cases such as 2000m, where we cannot tell if it is accurate to the nearest metre or kilometre. So we use a decimal point to indicate if the zeros are significant, such as in 2000**.** metres. Zeros at the right-hand end of the number do count if a decimal point is shown.

It is easier to tell the number of significant figures when numbers are written in scientific notation.

Examples The significant figures are underlined in the following examples

356 has 3 s.f.	3056 has 4 s.f.	0.356 has 3 s.f.	0.00356 has 3 s.f.
0.3560 has 4 s.f.	0.003506 has 4 s.f.	0.00035600 has 5 s.f.	3560 has 3 s.f.
3560. has 4 s.f.	3.56×10^3 has 3 s.f.	3.560×10^3 has 4 s.f.	

Significant figures and calculations What is the precision of the final answer when you perform calculations? Note that your calculations should be completed in full without any rounding until the final answer.

- **Multiplication and division**

Pick the number in the initial question with the least number of significant figures. The answer has the same number of significant figures as this number.

- **Addition and subtraction**

Pick the number with the least number of decimal places. The answer has the same number of decimal places as this number.

- **A combination of (1) and (2)** Use the appropriate rule for the steps.

Note Use the rule of order in your calculations:
BIMDAS – Brackets, Indices (raising to a power), Multiplication/Division, Addition/Subtraction

Examples

(i) $36.4 \div 1.2 \times 8.345 = 2.5 \times 10^2$ (2 s.f.)

(ii) $17.54 - 1.3 = 16.2$ (1 decimal place)

(iii) $12.335 \times 6.701 - 3.2 = 86.66 - 3.2 = 83.5$ (4 s.f. from first calculation and 1 decimal place from the second)

Rounding

For practical purposes numbers are often approximated by the nearest number to a certain accuracy.

For example finding 6% of $12.30 gives $ 0.738 or 73.8 cents. Clearly this is an impractical answer and so we would round 73.8 to the nearest cent, which is 74 cents. If asking for this amount of money from a customer, we would round even further to the nearest multiple of 5 cents, which is 75 cents.

To round to a given power of ten, look to the right and determine whether the next digit is greater than 5. If so, round upwards. If less than five, round downwards. If equal to five, then mathematicians round to the nearest even number. In **science** courses the rule would be to round upwards if the next digit is equal to 5.

Examples

15.6705 rounded to 1 decimal place is 15.7 15.6705 rounded to the nearest unit is 16

15.6705 rounded to the 3rd decimal place is 15.670 (or 15.671 in a science course)

15.6705 rounded to the nearest ten is 20 15.6705 rounded to the nearest hundredth is 15.67

Practice Problems - Significant Figures and Rounding

Note *Mathematical rounding is used*

1. Specify the number of significant figures indicated in each of the following quantities or values.

(a) 307 metres (b) 26.98 kilojoules (c) 1.5200 (d) 0.001305 (e) 2750 kilograms

(f) 20.060 litres (g) 2,892,000 to the nearest thousand people (h) 1.0×10^3

2. A grain of sand is weighed and found to have a mass of 650 mg. Write this mass in scientific notation to

(a) two significant figures (b) three significant figures (c) four significant figures

3. Round the following to one decimal place.

(a) 21.92 (b) 0.871 (c) 16.05 (d) 16.051 (e) 9.0009 (f) 100.99

4. An iceberg had a mass of 9,530kg. After three weeks floating in warm currents it has lost 64% of its mass. Find its remaining mass to

(a) the nearest kilo (b) the nearest hundred kilos (c) three significant figures

5. Perform the following calculations and give the answers in scientific notation to the correct number of significant figures:

(a) 5064 x 13 (b) 405.0 x 4.0 (c) 6.02 x 5.1 ÷ 0.00034

(d) 9.54 – 3.2 + 12.007 (e) 4.35 ÷ 9.1+1.7 (f) 12.8 + 9.08 x 7.1

Solutions to Practice Problems

1. 3 , 4 , 5 , 4 , 3 , 5 , 4 , 2

2. 6.5×10^2 6.50×10^2 6.500×10^2

3. 21.9 , 0.9 , 16.0 , 16.1 , 9.0 , 101.0

4. 3431 kg , 3400 kg , 3430 kg

5. 6.6×10^4, 1.6×10^3, 9.0×10^4, 1.83×10^1, 2.2×10^0, 7.7×10^1