Significant figures and scientific notation

Significant figures (or significant digits)

Measurements can never be made with perfect accuracy. The number of significant figures are a way of expressing the precision of a measured value.

Example: A measured length of 5.00 m is more accurate than 5.0 m, and this is yet more accurate than 5 m. 5.00 m implies that the measurement made has been rounded and could be anywhere between 4.995 m and 5.004 m, while 5 m could be anywhere between 4.5 m and 5.4 m and has been rounded to the nearest meter.

Rules of thumb:

- ➢ All non-zero digits are significant
- ➢ Leading zeroes are not significant: Count the total number of digits from the left, starting at the first digit which is not zero
- ➢ In numbers with a decimal point all zeroes to the right of non-zero digits are significant
- ➢ In numbers without decimal point it is not clear whether zeroes to the right of the last non-zero digit are significant

Examples:

$\dot{3}\dot{2}.\dot{2}\dot{4}$	four significant figures
$0.0\dot{3}$	one significant figure
$\dot{6}.\dot{0}\dot{2}\dot{0}\dot{7}\dot{0}$	six significant figures
800	Not clear: could be one, two or three significant figures

Calculations

If you make calculations using numbers from a measurement, the result cannot be more precise than the *least* precise value from your measurement.

For multiplication and division:

The number of significant figures in the final result of your calculation can be no greater than in the measured value with the *least* number of significant figures. Round your result to the *lowest* number of significant figures.

Example: $W = F \cdot s$ = 32.21 N · 1.8 m = ?
32.21 N contains four significant figures, 1.8 m contains two significant figures.
⇨ The result needs to be rounded to two significant figures:
32.21 N · 1.8 s = 57.978 m = <u>58 m</u>

For addition und subtraction:

The result cannot contain more decimal places than the *least* precise measurement.

Example: $m = m_1 + m_2 + m_2$ = 11.8 kg + 6.0520 kg = ?
11.8 kg contains one decimal place, 6.0520 kg contains four decimal places
⇨ The result needs to be rounded to one decimal place:
11.8 kg + 6.0520 kg = 17.852 kg = <u>17.9 kg</u>

Normalized scientific notation

In order to avoid a situation where we do not know how many digits are significant, we write the result with only one non-zero digit to the left of the decimal point, multiplied by a power of ten.

Examples: $378'509 = 37850.9 \cdot 10^1 = 3785.09 \cdot 10^2 = 378.509 \cdot 10^3 = 37.8509 \cdot 10^4 = \underline{\underline{3.78509 \cdot 10^5}}$

$0.0003750 = 0.003750 \cdot 10^{-1} = 0.03750 \cdot 10^{-2} = 0.3750 \cdot 10^{-3} = \underline{\underline{3.750 \cdot 10^{-4}}}$