MS.4 Significant figures

videos

When we carry out a calculation, we often get a number with many digits.

For example:

Question: A train travels 400.0 metres in 23.0 seconds. What is the average speed of the train?

$$\begin{aligned} average\ speed &= \frac{total\ distance}{total\ time} \\ &= \frac{400}{23} \\ &= 17.391304347826\ m/s \end{aligned}$$

It would be incorrect to quote this as an answer because it indicates a precision that is not justified. We must round this number to reflect the true precision of the answer. This depends on the precision of the two measurements (distance and time) used to calculate it. (We return to this at the end of the worksheet.)

Significant figures tell us about the precision of a measurement.

The following table summarises the rules for working out the number of significant figures:

number	*number of significant figures*	*rule*
532	3	1) All non-zero digits are significant.
49	2	
32.5	3	
301	3	2) Zeroes between non-zero digits are significant.
32.03	4	
1.07	3	
0.035	2	3) Zeroes to the left of the first non-zero digit are not significant.
0.00704	3	
0.0006	1	
0.200	3	4) Zeroes to the right of the last non-zero digit are significant if they end to the right of the decimal point.
0.1700	4	
21.65000	7	
3200	2, 3 or 4	5) When a number ends in zeros that are to the left of the decimal point, the zeroes are not necessarily significant.
3200.0	5 (see rule 4)	
600	1, 2 or 3	
600.0	4 (see rule 4)	

1) ✎ In the following table work out the number of significant figures for each number:

number	*number of significant figures*	*rule*
1278 23467 13.54		1
2006 456.003 12.0034		2
0.031 0.00012 0.00402		3
0.120 0.65000 14.100		4
340 340.0 12000 12000.00		4 and 5

2) ✎ In the following table work out the number of significant figures for each number and indicate which rule(s) you are following.

number	*number of significant figures*	*rule*
32.001		2
0.00167		
980		
19346		
1700.000		

Using Standard Form

Using Standard Form (see worksheet MS.3) helps to avoid any doubt in working out the number of significant figures.

For example, as discussed above (rule 5), the number 3200 could contain 2, 3 or 4 significant figures. We can write this number in Standard Form to distinguish:

$$3.2 \times 10^3 \ (2\ significant\ figures)$$
$$3.20 \times 10^3 \ (3\ significant\ figures)$$
$$3.200 \times 10^3 \ (4\ significant\ figures)$$

3) ✎ In the following table, write out the number in Standard Form to the correct number of significant figures.

number	*number of significant figures*	*Standard Form*
35300	4	
590000	4	
1790000	6	
120	2	
5300	3	

Rounding Rule

"In any calculation, the answer cannot be to more significant figures than the least number of significant figures in the raw data used in the calculation."

For example, returning to the question at the start. The *distance* was 400.0 *metres* (4 sig. fig.) and the *time* was 23.0 *seconds* (3 sig. fig.). This means that the answer must be to no more than 3 significant figures (i.e. the smallest). Hence:

$$average\ speed = 17.4\ m/s \quad (3\ sig.\ fig.)$$

4) ✎ A runner runs 100.00 metres in 11.1 seconds. What was their average speed?