Determining Which Zeros Are Significant

Because zeros must be written both as place holders and as indicators of the precision of the measurement, we must learn how to distinguish between them.

1. All non-zero figures are significant:
   421 – three significant figures
2. Zeros between significant figures are significant:
   4.021; 4.201; 402.1 – four significant figures
3. Zeros after (to the right of) the decimal point after (to the right of) the number are significant:
   42.100; 421.00 – five significant figures
4. A zero standing alone before (to the left of) a decimal point is not significant:
   0.421 – three significant figures
5. Zeros after (to the right of) the decimal point and before (to the left of) the number are not significant:
   0.000421 – three significant figures
6. Zeros after (to the right of) the number and before (to the left of) the decimal point are doubtful:
   421,000 – three significant figures? or four? or five? or six?
7. To eliminate all doubt, write the number in scientific notation. In this manner, all zeros will be to the right of the decimal point and need not be written if they are not intended to be significant:
   4.2100×10^5 – five significant figures
   4.21×10^5 – three significant figures

   A bar placed *above* a zero is also acceptable:

   $4{,}210{,}\bar{0}00$ – five significant figures
   $4{,}210{,}00\bar{0}$ – seven significant figures

Examples:

56.231	**Five significant figures. No non-zero figures.**
400.91	**Five significant figures. Zeros between significant figures are significant.**
4.00	**Three significant figures. Zeros to the right of the number and to the right of the decimal point are significant.**
0.421	**Three significant figures. Zero standing alone before the decimal place is not significant.**
0.000421	**Three significant figures. Zeros after the decimal point and before the other figures are not significant.**

Dealing with Those Zeros

How many significant figures are in the following numbers?

REMEMBER that zeros are significant when they are used to indicate the precision of the measurement. They are NOT significant when they are place holders only.

Example 1: 7623142516

Ten significant figures.
Reason 1 – All non-zero figures are significant.

Example 2: 706

Three significant figures.
Reason 2 – Zeros between significant figures are significant.

Example 3: 0.00761

Three significant figures.
Reason 5 – Zeros to the right of the decimal point and the left of the number are *not* significant. They do *not* indicate the precision of the measurement. They are place holders only.
Reason 4 – See Example 5 below.

Example 4: 421.00

Five significant figures.
Reason 3 – The zeros to the right of the decimal point are not needed as place holders. They are used only to indicate the precision of the measurement, and so they are significant.

Example 5: 0.538

Three significant figures.
Reason 4 – That one zero is there only to call attention to the decimal point following it. It can be eliminated with no change in the numerical value or the precision of the measurement.

Example 6: 5,000

This is a poor way to write a measurement because it gives no indication about whether the zeros are place holders only or if they are there for precision's sake. We know that the 5 is significant (Reason 1 – All non-zero figures are significant). So the number could have one, two, three, or four significant figures. To eliminate this uncertainty, the number should be written in scientific notation:

5	**$\times 10^3$**	**one significant figure**
5.0	**$\times 10^3$**	**two significant figures**
5.00	**$\times 10^3$**	**three significant figures**
5.000	**$\times 10^3$**	**four significant figures**