Why should I care about Significant Figures?

Significant figures are important because they tell us how good the data (datum) we are using are. They tell us how PRECISE the measurements are!!!

Consider the following 3 numbers…

1. 400 g
2. 400. g
3. 400.00 g

"What's the big deal? They're all the same!!!"

Example #1: 400 g

• This number is only accurate to the hundreds spot. Therefore, this number is closer to 400 than it is to 300 or 500!

Example #2: 400. g

• This number is accurate to the ones spot. Therefore, this number is closer to 400 than it is to 401 or 399.

Example #3: 400.00 g

• This number is accurate to the "hundredths" spot. The value of what we're measuring is closer to 400.00 grams than it is to 400.01 or 399.99 grams.

If your life depended on it, what confidence level would you prefer?

Rules for determining significant figures…

1. All written non-zero numbers (i.e. 123456789) are significant.

Sample Problems… How many significant figures?

<table>
<thead>
<tr>
<th>Number</th>
<th>Significant Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>81.3</td>
<td>3</td>
</tr>
<tr>
<td>19,715,634</td>
<td>8</td>
</tr>
<tr>
<td>3,119,875</td>
<td>7</td>
</tr>
<tr>
<td>92,568,714</td>
<td>8</td>
</tr>
<tr>
<td>22</td>
<td>2</td>
</tr>
</tbody>
</table>

2. Zeros appearing between nonzero digits are significant

Sample Problems… How many significant figures?

<table>
<thead>
<tr>
<th>Number</th>
<th>Significant Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>504</td>
<td>3</td>
</tr>
<tr>
<td>509,001</td>
<td>6</td>
</tr>
<tr>
<td>4,691,003,478</td>
<td>10</td>
</tr>
</tbody>
</table>

Rules (continued)…

- **Definition**: The significant figures of a measurement or calculation consist of all the digits known with certainty plus one estimate, or uncertain, digit.
- Significant DOES NOT mean important
- Significant means MEASURED!
- With significant figures there is no reason to ask the question "Where do I round?"
Rules (continued)...

3. Zeros that appear in front of nonzero digits are NOT significant

Sample Problems... How many significant figures?
- a) 0.05 m
- b) 0.0095087 km
- c) 0.0009 kg

<table>
<thead>
<tr>
<th>Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>0.05 m</td>
<td>1</td>
</tr>
<tr>
<td>0.0095087 km</td>
<td>5</td>
</tr>
<tr>
<td>0.0009 kg</td>
<td>1</td>
</tr>
</tbody>
</table>

Rules (continued)...

4. Zeros at the end of a number AND to the right of a decimal point are significant.

Sample Problems... How many significant figures?
- a) 5.0 m
- b) 85.00 km
- c) 9.070000000 kg

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>2</td>
</tr>
<tr>
<td>85.00</td>
<td>4</td>
</tr>
<tr>
<td>9.070000000</td>
<td>10</td>
</tr>
</tbody>
</table>

Rules (continued)...

5. Zeros at the end of a number (left of decimal) may or may not be significant depending on the presence of a decimal point
- a) A decimal point placed after zeros indicates that they have been measured and are significant.
- b) Without a decimal point, there is no way of knowing if the zeros were measured or are being used as a place holder.

Sample Problems... How many significant figures?
- a) 2000
- b) 2000.
- c) 540
- d) 50.0

<table>
<thead>
<tr>
<th>Number</th>
<th>Significant Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1</td>
</tr>
<tr>
<td>2000.</td>
<td>4</td>
</tr>
<tr>
<td>540</td>
<td>2</td>
</tr>
<tr>
<td>50.0</td>
<td>3</td>
</tr>
</tbody>
</table>

Scientific Notation

- \[3.32 \times 10^{-15} \text{ kg}\]
  = 0.000000000000003320 kg
  (4 Significant Figures)

- \[2.17 \times 10^{13} \text{ m}\]
  = 21,700,000,000,000 m
  (3 Significant Figures)
**Rounding Significant Figures...**

1. You will need to round while adding, subtracting, multiplying, dividing, Etc...
2. Identify / Determine the target significant figure number
3. Round based on the next number

\[
13,475,981,100.108 \text{ m}
\]

Rounding to 3 sig figs = \(13,500,000,000 \text{ m}\)

Rounding to 11 sig figs = \(13,475,981,100. \text{ m}\)

Rounding to 6 sig figs = \(1.34760 \times 10^{10} \text{ m}\)

**Rules for adding and subtracting**

- The answer can have no more digits to the right of the decimal point than there are in the measurement with the smallest number of digits to the right of the decimal point.

\[
\begin{array}{c}
3.95 \\
2.879 \\
\hline
213.6 \\
\hline
+ 220.429 \\
\hline
Correct Answer = 220.4
\end{array}
\]

\[
\begin{array}{c}
12.52 \\
349.0 \\
8.24 \\
\hline
829.76 \\
\hline
+ 369.76 \\
\hline
Correct Answer = 369.8
\end{array}
\]

\[
\begin{array}{c}
74.626 \\
28.34 \\
\hline
46.286 \\
\hline
- 46.29 \\
\hline
Correct Answer = 46.29
\end{array}
\]

**Rules for Multiplication and Division**

- The answer can have no more significant figures than there are in the measurement with the smallest number of significant figures.

\[
\begin{array}{c}
12.257 \quad \text{5 Sig Figs} \\
\times 1.162 \quad \text{4 Sig Figs} \\
\hline
14.246340 \quad \text{5 Sig Figs}
\end{array}
\]

Correct Answer = 14.24

\[
\begin{array}{c}
2.4526 \quad \text{5 Sig Figs} \\
+ 8.4 \quad \text{2 Sig Figs} \\
\hline
0.291976 \quad \text{2 Sig Figs}
\end{array}
\]

Correct Answer = 0.29

**Order of operations**

- You must state your numbers in terms of significant figures as you move from one order of operations to the next!

\[
(99.6 + 2.13) \times 0.0150870 = \frac{1.534}{1}
\]

Parenthesis
Exponents
Multiply
Divide
Add
Subtract
Basic rules

• 1. Adding & Subtracting can change the number of significant figures in an answer.

• 2. Significant figures in multiplication and division problems are determined by the smallest number of sig. figs. in the given information.

Remember...

“Your final answer can only be as precise as your least precise number!”