Worksheet 1 - Calculations

**Significant Figures** - The number of significant figures (sig. fig.) is a measure of the degree of uncertainty in a measurement. There is experimental uncertainty in the last significant figure of a measurement. The rules for sig. fig. are given in Chapter 1.5. All non-zero numbers are significant. Zeros between numbers are significant. Zeros to the left of numbers are not significant. Zeros to the right of numbers may be significant (in presence of a decimal point).

1. Express each of the following numbers in **scientific notation** and decide the number of significant figures:

<table>
<thead>
<tr>
<th>Scientific notation</th>
<th>sig.fig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>409.10</td>
<td>________</td>
</tr>
<tr>
<td>4091.00</td>
<td>________</td>
</tr>
<tr>
<td>0.004091</td>
<td>________</td>
</tr>
<tr>
<td>308,000</td>
<td>________</td>
</tr>
<tr>
<td>30.860</td>
<td>________</td>
</tr>
<tr>
<td>0.00056030</td>
<td>________</td>
</tr>
</tbody>
</table>

**Calculations with significant figures** - In **multiplication** or **division**, the number of sig. fig. in the answer has only as many sig. fig. as the factor with the smallest number of sig. fig.

\[
\frac{(0.46307)(0.0805)}{(63.54)(0.052)(2.809)} = 0.004016430 \\
\text{2 sig. fig. - limiting factor}
\]

which rounds to .0040 or 4.0 \times 10^{-3} (2 sig. fig.)

In **addition** and **subtraction**, the answer should be reported to the same number of decimal places as the term with the least number of decimal places.

\[
37.598 - 36.76 = 0.838 \\
\text{2 decimal places - limiting factor}
\]

which rounds to 0.84 or 8.4 \times 10^{-1}

Do addition and subtraction first. When rounding, numbers \( \geq 5 \) are rounded up. Do not round until the end of the calculations.
2. Do the following calculations and express the answers to the correct number of sig. fig.

\[
29.837 - 29.241 = 0.596
\]

\[
752.12 + 26.3 = 778.42
\]

**Dimensional Analysis** - This technique can be used to change units (K → °C) and also as an aid in solving problems, by carefully keeping track of units. SI Units and conversion factors are listed in Appendix 6 (A26) in the textbook. A table of metric to English conversion factors is on page 16 of the textbook.

*A certain process yields \(4.85 \times 10^{-2}\) g of a chemical product per second. How many kilograms will be produced in five days of continuous reaction?*

Start with what you know on the left and what you are trying to find on the right.

\[
\frac{4.85 \times 10^{-2}\text{ g}}{s} = \text{___ kg}
\]

Then find **conversion factors**, which allow you to change your units.

\[
\begin{align*}
4.85 \times 10^{-2}\text{ g} & \quad 60\text{ s} & 60\text{ min} & 24\text{ h} & 5\text{ days} & 1\text{ kg} = 20.95200\text{ kg} \\
\text{s} & \quad \text{min} & \quad \text{h} & \quad \text{day} & \quad 10^3\text{ g}
\end{align*}
\]

Finally, determine the number of sig. fig. The first term has 3 sig. fig. All of the other factors are definitions, and have \(\infty\) sig. fig. So, the answer will be limited to 3 sig. fig., 21.0 kg.

In the **conversion factors** the value of the numerator and denominator are the same; 60 seconds = 1 minute, 24 hours = 1 day. The final conversion unit illustrates the use of **metric prefixes**; 1000 grams = 1 kilogram. It is important to know these commonly used prefixes.

3. Fill in the missing information in the following chart.

<table>
<thead>
<tr>
<th>Metric prefix</th>
<th>Symbol</th>
<th>Exponent</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td></td>
<td>(10^{-9})</td>
</tr>
<tr>
<td>deci</td>
<td></td>
<td>(10^{-6})</td>
</tr>
<tr>
<td>kilo</td>
<td>p</td>
<td>(10^{-2})</td>
</tr>
</tbody>
</table>
4. A volume of 520. cm³ is equivalent to:
   _____ mL       _____ dL       _____ L

5. Make the following conversions (Express your answer in **scientific notation**.)
   a. 0.0024 km to nm
   b. 3.5 g/dm³ to mg/mm³
   c. 95 yards to cm (3 feet in a yard; 2.54 cm in 1 inch)

6. You feel a bit feverish and take your temperature with a lab thermometer, marked in degrees kelvin. It reads 310 K. What is your Fahrenheit temperature?
   [Remember \( ^{o}F = 1.8 \times ^{o}C + 32 \) and \( K = ^{o}C + 273 \)]

Work on the following problems, paying attention to sig. fig.

7. Write down your height. Convert it to meters (m.)
   ___ ft. ___ in. = ___ m.

8. A child's sandbox is 4.0 ft. wide, 4.0 ft. long and 9.0 in deep. If there are, on the average, 55 grains of sand per mm³, how many grains of sand are there in the sandbox?