Welcome to Grade 11 Chemistry!

Scientific Notation, SI and Unit Conversions

By the end of class you should be able to:
1. Convert numbers to and from scientific notation
2. Convert SI measurements to and from their base units
3. Use unit analysis and conversion factors to convert between different units
1. Scientific Notation

In science we often deal with very large or very small numbers which are difficult to write. We use scientific notation to make these numbers easier to read, and to show the correct number of significant digits.

- **speed of light**
  - 300,000,000 m/s
  - \(3.0 \times 10^8\) m/s

- **The Sun**
  - 1.3 \(\times\) 10^9 m diameter

- **mass of an electron**
  - 0.000000000000000000910938 kg
  - \(9.10938 \times 10^{-31}\) kg

- **Red Blood Cell**
  - 7 \(\times\) 10^-6 m diameter

- **Nucleus of an atom**
  - 1 \(\times\) 10^-14 m diameter

What do you notice about the exponents of big vs small numbers?

[Image of exponents]

**Common Notation to Scientific Notation**

Move the decimal place so that there is one number to the left of it. Then, count the number of spaces the decimal was moved and write this number in the exponent.

- **To convert a number bigger than 1 to scientific notation** move the decimal to the left. The exponent will be positive.
  - 120 = \(1.2 \times 10^2\)
  - 5678 = \(5.678 \times 10^3\)
  - 690.9 = \(6.909 \times 10^2\)

- **To convert a number smaller than 1 to scientific notation** move the decimal to the right. The exponent will be negative.
  - 0.000800 = \(8.00 \times 10^{-4}\)
  - 0.000 000 76 = \(7.6 \times 10^{-7}\)
  - 0.12345 = \(1.2345 \times 10^{-1}\)
### Convert into scientific notation

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) 3.400</td>
<td>3.4 x 10³</td>
<td></td>
</tr>
<tr>
<td>2) 0.000023</td>
<td>2.3 x 10⁻⁵</td>
<td></td>
</tr>
<tr>
<td>3) 101,000</td>
<td>1.01 x 10⁵</td>
<td></td>
</tr>
<tr>
<td>4) 0.010</td>
<td>1.0 x 10⁻²</td>
<td></td>
</tr>
<tr>
<td>5) 45.01</td>
<td>4.501 x 10¹</td>
<td></td>
</tr>
<tr>
<td>6) 1,000,000</td>
<td>1 x 10⁶</td>
<td></td>
</tr>
<tr>
<td>7) 0.00671</td>
<td>6.71 x 10⁻³</td>
<td>10⁰ = 1</td>
</tr>
<tr>
<td>8) 4.50</td>
<td>4.50 x 10⁰</td>
<td></td>
</tr>
</tbody>
</table>

### Scientific Notation to Common Notation

Move the decimal place the number of times indicated by the exponent.

If the exponent is **positive**, move the decimal **right**.

- \(1.2034 \times 10^2 = 120.34\)
- \(5.6 \times 10^3 = 5600\)
- \(6.400 \times 10^5 = 640000\)

If the exponent is **negative**, move the decimal **left**.

- \(3 \times 10^{-4} = 0.0003\)
- \(4.56 \times 10^{-10} = 0.0000000000456\)
- \(1.200 \times 10^{-1} = 0.1200\)
2. SI Units
Scientists have developed a common set of international rules for expressing their measurements.

The Fundamental SI Units

<table>
<thead>
<tr>
<th>Physical Quantity</th>
<th>Name of Unit</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass</td>
<td>kilogram</td>
<td>kg</td>
</tr>
<tr>
<td>Length</td>
<td>meter</td>
<td>m</td>
</tr>
<tr>
<td>Temperature</td>
<td>kelvin</td>
<td>K</td>
</tr>
<tr>
<td>Amount of substance</td>
<td>mole</td>
<td>mol</td>
</tr>
<tr>
<td>Time</td>
<td>second</td>
<td>s</td>
</tr>
<tr>
<td>Electric current</td>
<td>ampere</td>
<td>A</td>
</tr>
<tr>
<td>Luminous intensity</td>
<td>candela</td>
<td>cd</td>
</tr>
</tbody>
</table>

Unit Conversions and Significant Figures: Crash Course Chemistry #2 (11 min) Great Video!
http://www.youtube.com/watch?v=hQpQ0hxVNTg
SI Unit Conversions

The factor prefix chart shows prefixes we will use in front of the fundamental SI units. Replace the symbol given with the corresponding factor.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Prefix</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>10^9</td>
<td>giga</td>
<td>G</td>
</tr>
<tr>
<td>10^6</td>
<td>mega</td>
<td>M</td>
</tr>
<tr>
<td>10^3</td>
<td>kilo</td>
<td>k</td>
</tr>
<tr>
<td>10^-2</td>
<td>centi</td>
<td>c</td>
</tr>
<tr>
<td>10^-3</td>
<td>milli</td>
<td>m</td>
</tr>
<tr>
<td>10^-6</td>
<td>micro</td>
<td>μ</td>
</tr>
<tr>
<td>10^-9</td>
<td>nano</td>
<td>n</td>
</tr>
<tr>
<td>10^-12</td>
<td>pico</td>
<td>p</td>
</tr>
</tbody>
</table>

3.4 GW
= 3.4 x 10^9 W

45 cm
= 45 x 10^-2 m
= 4.5 x 10^-1 m

0.33 km
= 0.33 x 10^3 m
= 3.3 x 10^2 m

3. Unit Analysis

To convert measurements to different units, use conversion factors as fractions.

ex. \( \frac{100 \text{ cm}}{1 \text{ m}} = 1 \)

To convert 5 m to cm:
5 m x \( \frac{100 \text{ cm}}{1 \text{ m}} \) = 500 cm

Cross out units that appear on both the top and bottom.

Convert the following measurements to the units indicated, then put your answer into scientific notation.

1) 3.1 km to m
3.1 km x \( \frac{1000 \text{ m}}{1 \text{ km}} \) = 3.1 x 10^3 m

2) 4.2 kg to \( \mu \)g
Hint: start by converting to the base unit (g)
4.2 kg x \( \frac{1000 \text{ g}}{1 \text{ kg}} \) x \( \frac{1 \mu \text{ g}}{1 \times 10^6 \text{ g}} \) = 4.2 x 10^9 \( \mu \)g

= 4.2 x 10^{10} \( \mu \)g
3) How many seconds are there in 2 weeks?

\[
2 \text{ weeks} \times \frac{7 \text{ days}}{1 \text{ week}} \times \frac{24 \text{ h}}{1 \text{ day}} \times \frac{60 \text{ min}}{1 \text{ h}} \times \frac{60 \text{ s}}{1 \text{ min}} = 1,209,600 \text{ s}
\]

4) \(8 \text{ km} \text{ to} \frac{m}{h} \text{ to} \frac{s}{m}

\[
8 \text{ km} \times \frac{1,000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ h}}{60 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ s}} = 2.2 \text{ m/s}
\]

1 Scientific Notation & SI

1.1 Scientific Notation

In science we frequently encounter numbers which are difficult to write in the traditional way - velocity of light, mass of an electron, distance to the nearest star. Scientific notation, or standard notation, is a technique, using powers of ten, for concisely writing unusually large or small numbers.

Practice

1. Express each of the following in scientific notation.
   (a) 6,807
   (b) 0.000 053
   (c) 39,879 280 000
   (d) 0.000 000 813
   (e) 0.070 40
   (f) 400 000 000 000
   (g) 0.00
   (h) 68

2. Express each of the following in common notation.
   (a) \(7 \times 10^1\)
   (b) \(5.2 \times 10^3\)
   (c) \(8.3 \times 10^9\)
   (d) \(10.1 \times 10^2\)
   (e) \(6.386 \times 10^3\)
   (f) \(4.086 \times 10^5\)
   (g) \(6.3 \times 10^2\)
   (h) \(35.0 \times 10^3\)
More Unit Conversions
Convert the following units AND put your final answer into scientific notation.
1) 0.89 L into mL

2) 1.2 \times 10^{-3} \text{ km} \text{ into mm}

3) 790 mL into L

4) How many inches in 62 centimeters? (2.54 centimeters = 1 inch)

5) Calculate how many seconds old you will be at midnight.
Homework
1) All Scientific Notation and Unit Conversion questions in this booklet
2) The Gold Dust Kid (review elements)