

## Scientific (Exponential) Notation

### key concepts:

- **Scientific notation** is an efficient means of expressing extremely large and small numbers.
- To add numbers in scientific notation, they must both be expressed to the same power of ten.
- To multiply or divide numbers in scientific notation, consider the number and power parts separately.
- For powers and roots of numbers in scientific notation, consider the number and power parts separately.

<p><b>Example:</b></p> <table border="1"> <thead> <tr> <th></th> <th>scientific notation</th> </tr> </thead> <tbody> <tr> <td> <p>Avogadro's number 602 213 700 000 000 000 000 000 decimal point moves 23 places to the left</p> </td> <td> <p><math>6.022 \times 10^{23}</math> positive exponent</p> </td> </tr> <tr> <td> <p>0.000371 four places to the right</p> </td> <td> <p><math>3.71 \times 10^{-4}</math> negative exponent</p> </td> </tr> </tbody> </table>		scientific notation	<p>Avogadro's number 602 213 700 000 000 000 000 000 decimal point moves 23 places to the left</p>	<p><math>6.022 \times 10^{23}</math> positive exponent</p>	<p>0.000371 four places to the right</p>	<p><math>3.71 \times 10^{-4}</math> negative exponent</p>	<p>Scientific notation is an efficient means of expressing extremely large and small numbers.</p> <p>In scientific notation, numbers are expressed in the form <math>r \times 10^t</math>, where <math>r</math> is a number greater than or equal to one and less than ten and <math>t</math> is an integer. For example, <b>Avogadro's number</b> can be expressed in scientific notation as <math>6.022 \times 10^{23}</math>.</p> <p>If the decimal point is moved to the left, <math>t</math> is a positive integer. If the decimal point is moved to the right, <math>t</math> is a negative exponent.</p>
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<p><math>3.94 + (6.7 \times 10^{-1}) = 4.61</math></p> <p>equal to one</p> <p><math>(3.94 \times 10^0) + (0.67 \times 10^0) = (4.61 \times 10^0) = 4.61</math></p> <p>Not in scientific notation!</p>	<p>To add numbers in scientific notation, they must both be expressed to the same power of ten. For example, to add <math>3.94</math> and <math>6.7 \times 10^{-1}</math>, express both to the same power of ten.</p> <p>Once both numbers are expressed to the same power of ten, simply add them together. If the result is no longer in proper scientific notation, the decimal place might have to be moved to the left or right and the power of ten adjusted accordingly.</p>						
<p><math>(3.94 \times 10^2) \cdot (6.7 \times 10^{-3})</math></p> <p><math>= (3.94 \cdot 6.7) \times 10^{(2+(-3))}</math></p> <p><math>= 26.398 \times 10^{-1}</math></p> <p>to two significant figures</p> <p><math>= 26 \times 10^{-1}</math></p> <p>shift decimal to express in scientific notation</p> <p><math>= 2.6</math></p>	<p>To multiply or divide numbers in scientific notation, consider the number and power parts separately.</p> <p>For example, to multiply <math>3.94 \times 10^2</math> by <math>6.7 \times 10^{-3}</math>, multiply <math>3.94</math> by <math>6.7</math>, and add the exponents together.</p> <p>Similarly, to divide <math>3.94 \times 10^2</math> by <math>6.7 \times 10^{-3}</math>, divide <math>3.94</math> by <math>6.7</math>, and subtract the second exponent from the first. This yields <math>0.59 \times 10^5</math>, or <math>5.9 \times 10^4</math> in proper scientific notation.</p>						

## Scientific (Exponential) Notation

$(r \times 10^t)^b = r^b \times 10^{(t \cdot b)}$ $(6.7 \times 10^{-1})^4 = (6.7)^4 \times 10^{(-1 \cdot 4)}$ $= 2015 \times 10^{-4}$ $= (2.015 \times 10^3) \times 10^{-4}$ $= 2.015 \times 10^{(3+(-4))}$ <p><i>Round to the correct number of significant figures.</i></p> $= 2.0 \times 10^{-1}$	<p>For powers and roots of numbers in scientific notation, consider the number and power parts separately.</p> <p>To raise a number in scientific notation (<math>r \times 10^t</math>) to the power <math>b</math>, raise <math>r</math> to the <math>b</math> and multiply <math>t</math> times <math>b</math>.</p>
$\sqrt[b]{r \times 10^t} = r^{\frac{1}{b}} \times 10^{\frac{t}{b}}$ $\sqrt{9.67 \times 10^{-4}}$ $= (9.67 \times 10^{-4})^{\frac{1}{2}}$ $= 9.67^{\frac{1}{2}} \times 10^{\frac{-4}{2}}$ $= 3.11 \times 10^{-2}$	<p>Similarly, to take the <math>b</math>th root of a number in scientific notation (<math>r \times 10^t</math>), take the <math>b</math>th root of <math>r</math> and divide <math>t</math> by <math>b</math>.</p>