

## Significant figures

When doing math in science, it is sometimes tempting to use numbers with long decimals. Believe it or not, this is not good. In science, we don't want to use more numbers than we have to. So, we learn which numbers are important. Here are some examples:

$$\begin{array}{r} 3.04 \\ +2.7482547 \\ \hline \end{array}$$

In this problem, the first number has only three important digits. Even though we can add them together, the extra decimal numbers really don't matter. In science, all we need to do is round the bottom number to three important digits. It would round to 2.75. That makes math easier.

When you add, look at the decimals. The one with the shorter decimal rules. You round the longer number to the shorter place. When multiplying, the shorter decimal rules again. Look here:

$$\begin{array}{r} 123 \\ \times 5.35 \\ \hline \end{array}$$

The top number has no decimal. The bottom number has two decimal places. Although you will probably use a calculator for the math, round to zero places.

What you will have to do in these assignments is figure out how many digits are significant. Most of the time it's easy to tell. Just count the numbers. Zeros are tricky. Here are the rules:

Zeros between non-zero digits are significant.

Example: 50.3 has three significant figures, and 3.0025 has five.

Zeros in front of non-zero digits are NOT significant.

Example: 0.892 has three significant figures, and 0.00008 has one.

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

Example: 57.00 has four significant figures. 2.00000 has six.

Zeros at the end of a number but to the left of the decimal may or may not be significant.

If they were measured carefully, they are, but if an estimate, they're not.

Example: 1000 may have one or four significant figures. If you want it to express four figures, place a decimal at the end, and you know for certain it's four. The number 20 may have one or two. For our work, assume the max.

### **Reminders on rounding (this is DIFFERENT for significant figures):**

Whenever the last digit is 0-4, round down.

When the last digit is 6-9, round up.

If the last significant number is a five followed by other numbers, round UP.

*When it's a five, and the number before it is even, round DOWN.*

When it's a five, and the number before it is odd, round UP.

The item in italics is different from regular math rules.

# Scientific Notation

Science deals with numbers that are very large and very small. Suppose you had to count the number of atoms in a grain of salt. The number is so huge it can hardly be understood. The number of molecules in one gram of hydrogen (the weight of one paperclip) is:

602,200,000,000,000,000,000

Too many to think about. More than 602 septillion atoms are there. We need an easier way to handle numbers that are very large, or very, very small.

Here's how to do scientific notation. We pay attention to the first number. Everything else goes into decimals. We count how many numbers we have removed. If you count the number above, you'll see we got rid of 23 numbers. In scientific notation, this number will look like this:

$6.022 \times 10^{23}$

The 6.022 are the important digits. The 10 is just a place holder. It is just a way of writing the number down. The other important part is the 23. (It's called the exponent.) That's how many numbers we threw away. It works for really small numbers too. Look at this one:

0.000000000000000000000000000004

Very annoying. Again, we count how many places we move the decimal to only get one number in front. We have to move the decimal 26 places. But this time, we're moving it the other way. Here's how that looks:

$4 \times 10^{-26}$

So huge numbers become easy to work with. Here's some help.

Adding:

If the exponents are the same, just add the front numbers.  $(5 \times 10^{-15}) + (3 \times 10^{-15})$  is just  $8 \times 10^{-15}$

The same is true of subtracting. If different, move the decimals and exponents until alike:

$3 \times 10^{78} + 4 \times 10^{75}$  (Move the decimal on the 3 three places until we have  $3000 \times 10^{75}$ )

Then just add.  $(3000 \times 10^{75}) + (4 \times 10^{75}) = 3004 \times 10^{75}$ . Now move everything back so we only have one number in front. We have  $3.004 \times 10^{78}$  as our final answer.

Multiplying.

When we multiply scientific notation, we multiply the front numbers, and then add the exponents. Here's an example.

$(3 \times 10^5)(2 \times 10^7) = 6 \times 10^{12}$

If the numbers get complicated, just follow step by step.

$(5 \times 10^{-34})(9 \times 10^{22}) = 45 \times 10^{-12}$  This isn't scientific notation yet, so we move the decimal so only one number is in front. We will end up with  $4.5 \times 10^{-11}$ .

I'll help you through this, but this paper is your guide.

Name \_\_\_\_\_

Period \_\_\_\_\_

## Numbers in Science

How many significant figures are in the following measurements?

- |    |                     |     |                    |
|----|---------------------|-----|--------------------|
| 1. | 300,000,000         | 2.  | $3.00 \times 10^8$ |
| 3. | 25.030              | 4.  | 0.0006070          |
| 5. | 1.0004              | 6.  | 0.000350           |
| 7. | $3.788 \times 10^4$ | 8.  | 0.0032             |
| 9. | 20007               | 10. | 0.045              |

Change the following to scientific notation.

- 3,000,000,000,000
- 0.000000004
- 740,000,000
- 0.0093
- 5743

Change the scientific notation into regular numbers.

- $3 \times 10^{17}$
- $2.5 \times 10^{-5}$

Do the math using scientific notation.

- $(4 \times 10^{14}) + (2 \times 10^{14}) =$
- $(3 \times 10^6) \times (1 \times 10^7) =$
- $(5 \times 10^{-4}) \times (7 \times 10^{14}) =$

BONUS

- $(5.73 \times 10^{14}) + (4.3 \times 10^{15}) =$