Scientific Notation
Introduction:
Scientific notation is a shorthand way to express large or tiny numbers. Since you will need to do calculations throughout the year WITHOUT A CALCULATOR, we will consider anything over 1000 to be a large number. Writing these numbers in scientific notation will help you do your calculations much quicker and easier and will help prevent mistakes in conversions from one unit to another. Like the metric system, scientific notation is based on factors of 10. A large number written in scientific notation looks like this:

$$1.23 \times 10^{11}$$

The number before the x (1.23) is called the <u>coefficient</u>. The coefficient must be greater than 1 and less than 10. The number after the x is the base number and is always 10. The number in superscript (11) is the <u>exponent</u>.

Part I: Writing Numbers in Scientific Notation
To write a large number in scientific notation, put a decimal after the first digit. Count the number of digits after the decimal you just wrote in. This will be the exponent. Drop any zeros so that the coefficient contains as few digits as possible.

> *Example*: 123,000,000,000
>
> > *Step 1: Place a decimal after the first digit.* 1.23000000000
> > *Step 2: Count the digits after the decimal…there are 11.*
> > *Step 3: Drop the zeros and write in the exponent.* 1.23×10^{11}

Writing tiny numbers in scientific notation is similar. The only difference is the decimal is moved to the left and the exponent is a negative. A tiny number written in scientific notation looks like this:

$$4.26 \times 10^{-8}$$

To write a tiny number in scientific notation, move the decimal after the first digit that is not a zero. Count the number of digits before the decimal you just wrote in. This will be the exponent as a negative. Drop any zeros before or after the decimal.

> *Example*: .0000000426
>
> > *Step 1*: 00000004.26
> > *Step 2: Count the digits before the decimal…there are 8.*
> > *Step 3: Drop the zeros and write in the exponent as a negative.* 4.26×10^{-8}

Part II: Adding and Subtracting Numbers in Scientific Notation
To <u>add</u> or <u>subtract</u> two numbers with exponents, the exponents must be the same. You can do this by moving the decimal one way or another to get the exponents the same. Once the exponents are the same, add (if it's an addition problem) or subtract (if it's a subtraction problem) the coefficients just as you would any regular addition problem (review the previous section about decimals if you need to). The exponent will stay the same. Make sure your answer has only one digit before the decimal – you may need to change the exponent of the answer.

> *Example*: $1.35 \times 10^{6} + 3.72 \times 10^{5} = ?$
> > *Step 1: Make sure both exponents are the same. It's usually easier to go with the larger exponent so*
> > *you don't have to change the exponent in your answer, so let's make both exponents 6 for this*
> > *problem.*
> > $$3.72 \times 10^{5} \rightarrow .372 \times 10^{6}$$
> > *Step 2: Add the coefficients just as you would regular decimals. Remember to line up the decimals.*

$$1.35$$
$$+ .372$$
$$1.722$$

Step 3: Write your answer including the exponent, which is the same as what you started with.

$$1.722 \times 10^6$$

Part III: Multiplying and Dividing Numbers in Scientific Notation

To <u>multiply</u> exponents, multiply the coefficients just as you would regular decimals. Then add the exponents to each other. The exponents DO NOT have to be the same.

Example: 1.35×10^6 X $3.72 \times 10^5 = ?$

    Step 1: Multiply the coefficients.

$$1.35$$
$$x\ 3.72$$
$$270$$
$$9450$$
$$\underline{40500}$$
$$50220 \rightarrow 5.022$$

    Step 2: Add the exponents.

$$5 + 6 = 11$$

    Step 3: Write your final answer.

$$5.022 \times 10^{11}$$

To <u>divide</u> exponents, divide the coefficients just as you would regular decimals, then subtract the exponents. In some cases, you may end up with a negative exponent.

Example: 5.635×10^3 / $2.45 \times 10^6 = ?$

    Step 1: Divide the coefficients.

$$5.635 / 3.45 = 2.3$$

    Step 2: Subtract the exponents.

$$3 - 6 = -3$$

    Step 3: Write your final answer.

$$2.3 \times 10^{-3}$$

Practice: Remember to show all your work, include units if given, and NO CALCULATORS! All work and answers go on your answer sheet.

Write the following numbers in scientific notation:
1. 145,000,000,000
2. 13 million
3. 435 billion
4. .000348
5. 135 trillion

6. 24 thousand

Complete the following calculations:
7. $3 \times 10^3 + 4 \times 10^3$
8. $4.67 \times 10^4 + 323 \times 10^3$
9. $7.89 \times 10^{-6} + 2.35 \times 10^{-8}$
10. $9.85 \times 10^4 - 6.35 \times 10^4$
11. $2.9 \times 10^{11} - 3.7 \times 10^{13}$
12. $1.278 \times 10^{-13} - 1.021 \times 10^{-10}$
13. three hundred thousand plus forty-seven thousand
14. 13 million minus 11 thousand
15. $1.32 \times 10^8 \times 2.34 \times 10^4$
16. $3.78 \times 10^3 \times 2.9 \times 10^2$
17. three million times eighteen thousand
18. one thousandth of seven thousand
19. eight ten-thousandths of thirty-five million
20. $3.45 \times 10^9 / 2.6 \times 10^3$
21. $1.98 \times 10^{-4} / 1.72 \times 10^{-6}$
22. twelve thousand divided by four thousand