Scientific Notation

Video Notes
In this lesson you will

- Express numbers in the correct scientific notation
- Convert from scientific to decimal notation
- Convert from decimal to scientific notation
- Use a calculator to work problems in scientific notation
How do you write VERY big Numbers in a small space?

• Say you had 1,000,000 atoms multiplied by 1,000,000 atoms. You would have a total of 1,000,000,000,000 atoms… That is a large number to write.

• Scientists use a method called **Scientific Notation** to express Very Large Numbers.
Scientific Notation

- \( M \times 10^n \)
- Also called exponential notation
- Rules:
  - \( M \) is \( \geq 1 \), but less than 10
  - Number is multiplied by 10 and raised to a power (n)
  - \( n \) is the number of places before or after the decimal.
  - Examples:
    - 567 = 5.67 \times 10^2
    - 0.000567 = 5.67 \times 10^{-4}
Examples to try--mark C for correct form, I for incorrect form

• 1) $9.2 \times 10^2$
• 2) $0.4 \times 10^{-14}$
• 3) $1.8 \times 2^5$
• 4) $860 \times 10^{-3}$
• 5) $9.898989887 \times 10^1$
1) 9.2 \times 10^2 \textbf{Correct}

2) 0.4 \times 10^{-14} \textbf{Incorrect}- the number is less than 1, the calculator will automatically place this in correct notation if entered into the calculator.

3) 1.8 \times 2^5 \textbf{Incorrect}- the number is not multiplied by 10

4) 860 \times 10^{-3} \textbf{Incorrect}- the number is greater than 10 calculator may correct this one as well

5) 9.898989887 \times 10^1 \textbf{Correct}, although placing this number in Scientific Notation does not make anything simpler about this number.
Change from Scientific Notation to Decimal Notation

• Power of 10- what does it mean?
  ◦ You are simply multiplying by 10 the number of times that are listed in the exponent.
  ◦ **Even Simpler**- Move the decimal the number of times listed in the exponent!
  ◦ Positive exponent- move the decimal to the right the number of times of the exponent
    ▪ $2.1 \times 10^3 = 2,100$
  ◦ Negative exponent- move the decimal to the left the number of times of the exponent
    ▪ $2.1 \times 10^{-3} = 0.0021$
Your turn- Problem set 1

• A. 2.4 \times 10^{-5}
• B. 7.06 \times 10^{3}
• C. 6 \times 10^{6}
• D. 1.949 \times 10^{2}
• E. 2.5007 \times 10^{-1}
Problem set 1 answers

• **A. 2.4 x 10^{-5}**
  ○ Tells you to divide by 10 five times. This moves the decimal to the left 5 times. Answer is 0.000024.

• **B. 7.06 x 10^{3}**
  ○ Tells you to multiply by 10 three times. This moves the decimal to the right 3 times. The answer is 7060.

• **C. 6 x 10^{6}**
  ○ Tells you to multiply by 10 six times. This moves the decimal to the right 6 times. You will need to add zeros after the 6 to fill the places. The answer is 6,000,000.
Problem set 1 answers continued

• D. $1.949 \times 10^2$
  ○ Tells you to multiply by 10 two times. This moves the decimal to the right 2 times. The answer is 194.9

• E. $2.5007 \times 10^{-1}$
  ○ Tells you to divide by 10 one time. This moves the decimal to the left one time. The answer is 0.25007
Changing from Decimal Notation to Scientific Notation

• Numbers are BIG in Chemistry.... Think about Avogadro's number!
• 602,000,000,000,000,000,000,000

• Again, this is easy!
• With Avogadro's number, place the decimal behind the 6 (remember the number must be greater than one, but less than 10.
• Count the number of numbers after the 6. This is the exponent number. Remember this will be positive as the actual number is greater than 1. In this case the answer will be 23, so the scientific notation is 6.02 x 10^{23}. 
Changing from Decimal Notation to Scientific Notation, continued

• Some examples!
• $567 = 5.67 \times 10^2$
• $0.667 = 6.67 \times 10^{-1}$ (remember, this number is less than 1 to begin with, so the exponent must be negative- divide by 10).
• One more- $3456000 = 3.456 \times 10^6$ Notice, I can drop the extra zeros after the 6 when using scientific notation. They are still there, just not necessary for representation!
Problem set 2- place each of the numbers in scientific notation

• A. 6,011,000
• B. 0.058
• 35
• 0.009009
• 6.732104
Problem set 2 answers

• A. 6,011,000 = \(6.011 \times 10^6\) Positive exponent because the number is greater than 1.
• B. 0.058 = \(5.8 \times 10^{-2}\) Negative exponent because the number is less than 1
• 35 = \(3.5 \times 10^1\)
• 0.009009 = \(9.009 \times 10^{-3}\)
• 6.732104 = looks like a trick because it is already a number that is greater than 1 or less than 10, but you can place this in scientific notation by giving 10 a power of 0. This simply means to multiply by 1. The answer is \(6.732104 \times 10^0\)
Common Chemistry numbers!

• Avogadro’s number
  ○ 602,000,000,000,000,000,000,000,000
  ○ In SN: 6.02 x 10^{23}

• Mass of an atom
  ○ 0.0000000000000000000000000000091
  ○ 9.1 x 10^{-31}

• Can you see how SN is helpful??
SN on the Calculator

• You need a scientific calculator… Ready to play?

• Find the Exp or EE button. This is the button to enter the exponent.
• To enter a number with an exponent, enter the number, press the EXP or EE button then the exponent number (it is not necessary to input the 10)
• $(2 \times 10^3) \times 4 = 8000$

• Try it! See if your calculator gives you the answer desired…
• Remember to not enter the 10, otherwise your answer might be 80,000.
Your Turn-Try these on your calculator!

• A. \((6 \times 10^4) \times (5 \times 10^8)\) =

• B. \((3 \times 10^{-3}) / (6 \times 10^4)\) =

• 1 inch Copper cube- 100,000,000 \times 100,000,000 atoms on the surface = what? Plug this into your calculator using SN and give an answer using SN.
Try these answers

- A. \(3 \times 10^{13}\)
- B. \(5 \times 10^{-8}\)
- C. Copper Cube-
  \(\circ (1 \times 10^8) \times (1 \times 10^8) = 1 \times 10^{16}\)
Volume of a block

- Suppose a block has a length of 4.2, a width of 8.3, a height of 12.5. What is the volume in SN?
Volume of a block

- $12.5 \times 8.3 \times 4.2 = 435.74 \text{ cm}^3$
- $4.3574 \times 10^2 \text{ cm}^3$

- Remember, the answer your calculator gave is more specific than the measurements you put in your calculator, so for now, you can report your answer as $4.3 \times 10^2 \text{ cm}^3$ (your answer should have the same number of digits as your measurements).
Chemistry Quiz

• CR 1. In an experiment, the variable deliberately changed by the scientist is called:
  1. Control variable
  • Manipulated variable
  • Responding variable
Chemistry Quiz

• CR 2. What is the volume of a cube if each side measures 2.0 cm?
  ○ A. 8.0 cm
  ○ B. 8.0 cm³
  ○ C. 2.0 cm
  ○ D. 6.0 cm³
M x 10^n

1. numbers in scientific notation must be expressed in this form where...
   - A. M is one and n is greater than or equal to one but less than ten.
   - B. M is greater than or equal to one but less than ten and n is one
   - C. n is greater than or equal to one but less than ten
   - D. M is greater than or equal to one but less than ten.
Chemistry Quiz

2. Which of the following is correct scientific notation?
   - A. 16.5 \times 10^3
   - B. 3.0 \times 3^3
   - C. 1.3 \times 10^3
   - D. 0.54 \times 10^3
Chemistry Quiz

• 3. Express 0.0003 in correct scientific notation.
  ○ A. $0.0003 \times 10^1$
  ○ B. $2 \times 10^4$
  ○ C. $3 \times 10^{-4}$
  ○ D. $0.3 \times 10^4$
Chemistry Quiz

4. Multiply $3 \times 10^2$ times $2 \times 10^{-3}$ with your calculator:
   - A. $6 \times 10^{-1}$
   - B. $6 \times 10^1$
   - C. 6
   - D. $6 \times 10^5$
Chemistry quiz answers

• Cr1. b
• Cr2. b
• 1. d
• 2. c
• 3. c
• 4. a