Expressing Numbers in Science

Chapter 1

Scientific Notation

- Scientific Notation has you express numbers in terms of **exponentials**. An exponential is a number multiplied by itself a certain number of times.
  - $4^3 = 4 \times 4 \times 4 = 64$
  - $10^6 = 10 \times 10 \times 10 \times 10 \times 10 \times 10 = 1{,}000{,}000$
- Scientific notation uses only exponentials of 10.
- In scientific notation, values are expressed as a number in decimal form where $1 \leq n < 10$ multiplied by 10 raised to a power.

Scientific Notation

- To change a number ≥ 10 to scientific notation, count how many times you are moving the decimal to the left to change the number to a number between 1 and 10.
- That number is the number of factors of 10 you are dividing out of the number and will be the exponent on the 10 in scientific notation.

  9 8 7, 0 0 0 = 9.87×10^5

Scientific Notation

- To change a number < 1 to scientific notation, count how many times you are moving the decimal to the ***right*** to change the number to a number between 1 and 10.
- That number is the number of factors of 10 you are multiplying into the number and the ***negative*** of that number will be the exponent on the 10 in scientific notation.

  0 . 0 0 3 0 9 = 3.09×10^{-3}

Examples of Scientific Notation

Express the following numbers in proper scientific notation:

a) 254,000,000,000,000,000 = 2.54×10^{17}

b) 648 = 6.48×10^2

c) 32,700 = _____

d) 0.009926 = 9.926×10^{-3}

e) 0. 774 = _____

f) 2.35 = _____

g) 1000 = _____

h) 10^6 = _____

i) 0.0035×10^8 = _____

Examples of Scientific Notation

- Express the following numbers in standard notation:

1) 2.87 x 105 = _____

2) 8.91 x 10-7 = _____

3) 2.5378 x 103 = _____

Scientific Notation on the Calculator

To put an exponential number in your calculator, follow the examples below:

To enter **7.35 x 10^5**, press:
[7] [.] [3] [5] [EE] [5]

To enter **4.5 x 10^{-2}**, press:
[4] [.] [5] [EE] [+/-] [2]

Note: If your calculator does not have the [EE] key, use the [EXP] key.

To read an exponential off of your calculator, follow these examples:
4.153 ^{04} would be read as **4.153 x 10^4** or **41,530**
8.1 $^{-02}$ would be read as **8.1 x 10^{-2}** or **0.081**

Various calculator readouts of 8 x 10^3:

Important note: You must express numbers on paper with proper scientific notation to receive full credit!

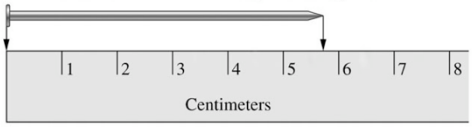
Significant Figures (digits)

- If you divide two numbers, like 1.20 g by 0.07023 mL, your calculator will tell you that the answer is 17.08671507903 g/mL.
- You probably know that you should round the number, but where, and how do you decide?
  - Consider the precision of the numbers.
  - The last digit in all measurements is *estimated* and determines the number of significant digits in the quantity.
  - Numbers encountered in most problems are measured values with the last digit estimated.

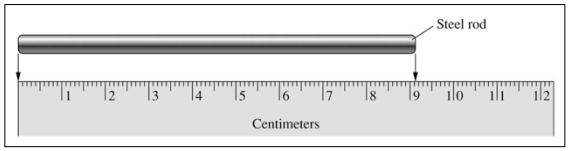
Uncertainty in Measurement

A digit that must be estimated is uncertain.
A measurement always has some degree of uncertainty.

Conceptual Problem What is the length of the nail reported to the correct number of significant figures?



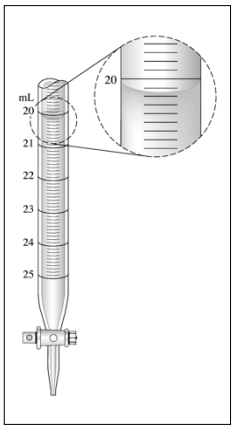
Measurement to higher precision



Estimate the volume in the buret.

Notes:

- Each division is 0.1 mL.
- Volume is read at the bottom of the meniscus.
- Volume markings increase from top to bottom.



Rules for counting Significant Figures:

1. All non-zero digits are significant.
2. All zeros between significant digits are significant.
3. All leading zeros are NOT significant.
4. Ending zeros are significant if the number contains a decimal point.

Rules for significant figures in calculations:

- For ***multiplication and division***, the answer will have the same number of significant digits as the quantity with the least number of significant digits.
    1) 550 x 321
    2) $5.1200 \times 10^3 / 0.002405$

Rules for significant figures in calculations:

- For ***addition and subtraction***, in numbers that have a decimal place, the answer will have the same number of decimal places as the quantity with the fewest number of decimal places.
- In numbers with no significant decimal places, the number that has its last significant digit farthest to the left determines where the answer will be rounded (see examples).
    1) 35.290 + 212.1
    2) 768,350,000 – 483,200

Additional Examples: Significant figures in Calculations

1) (6.2 + 85.60) / 11.558

2) 88,000 + 52

"Sig Figs" - Additional Notes

- Exact numbers and counting numbers have an infinite number of significant figures.
- In a number in which some ending zeros are significant, but others are not, a bar (above the digit) may be used to indicate the last significant zero.
- If a calculation involves many steps, do NOT round at the intermediate steps – Carry at least one or two extra significant figures to prevent the introduction of rounding errors.

Sig figs & Scientific notation

- When numbers are written in scientific notation, all digits should be significant.

Calculations with Scientific Notation

Express answers to the following expressions in scientific notation with the correct number of significant figures.

- $\dfrac{8.84 \times 10^{-15}}{0.001232} = ?$
- $(6.2 \times 10^3 + 3.11 \times 10^2) \bullet 1.1 \times 10^5 = ?$