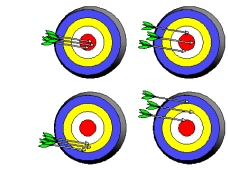
Scientific Notation , Metric System, and Significant Figures

Review of Math Skills used in Chemistry

Precision vs. Accuracy



- **Precision** – is the degree to which repeated measurements under unchanged conditions show the same results.
- **Accuracy -** the degree of closeness of measurements of a quantity to its actual (true) value.

Scientific Notation and the Metric System

• Each system is a method of expressing numbers in its simplest form.

• Each system is based on the unit of 10.

• Each system is interpreted by counting the number of decimal places that have been moved.

Metric System

Kittens **H**ate **D**ogs **B**ecause **D**ogs **C**ant **M**eow

Prefixes:

K = kilo (1000) **H** = hecta (100) **D** = deca (10)

B = base units

Base units are: Mass = grams
Length = meter
Volume= liter

D = deci (.1) **C** = centi(.01) **M** = milli (.001)

Move the decimal point within the metric system in the same direction as the prefix.

Scientific Notation

- Coefficient X 10 exponent

Rules:

- The **coefficient** must be greater than or equal to 1 and less than 10.
- The exponent will indicate the number of decimal places as well as the direction of movement. Negative exponents represent a number less than 1. Positive exponents represent a number greater than 1.

Math with Scientific Notation

Addition and Subtraction:

1. Change the members of the problem so that they all have the same exponent.
2. Add or subtract the base numbers.
3. DO NOT CHANGE THE EXPONENT!
4. Adjust to correct scientific notation format.

Math Operations with Scientific Notation

Multiplication:

1. Multiply the base numbers
2. ***Add*** the exponents
3. Adjust to correct scientific notation format

Division:

1. Divide the base numbers
2. ***Subtract*** the exponents
3. Adjust to correct scientific notation format

Multiplication example:

Multiplication:

$(5 \times 10^4)(7 \times 10^5)$

$= (5 \times 7)(10^4 \times 10^5)$

$= (35)(10^{4+5})$ add exponents.

$= 35 \times 10^9$

But we're not done yet…

Review your answer.

35×10^9

35 is not between 1 and 10!

So… move decimal and add one more place for 10

Final answer: 3.5×10^{10}

Division example:

$$\frac{(4 \times 10^9)}{(8 \times 10^5)} = \frac{4}{8} \bullet \frac{10^9}{10^5}$$

$= 0.5 \bullet 10^{9-5}$ subtract exponents

$= 0.5 \bullet 10^4$

It's not done yet…

Review your answer:

$0.5 \bullet 10^4$

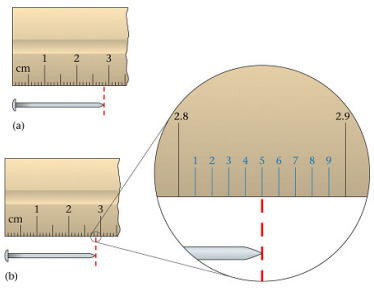
.5 not between 1 & 10!

Move the decimal to the right, and subtract one from the exponent.

Final answer: 5×10^3

Significant Figures

- Measurements always has some degree of uncertainty.



Significant Digits

- Significant figures are extremely important when reporting a numerical value.
- The number of significant figures used indicates the confidence (certainty) of that value.

Significant Digits

- A significant figure is an accurate digit although the last digit is accepted to have some error.
- If length = 7.58 cm

  Slight error
  exact
  exact
- The number of significant figures **does not** include zeros required to place decimal points.

Significant Digits

- **Significant digits allow us to systematically express a degree of confidence in a number.**
- A **significant digit or figure** is any digit used in a number except:
  - **Zeros that are used to locate the decimal point, such as:**

    0.05 0.0003 0.002300
  - **Zeros that do not have any nonzero digits on their left, such as:**

    0.5 0.515 0.25

Significant Digits

- Do the numbers 5000 and 5000. imply the same significance?
- 5000. contains *four* **significant digits.**
- 5000 is an ambiguous number. It contains either *one, two, three, or four* **significant digits.**
- How do you write 5000 to *two* significant digits?
  - Use scientific notation: 5.0×10^3

Rules for Significant Digits

- In **multiplication and division -** use as many significant digits as the number that has the fewest (excluding exact conversion factors)

  $(4.00\ kg)\ (4\ m/s^2) = 20\ kg\ m/s^2$

- In **addition and subtraction -** line up the decimals and retain the least significant place.

  897.0
  - 0.0922
  896.9078
  896.9 (Answer)

Rules for Significant Digits

Combined operations:

If products or quotients are to be added or subtracted, perform the multiplication and division first, establish the correct number of significant figures in the subanswer, perform the addition and subtraction, then round to the proper number of significant figures.

How do I know how many Significant Figures?

Key to determining number of significant figures is understanding when the zeros are significant and when they are not.

- *1 st Exception to rule:* In whole numbers that end in zero, the zeros at the end are not significant.

How do I know how many Significant Figures?

- *2nd Exception to rule:* If zeros are sandwiched between non-zero digits, the zeros become significant.

How do I know how many Significant Figures?

- *3rd Exception to rule:* These zeros are showing how accurate the measurement or calculation are.

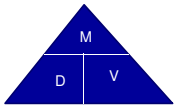
Density

Compares the mass of an object to its volume.

- Is the mass of a substance divided by its volume.

Density = $\frac{\text{mass}}{\text{volume}} = \frac{\text{g}}{\text{mL}}$ or $\frac{\text{g}}{\text{cm}^3} = \text{g/cm}^3$

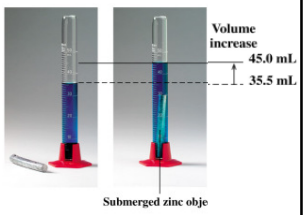
Note: 1 mL = 1 cm^3



Volume by displacement

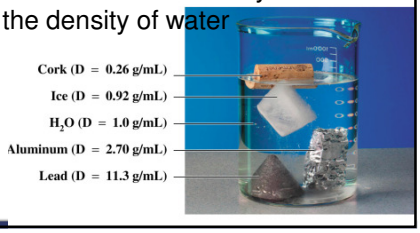
- A solid completely submerged in water displaces its own volume of water.
- The volume of the solid is calculated from the volume difference.

45.0 mL - 35.5 mL = 9.5 mL = 9.5 cm^3



Relative density

- Ice floats in water because the density of ice is less than the density of water.
- Aluminum sinks because its density is greater than the density of water



Dimensional Analysis

Also known as the Factor Label Method

5 Steps of Dimensional Analysis

- Start with what value is known, proceed to the unknown.
- Draw the dimensional lines (also known as the conversion factors)
- Insert the unit relationships.
- Cancel the units.
- Do the math, include units in answer.

Using dimensional analysis in conversion

How many seconds are there in 1 year?

$$1\ \text{year} \times \frac{365\ \text{days}}{1\ \text{year}} \times \frac{24\ \text{hours}}{1\ \text{day}} \times \frac{60\ \text{minutes}}{1\ \text{hour}} \times \frac{60\ \text{seconds}}{1\ \text{minute}}$$

$$= 31{,}536{,}000\ \text{seconds}$$