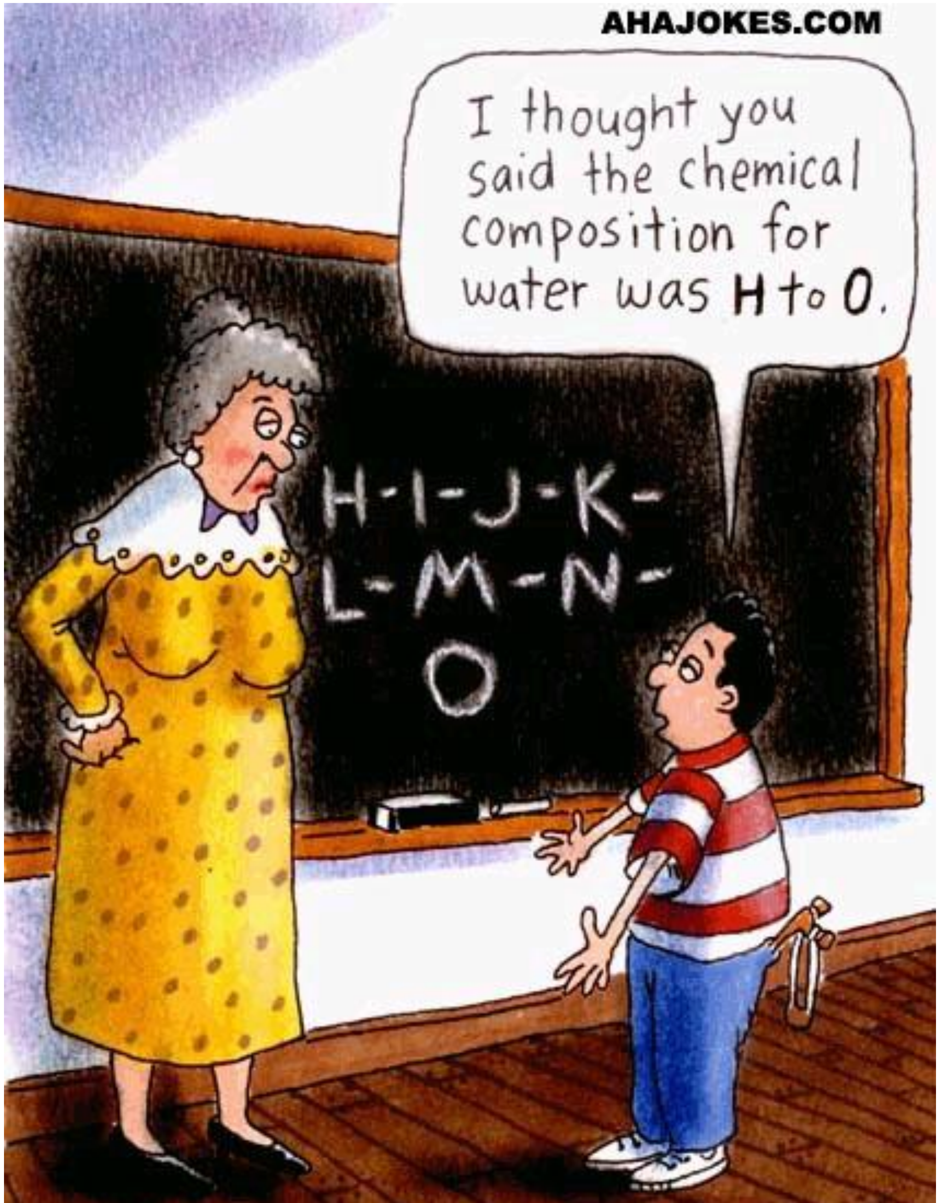
Chemistry

- **Is the interaction between matter and energy**



Matter & Energy

- **Matter - anything that has inertia**
- **Energy - the capacity to do work**
  - **Potential energy - energy of position**
  - **Kinetic energy - energy of motion**
- **Matter & Energy - Once it was believed that matter and energy in the universe was constant.**
  - **$E=mc^2$**
  - **Bremsstrahlung & Pair production**
  - **Matter can change to energy and energy to matter**

Qualitative verses quantitative

- **Qualitative - Property without measurements**
- **Quantitative- property described by measurements**
  - **Time, temperature, volume, mass, distance, etc. . .**
  - **Must have a standard to measure by**

Measurement and uncertainty

Parallax error is an error do to the position of the person reading the measurement.

SI system

- **Based on the metric system**
- **Mass vs Weight**
  - **Weight – gravitational pull and is measured in Newtons**
  - **Mass – depends on quantity of matter and is measured in grams**

Precision vs. Accuracy

- Precision refers to the uncertainty of the measurement or how precise the instrument is
- Accuracy refers to how close a measurement is to the actual quantity

Example 1:

- How old are you?
  - I am 16 years old
  - I am 15 years and 8 months old
  - I am 15years, 8 months, and 5 days old
  - I am 15 years, 8 months, 5 days, and 10 hours old

Accuracy vs. Precision for Example 1

- Each of these statements is more accurate and more precise than the one before it.
- Statement two is more accurate and more precise that statement one.
- Statement three is more accurate and more precise than statement two.

Example 2:

- How long is a piece of string?
  - Johnny measures the string at 2.63 cm.
  - Using the same ruler, Fred measures the string at 1.98 cm.
  - Who is most precise?
  - Who is most accurate?

Accuracy vs. Precision for Example 2

- The actual measurement is 2.65 cm.
- Johnny is fairly accurate and also very precise.
- Fred is very precise, however, he is not very accurate. His lack of accuracy is due to using the ruler incorrectly.

Example 3

- Using a centigram balance,
  - Mary measured a sample at 3 g.
  - Ashley measured the same sample at 3.00 g.
  - Who is most precise?
  - Who is most accurate?

Accuracy vs. Precision for Example 3

- The actual measurement is 3.01 g.
- Mary is reasonably accurate. She was not very precise because the balance was capable of measuring to two decimal places.
- Ashley is much more accurate because of the precision of her measurement *and* closeness of her value to the actual value.

ACCURACY/PRECISION

- You can tell the precision of a number simply by looking at it. The number of decimal places gives the precision.
- Accuracy on the other hand, depends on comparing a number to a known value. Therefore, you cannot simply look at a number and tell if it is accurate

In Conclusion

- In science we depend upon both the accuracy and precision of the numbers we use.
- The need for accuracy and precision varies with the circumstance and other measurements being used.

Handling numbers in Science

- **Scientific notation**
  - **Standard form is decimal point after first whole number**
  - **Then x 10 to the power**
    - **Example 6.02 x 10^{23}**

Scientific Notation

- **A. Purpose is to show the precision of the measurement and calculation**
  - **Standard form is 1 whole # and decimal 1.32 x 10^6**
  - **As you move the decimal to the left you increase the exponent, and as you move to the right exponent decreases**
  - **The negative exponent indicates an inverse. 10^{-3} = $1/10^3$ = 1/1000 = .001**
  - **When adding get exponents the same and add**
  - **When multiplying, multiply the numbers and add the exponents**
  - **When dividing, divide the numbers and substract the exponents**
  - **When taking power to power, find power of the number and multiply exponents**

Adding & Subtracting

- Make power the same and add or subtract

Multiplication

- Multiply the main # and add exponent
  - Example $(2.5 \times 10^{2})(2 \times 10^{3}) = 5 \times 10^{5}$

Dividing

- You divide the main # and subtract the exponent
  - Example $(2.5 \times 10^{2})/(2 \times 10^{3}) = 1.25 \times 10^{-1}$

Powers to Power

- You take the power of the main number (mantissa) and you multiply the exponents.
  - Example: $(2 \text{ x } 10^2)^3 = 8 \text{ x } 10^6$
  - $(2 \text{ x } 10^2)^{-3} = 1 \text{ x } 10^0 / (2 \text{ x } 10^2)^3 = 1 \text{ x } 10^0 / 8 \text{ x } 10^6 = .125 \text{ x } 10^{-6} = 1.25 \text{ x } 10^{-7}$

When you do the cubed root you find the root of the main number and divide the exponent by 3

$(8 \times 10^6)^{1/3} = 2 \times 10^2$

Derived units -

- **Derived units are a combination of fundamental units**
  - **Speed = distance/time**
  - **Area = length x width**
  - **Volume = L x W x H (cm^3)**
  - **Density = mass/volume**

Factor Label Method

- **Solving problems using the factor label method**
- **Set up equation to factor out labels to get to the answer**

Factor Label Method

- Simply using conversion units
- Example
  - How many miles does light travel in one year? (Speed of light = 3.0×10^8 m/s)

Significant digits (sig figs)

- Purpose
  - To show the presision of the measurement
- All digits that occupy places for which actual measurement was made is significant
- Rules
  - Digits other than zero always significant
  - Zeros after decimal point are significant
  - Zeroes between 2 significant digits are significant
  - Zeroes for spacing decimal are not significant

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Significant digits in calculations

Addition and subtraction the answer contains only as man decimal places as the least precise value

Example: 2.01 + 2 = 4

In multiplication and division, the answer can contain only as many significant digits as the least precise value used to arrive at the answer

Example: 1.133 x 5.126000 = 5.807758 but the correct answer is 5.808

Sig Fig Calculations

- **To determine significant digits in calculations**
  - **Addition and subtraction the answer contains only as man decimal places as the least precise value**
    - **Example: 2.01 + 2 = 4**
    - **Example: 20 + 5.7 = 3 x 10^1 , 2.5 + 7 = 1.0 x 10^1**
    - **Problems p. 27**

Relative Error

- Percentage uncertainty in a measurement
  - Accuracy/measurement total
  - (Uncertainty/total measurement)x 100
  - Example
    - Measurement 24.3 cm
    - Accuracy $\pm$ 0.1 cm
    - (0.1/24.3) X 100 = 0.4%

Density

- D=m/v
- Do example problems page 34