**Chemistry Unit Nine – Scientific Measurement**

**Podcast 2.1 Scientific Notation**

**Scientific Measurement:** Using and Expressing Measurements

Measurements in chemistry often involve very large or very small numbers

EXAMPLE.

2 grams of Hydrogen = 602,000,000,000,000,000,000,000 hydrogen atoms.

* Scientists use “Scientific Notation” to write numbers in Exponential form
* Notation is based on powers of \_\_\_\_\_

10 = 101

100 = 102

1000 =

10,000 =

100, 000 =

**Writing Numbers with Scientific Notation**

1. Move or add a decimal point so that only \_\_\_\_\_\_\_ digit is in front of the decimal.
2. Write \_\_\_\_\_\_\_\_\_\_
3. Count the number of decimal places you moved and write that number as superscript.
4. Look which way you moved the decimal
   1. Left = + superscript or b. Right = − superscript

Left LARGER Right REDUCES

**Put the following numbers into or take them out of Scientific Notation:**

***1)*** 13400000

***2) 0***.000724

***3)*** 5.903 x 10-8

***4)*** 6.20 x 103

**Calculations with Numbers in Scientific Notation**

* Addition: Change exponents so they match

EX. 1.03 x 103 + 2.10 x 102

Answer = **\_\_\_\_\_\_\_\_\_\_\_\_**

* Subtraction: Change exponents so they match

EX. 1.03 x 103 - 2.10 x 102

Answer = \_\_\_\_\_\_\_\_\_\_\_\_\_

* Multiplication: Multiply numbers and add exponents

EX. 1.03 x 103 x 2.10 x 102

Answer = \_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Division: Divide numbers and subtract exponents

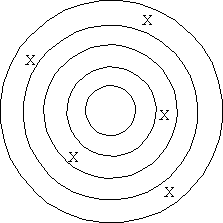
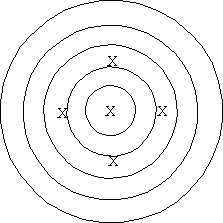
EX. 1.03 x 103 / 2.10 x 102

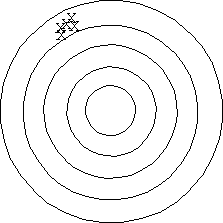
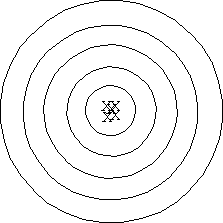
Answer = \_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Podcast 2.2: Accuracy, Precision, and Error**

**Uncertainties in Measurement**

* \_\_\_\_\_\_\_\_\_\_\_\_\_ – the closeness of a measurement to the true value of what is being measured.
* \_\_\_\_\_\_\_\_\_\_\_\_\_ – is a measure of how close a series of measurements are to one another.

**How do we measure Accuracy?**

By determining \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* measured value – correct value
* Experimental value – Theoretical value

**Error = “whatcha got” – “Whatcha shoulda got”**

* Percent Error : How critical is the error?

Percent error =

Ex. Experimental = 1.24 g

Accepted = 1.30 g

Percent Error =

**Causes of Error**

Four types of Errors

* Instrumental error – error that deals with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of instrument
* \_\_\_\_\_\_\_\_\_\_ error – error that deals with error in your human limitations to record observations
* Environmental error – occurs when uncontrolled environmental conditions effect the outcome
* \_\_\_\_\_\_\_\_\_\_\_ error – introduced from abnormal chemical behavior.

**Calculator Lesson:**  All calculators are NOT created equal

* Graphing calculators follow the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, so the use of parentheses is VERY important
* Simpler calculators do the operations as you put them in

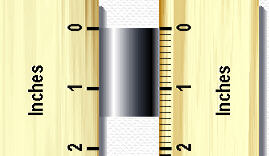
**Scientific Notation and your calculator**

* Depending on the calculator, the exponential key may be labeled “EE” “EXP” or “EEX” or you may not have one…bummer
* Example: 4.56×108
  + It’ll show up as either 4.568 or 4.56E8
  + The ×10 is assumed so it’s not shown
* Example: What is 2.43 x 1023 x 7.30?
* Enter it as 2.43 EE 23 × 7.30

Answer = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Podcast 2.3: Significant Figures** “Sig-Figs”

**Measurement Uncertainty**

* Measurements in science needs to be \_\_\_\_\_\_\_\_\_\_\_\_\_ and therefore hopefully \_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Uncertainty on measurements are based upon the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ used
  + Made up of a number of digits that are certain, and one additional digit which represents an estimation
* Example: Use a ruler to measure the length of the metal rod.
  + The \_\_\_ and\_\_\_\_ are the certain numbers
  + The \_\_\_\_\_ in the hundredth place is the uncertainty digit (based upon ruler provided)

Length of rod \_\_\_\_\_\_\_\_\_\_\_\_

**Significant Figures:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_ digits in a MEASUREMENT

1. Exact numbers are counted, have unlimited significant figures
2. \_\_\_\_\_\_\_ \_\_\_\_\_\_\_ except zero are significant.
3. Some zeros are, some aren’t…

Which Zeroes Count?

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_ other sig figs
2. NOT \_\_\_\_\_\_\_\_\_\_\_\_\_ the first number
3. After the last number counts if and only if…

-- it is after the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – or – the decimal point is written in

* + 3200 \_\_\_ sig figs
  + 3200. \_\_\_ sig figs
  + 320.0 \_\_\_ sig figs

How many sig figs do the following numbers have?

1. 1.032
2. -0.007
3. 6800
4. 1.30
5. 2.46
6. 10.02
7. 6800.0

**Doing the Math**

For multiplication and division, your answer can only have as many sig-figs as the LEAST number of sig-figs in the problem

* Ex: 1.31 x 2.2 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_

For addition and subtraction, the number with the least number of decimal places is used.

* Ex. 1.31 + 2. 2 =

Try These:

1. 2.36 + 1.7 + 3.284
2. 1.89 x 2.03 x 3.277
3. 8.2 / 3.74

Please report your results with the appropriate number of significant figures. Thanks!

1. 2.090 x 1.23 x 1.9
2. 12.036 – 3.42 – 2.067
3. 1.096 + 7.09 + 5.2
4. 13.040 / 3.23

**Podcast 2.4 – SI and the Metric System (notes on Mega Metric Mania)**

**Podcast 2.5 – Measuring Temperature**

**Heat and Temperature**

* \_\_\_\_\_\_\_\_\_\_\_\_– the energy an object has due to the motion of it’s particles
* \_\_\_\_\_\_\_\_\_\_\_\_ – the average kinetic energy of all particles in an object

Measures transfer of heat

**Movement of Heat**

* Heat always moves from \_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_
* Objects tend to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ with an increase in temperature and contract with decreasing temperature.

**Measuring Temperature**

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – the zero point on the Kelvin scale which is equal to -273 C. At this point all atomic motion theoretically stops.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of Water – 100 oC or 212 oF
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of Water – 0 oC or 32 oF

**Converting Temperature**

Fahrenheit, Celsius, and Kelvin are all describing the same height of mercury on a thermometer, just using a different scale

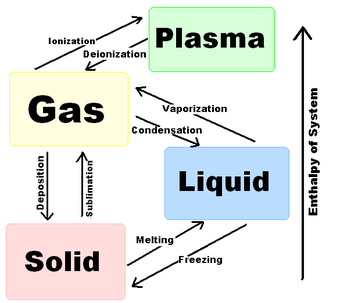
F =

C =

K =

\*Note: Kelvin is based on absolute zero, so it does not use “degrees of change”, don’t use a ” o ”with the unit K

Example Problems

1. Convert 298 K to oC
2. Convert 37 C to Kelvin
3. Convert 72 oF to Kelvin

1st change to oC

2nd change to K

1. Convert 74 Kelvin to oF

1st change to oC

2nd change to oF

Phase Change Diagram

**Podcast 2.6: Density and Specific Gravity**

**Density – is the ratio of the mass of an object to its volume.**

* Formula for Density
  + Units are given as \_\_\_\_\_\_\_ or \_\_\_\_\_\_\_

Example1: A copper rod has a mass of 0.52g. The volume was determined by water displacement to be 0.0581 mL. What is the density?

Example 2: A 1.60-L sample of tin (II) fluoride has a mass of 2.59 kg. What is the density of this substance in g/cm3?

Example 3: What is the volume of 7.4 x 103  mg of copper if the density is 8.92 g/cm3 ?

Example 4: A beach ball with a volume of 21.8 cm3 has a mass of 16.1 g. Would this ball sink or float in water?

Specific Gravity: A comparison of the density of a substance with the density of a reference substance that is at the same temperature.

* Reference Substance = (usually) \_\_\_\_\_\_\_\_\_\_\_ at 4o C
* Formula of Specific Gravity
* Specific Gravity is the only \_\_\_\_\_\_\_\_\_\_\_\_\_ quantity.

Example: A chunk of granite weighing 31.2 grams displaces 11.8 cm3 of water. What is the specific gravity of this rock?

**Podcast 2.7: Dimensional Analysis and T-Tables**

**Dimensional Analysis**

* Using \_\_\_\_\_\_\_\_\_ to help solve problems
* A \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ can be used to convert between different units.
* Conversion factors are reversible so that you can obtain the result you need.

**T-Table and Conversions** In chemistry we use a T-table to help us convert between different units.

Example 1: Convert 157 cs to s

Example 2: 8.25 x 102 cg to ng

Example 3: 0.44 mL/min to μL/s

Example 4: The radius of a potassium atom is 0.227 nm. Express this radius in the unit centimeters.

**Please use T-Tables to convert the following units.**

Example 5: The diameter of Earth is 1.3x104 km. What is the diameter expressed in decimeters?

Example 6: Light travels at a speed of 3.00 × 1010cm/s. What is the speed of light in kilometers/hour?

**Using T-tables to Solve Density Problems:** Use density as a conversion factor to change mass to volume or volume to mass

g/mL or mL/g

Example 7: Convert 6 g to mL if the density of the substance is 12 g/mL