Unit Two: Scientific Measurement

What is a measurement?

It is important to be able to make measurements and to decided whether a measurement is correct. In chemistry, you will often encounter very large or very small numbers.

1g of hydrogen = 602,000,000,000,000,000,000,000 hydrogen atoms
1 atom of gold = 0.000000000000000000000327 grams

As scientists we use _____ _____ to make working with these large and small numbers more manageable.

Scientific Notation:

In scientific notation, the coefficient is always a number greater than or equal to one and less than ten.

** a _____ exponent indicates how many times the coefficient needs to be multiplied by ten.

** a _____ exponent indicates how many times the coefficient needs to be divided by ten.

Writing Scientific Notation:

When writing numbers greater than ten in scientific notation, the exponent is positive and equals the number of places that the original decimal point has been moved to the left.

6,300,000

94,700

Numbers less than one have a negative exponent when written in scientific notation. The value of the exponent equals the number of places the decimal has been moved to the right.

0.000008

0.00736

Accuracy, Precision, and Error

Accuracy =

Precision =

To evaluate the accuracy of a measurement, the measured value must be compared to the correct value. To evaluate the precision of a measurement, you must compare the values of two or more repeated measurements.

In the lab we evaluate the accuracy of our data using a _____ _____ calculation.

Significant Figures:

In any measurement there are digits that we know for certain and then there is one digit that we estimate- this is known as the uncertain digit.

Temperature reading 22.9°F

The first two digits (2,2) are known with _____

The last digit (9) involves some _____

These reported digits all convey useful information and are called

_____ _____.

Measurements must always be reported to the correct number of significant figures because calculated answers often depend on the number of significant figures in the values used in the calculation.

**instruments differ in the number of significant figures that can be obtained from their use and thus in the precision of measurements.

How to Determine Significant Figures:

How to Determine Significant Figures (continued):

Addition and Subtraction with Significant Figures:

Multiplication and Division with Significant Figures:

Suppose you use a calculator to find the area of a floor that measures 7.7 meters by 5.4 meters. The calculator would give an answer of 41.58 square meters. However, each measurement used in the calculation is expressed to only two significant figures.

What should the answer be using the proper numbers of significant figures?

Practice:

Determine how many significant figures are in each measurement.

A. 123 m _____

B. 40,056 mm _____

C. 9.8000×10^4 m _____

D. 22 meter sticks _____

E. 0.07080 m _____

F. 98,000 m _____

G. 0.05730 m _____

H. 8765 m _____

I. 0.00073 m _____

J. 40.007 meters _____

K. 143 g _____

L. 0.074 m _____

M. 8.750×10^{-2} m _____

N. 1.072 mL _____

Units of Measurement:

All metric units are based on multiples of 10. As a result, you can convert easily between units.

Quantity	SI base unit	Symbol
Length		
Mass		
Temperature		
Time		
Amount of Substance		
Volume		

For very large or very small numbers it may be useful to use prefixes.

Prefix	Symbol	Factor
mega		
kilo		
deci		
centi		
milli		
micro		
nano		
pico		

Temperature Scales:

Scientists commonly use two equivalent units of temperature, the degree Celsius scale and the kelvin.

The Celsius scale uses two readily determined temperatures as reference temperatures:

On the Kelvin scale, the freezing point of water is _____ and the boiling point is _____ (notice that the Kelvin scale does not use a degree sign).

Zero kelvin is known as absolute zero.

Density:

The density of an object show the relationship between an object's mass and its volume.

Density is an intensive property that depends only on the composition of a substance, not on the size of the sample.

Density is usually expressed in units of grams per milliliter (_____).

**Osmium, a blue/white metal, is the densest substance on Earth! A football sized piece is too heavy to lift.

We can use the density of an object to determine if it will float or sink:

Float:

Sink:

Practice:

1) A copper penny has a mass of 3.1 g and a volume of 0.35 cm^3. What is the density of the copper?

2) A bar of silver has a mass of 68.0g and a volume of 6.48 cm^3. What is the density of silver?

3) A student finds a shiny piece of metal that she thinks is aluminum. In the lab, she determines that the metal has a volume of 245 cm^3 and a mass of 612g. Calculate the density. Is the metal aluminum? (Actual density of aluminum = 2.70 g/cm^3).

Conversion Factors:

Quantities can be expressed in several different ways:

1 dollar = 4 quarters = 10 dimes = 20 nickels = 100 pennies

A conversion factor is a ratio of equivalent measurements.

Dimensional Analysis:

A way to analyze and solve problems using the units, or dimensions, of the measurements.

Example: How many seconds are in a workday that lasts exactly eight hours?

Practice:

1) Express 750 dg in grams (use dimensional analysis),

2) What is the volume of a pure silver coin that has a mass of 14g? The density of silver is 10.5 g/cm^3?

3) The density of manganese, a metal, is 7.21 g/cm^3. What is the density of manganese expressed in units of kg/m^3?