Presentation 1.2

Scientific Measurement

Chemistry 2 Honors
Jeff Venables
Northwestern High School

Scientific Measurement

- Qualitative Measurements –

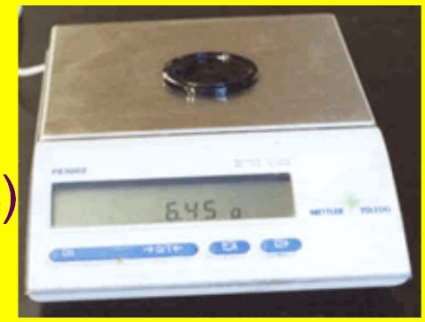
–Observations that are recorded in a descriptive (nonnumerical) form.

- Quantitative Measurements –

–Measurements that are recorded using numbers and units.

Units of Measurement

- Quantity – Something that has magnitude or size.
- Unit –
  - –The standard used to measure a quantity.
  - –Examples?



- SI –
  - –International System of units (metric)

SI units

Quantity	Symbol	Unit	Abbreviation
Length			
Mass			
Time			
Temperature			
Amount of Substance			
Electric Current			
Luminous Intensity			
	I t m Iv n T I	mole kelvin meter candela second kilogram ampere	cd A m K mol kg s

SI Metric Prefixes

Prefix	Abbrev.	Multiplier	Meaning	Example
Giga-				
Mega-				
Kilo-				
(Base unit)				
Deci-				
Centi-				
Milli-				
Micro-				
Nano-				
Pico-				
Femto-				

SI Metric Prefixes

Prefix	Abbrev.	Multiplier	Meaning	Example
Giga-	G	10^{9}	1 000 000 000	1 Gigameter (Gm) = 1 x 10^{9} m
Mega-	M	10^{6}	1 000 000	1 Megameter (Mm) = 1 x 10^{6} m
Kilo-	k	10^{3}	1 000	1 kilometer (km) = 1 x 10^{3} m
(Base unit)		10^{0}	1	1 meter (m)
Deci-	d	10^{-1}	0.1	1 decimeter (dm) = 0.1 m
Centi-	c	10^{-2}	0.01	1 centimeter (cm) = 0.01 m
Milli-	m	10^{-3}	0.001	1 millimeter (mm) = 0.001 m
Micro-	μ	10^{-6}	0.000 001	1 micrometer (μm) = 1 x 10^{-6} m
Nano-	n	10^{-9}	0.000 000 001	1 nanometer (nm) = 1 x 10^{-9} m
Pico-	p	10^{-12}	0.000 000 000 001	1 picometer (pm) = 1 x 10^{-12} m
Femto-	f	10^{-15}	0.000 000 000 000 001	1 femtometer (fm) = 1 x 10^{-15} m

Scientific Notation

- A number between 1 and 10 multiplied by 10 raised to some power.
  - If the power of 10 is positive, the number is greater than 10.
  - If the power of 10 is negative, the number is less than 1.
- Examples – Write the following in scientific notation:

1. 24 900
2. 0.000 56
3. 375 000 000
4. 0.000 000 036 0
5. 1 500 000 000 000
6. 6.51

Write each of the following in standard notation:

1. 5.07×10^{-7} 2. 3.70×10^{4}

In a calculator, 5.07×10^{-7} would be entered as 5.07 EE (or EXP) –7.

Significant Figures and Error

•Accuracy – Closeness of a measurement to the true value.
•Precision – Closeness of a series of measurements to one another. (alt. – the number of decimal places to which a measurement is read)

•% Error – A measure of accuracy:

$$\%\,error = \frac{experimental - theoretical}{theoretical} x100$$

Example – If you measure the boiling point of ethanol to be 74.8°C, and the accepted boiling point is 78.4°C, what is your percent error?

•Significant Figures – A measure of precision of a single measurement.

– Discloses the number of digits that are actually part of the measurement (more sig figs mean more precision)

What digits are significant?

– If it is only a placeholder, it is not significant.

1. All Non-Zero Digits are significant
2. All Zeros that come between nonzero digits are significant (ex: 4008)
3. Leading zeros are never significant (ex: 0.002)
4. Trailing zeros depend on decimal point:

– If there is a decimal point (written), trailing zeros are significant.

– If there is no decimal point, trailing zeros are only placeholders (not significant)

Look for a Decimal Point

Pacific

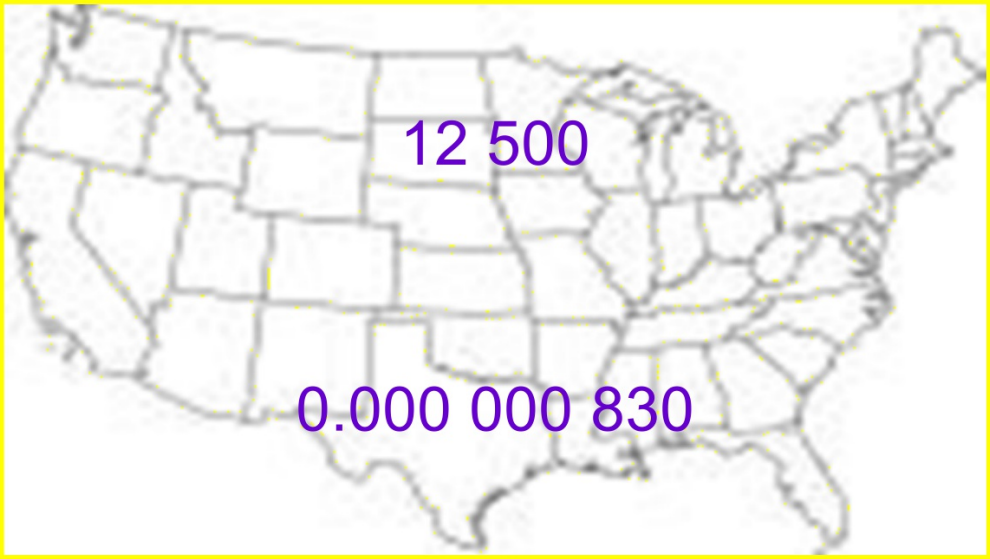
Present

Atlantic

Absent

Moving from the proper side, skip all zeros until you get to the first non-zero digit. All remaining digits, including zeros, are significant.

•Scientific Notation – all digits are significant (eliminates ambiguity)
•ONLY APPLIES TO MEASUREMENTS – NOT COUNTING!!!



Examples: How many significant figures are in each of the following?

1. 52300 m
2. 0.000487 kg
3. 29.0400 s
4. 507 people
5. 230,050 cm
6. 45.600 A

Examples: How many significant figures are in each of the following?

1. 52300 m 3
2. 0.000487 kg 3
3. 29.0400 s 6
4. 507 people ∞
5. 230,050 cm 5
6. 45.600 A 5

Significant figures in calculations

- Multiplication and division: Round the answer to the number of significant figures in the measurement that has the least significant figures.
  - Examples:

134.92 mL x 2.7 g/mL

2334.88765 m ÷ 35.1 s

Significant figures in calculations

- Multiplication and division: Round the answer to the number of significant figures in the measurement that has the least significant figures.
  - Examples:

134.92 mL x 2.7 g/mL

94 g

2334.88765 m ÷ 35.1 s

9.54 m/s

- Addition and Subtraction – Answer is rounded off to the decimal place where the least precise measurement ends.
- Example

13.462 g
- 11.7 g

- Addition and Subtraction – Answer is rounded off to the decimal place where the least precise measurement ends.
- Example

$$\begin{array}{rr} 13.462 & g \\ -\ 11.7 & g \\ \hline 1.8 & g \end{array}$$

STOP!!!!!

Program will crash if you advance!

- C-1.1 - Apply established rules for significant digits, both in reading a scientific instrument and in calculating a derived quantity from measurement.
- C-1.3 - Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.
- Identify fundamental SI (metric) base units.
- Identify and apply metric prefixes.
- Express numbers in standard and scientific notation.