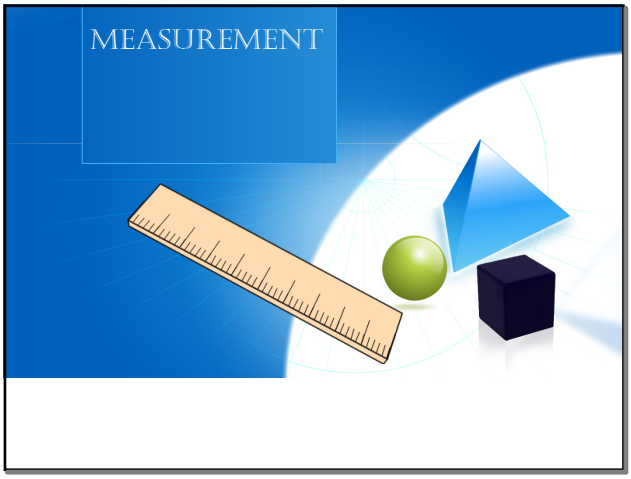
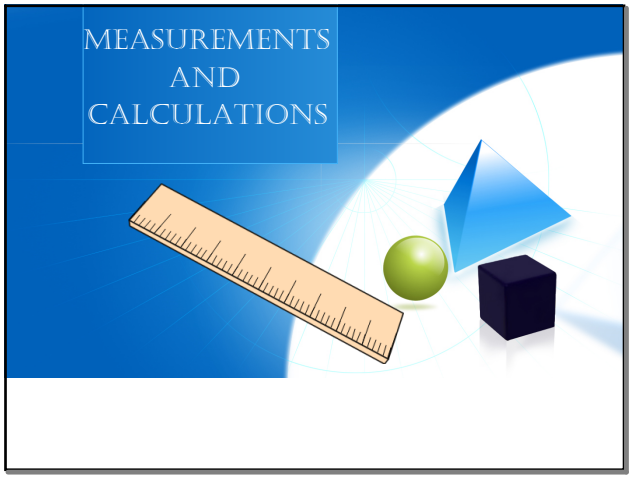
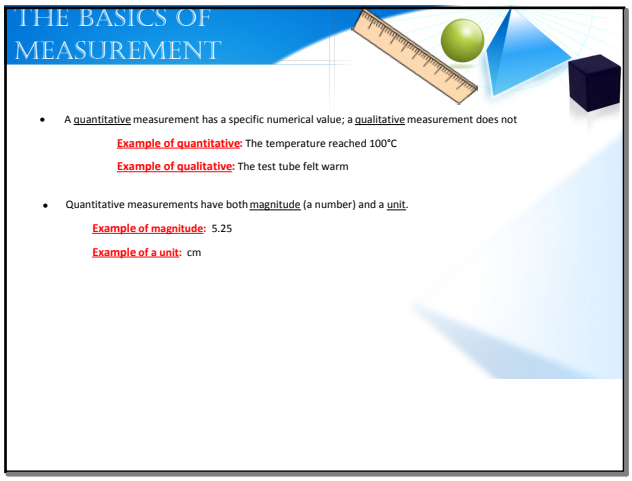


Measurement



Measurement and Calculation

The Metric System vs Customary Units



The Metric System vs Customary Units

MAGNITUDE

You will encounter very small and very large numbersin chemistry.
Scientific notation is useful for expressing these numbers.

Rules for expressing numbers in scientific notation:

- Move the decimal so that there is only ONE nonzero digit to the left of the decimal
- Express that number x 10
- Count the number of times you moved the decimal and that is your power of ten
- If the number was a BIG number (greater than 1), the exponent is positive
- If the number was a SMALL number (less than 1), the exponent is negative

Examples:

56000= _____

0.095= _____

Scientific Notation

MAGNITUDE

Rules for expressing numbers in standard notation:

- look at the exponent and move the decimal ____ times to the left/right
  - BIG numbers have a positive exponent
  - SMALL numbers have a negative exponent

Examples:

6.6×10^{5} = _____

5.34×10^{-3} = _____

Standard Notation

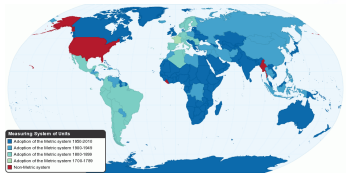
UNIT

Pronunciation (French)

A unit tells us what was measured. Units must always follow the numerical portion of a measurement.

There are **two** major unit systems used in the world today.

1. The United States Customary System (USCS)
   - Used in the U.S. primarily for nonscientific purposes
   - **Example:** pound and the gallon
2. The Système internationale d'unités (or SI)
   - English translation: International System of Units
   - Is used by most other countries and all scientists in the U.S.
   - We will be using SI units in this class



The Metric System vs Customary Units

SI UNITS IN CHEMISTRY

Physical quantity measured	Base unit	SI abbreviation
	mole	mol
	meter	m
	kilogram	kg
	second	s
	kelvin	K
	ampere	A
	candela	cd

www.sciencewithme.com

The Metric System vs Customary Units

METRIC SYSTEM

The **metric system** is based on **powers of ten**.

- Metric system prefixes are used with SI units to represent quantities that are larger or smaller (by powers of 10) than the base units.

Prefix	Symbol	Value	Power of 10	Meaning
tera	T	1,000,000,000,000	10^{12}	trillion
giga	G	1,000,000,000	10^{9}	billion
mega	M	1,000,000	10^{6}	million
kilo	k	1000	10^{3}	thousand
hecto	h	100	10^{2}	hundred
deca	da	10	10^{1}	ten
—	—	1	10^{0}	one
deci	d	0.1	10^{-1}	tenth
centi	c	0.01	10^{-2}	hundredth
milli	m	0.001	10^{-3}	thousandth
micro	μ	0.000001	10^{-6}	millionth
nano	n	0.000000001	10^{-9}	billionth
pico	p	0.000000000001	10^{-12}	trillionth
femto	f	0.000000000000001	10^{-15}	quadrillionth

***You need to **memorize** the order and meaning of the prefixes **from kilo- to milli-**

king henry danced Before drinking chocolate milk

VIDEO

The Metric System

METRIC SYSTEM

The basics of metric relationships:

To relate two metric units to each other, start by putting a "1" on the larger unit. Count the number of metric place moves to the desired unit. This is the same number of zeros you must add on to make the conversion, since the metric system is based on powers of 10.

Example of a metric equality: **1 km = 1000 m**

Practice: Write an equality for the following metric unit pairs:

1. m and cm
2. m and dm
3. m and mm
4. g and Mg
5. **g and Gg**
6. **g and dag**
7. **L and nL**
8. **L and hL**
9. **L and μL**

Prefix	Symbol	Value	Power of 10	Meaning
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hecto	h	100	10^{2}	hundred
deca	da	10	10^{1}	ten
—	—	1	10^{0}	one
deci	d	0.1	10^{-1}	tenth
centi	c	0.01	10^{-2}	hundredth
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nano	n	0.000000001	10^{-9}	billionth
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The Metric System

METRIC SYSTEM

Practice: Write an equality for the following metric unit pairs:

1. m and cm
2. m and dm
3. m and mm
4. g and Mg
5. g and Gg
6. g and dag
7. L and nL
8. L and hL
9. L and μL

Answers:

5. 1×10^{9} g = 1 Gg
6. 10 g = 1 dag
7. 1 L = 1×10^{9} nL
8. 100 L = 1 hL
9. 1 L - 1×10^{6} μL or 1 000 000 μL

Prefix	Symbol	Value	Power of 10	Meaning
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The Metric System

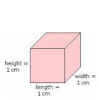
METRIC SYSTEM

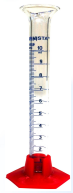
Derived units are combinations of simple units.

- They are produced by multiplying or dividing simple units.

Example: a derived unit for volume is cm^3 (length x width x height)

*Important note: A cubic centimeter (cm^3) is sometimes abbreviated as a "cc" in medical applications. A cubic centimeter is the same size volume as a milliliter. **1 cm^3 = 1 mL**





Example: Density (the ratio of mass to volume for a substance) also uses a derived unit: g/cm^3 or g/mL for solids and liquids and g/L for gases.

The Metric System

USING SCIENTIFIC MEASUREMENTS

If you have ever measured something several times, you know that the results can vary. In science, for a reported measurement to be useful, there must be some indication of its reliability or uncertainty.

- Accuracy refers to the closeness of a measurement to the correct or accepted value.

Accuracy = correctness

- Precision refers to the closeness of repeated measurements to each other.

Precision = reproducibility

Using Scientific Measurements

PRECISION VS ACCURACY

Are the following groups of measurements accurate, precise, both, or neither?

- The true volume of sample of water is 33.3 mL
  measurements made: 22.4 mL, 22.2 mL, 22.4 mL, 22.3 mL

- The true length of copper wire is 58.5 cm
  measurements made: 58.4 cm, 58.5 cm, 58.5 cm, 58.4 cm

- The true mass of sample of zinc is 14.5 g
  measurements made: 13.2 g, 15.6 g, 17.9 g, 12.0 g

Precision vs Accuracy

PERCENT ERROR

Percent error is a calculation scientists use to compare an experimental result with a theoretical or accepted value. It is an assessment of accuracy and is a lab "quality check."

$$\%\ \text{error} = \frac{|\text{accepted value} - \text{experimental value}|}{\text{accepted value}} \times 100$$

Example: Calculate the percent error in a length measurement of 4.25 cm if the correct value is 4.08 cm.

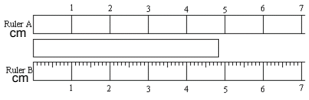
Percent Error

Making Measurements

Due to human error, measurements always contain a degree of uncertainty.

When recordings measurements from equipment, it is important to record answers to the correct number of figures. A measurement should include all certain digits and one uncertain digit (estimated digit). The certain digits are determined by the calibrations on the equipment.

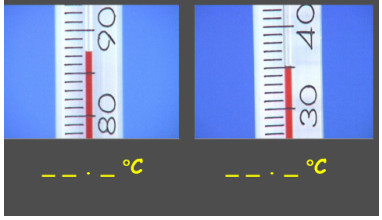
How to do this? Examine the equipment and find the smallest increment (interval). Your final answer must be one place past the smallest increment.



Apr 27-2:19 PM

Reading the Thermometer

Determine the readings as shown below on Celsius thermometers:



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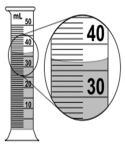
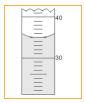
Graduated cylinders

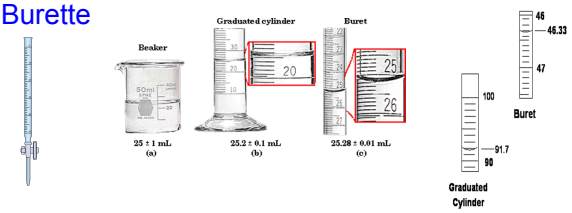




meniscus---curve produced by a liquid

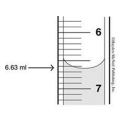
Apr 27-2:43 PM

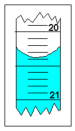
Burette



Apr 27-3:01 PM

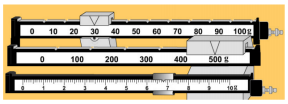
Burette





Apr 28-9:02 AM

Triple beam balance



Apr 28-9:35 AM

Digital equipment

Note: On digital equipment, record exactly what you see.

Apr 28-9:38 AM

Concludes Video 1:

Make sure you have taken good notes.

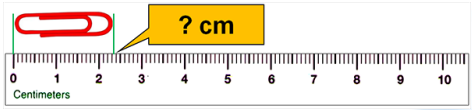
Come to class with any questions.

Apr 28-9:53 AM

SIG FIGS

Scientific measurements are limited by the degree of "exactness" or precision that the measuring instrument gives us.

EX: If we wish to measure the length of a paperclip with a centimeter ruler, we can estimate the length to the hundredths place, estimating one digit beyond what we can see marked on the ruler. **The digits we obtain in our measurements are called significant figures.**



Sig Figs