

# Chemistry !!!

101

Spring 2018

Dr. Maria A. Donnelly  
Beaupre 117C  
madon@uri.edu



# Why Learn Chemistry?

To better understand the environment around us



## Medicine

- Understanding disease
- Develop new drugs

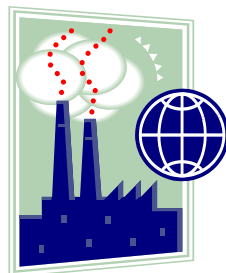
## Criminal Justice & Safety

- Forensics
- Explosives & Drug detection
- Safety equipment



## Environmental Science

- Ozone layer
- Global warming
- Acid rain



## Agriculture

- Bioengineered food
- Fertilizers

## Material Science

- Better built houses
- More efficient cars
- Plastics, composites





# Why Learn Chemistry?

## Fun!

Fireworks!



New materials for sports equipment!



Better electronic devices  
& gaming systems!



High tech clothing  
for any activity!





# Expectations

## CHM101 - Freshman Chem. Lecture (lab – CHM102)

- Required if 3-4 semesters of chem. required by major
- Pharmacy, Engineering, Biology
- Pre-professional programs: med, dental, veterinary etc.
- Some environmental science groups
- **Emphasis on mathematical skills (esp. algebra) & problem solving (most exams ~ 80% math)**
- **Other General Chemistry courses – 103, 191**
- Grading:
  - Connect on-line homework & Learnsmart (15%)
  - Four lecture exams (68%)
  - Final exam (17%)
  - to calculate:  $(\text{HW avg} * 0.15) + (\text{exam avg} * 0.85)$



# **Your choices will determine your level of success**

- **Attendance is important**
  - prepare in advance – become familiar with key terms & ideas
  - pay attention, ask me questions
  - print out slides and bring them with you to take notes on
- **Assignments are designed to help you learn**
  - focus on WHY you need to follow certain steps to solve problems rather than trying to memorize the steps
  - ask yourself what you do and do not understand
- **Complete assignments on time**
  - mastery of early material will help with material covered later
  - avoid having assignments build up & losing points due to lateness
- **Seek help right away!**
  - office hours
  - TAs in Beaupre 115 Learning Center
  - AEC tutoring group or walk in tutoring



## Be Courteous to Your Classmates

- If you arrive late/need to leave early, use the back entrance
- Your peers can be a great resource, but please wait till after lecture to talk with them
- Give everyone a chance to answer
- Remember why you are here
  - TV shows, games, movies, & social media will not help you learn
  - they are also visible to the students sitting behind you & can be quite distracting



# Useful Information: Sakai

Where to find lecture slides & other useful information

**Overview**

**OVERVIEW**

Welcome

CHM 161 is a general chemistry course designed to introduce a variety of concepts and principles that are fundamental to the study of chemistry. Significant emphasis will be placed on mathematical skills and problem solving.

Instructor: Dr. Maria Connolly

Email: mconnol@sul.edu

Office: Basque 117C

Office hours:

Office hour appointments should be made through the Starfish Success Web - simply click on the link below. Appointments are not required but students with appointments will be given priority over those who have not made appointments. During walk-in hours, appointments are not accepted and multiple students may be helped at the same time.

**Starfish Success Web**

[Link to Student Resources \(Lecture slides, Syllabus, Sakai information, Connect information, List of vocabulary that you should know for each chapter\)](#)

[Link to the Connect Registration/login page](#)

[Link to TA Office Hours in Basque 115\\*](#)

\*Office hours are listed based on lab; the TAs for this course would be the CHM162 TAs

**Recent Announcements**

Options

**Announcements**

Viewing announcements from

There are currently no

**Calendar**

Options Publish (private)

**September 2018**

Sun	Mon
2	3

Starfish!  
For making  
appointments, etc.



# Useful Information: Lecture Notes, etc.

Home

People ▾

Research

For Prospective Students

For Current Students

Links ▾

Contact Us

Teaching

## Dr. Donnelly's CHM 101 Student Resources

### Course Information

- Syllabus
- Sakai Information Guide
- Beaupre 100 Seating Chart

### Connect Information

- General Connect Information
- Registration Information

### Lecture Slides

- Chapter 1
- Chapter 2
- Chapter 3
- Chapter 4
- Chapter 5
- Chapter 6
- Chapter 7



# Useful Information: Connect

Registration Information  
is section specific!

Your Section!

Section 1:  
Spring 2018  
TTh 9:30 am

connect

student registration information  
course

Spring 2018 CHM 101 General Chemistry  
with LearnSmart and LearnSmart Prep

Instructor

Mara Donnelly

section

Spring 2018 Section 1 TTh 9:30 am

online registration instructions  
Go to the following web address and click the "register now" button.

<https://connect.mheducation.com/learn-smart/spring-2018-section-1-tth-930-am>

This is a unique address for  
**Spring 2018 Section 1 TTh 9:30 am**

Having trouble registering?  
Get help here: <https://bit.ly/learn-smart-registration>

© 2018 McGraw-Hill Education. All rights reserved.

Section 2:  
Spring 2018  
TTh 11:00 am

connect

student registration information  
course

Spring 2018 CHM 101 General Chemistry  
with LearnSmart and LearnSmart Prep

Instructor

Mara Donnelly

section

Spring 2018 Section 2 TTh 11:00 am

registration dates

11/03/18 - 05/01/19

online registration instructions  
Go to the following web address and click the "register now" button.

<https://connect.mheducation.com/learn-smart/spring-2018-section-2-tth-1100-am>

This is a unique address for  
**Spring 2018 Section 2 TTh 11:00 am**

Having trouble registering?  
Get help here: <https://bit.ly/learn-smart-registration>

© 2018 McGraw-Hill Education. All rights reserved.

Section 4:  
TTh 9:30 am

connect

student registration information  
course

Fall 2018 CHM 101 General Chemistry  
with LearnSmart and LearnSmart Prep

Instructor

Mara Donnelly

section

Fall 2018 CHM 101 Section 4 TTh 9:30 am

registration dates

08/04/18 - 12/11/18

online registration instructions  
Go to the following web address and click the "register now" button.

<https://connect.mheducation.com/learn-smart/fall-2018-section-4-tth-930-am>

This is a unique address for  
**Fall 2018 CHM 101 Section 4 TTh 9:30 am**

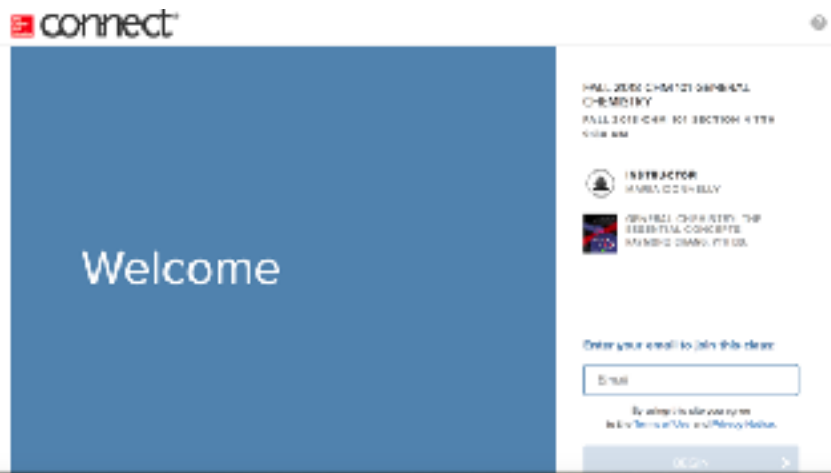
Having trouble registering?  
Get help here: <https://bit.ly/learn-smart-registration>

© 2018 McGraw-Hill Education. All rights reserved.

Link to registration page



# Useful Information: Connect Registration



Create your McGraw-Hill Education account.

**USER NAME:**

**EMAIL:**

**First Name:**

**Last Name:**

**Country:**

**Address:**

**Phone Number:**

**Continue**



## Student Registration

**General Chemistry: The Essential Concepts**  
 10th Edition  
 Raymond Chang, Kenneth Goldsby

**Already purchased?**  
 To access your course materials, enter your registration code.

**Registration Code:**

**Submit**

**Need to purchase?**  
 The registration code, or password, you can buy online to access General Chemistry: The Essential Concepts right now. All you need is a credit card.

**Buy Online**

**Need Temporary Access?**  
 You can get the week access to your course materials for free. After that your work will be deleted and you can purchase again.

**Start temporary access**

Courtesy Access has been extended to 1 month for this semester.







(Older screenshot, may look slightly different now)




# Useful Information: Connect Assignments

Required


NOT  
Required







Assignment list			
Ungrouped Assignments			
		Due Date	Status Attempts Remaining
	Chapter 1 Homework	 01/28/18 11:58PM	Unlimited
	Chapter 1, Introduction	 01/25/18 11:58PM	N/A
	Chapter 1 Practice	 06/31/18 11:58PM	Unlimited

**Section Info**

 **Instructor**  
**Maria Donnelly**

---

 **eBook**  
**General Chemistry: The Essential Concepts**  
Raymond Chang, Kenneth Goldsby 7

Assignment list			
Ungrouped Assignments			
		Due Date	Status Attempts Remaining
	Chapter 1 Homework	 09/15/17 11:58PM	Unlimited
	Chapter 1, Introduction LearnSmart Assignment	 12/11/17 11:58PM	N/A
	Chapter 2, Atoms, Molecules, and Ions	 12/11/17 11:58PM	N/A

LS = Learnsmart

Learnsmart assignments for chapters 1 & 2

Link to Learnsmart  
practice problems

General Chemistry - General Chemistry: The Essential Concepts - Chang/Goldsby, 7e, Introduction

Introduction

1.1 The Study of Chemistry

1.2 The Scientific Method

1.3 Classification of Matter

1.4 Physical and Chemical Properties of Matter



Similar concepts

Study of Chemistry: Chemistry is the scientific study of matter and the changes it undergoes. Chemical and physical properties of matter are used to describe and understand the world around us.

Physical and Chemical Properties: To characterize a substance, and to make predictions about its behavior, we use its physical and chemical properties. Physical properties are those that can be observed or measured without changing the identity and chemical composition of the substance. Chemical properties are those that can only be observed when the substance undergoes a chemical change.

Quantitative and Qualitative: Chemistry is a quantitative science and measurements are essential. The scientific method is a systematic way of gathering data, analyzing it, and drawing conclusions. The scientific method is a process that involves making observations, asking questions, forming hypotheses, testing hypotheses, and drawing conclusions.



# Useful Information: Sakai

Adding (or removing) courses from tabs in Sakai

The screenshot displays the Sakai LMS interface for a course site. At the top, the navigation bar shows the site name 'UNIVERSITY OF RHODE ISLAND' and the current site '2179-CHM1010002: Gene...'. A red circle highlights the 'Sites' icon in the top right corner, with a red arrow pointing to the 'Sites' drawer below. The drawer is titled 'Organize Favorites (3)' and contains a search bar and two sections: 'Spr 2018' and 'OTHER'. The 'Spr 2018' section lists three courses, each with a yellow star icon and a dropdown arrow. The 'OTHER' section shows a 'Home' link. The 'PROJECTS' section is partially visible at the bottom. A red arrow points from the 'Sites' icon to the 'Sites' drawer. Another red arrow points from the 'Yellow stars will show up as tabs' text to the yellow star icons in the 'Spr 2018' section.

UNIVERSITY OF RHODE ISLAND

Home 2179-CHM1010002: Gene... 2179-CHM1010002: Gene...

Sites Maria

2179-CHM1010002: Gene... OVERVIEW

Site Information Display

CHM 101 is a general chemistry course designed to introduce a variety of concepts and principles that are fundamental to the study of chemistry. Significant emphasis will be placed on mathematical skills and problem solving.

Instruction: Dr. Maria Donnelly

Email: mdonnelly@che.uri.edu; maddon@uri.edu

Office: Biospr 117C

Office hours: MWF 10:15 am - 11:30 am  
Tu 1:30 pm - 4:30 pm

Recent Announcements

Announcements  
(viewing announcements from the last 10 days)

Welcome to CHM 101  
(Maria Donnelly - Sep 8, 2017 6:43 pm)

Sites Organize Favorites (3)

Search sites in this drawer

Spr 2018

★ 2181-CHM1010001: Gene...  
★ 2181-CHM1010002: Gene...  
★ 2181-CHM1010200: Gene...

OTHER

Home

PROJECTS

Yellow stars will show up as tabs



# **Chemistry Labs Start This Week!!!**

**Safety Training is required for all Chem. labs and is only given during your first lab session**

**Anyone without safety training after the first week will be dropped from their lab section**

## **If you miss your first lab:**

1. Attend a makeup safety training session by **Tuesday September 11<sup>th</sup>**
2. You must attend a safety training specific to your course (see ecampus for times)
3. Attend your assigned lab next week

## **If you want to get into a lab:**

1. Sign up on Wait List at [www.chm.uri.edu](http://www.chm.uri.edu)
2. Attend a safety training session
3. You will be emailed a permission number if an opening becomes available

**Safety training is held during regularly scheduled labs ONLY**  
**If you miss your lab, you must make up the safety training by Tues.**





# **Chapter 1**

# **Introduction**



The science that studies the properties of substances & how substances react with one another.

How stuff works on a molecular/atomic/subatomic level

# *Chemistry!*

**MATTER**

Has mass &  
takes up  
space



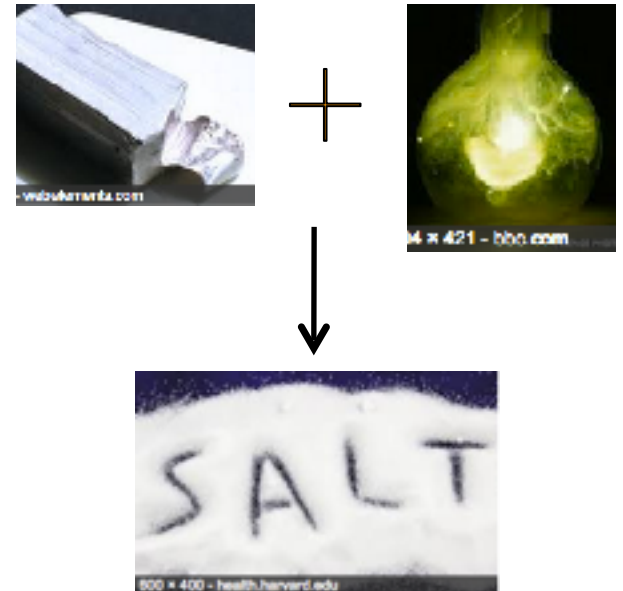
**ENERGY**

The capacity to do  
work or cause  
change



**REACTIONS**

How materials  
interact & change



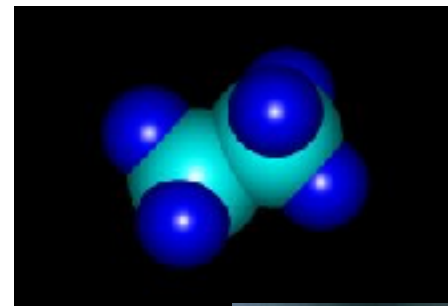


# Learning the Language

Chemistry describes materials and predicts behavior using three basic concepts

## Composition

- Mass percent of elements/compounds present
- Atomic/molecular ratios within material
- Stoichiometry



## Structure

- Molecular/ionic/atomic arrangement
- Phase (solid, liquid, gas)



## Properties – chemical & physical

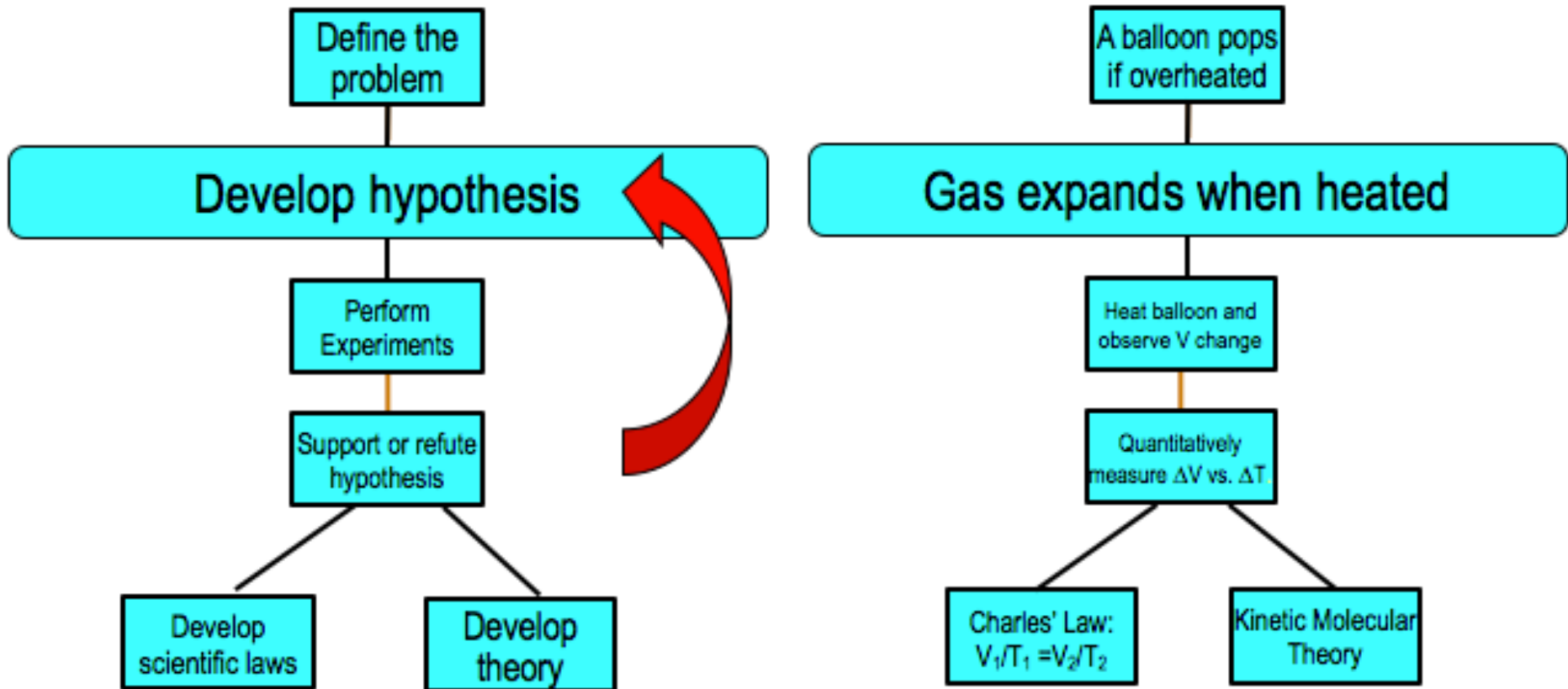
- Specific to a particular material
- ex: boiling point, color, odor, reactivity
- Used for identification





# The Scientific Method

Series of steps that explain an observation



Molecules move faster when heated requiring more space, causing balloon to pop.



# Classifications of Matter

What is in the material you are investigating?





# Pure materials

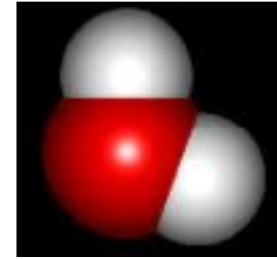
## Atom:

- Smallest distinctive unit w/ properties of element



## Molecule:

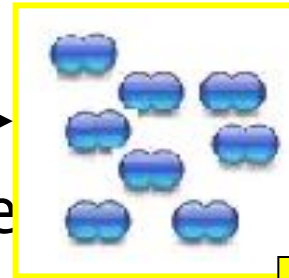
- 2 or more atoms together



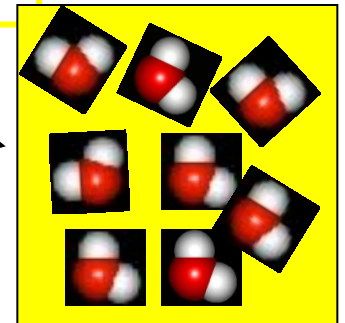
## Pure Substance:

- Definite/constant composition & distinct properties
- **TWO** types of pure substances:

- **Element** → one type of atom →
- **Compound** → more than one type of atom chemically bonded →



- **Compounds contain more than one element – still a pure substance!!!**





# Mixtures

**Mixture:** Combination of 2 or more pure substances  
• Can be separated by physical means

## Homogeneous Mixture

- Substances stay mixed
- No distinct layers
- Uniform properties
- Also called a **“solution”**



14 karat gold  
Mixture of gold and silver

## Heterogeneous Mixture

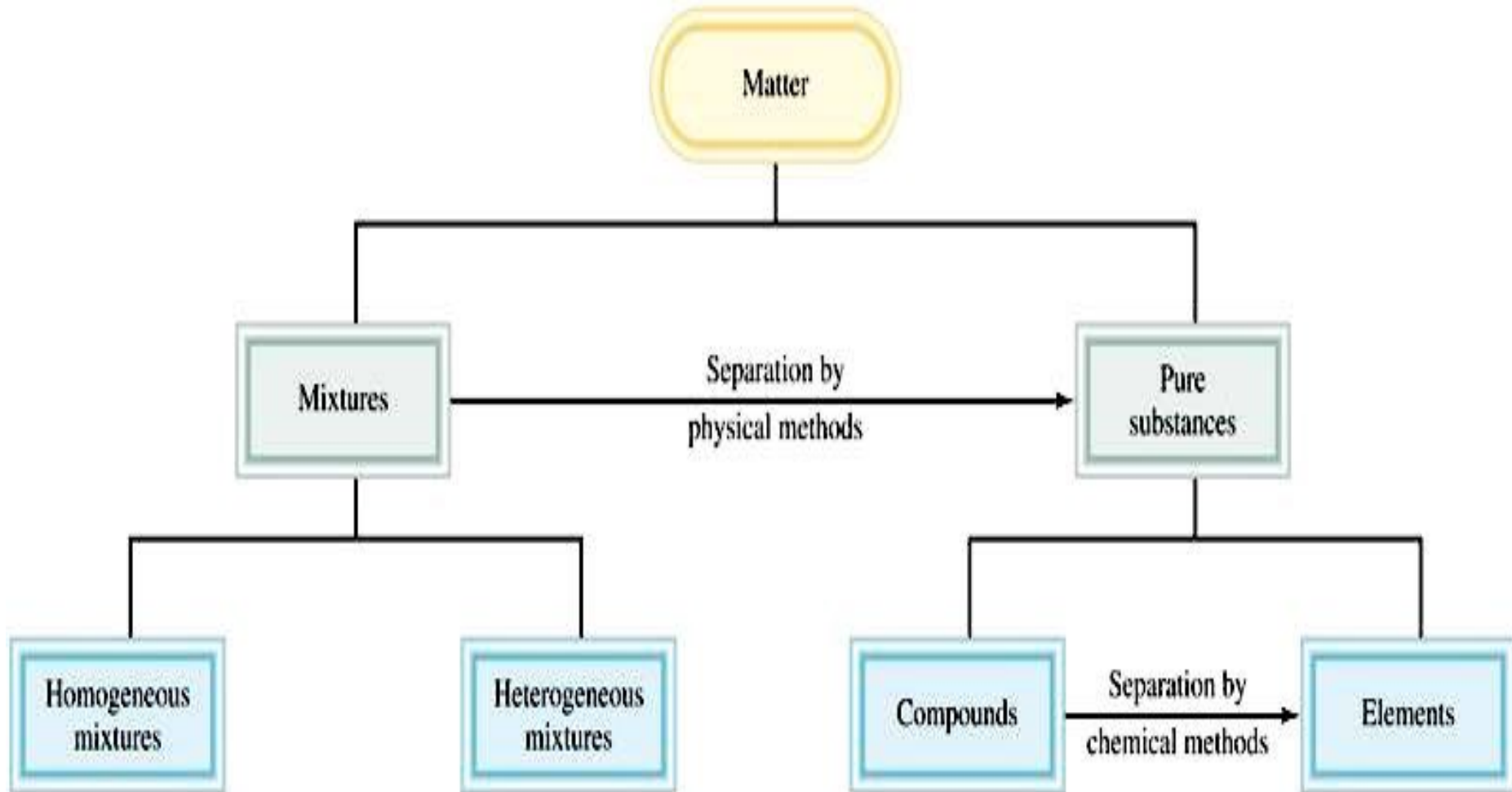
- Substances separate easily
- Distinct layers often seen
- Properties may not be uniform



Iron filings and sand



# Matter Summary





Heterogeneous  
mixture

Homogeneous  
mixture

Pure Substance<sup>22</sup>





# Physical and Chemical Properties of Matter

Can be used to identify & separate substances





# Physical Properties of Matter

Can be changed without changing molecular composition

Chemical identity is NOT CHANGED

eg: smashing a window – still glass  
melting ice – still water

Phase changes are physical changes  
(solid to liquid to gas etc.)

Melting, freezing, boiling, etc.

**CHEMICAL BONDS ARE NOT BROKEN  
DURING PHASE CHANGES!**

Can be used to ID a substance without damage

Color, odor, solubility, conductivity, density

molecular mass, boiling/melting points

Original compound can be recovered





# Chemical Properties of Matter

**Describe how chemicals react with each other**

What will they react with?

How will they react?

- Generate heat or light?
- Burn? Explode?
- Decompose slowly? (Rusting, rotting)



**Compositional changes to molecules**

- Often called a chemical change
- Original material changed on an atomic level



**Original compound no longer present**

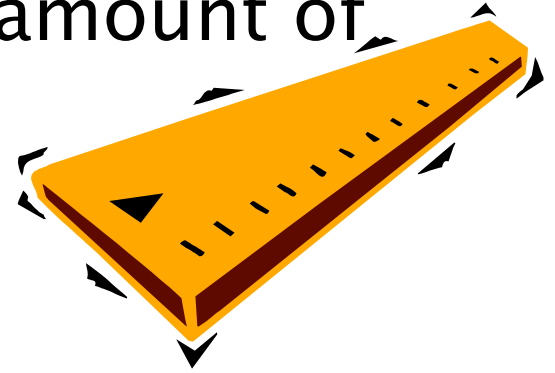
- Compound cannot be restored to its original form without another chemical change



# Extensive and Intensive Properties

**Extensive Property:** Depends on amount of matter present

ex: mass, length, volume, heat, intensity of color or odor



**Intensive Property:** Independent of amount of matter present

ex: Temperature, boiling point, color, odor

Often a calculated ratio

ex: Density (mass/vol ratio)

Molar mass (grams/mol)

Specific heat (J/g)



Intensive properties can be used to identify a material, extensive properties cannot. Why?



# Measurements

Determining how much matter is present



olin.edu



amazon.com



# Base Units of Measurement

## International System of Units (SI)

**TABLE 1.2**   **SI Base Units**

Base Quantity	Name of Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electrical current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol

Will be used frequently in CHM 10; you are expected to know them! (Depending on other classes, will likely need to know ampere in the future.)



# SI Prefixes

Yes, you need to know these too

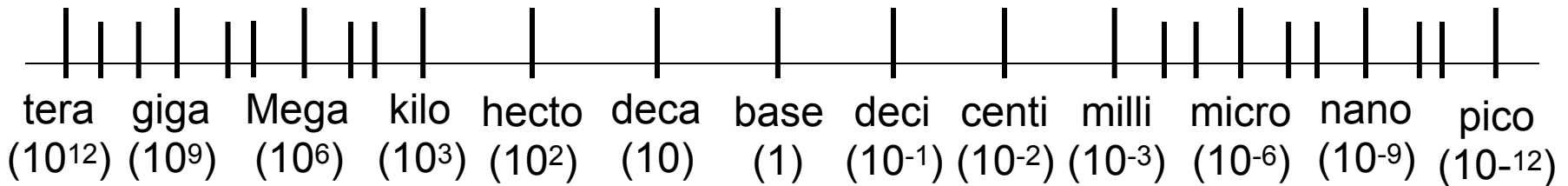
TABLE 1.3		Prefixes Used with SI Units
Prefix	Symbol	Meaning
tera-	T	1,000,000,000,000, or $10^{12}$
giga-	G	1,000,000,000, or $10^9$
mega-	M	1,000,000, or $10^6$
kilo-	k	1,000, or $10^3$
deci-	d	1/10, or $10^{-1}$
centi-	c	1/100, or $10^{-2}$
milli-	m	1/1,000, or $10^{-3}$
micro-	$\mu$	1/1,000,000, or $10^{-6}$
nano-	n	1/1,000,000,000, or $10^{-9}$
pico-	p	1/1,000,000,000,000, or $10^{-12}$

hecto ( $10^2$ )  
deca ( $10^1$ )  
Base

**The Great Majestic King Henry Died By  
Drinking Chocolate Milk at Mad Nick's Palace**



# The Great Majestic King Henry Died By Drinking Chocolate Milk at Mad Nick's Palace



$$25 \text{ m} = 0.0000000000025 \text{ Tm}$$

$$25 \text{ m} = 0.000000025 \text{ Gm}$$

$$25 \text{ m} = 0.000025 \text{ Mm}$$

$$25 \text{ m} = 0.025 \text{ km}$$

$$25 \text{ m} = 0.25 \text{ hm}$$

$$25 \text{ m} = 2.5 \text{ dam}$$

$$25 \text{ m} = 25 \text{ m}$$

$$25 \text{ m} = 250 \text{ dm}$$

$$25 \text{ m} = 2500 \text{ cm}$$

$$25 \text{ m} = 25000 \text{ mm}$$

$$25 \text{ m} = 25,000,000 \text{ }\mu\text{m}$$

$$25 \text{ m} = 25,000,000,000 \text{ nm}$$

$$25 \text{ m} = 25,000,000,000,000 \text{ pm}$$

$$25 \text{ Tm} = 25,000,000,000,000 \text{ m}$$

$$25 \text{ Gm} = 25,000,000,000 \text{ m}$$

$$25 \text{ Mm} = 25,000,000 \text{ m}$$

$$25 \text{ km} = 25,000 \text{ m}$$

$$25 \text{ hm} = 2500 \text{ m}$$

$$25 \text{ dam} = 250 \text{ m}$$

$$25 \text{ m} = 25 \text{ m}$$

$$25 \text{ dm} = 2.5 \text{ m}$$

$$25 \text{ cm} = 0.25 \text{ m}$$

$$25 \text{ mm} = 0.025 \text{ m}$$

$$25 \text{ }\mu\text{m} = 0.000025 \text{ m}$$

$$25 \text{ nm} = 0.000000025 \text{ m}$$

$$25 \text{ pm} = 0.0000000000025 \text{ m}$$



# Metric Conversion Examples

1.) Convert 256.74g to kg  
(0.25674 kg)

2.) How many milliliters are in 3.78 L?  
(3780 mL)

3.) Convert 18000000 cm into Mm  
(0.18 Mm)

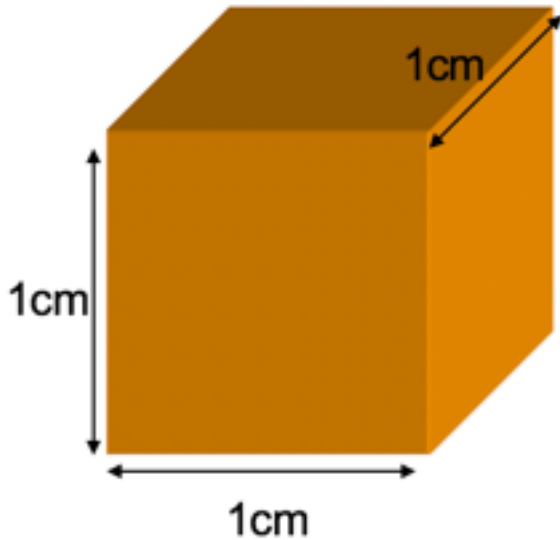


# Derived Units: Volume

SI derived unit for volume is a cubic meter ( $m^3$ )

Common unit is a “**Liter (L)**”

$$1L = 1000cm^3 = \frac{1000cm}{1} \times \frac{1cm}{1} \times \frac{1cm}{1} \times \frac{1m}{100cm} \times \frac{1m}{100cm} \times \frac{1m}{100cm} = 1 \times 10^{-3} m^3$$



$$\underline{1 L \neq 1 m^3}$$

$$\underline{1 L = 1 \times 10^{-3} m^3}$$

$$\underline{1 mL = 1 cm^3}$$





# Metric Conversions with Units that are squared ( $s^2$ ), cubed ( $cm^3$ ), etc. can be tricky:

ex.) Convert  $87856 \text{ cm}^3$  to  $m^3$

Note:  $1 \text{ m} = 100 \text{ cm}$  but  $1 \text{ m}^3 \neq 100 \text{ cm}^3$

Need to do the conversion 3x for cubed numbers  
(2x for squared, etc.)

$$87856 \text{ cm}^3 = 0.087856 \text{ m}^3$$



# Derived Units: Density

Density: Ratio of mass to volume of a material

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{m}{V}$$

SI derived unit for density is  $\text{kg/m}^3$

$$1 \text{ g/cm}^3 = 1 \text{ g/mL} = 1000 \text{ kg/m}^3$$

Substance	Density ( $\text{g/cm}^3$ )
Air*	0.001
Ethanol	0.79
Water	1.00
Mercury	13.6
Table salt	2.2
Iron	7.9
Gold	19.3

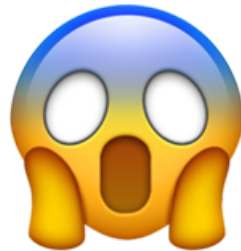
## Intensive property

- Can be used to identify a material
- Units of mass and volume may vary



# Handling Numbers

## Math Review





# Scientific Notation

For very large or very small numbers

Significant digits  $\longrightarrow$  **1.7** **x** **10**<sup>6</sup>  $\longleftarrow$  Size of number  
(multiplier)

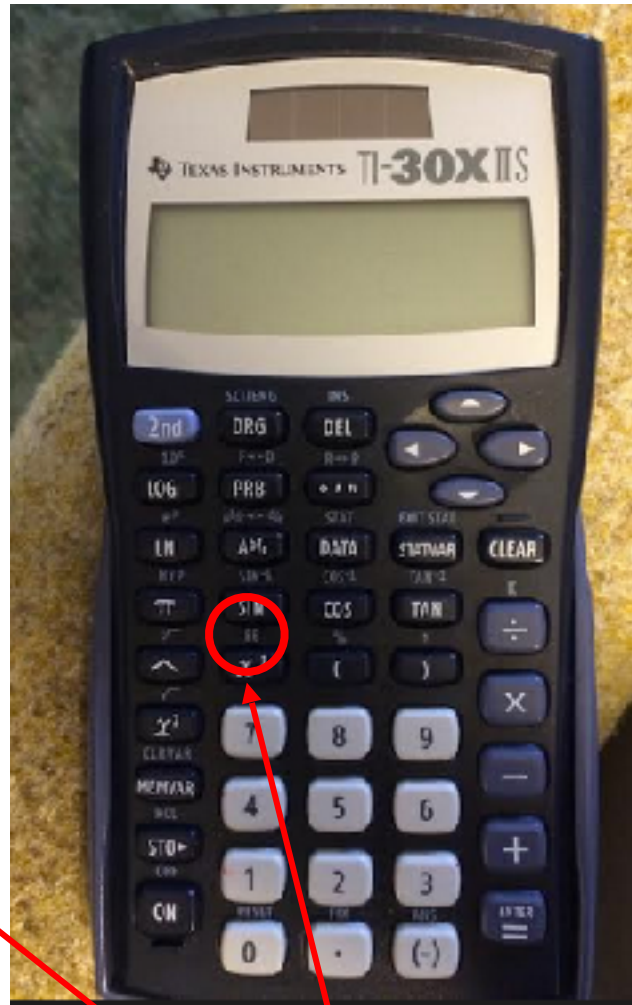
**1700000**  $\rightarrow$  **1.7** **x** **10**<sup>6</sup>  $\longleftarrow$  Positive exp = large number (>1)

**0.0000017**  $\rightarrow$  **1.7** **x** **10**<sup>-6</sup>  $\longleftarrow$  Negative exp = small number (<1)

Rules:

- Keep all significant numbers
- Place decimal after 1<sup>st</sup> significant number (**1.7**)
- To get exponent:
  - Count number of places decimal moved to get to correct location (after 1<sup>st</sup> significant number). This value is your exponent.
  - If the number is >1, exp is positive **1700000**  $\rightarrow$  **1.7** **x** **10**<sup>6</sup>
  - If the number is <1 exp is negative **0.0000017**  $\rightarrow$  **1.7** **x** **10**<sup>-6</sup>





Use **EXP**, **SCI**, **EE** or  **$\times 10^x$**  keys on calculator



# Scientific Notation Examples

Write the Following in  
Scientific Notation:

1.) 280000000

2.) 280.0

3.) 0.0000000004577

4.) 0.000000060

Write the Following  
in Standard Format:

1.)  $2.45 \times 10^2$

2.)  $3.98 \times 10^6$

3.)  $4.29 \times 10^{-3}$

4.)  $8.0 \times 10^{-6}$



# Significant Figures:

## Number of Digits to Report in Final Answer

1. All non-zero digits are significant
2. Use decimal point to decide if zeros are significant
 

Between 2 numbers	significant	<u>5</u> <u>0.00</u> <u>2</u>	5 sig figs
Before decimal point	not significant	<u>0.50</u> <u>2</u>	3 sig figs
Before the first digit	not significant	<u>0.00</u> <u>52</u>	2 sig figs
End of # after decimal	significant	<u>0.02</u> <u>00</u>	3 sig figs
No decimal point:	not significant	5 <u>00</u>	1 sig fig
3. **Exact** numbers have unlimited number of sig. figs.
 

Inherently an integer:	e.g. 4 sides to a square
Inherently a fraction:	e.g. $\frac{1}{2}$ of a pie
Obtained by counting:	e.g. 47 people in a class
Defined quantity:	e.g. 12 eggs in a dozen



# Determining the correct number of significant figures (sigfigs) in math problems:

**Answer is based on the LEAST significant value**

Addition/subtraction – Sig figs based on decimal

$$\begin{array}{r} 1500 \\ + 2976 \\ \hline 4476 \end{array} \longrightarrow 4500$$

$$\begin{array}{r} 12.45\text{XX} \\ - 9.2680 \\ \hline 3.1820 \end{array} \longrightarrow 3.18$$

Multiplication/Division – Sig figs based on all sig digits

4 sig figs

3 < 4 so 3 sig figs

$$\begin{array}{c} 4 \text{ sig figs} \\ 3.182 \times 3.57 = 11.35974 \longrightarrow 11.4 \\ 3 \text{ sig figs} \end{array}$$

Rounding is based on number after last sigfig:

$\geq 5$  round up

$\leq 5$  round down



# Multiple math functions – follow order of ops

$$(12.45 - 9.2680) \times 3.575 = 11.37565$$

Step one: Subtraction → Sigfigs based on decimal

$$(12.45 - 9.2680) = 3.182$$

2 sigfigs after decimal

3 sigfigs overall in final answer

$$\begin{array}{r} 12.45\text{XX} \\ - 9.2680 \\ \hline 3.1820 \end{array}$$

Step two: Multiplication → Sigfigs based on all sig digits

$$3.182 \times 3.575 = 11.37565$$

3 sigfigs in 1<sup>st</sup> number, 4 in 2<sup>nd</sup> → 3 in final answer  
Here addition limits sigfigs

Round up because the next number is >5

$$11.37565 \rightarrow 11.4$$



# Why do significant figures matter?

123.52 cm



121 cm



Width of room: 244.6 cm  
Will the two desks fit?

$$\begin{array}{r}
 123.52 \text{ cm} \\
 + 121.?? \text{ cm} \\
 \hline
 244.52 \text{ cm} \rightarrow 245 \text{ cm}
 \end{array}$$

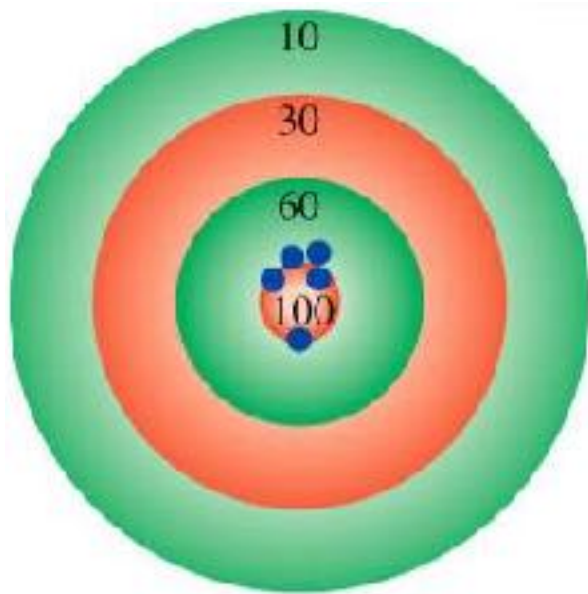
Fitting desks in a room may not seem all that important – but the same concept is true for the design of buildings & bridges!



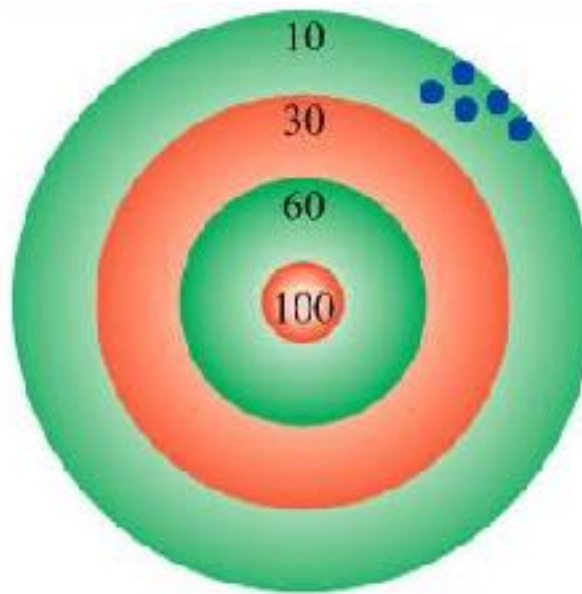
# Precision and Accuracy

**Accuracy** – how close a measurement is to the true value

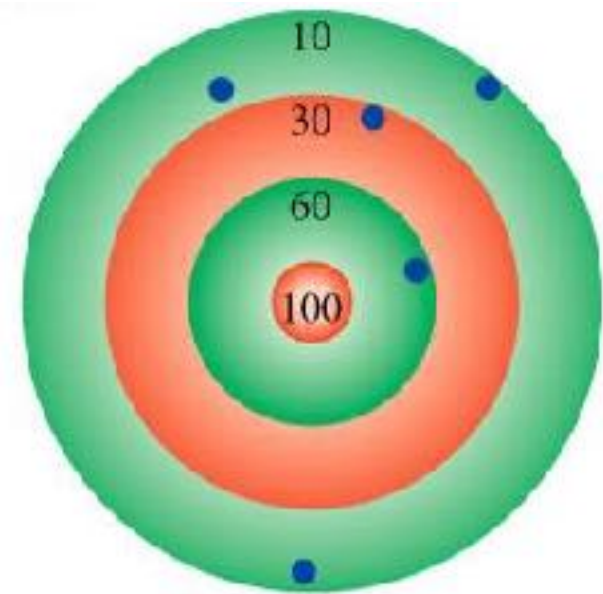
**Precision** – how close measurements are to each other



accurate  
&  
precise



precise  
but  
not accurate



not accurate  
&  
not precise



# Percent Error

## Comparison of experimental results to expected or real values

- Usually reported without a + or - sign

$$\% \text{ error} = \frac{|\text{Experimental value} - \text{Real value}|}{\text{Real value}} \times 100$$

Experimental value - Real value = **Deviation**

- Often reported with a + or - sign

### Real value:

- Widely accepted, often an industry standard value
- Average of several experiments can sometimes be used if real value is unknown



# Dimensional Analysis

## Algebra and canceling units

Look at question:

How many kilograms of methanol will fill a 15.5 gallon fuel tank of a car modified to run on methanol? (Density of methanol = 0.791 g/mL)

What unit do you want to solve for?

What information do you need?

Data in problem:

Data to look up:

Data to know:

$$\frac{kg}{1} = \frac{0.791g}{1ml} \times \frac{1kg}{1000g} \times \frac{1000mL}{L} \times \frac{3.785L}{1gal} \times \frac{15.5gal}{1} = 46.4kg$$



# Dimensional Analysis Problems

1) How many kilograms of methanol will fill a 15.5 gallon fuel tank of a car modified to run on methanol? (Density of methanol = 0.791 g/mL; 1 gal = 3.785 L) **A: 46.4 kg**



2) How many liters are equal to 500. cm<sup>3</sup>? A: 0.500 L

3) A cube with sides measuring 7.50 m has a mass of 0.04567 mg. What is the density of the cube in  $\mu\text{g/mL}$ ? A:  $1.08 \times 10^{-7} \mu\text{g/mL}$