CHEM 1A
TUESDAY 2-4:50 PM , 6-9 PM LAB
THURSDAY 2-4:50 PM

Dr. Eileen Clifford

Office hours Tuesday 11-12 Adjunct office

Virtual on moodle Monday 9-10 PM

Chemistry: The central Science, 11th edition (reserve, online)

Bound lab manual with lines

Safety goggles

Scientific calculator (graphing not required)

Email address and ability to use computer lab or internet for moodle

3x5 index cards

Basics

- Math course required is Intermediate Algebra
- Quiz will help verify that you are prepared
- Available assistance at LRC, second floor (FREE)
- Office hours Tuesday 11-12 in adjunct office, also by appt or before class.
- Online office hour Monday 9-10 PM on moodle
- Email for questions, and additional help

- I will be working from the textbook. The HW problems reflect what is important to know, and what may be on the exams. Lectures will cover the most important concepts.
- Chemistry is an experimental science, and the lab allows us to practice it rather than just read about it. Whatever you will use chemistry for will most likely be practical and hands on.

Website, syllabus, and grading

- Chapters covered: 1-11, 13,15
- 13 lab experiments with pre and post lab reports
- 11 in class quizzes at the beginning of class (-1)
- 1 midterm exam
- Final exam
- Homework

- Websites for class
- http://www.alameda.peralta.edu/eileen_chem1a
- http://online.peralta.edu/spring2012/

- eileen_chem1a@yahoo.com
- eclifford@peralta.edu
- Syllabus and class assignments will be posted

Class Business

- Read chapters 1 and 2
- CH 1: problems 1-51 odd, 58, 59, 60, 63, 69, 73
- Keep up with the homework—if you do, you will learn the material and not get behind

- When is HW turned in? 1 week from assigned
- Class participation grade
  - HW, attendence, participation—you are expected in class!

- No phones/MP3 players/music/texting in lecture.
- School conduct code applies
- Two breaks per 3 hour lecture
- No eating/drinking in lab, must wear closed toe shoes and pull back hair.

Syllabus

- syllabus

Quiz

- 20 minutes

Homework for Chapter 1: due Tuesday Jan 30
CH 1: problems 1-51 odd, 58, 59, 60, 63, 69, 73

CHAPTER 1: MATTER AND MEASUREMENT

Concepts in Chapter 1

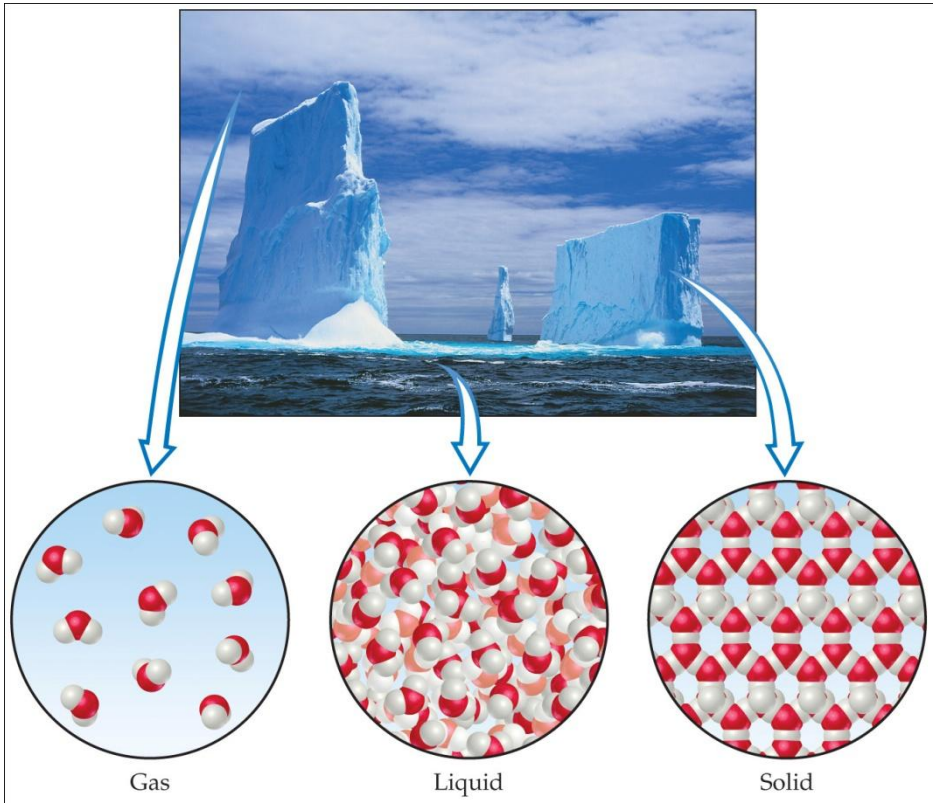
- Very useful to look at before (and after) reading the chapter, found at end of chapter

- Matter is composed of elements with unique properties.
- Types of matter, observed laws.
- Physical and chemical properties
- Metric system and SI units.
- Precision, accuracy, and significant figures.
- Dimensional analysis.

Chemistry, the central science

- Why called the central science?
- Used where?
  - Food science—cooking, manufacturing (Nutrasweet, Doritos)
  - Petroleum chemistry—find and refine gasoline, biodiesel
  - Pharmaceuticals—huge industry to make and discover new drugs
  - Medicine—affects all of us
  - Agriculture—fertilizers, soil chemistry, trace contaminants
  - Fabrics—rayon, polyester, vinyl
  - Cleansers and laundry detergents—new enzymes, soaps
  - ??
- Chemistry is visible in everyday tasks
- Study of stuff, its properties, and how it reacts

Chemistry



In this science we study matter and the changes it undergoes.

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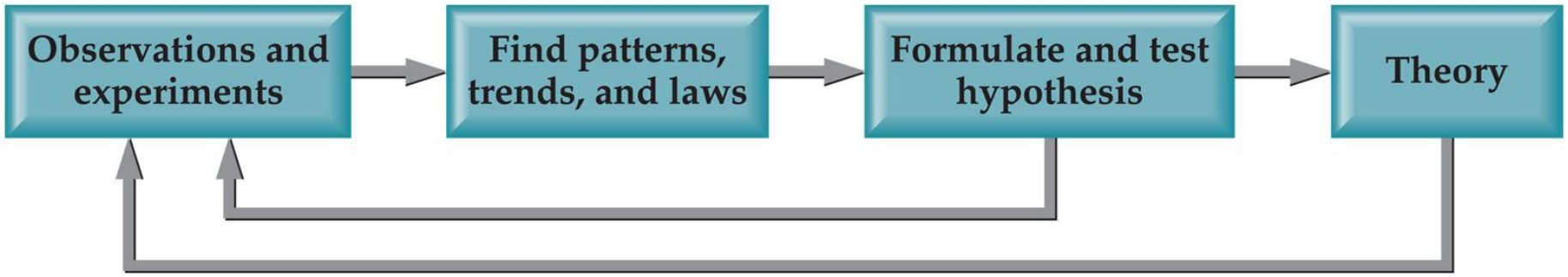
Scientific Method

The scientific method is simply a systematic approach to solving problems.



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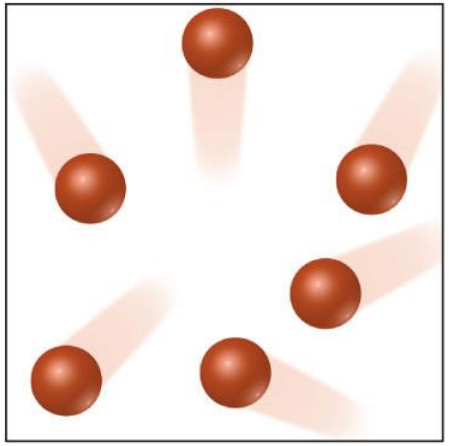
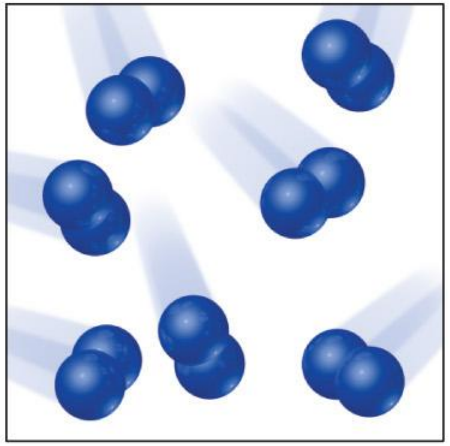
Matter

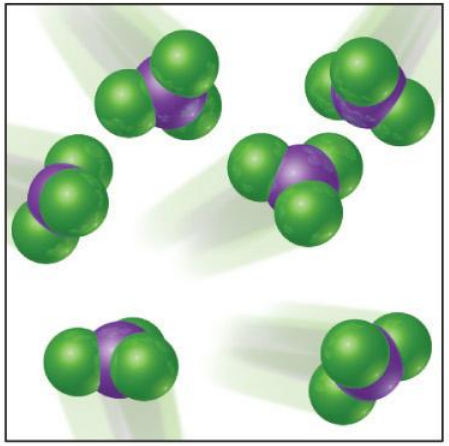
We define matter as anything that has mass and takes up space.



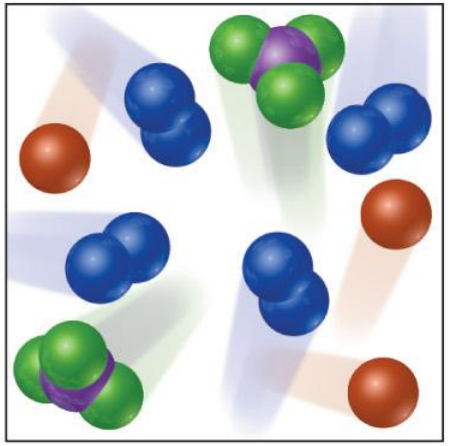
(a) Atoms of an element



(b) Molecules of an element

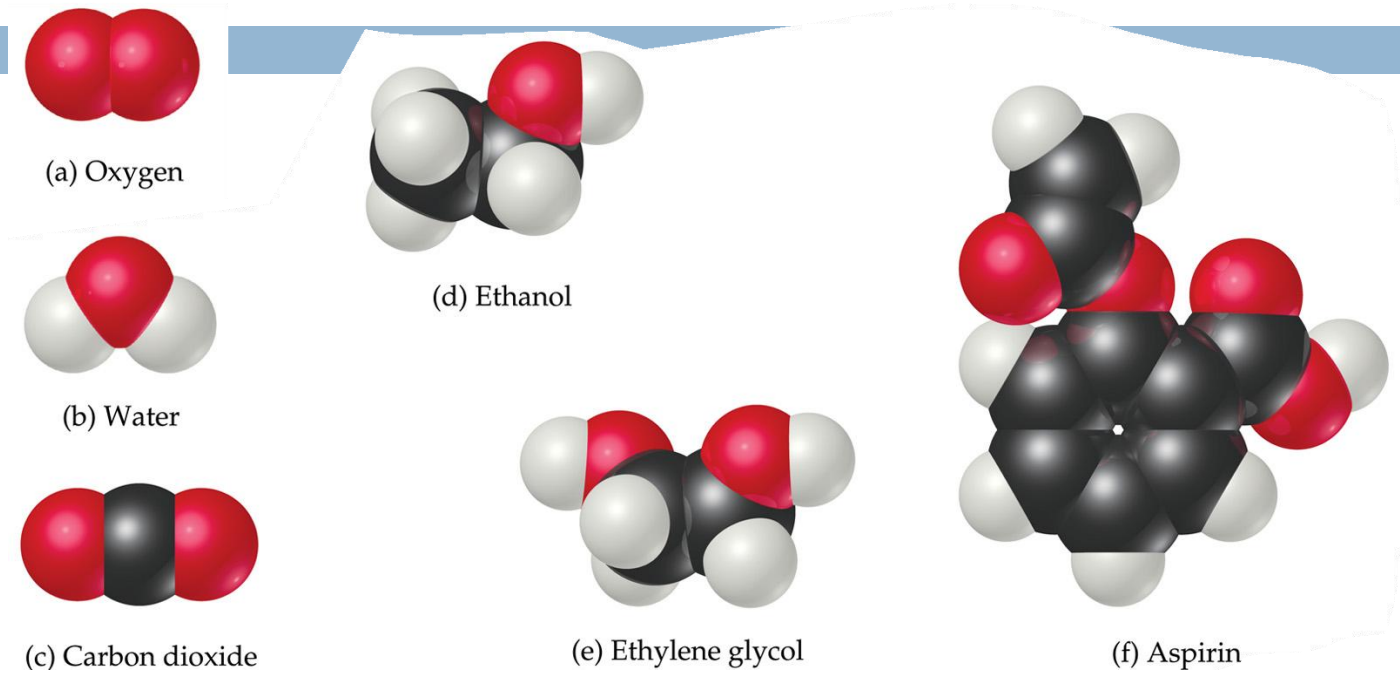


(c) Molecules of a compound



(d) Mixture of elements and a compound

Matter



- Atoms are the building blocks of matter.

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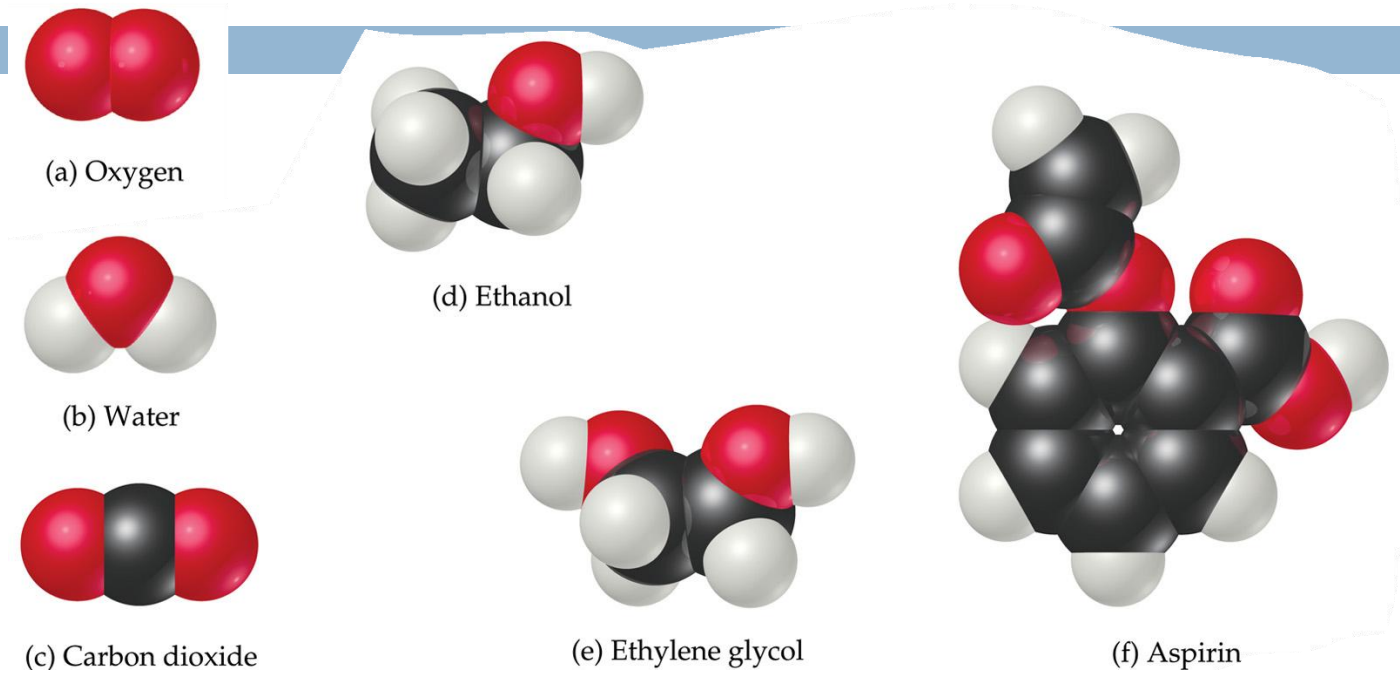
Matter



- Atoms are the building blocks of matter.
- Each element is made of the same kind of atom.
- A compound is made of two or more different kinds of elements.

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States of Matter

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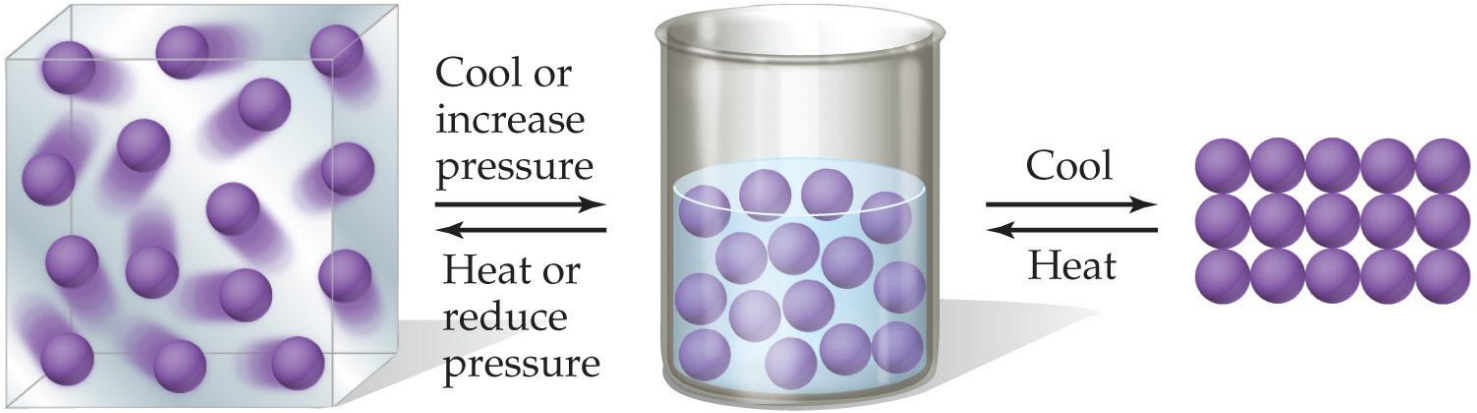

Gas

Total disorder; much empty space; particles have complete freedom of motion; particles far apart

Liquid

Disorder; particles or clusters of particles are free to move relative to each other; particles close together

Crystalline solid

Ordered arrangement; particles are essentially in fixed positions; particles close together

3 states of matter

- http://states of matter

Gas	Liquid	Solid
assumes the shape and volume of its container particles can move past one another, vibrate and move at high speeds	assumes the shape of the container it occupies particles can move/slide past one another	keeps fixed volume and shape, often atoms are packed in regular pattern rigid--particles locked in place
compressible lots of free space between particles	not easily compressible limited free space between particles	not easily compressible limited free space between particles
flows easily particles can move past one another	flows easily particles can move/slide past one another	does not flow easily particles stay in rigid matrix

Classification of Matter

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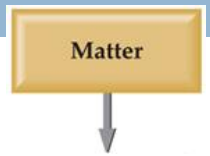

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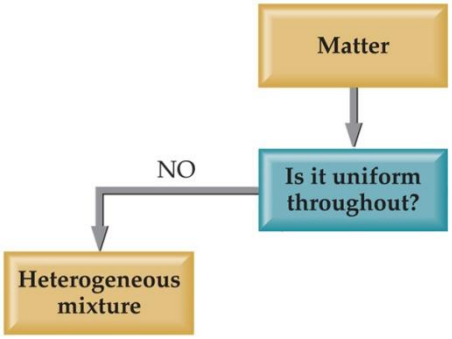

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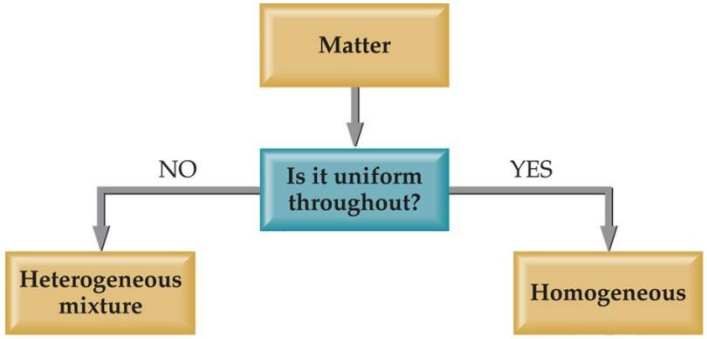

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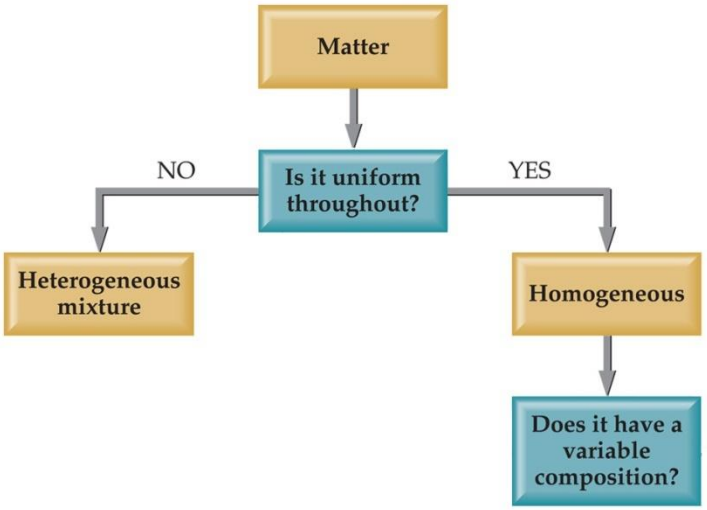

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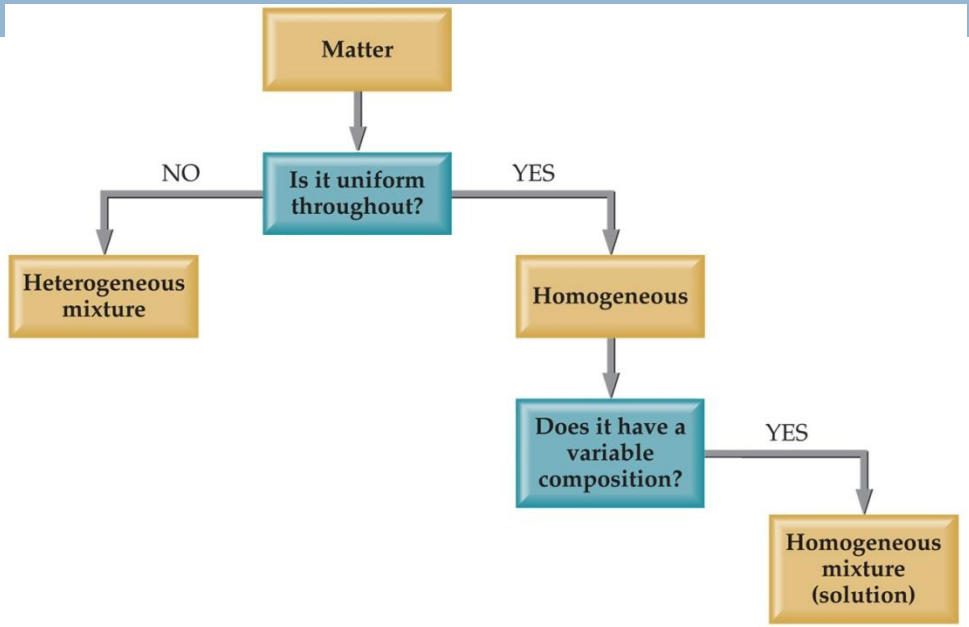

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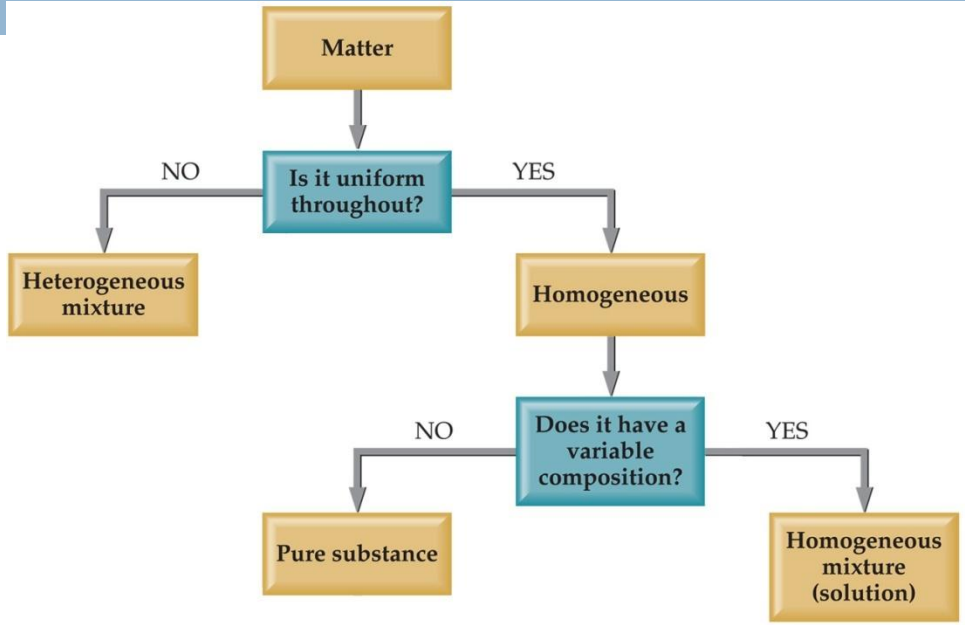

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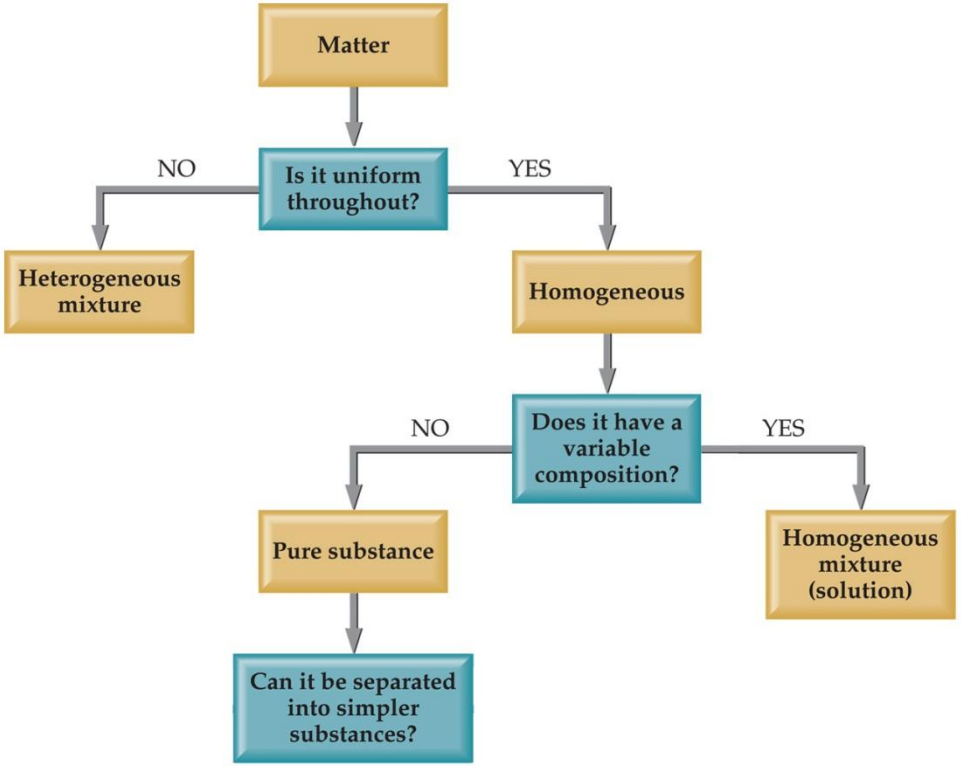

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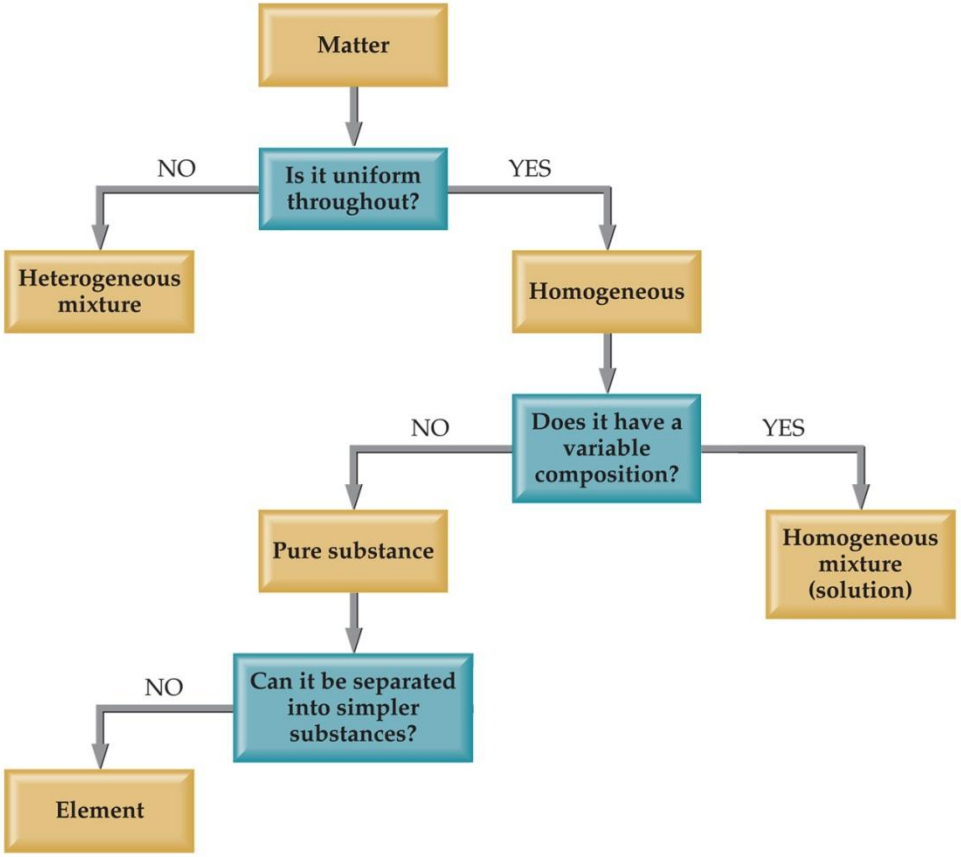

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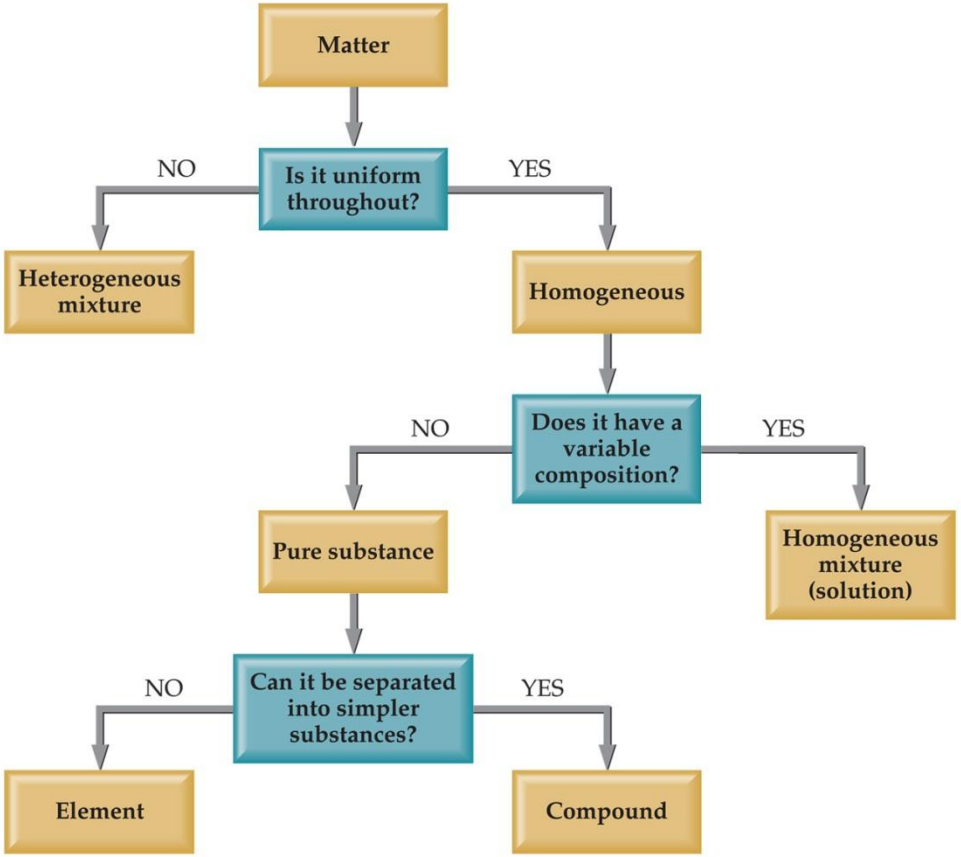

Elements and Compounds and Mixtures

- Element is chemically pure
  - Composition does not vary
- Compound is made of two or more elements and cannot be separated without changing it chemically
  - Composition does not vary
- Mixture of two or more elements or compounds
  - Homogeneous or heterogeneous
  - Can be separated into components without changing the components or doing any chemistry—by physical means

- Gasoline
- Chocolate chip cookie
- Chalk
- Soda
- 14 karat gold ring

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PROPERTIES AND CHANGES OF MATTER

Types of Properties

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- Physical Properties…
  - Can be observed without changing a substance into another substance.
    - Boiling point, density, mass, volume, etc.
- Chemical Properties…
  - Can *only* be observed when a substance is changed into another substance.
    - Flammability, corrosiveness, reactivity with acid, etc.

Types of Properties

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- Intensive Properties…
  - Are independent of the amount of the substance that is present.
    - Density, boiling point, color, etc.
- Extensive Properties…
  - Depend upon the amount of the substance present.
    - Mass, volume, energy, etc.

Types of Changes

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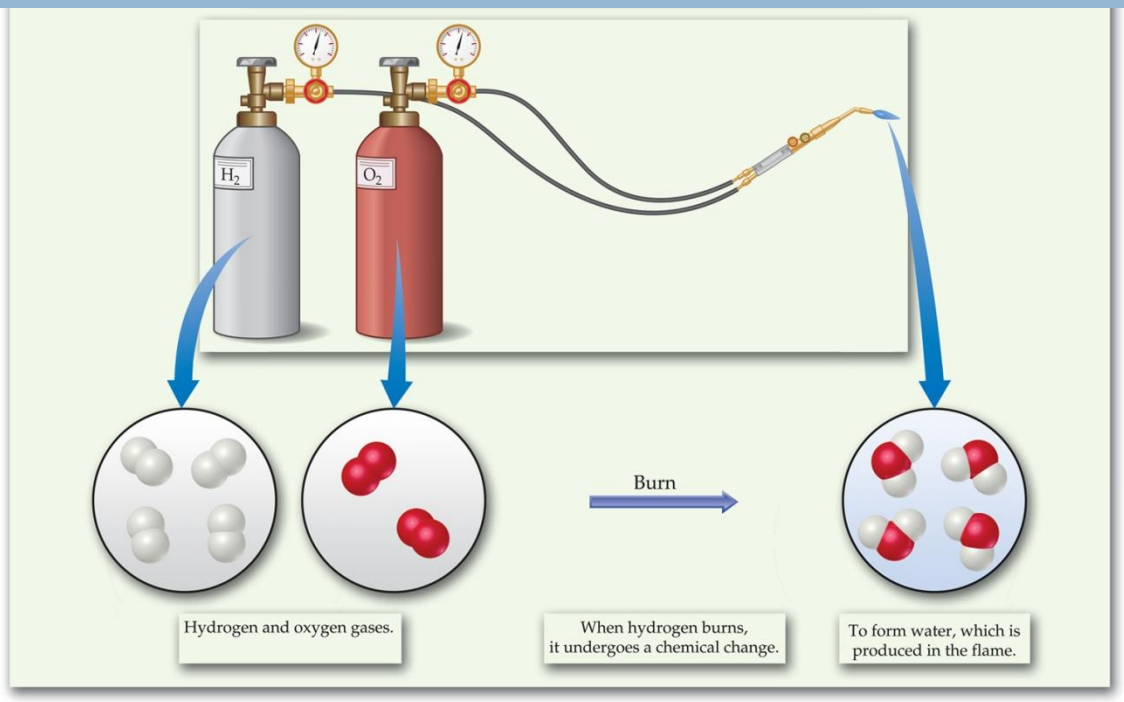
- Physical Changes
  - These are changes in matter that do not change the composition of a substance.
    - Changes of state, temperature, volume, etc.
- Chemical Changes
  - Chemical changes result in new substances.
    - Combustion, oxidation, decomposition, etc.

Questions

- Is it a physical or chemical change?
  - Boiling water
  - Burning a log
  - Carving a log into a totem pole
  - Mix sugar into a cup of tea
  - Cut up a t-shirt
  - Break a pencil lead
  - Let iron rust

Chemical Reactions



In the course of a chemical reaction, the reacting substances are converted to new substances.

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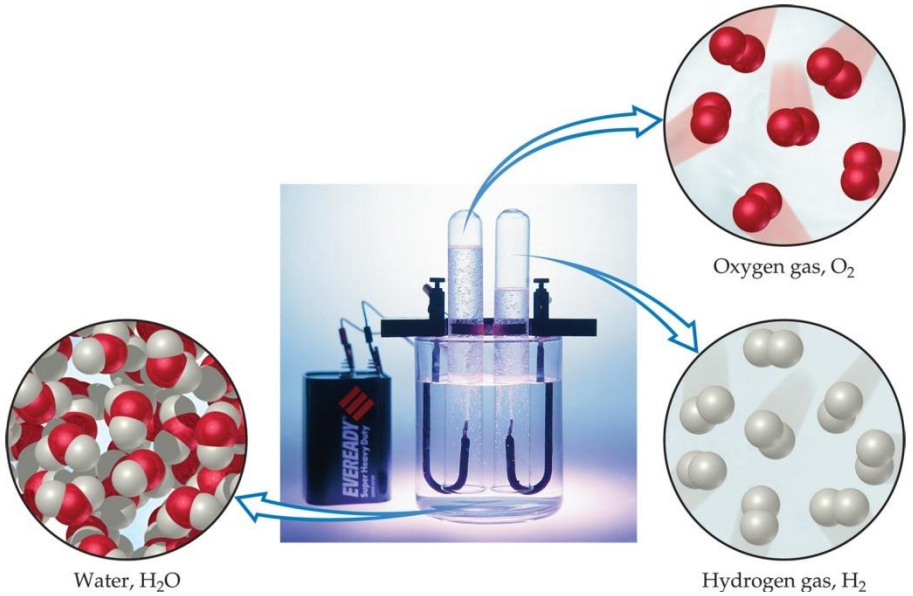
Compounds

Compounds can be broken down into more elemental particles.



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Physical and Chemical Properties

- Physical properties observed without changing substance
  - Color, odor, density, melting point, boiling point, hardness, …
- Physical change does not change substance
  - Evaporation, freezing
- Chemical properties must react to observe
  - Flammability, reaction with other compounds
  - Chemical change (reaction) changes the substances
    - Burn hydrogen in air, get water or react nitric acid with copper

Intensive/extensive properties

- Intensive properties do not depend on the amount. (Mass and volume are extensive properties)

Problems

- 1.18 physical/chemical properties

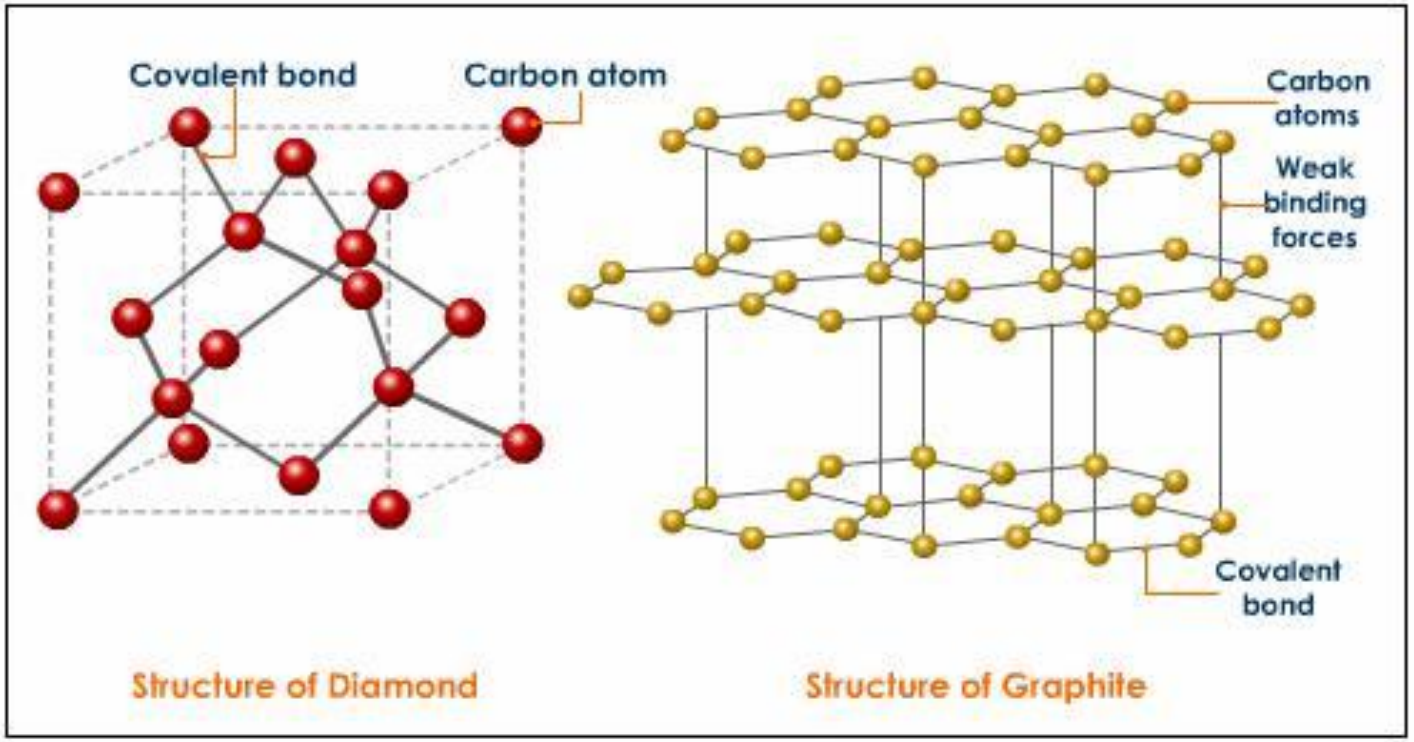
- Explain how you could check your breakfast cereal to make sure they added the correct amount of iron claimed on the box.
  - What might be a source of error in your measurement?
  -

Common elements and symbols

- Inside front cover of book is list of elements with abbreviations that you need to know.
- Quick test: table 1.2 common elements
  - Carbon, Gold, Lead, Iron, Copper, Sodium
  - P, S, Hg, K, Ag
- The Elements

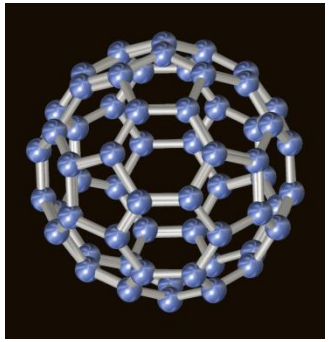
- Element is made of only one type of atom.
  - Can be more than one atom
    - O_2, H_2, F_2
    - He, Ar, Xe
    - Carbon is found in clusters—buckyballs, graphite, diamonds, carbon nanotubes

How atoms are arranged changes properties

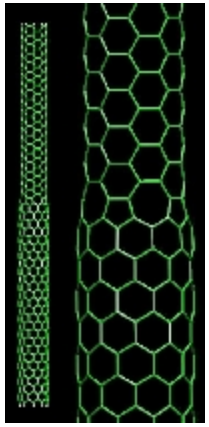


Shapes of carbon II

- Fullerenes
  - a convex cage of atoms with only hexagonal and/or pentagonal faces
- Buckyball
  - First type discovered C60, “soccer ball”
  - Dr. Richard Smalley and Dr. Robert Curl won Nobel Prize for chemistry in 1996
  - Only element to form hollow ball
    - Drug delivery?
  - the buckyball can withstand slamming into a stainless steel plate at 15,000 mph, merely bouncing back, unharmed. When compressed to 70 percent of its original size, the buckyball becomes more than twice as hard as its cousin, diamond



- Nanotubes
  - Can be used as wires—insulating, superconducting, doped (also Si, boron nitride)
  - Very strong structural elements, carbon fiber used in airplane/car bodies
  - Discovered 1991 by Sumio Iijima, resemble rolled up graphite sheets
  - Nanotubes in nanotubes, multiwalled
  - electrical conductivity as high as copper, thermal conductivity as high as diamond, strength 100 times greater than steel at one sixth the weight, and high strain to failure.
  - Properties depend on structure (overhead, use 3 types of bending)
    - http://mrsec.wisc.edu/Edetc/cineplex/nanotube/index.html
- In combination with other elements
  - Life (including petrochemicals, former life)
    - http://www.nanotech-now.com/nanotube-buckyball-sites.htm



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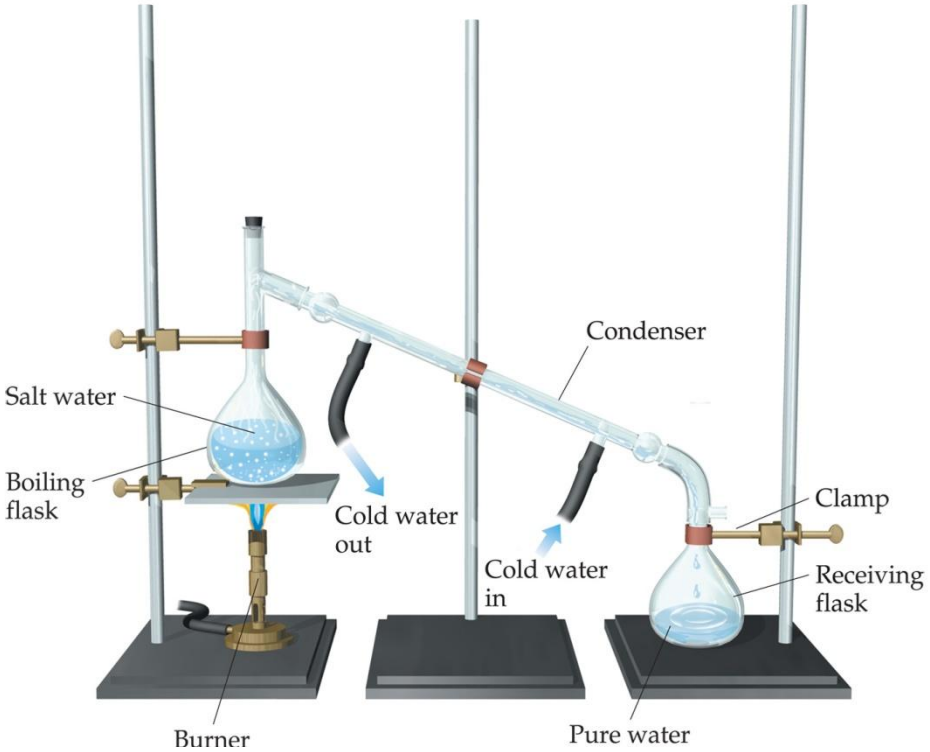
SEPARATION OF MIXTURES

Distillation



Distillation uses differences in the boiling points of substances to separate a homogeneous mixture into its components.

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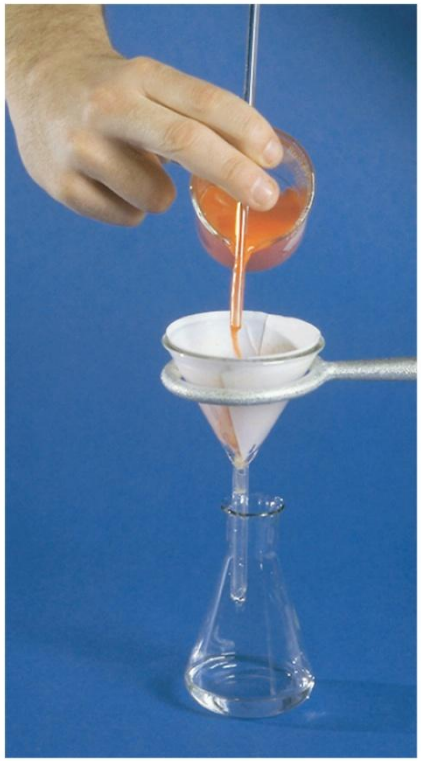
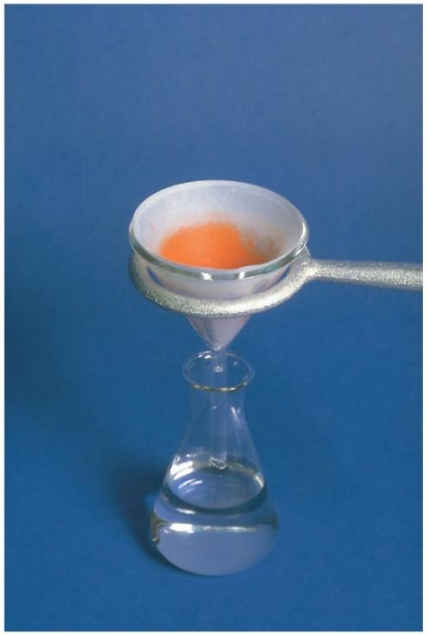
Filtration





In filtration solid substances are separated from liquids and solutions.

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Chromatography

This technique separates substances on the basis of differences in solubility in a solvent.

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- Separating mixtures
  - Filtration, distillation, chromatography, centrifuge
  - Distillation apparatus works by
  - Examples of mixtures to separate in kitchen?
    - Pasta in water
    - Salad dressing shaken up

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UNITS OF MEASUREMENT

SI Units

Physical Quantity	Name of Unit	Abbreviation
Mass	Kilogram	kg
Length	Meter	m
Time	Second	s[a]
Temperature	Kelvin	K
Amount of substance	Mole	mol
Electric current	Ampere	A
Luminous intensity	Candela	cd

[a]The abbreviation sec is frequently used.

- *Système International d'Unités*
- A different base unit is used for each quantity.

Metric System

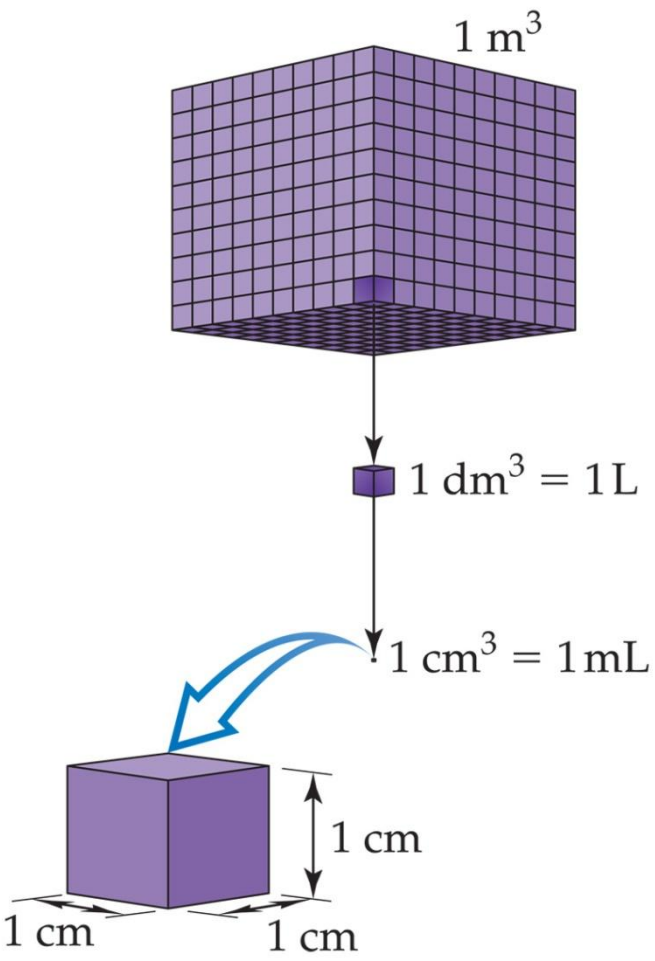
Prefixes convert the base units into units that are appropriate for the item being measured.

Prefix	Abbreviation	Meaning	Example
Giga	G	10^{9}	1 gigameter (Gm) = 1×10^{9} m
Mega	M	10^{6}	1 megameter (Mm) = 1×10^{6} m
Kilo	k	10^{3}	1 kilometer (km) = 1×10^{3} m
Deci	d	10^{-1}	1 decimeter (dm) = 0.1 m
Centi	c	10^{-2}	1 centimeter (cm) = 0.01 m
Milli	m	10^{-3}	1 millimeter (mm) = 0.001 m
Micro	μ[a]	10^{-6}	1 micrometer (μm) = 1×10^{-6} m
Nano	n	10^{-9}	1 nanometer (nm) = 1×10^{-9} m
Pico	p	10^{-12}	1 picometer (pm) = 1×10^{-12} m
Femto	f	10^{-15}	1 femtometer (fm) = 1×10^{-15} m

[a]This is the Greek letter mu (pronounced "mew").

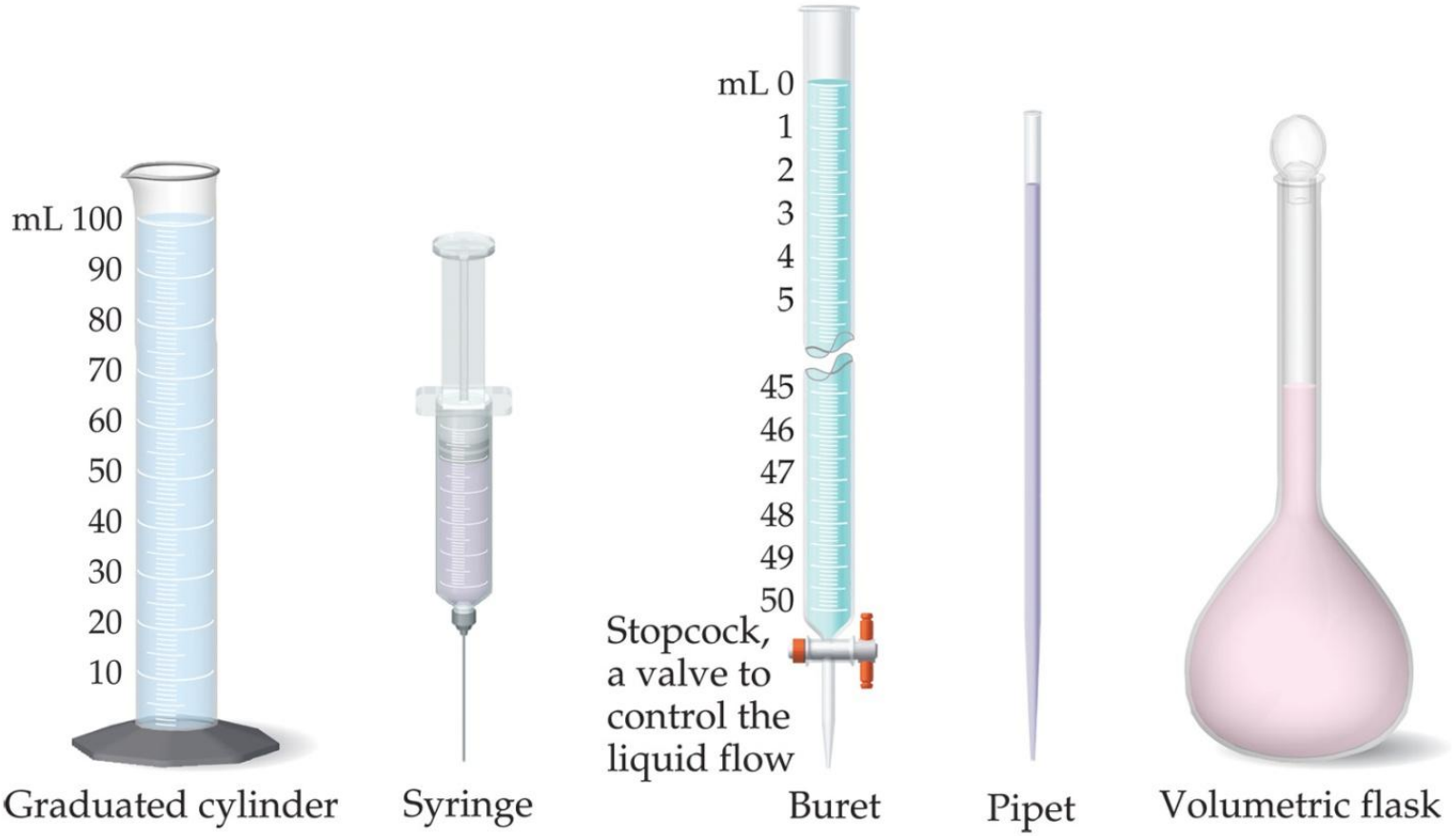
Volume

- The most commonly used metric units for volume are the liter (L) and the milliliter (mL).
  - A liter is a cube 1 dm long on each side.
  - A milliliter is a cube 1 cm long on each side or 1 cm^3.

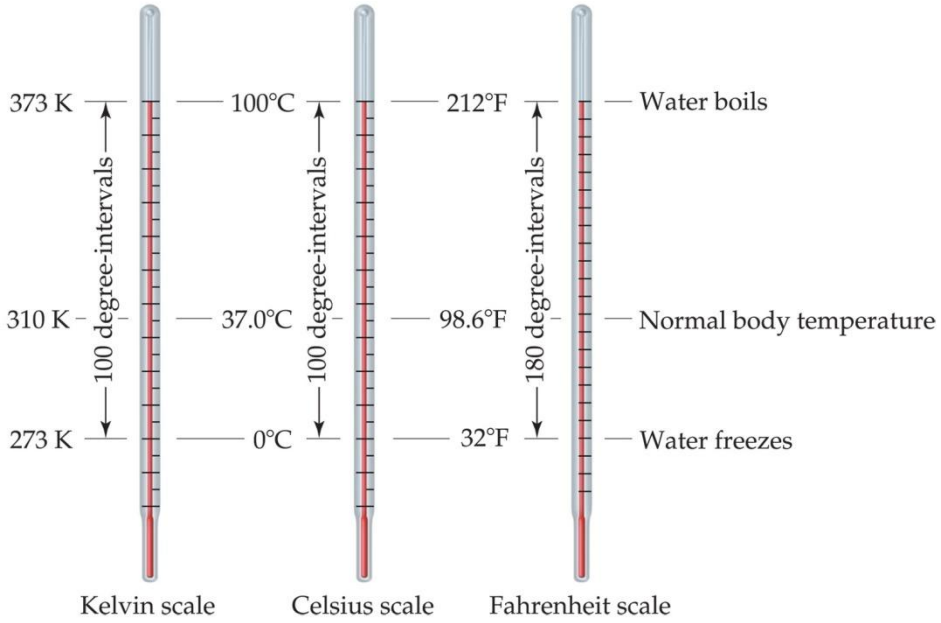


Uncertainty in Measurements

Different measuring devices have different uses and different degrees of accuracy.



Temperature



By definition temperature is a measure of the average kinetic energy of the particles in a sample.

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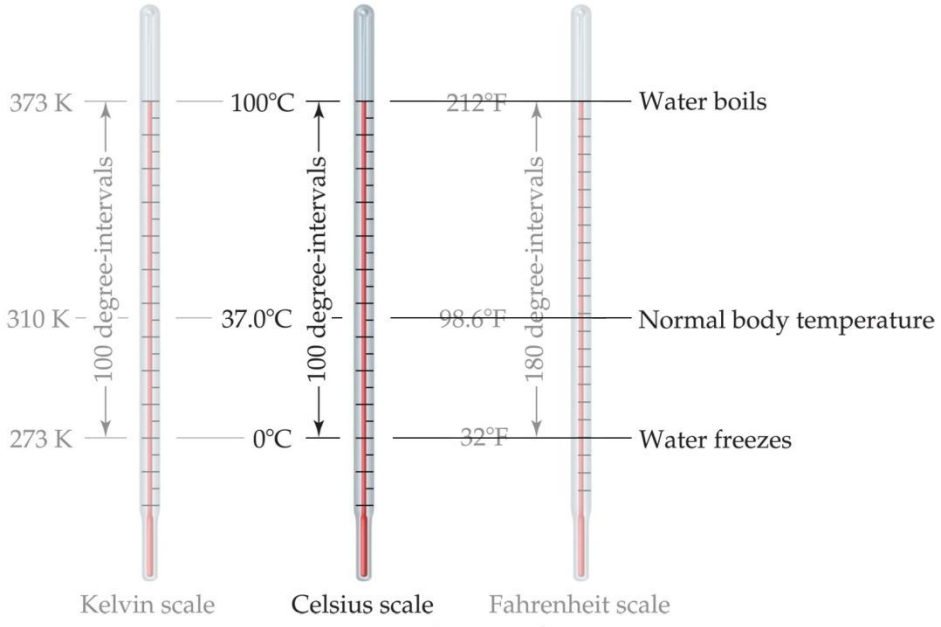
Temperature



- In scientific measurements, the Celsius and Kelvin scales are most often used.
- The Celsius scale is based on the properties of water.
  - 0°C is the freezing point of water.
  - 100°C is the boiling point of water.

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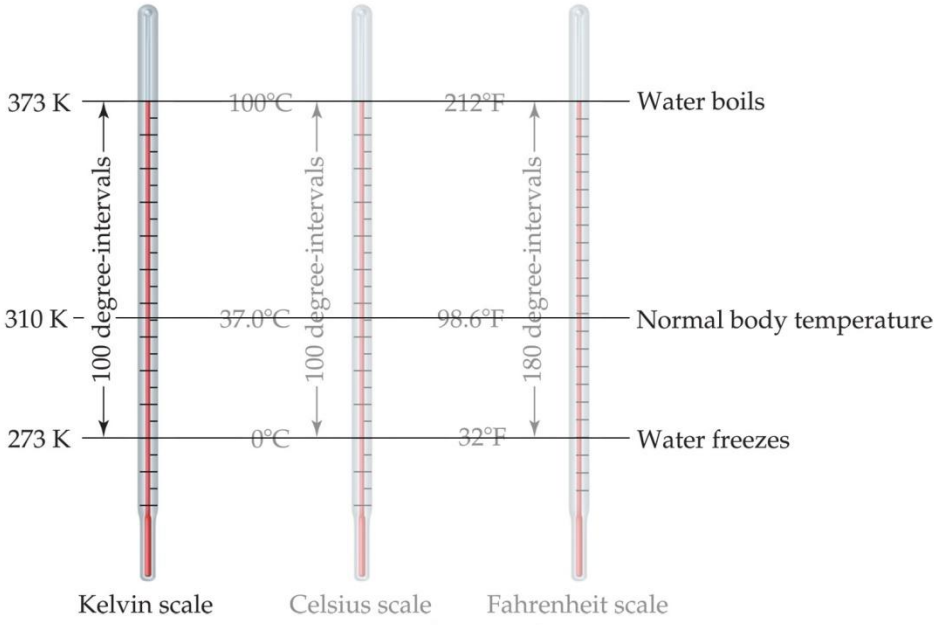
Temperature



- The Kelvin is the SI unit of temperature.
- It is based on the properties of gases.
- There are no negative Kelvin temperatures.
- K = °C + 273.15

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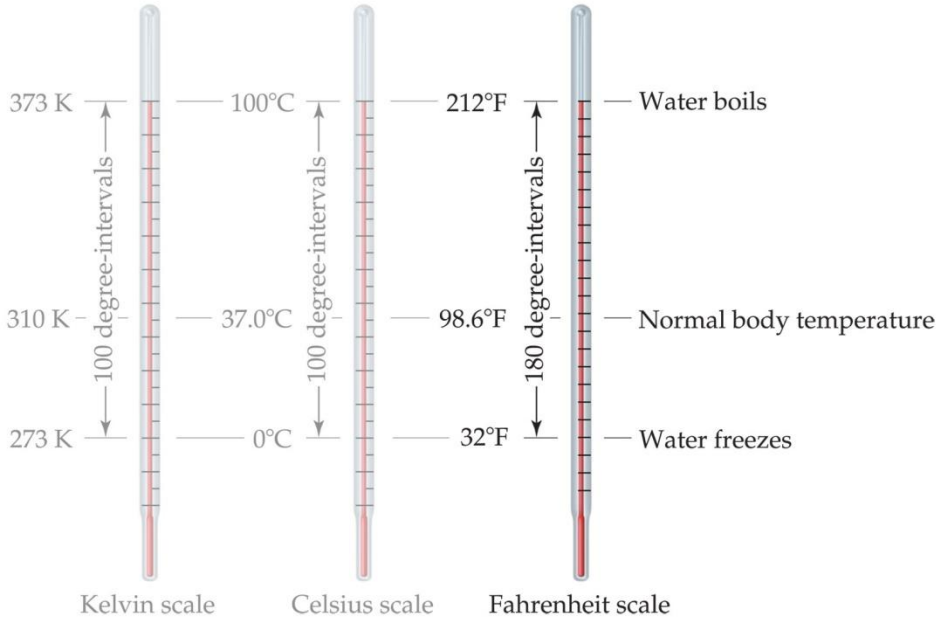
Temperature



- The Fahrenheit scale is not used in scientific measurements, just in weather reports.

- $°F = 9/5(°C) + 32$
- $°C = 5/9(°F - 32)$

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Density

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Density is a physical property of a substance.

$$d = \frac{m}{V}$$

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UNCERTAINTY IN MEASUREMENT

Significant Figures

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- The term significant figures refers to digits that were measured.
- When rounding calculated numbers, we pay attention to significant figures so we do not overstate the accuracy of our answers.

Significant Figures

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1. All nonzero digits are significant.
2. Zeroes between two significant figures are themselves significant.
3. Zeroes at the beginning of a number are never significant.
4. Zeroes at the end of a number are significant if a decimal point is written in the number.

Significant Figures

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- When addition or subtraction is performed, answers are rounded to the least significant decimal place.
- When multiplication or division is performed, answers are rounded to the number of digits that corresponds to the *least* number of significant figures in any of the numbers used in the calculation.

RULES FOR ROUNDING OFF

- **I. When the first digit of those to be dropped <u>is less than 5</u>, leave the preceding digit unchanged.**
- Ex. The number 56.748 rounded off to the nearest 0.1 becomes 56.7.
-
- **II. If the first digit of those to be dropped <u>is greater than 5</u>, raise the preceding digit by 1.**
- Ex. The number 2.146 rounded off to the nearest 0.01 becomes 2.15.
-
- **III. If the first digit of those to be dropped <u>is 5</u> and:**
- **a. If <u>any nonzero digits</u> follow the 5, raise the preceding digit by 1.**
- Ex. The number 21.4501 rounded off to the nearest 0.1 becomes 21.5.
- **b. If <u>no nonzero digits</u> follow the 5 and**
- **1. the preceding digit is <u>odd</u>, raise the preceding digit by 1.**
- Ex. The number 21.350 rounded off to the nearest 0.1 becomes 21.4.
- **2. the preceding digit is <u>even</u>, leave the preceding digit unchanged.**
- Ex. The number 21.45 rounded off to the nearest 0.1 becomes 21.4.

How many significant figures?

- 14.35 g 0.00034 m
- Rule: zeros used to place the decimal point are not significant
- 3,005.3 L 13.001 g 4.0000 sec
- Rule: zeros at the end of a number are significant if the number has a decimal place
- 3,000 L 3,000.0 L
- Rule: zeros in the middle of a number are always significant
- 4,500.2 g 3.0058 g 0.0903 g

Calculating with significant figures

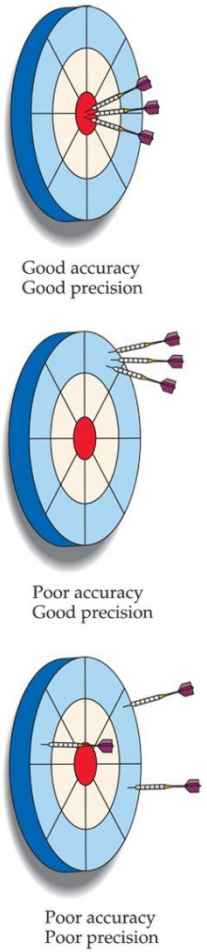
- Addition and subtraction
  - Result has same sig figs as the measurement with the fewest decimal places
  - 20.42 + 1.322 + 83.1 = 104.842
- Multiplication and division
  - Result has the same number of sig figs as the measurement with the fewest sig figs.
  - Area of 6.221 cm x 5.2 cm = 32.3492 cm^2
- All exact numbers have an infinite number of sig figs.
  - 12 eggs in a dozen is exact
- How to round off to the correct number
  - Leftmost digit to be removed is less than 5 3.0443 ⇨ 3.044
  - Leftmost digit to be removed is more than 5 3.0447 ⇨ 3.045
  - Leftmost digit to be removed is 5 3.0445 ⇨ 3.044 3.0435 ⇨ 3.044
    - Round half to even

Problems in Sig Figs and Units

- 1.26 Temperature conversions
- 1.32 Using density in calculations
- 1.34 exact numbers and inexact numbers
- 1.40 Calculations with significant figures

Accuracy versus Precision

- Accuracy refers to the proximity of a measurement to the true value of a quantity.
- Precision refers to the proximity of several measurements to each other.



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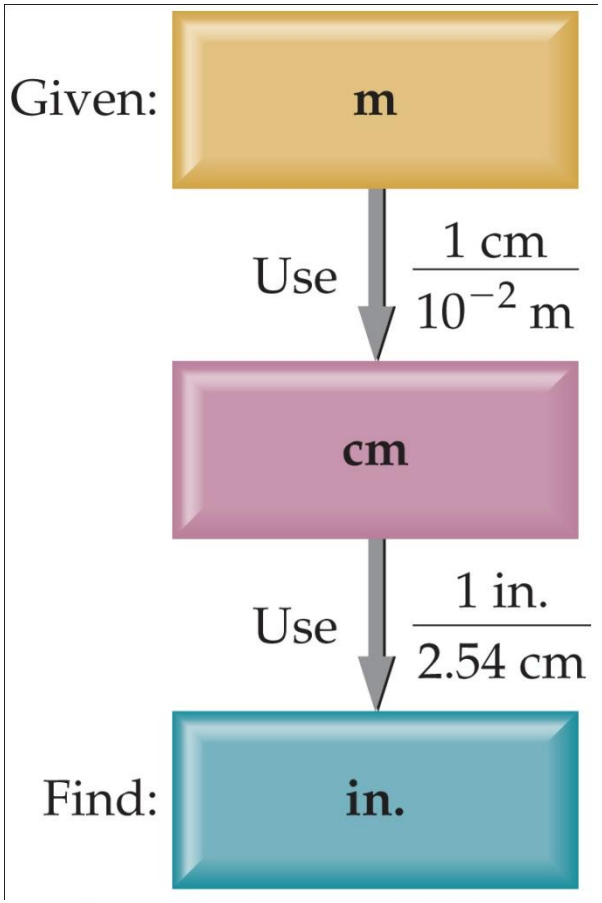
Dimensional Analysis



- We use dimensional analysis to convert one quantity to another.
- Most commonly dimensional analysis utilizes conversion factors (e.g., 1 in. = 2.54 cm)

$$\frac{1\text{ in.}}{2.54\text{ cm}} \quad \text{or} \quad \frac{2.54\text{ cm}}{1\text{ in.}}$$

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Dimensional Analysis

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Use the form of the conversion factor that puts the sought-for unit in the numerator.

Dimensional Analysis

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- For example, to convert 8.00 m to inches,
  - convert m to cm
  - convert cm to in.

$$8.00\ \text{m} \times \frac{100\ \text{cm}}{1\ \text{m}} \times \frac{1\ \text{in.}}{2.54\ \text{cm}} = 315\ \text{in.}$$

Dimensional Analysis

- Useful way to convert units and keep track
- Conversion factor is the number 1 with a numerator and denominator in different units
  - 1 kg/2.2046 lbs 1 cm/0.39370 in
  - 1200 lbs x 1kg/2.2046 lbs = 544.3 kg

  - 200 x 1 = 200
  - 200 feet x 12 inches/foot =
  - 200 feet x 12 in/foot x 1 cm/0.3970 in =
- OR box method

Using several conversion factors

- Convert 100 miles/hour to km/sec using conversion factors

Using several conversion factors

- Convert 100 miles/hour to km/sec using conversion factors

- 1 km = 0.62137 mi
- 1 hour = 60 minutes
- 1 minute = 60 seconds

- 2.690213 km/sec
- Sig figs?

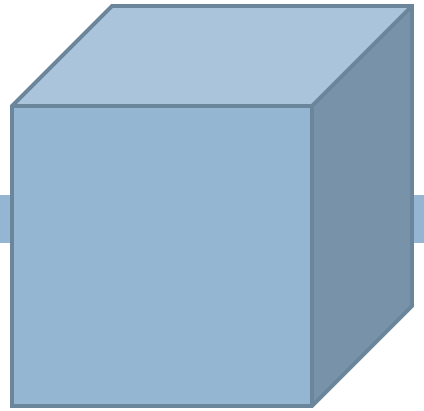
Using several conversion factors

- Convert 100 miles/hour to km/sec using conversion factors

- 1 km = 0.62137 mi
- 1 hour = 60 minutes
- 1 minute = 60 seconds

- 0.01726000 km/sec
- Sig figs?

Volume conversions



- Volume is the area within a 3D object
  - Not a defined SI unit, but length is.
  - Calculated from lengths
- Unit of volume: cc, L, gallon, cup, m^3, cubic feet
- Airline carryon bag 22” x 14” x 9”
- If you want to fill it with chocolate, how much would it weigh?
  - Density of chocolate (varies) 1325 kg/m^3

Eureka!

- Archimedes (~250 BC) said stepping into his bath, noticing that his foot displaced some of the water
- He was trying to figure out a way to measure if the goldsmith had used only gold to make a crown, or had added silver (cheaper) to it.
- Crown weighs 0.500 kg, and the volume of the water displaced by the crown is 33.54 mL
- Densities: gold 19.32 g/cm^3, silver 10.49 g/cm^3

- Is the crown pure gold?

- additional dimensional analysis