Chapter 1
Essential Ideas

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HW Site: Sapling Learning

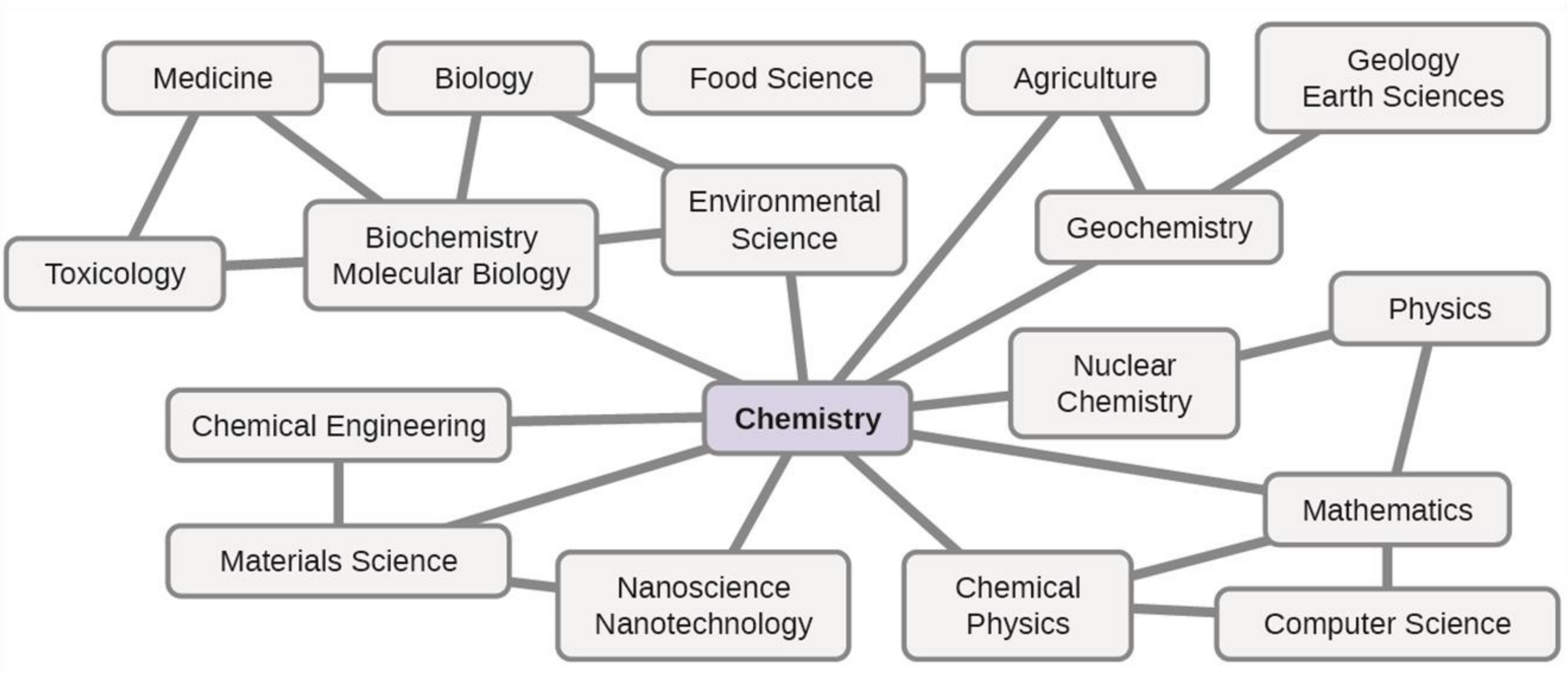
- Login your Blackboard account at Buffalstate.edu
- Click CHE111>> Click Content >> Sapling HW
- Click on the US Higher Ed option at the top right.
- Create your account.
- Choose, Buffalo State College - CHE 111 - Fall19 – KIM
- Direct pay at website or you can buy access code at Campus bookstore

HW0A and HW0B: Extra Credit

- Login your Blackboard account at Buffalstate.edu
- Click CHE111>> Click Content >> Sapling Learning HW
- Introduction and Review
  1. Watch Video: Introduction to Sapling Learning
  2. HW0A: How to use Sapling learning (10 pts, extra pts)
  3. HW0B: Math Review (5 pts, extra pts)
- Due: 11:50 pm, Friday September 6, 2019
- Window will be closed after due
- For questions, email me

Chemistry: Central Science

- Chemistry is everywhere



Gathering Empirical Knowledge – Observation

- Some observations are descriptions of the characteristics or behavior of nature – **qualitative (sometimes subjective)**
  - ✓ "The soda pop is sweet."
  - ✓ He is tall.
- Some observations compare a characteristic to a standard numerical scale – **quantitative (very objective)**
  - ✓ "A 240 mL serving of soda pop contains 27 g of sugar."
  - ✓ His height is 6'2".

Classifying Matter by Physical State

- Substances

- Phases:

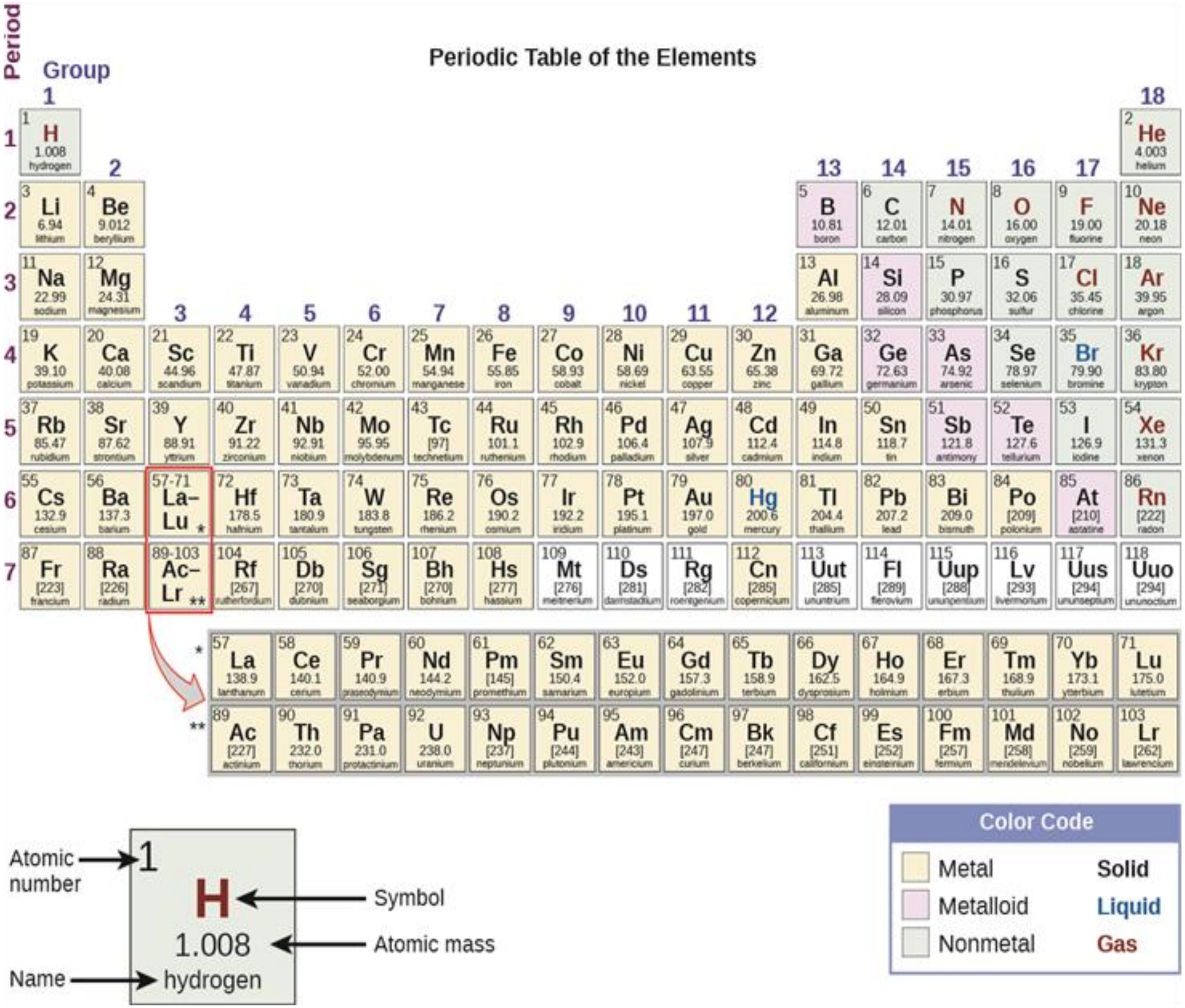
State	***Shape***	***Volume***	***Compressible?***	***Flow?***
Solid	Rigid	Maintains	No	No
Liquid	Assumes Container's	Maintains	No	Yes
Gas	Assumes Container's	Assumes Container's	Yes	Yes

Atoms and Molecules

- Atoms (C, O, N, etc)
  - are submicroscopic particles
  - are the fundamental building blocks of ordinary matter
- Molecules (CO, CO_2, O_2, etc)
  - are two or more atoms attached together in a specific geometrical arrangement
    - attachments are called bonds
    - attachments come in different strengths
  - come in different shapes and patterns

- **Chemistry** is the science that seeks to understand the behavior of matter by studying the behavior of atoms and molecules

Periodic Table



Classifications of Substances by Compositions

- Substances:

- Pure substances

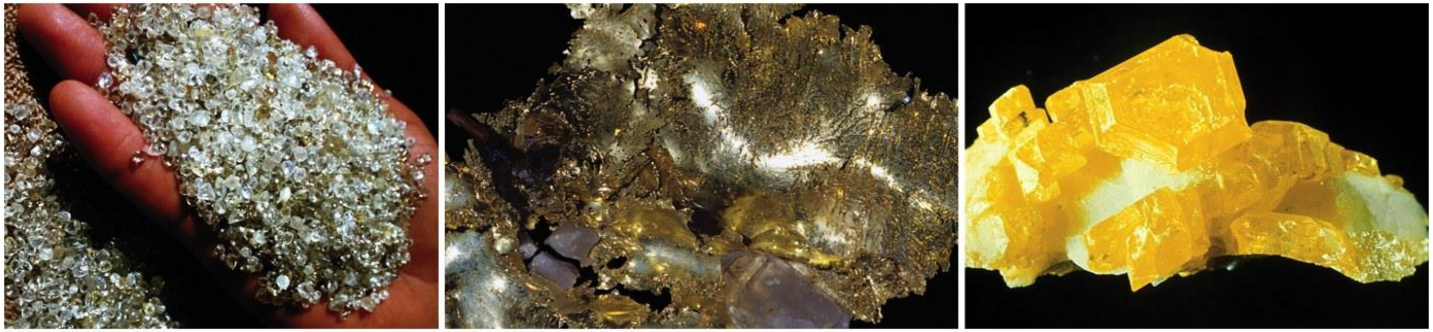
1. Elements:
2. Compounds:

- Mixtures

1. Homogeneous:
2. Heterogeneous:

Pure substances: Elements and Compounds

- <u>Elements</u>:



Peter/Stef Lamberti/GettyImages, Inc.; Ken Lucas/VisualsUnlimited; Manfred Kage/PeterArnold, Inc.

diamond = carbon (C) Gold (Au) Sulfur (S)

- <u>Compounds</u>: Substances composed of two or more types of atoms
- e.g.:

Example 1: Elements and Compounds ?

1. Silver:
2. Ice:
3. Carbon monoxide:
4. Argon:
5. Propane:
6. Sulfuric acid:

Elements, Compounds Atoms, and Molecules

1. Silver: element consisting of silver (Ag) atoms
2. Ice: compound (H_2O molecule consisting of two H atoms and one O atom)
3. Carbon monoxide: compound (CO molecule consisting of one C atom and one O atom)

Water, Ice and Vapor

1. All are same compounds, but different phase (solid, liquid, and gas)

Mixtures

Mixture

- Made up of two or more substances
- e.g.: air (nitrogen, oxygen, etc)
- Two broad categories of mixtures:
  - Heterogeneous
  - Homogeneous

Example 2: Pure Substance or Mixture?

1. Coke:
2. Glass:
3. Sea water:
4. Coffee:
5. Caffeine:
6. Snow:
7. Gas (gasoline):

Homogeneous Mixtures

- Same properties throughout sample
- Uniform compositions
- **Solution**
  - Thoroughly stirred homogeneous mixture

  Ex.
  - **Liquid solution**
    - Sugar in water
  - **Gas solution**
    - Air: Contains nitrogen, oxygen, carbon dioxide & other gases
  - **Solid solution**
    - US 5¢ coin – Metal Alloy
      - Contains copper & nickel metals

Heterogeneous Mixtures

- 2 or more regions of different properties
- Solution with multiple phases
- Separate layers

Ex.

- – Chocolate bar
- – Rock

Example 3: Homogeneous or Heterogeneous

1. Coke:

2. Pizza with pepperoni topping:

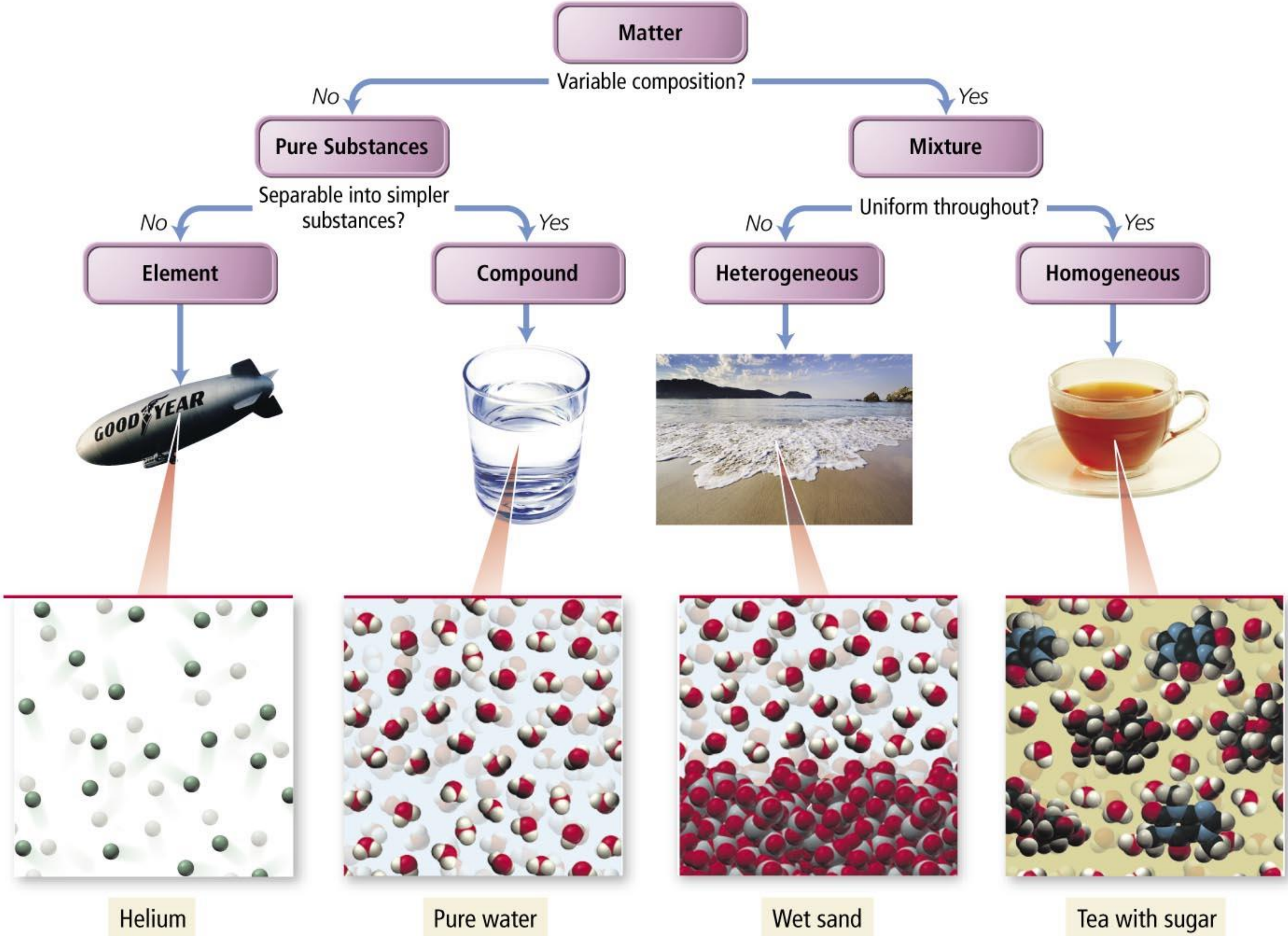
3. Sea water:

4. Air:

5. Our body:

6. Our planet:

Classification of Matters by Compositions



Physical & Chemical Properties

- Physical Properties: property that is measurable whose value describes a state of a physical system.
  1. Mass, volume, length, color, boiling point
  2. Area, solubility, concentration, etc

- Chemical Properties: any of a material's properties that becomes evident during a chemical reaction.

  1. Flammability
  2. Toxicity
  3. Chemical stability

Physical & Chemical Changes

- Physical Change:
  1. No new substances formed
  2. Substance may change state or the proportions
  3. Ice melting, salt dissolution in water, etc

- Chemical Change
  1. Formation of new substances or compounds
  2. Involves changing chemical makeup of substances
  3. New substance has different physical properties
  4. Combustion of oil, rust formation, digestion of foods in stomach, etc

Example 4: Physical & Chemical Changes

- Water boiling:
- Propane combustion:
- Making cocktail:
- Extraction of gold from ore:
- UV damage of your skin:
- Erosion of rock:
- Corrosion of your car:

The Standard Units

- Scientists have agreed on a set of international standard units for comparing all our measurements called the **SI units**
  - *Système International* = International System

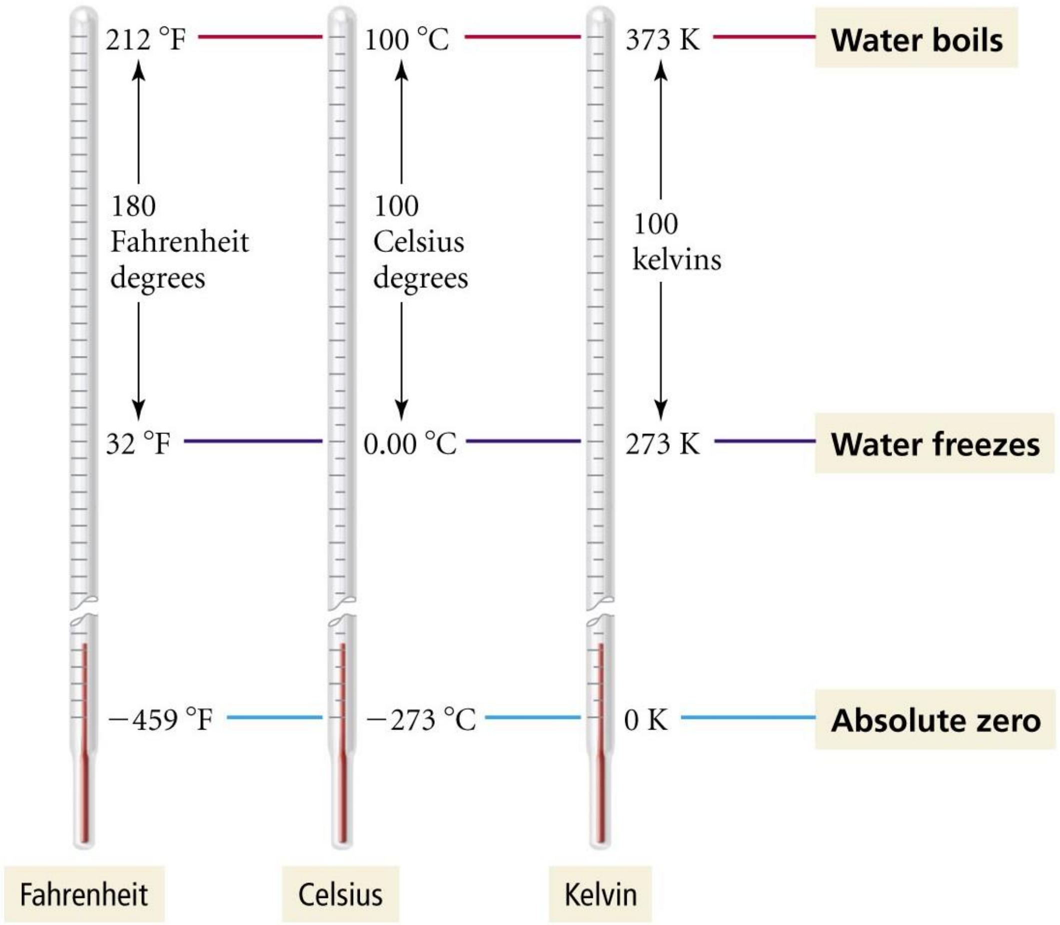
Quantity	Unit	Symbol
length	meter	m
mass	kilogram	kg
time	second	s
temperature	kelvin	K

Length, mass, and time

- Commonly use centimeters (cm)
  - 1 m = 100 cm
  - 1 cm = 0.01 m = 10 mm
  - 1 inch = 2.54 cm (exactly)
- Commonly measure mass in grams (g) or milligrams (mg)
  - 1 kg = 2.2046 pounds, 1 lb. = 453.59 g
  - 1 kg = 1000 g = 10^3 g
  - 1 g = 1000 mg = 10^3 mg
  - 1 g = 0.001 kg = 10^{-3} kg
  - 1 mg = 0.001 g = 10^{-3} g
- Commonly use second (s)

Temperature Scales

- Fahrenheit scale, °F
  - used in the U.S.
- Celsius scale, °C
  - used in all other countries
- <u>Kelvin scale, K</u>
  - absolute scale
    - no negative numbers
  - directly proportional to average amount of kinetic energy
  - 0 K = absolute zero



Conversion of Temperature Scales

$$°C = \frac{(°F - 32)}{1.8}$$

$$K = °C + 273.15$$

Temperature Conversion

- 0 F >>> K
- 300 K >>> F

Common Prefix Multipliers in the SI System

Prefix	Symbol	Decimal Equivalent	Power of 10
mega-	M	1,000,000	Base x 10^{6}
kilo-	k	1,000	Base x 10^{3}
deci-	d	0.1	Base x 10^{-1}
centi-	c	0.01	Base x 10^{-2}
milli-	m	0.001	Base x 10^{-3}
micro-	μ or mc	0.000 001	Base x 10^{-6}
nano-	n	0.000 000 001	Base x 10^{-9}
pico	p	0.000 000 000 001	Base x 10^{-12}

Common Units and Their Equivalents

Length

1 kilometer (km)	=	0.6214 mile (mi)
1 meter (m)	=	39.37 inches (in.)
1 meter (m)	=	1.094 yards (yd)
1 foot (ft)	=	30.48 centimeters (cm)
1 inch (in.)	=	2.54 centimeters (cm) exactly

Common Units and Their Equivalents-Continued

Mass

1 kilogram (km)	=	2.205 pounds (lb)
1 pound (lb)	=	453.59 grams (g)
1 ounce (oz)	=	28.35 grams (g)

Volume

1 liter (L)	=	1000 milliliters (mL)
1 liter (L)	=	1000 cubic centimeters (cm^3)
1 liter (L)	=	1.057 quarts (qt)
1 U.S. gallon (gal)	=	3.785 liters (L)

Intensive vs. Extensive Properties

Intensive properties

– Independent of sample size

– Used to identify substances

Ex. Color

Density

Boiling point

Melting point

Chemical reactivity

Extensive properties

– Depend on sample size

Ex. volume & mass

Density

- Density is the ratio of mass to volume
  - is an **intensive property**
- units = g/cm^3
  or g/mL

$$Density = \frac{Mass}{Volume}$$

- Volume of a solid can be determined by water displacement – Archimedes principle
- Density : solids > liquids >>> gases
- Volumes changes as Temperature changes
- Temperature should be specified.

Decide if a ring with a mass of 3.15 g that displaces 0.233 cm^3 of water is platinum

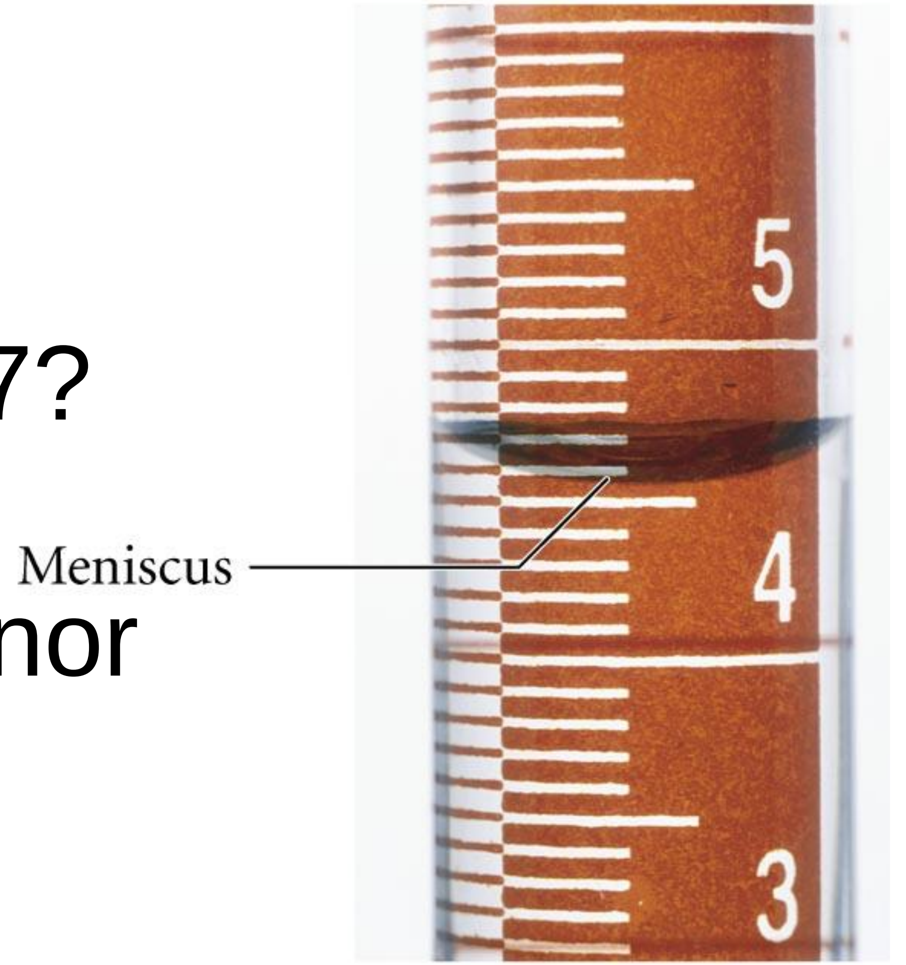
Significant Figures

What's your measurement?

4.55 or 4.56 or 4.57?

surely

4.5X neither 4.6X nor 4.4X

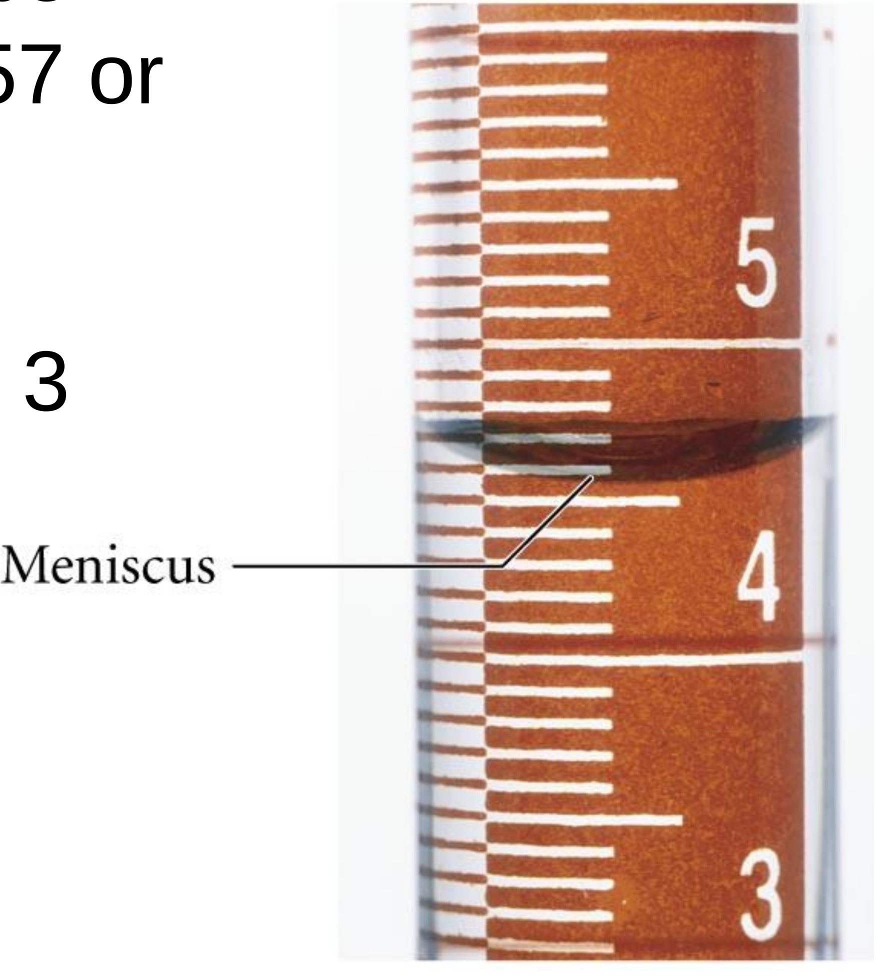


Number of Significant Figures

Your measurement will be either 4.55 or 4.56 or 4.57 or etc

# of significance figures: 3

Uncertainty (estimates) location: 4.57



What’s Difference between 12.3 and 12.30?

Significant Figures

How many apples?

2.1 or 1.9 or 2.0 or what?

No ambiguity

<u>Infinite number of significant numbers</u>
(2, 2.0, 2.00, 2.000, etc, all ok, but conventionally 2)

Counting Significant Figures

1. All non-zero digits are significant
   - 1.5 has 2 sig. figs.
2. Interior zeros are significant
   - 1.05 has 3 sig. figs.
3. Leading zeros are **NOT** significant
   - 0.001050 has 4 sig. figs.
     - 1.050×10^{-3}

Counting Significant Figures

4. Trailing zeros may or may not be significant
   a) Trailing zeros after a decimal point are significant
      - 1.050 has 4 sig. figs.
   b) Trailing zeros before a decimal point are significant if the decimal point is written
      - 150.0 has 4 sig. figs.
   c) Zeros at the end of a number without a written decimal point are ambiguous and should be avoided by using scientific notation
      - 150 is ambiguous
      - if 150 has 2 sig. figs. then 1.5×10^2
      - but if 150 has 3 sig. figs. then 1.50×10^2

Determine the number of significant figures

• 120.	3 sig. figs.
• 120	ambiguous
• 120.0	4 sig. figs.
• 10000	ambiguous
• 1 in = 2.54 cm	unlimited (not ambiguous b/c determined quantity by definition)
• 1.1 in	2 sig. figs.

Determine the number of significant figures

- 100 dollars unlimited
- 6 cars unlimited

Rounding 1

- Rounding to 2 significant figures
- 2.34 rounds to 2.3
  - because the 3 is where the last sig. fig. will be and the number after it is 4 or less
- 2.37 rounds to 2.4
  - because the 3 is where the last sig. fig. will be and the number after it is 5 or greater
- 2.349865 rounds to 2.3
  - because the 3 is where the last sig. fig. will be and the number after it is 4 or less

Rounding 2

- Rounding to 2 significant figures
- 0.0234 rounds to 0.023 or 2.3×10^{-2}
  - because the 3 is where the last sig. fig. will be and the number after it is 4 or less
- 0.0237 rounds to 0.024 or 2.4×10^{-2}
  - because the 3 is where the last sig. fig. will be and the number after it is 5 or greater
- 0.02349865 rounds to 0.023 or 2.3×10^{-2}
  - because the 3 is where the last sig. fig. will be and the number after it is 4 or less

Multiplication and Division with Significant Figures

- When multiplying or dividing measurements with significant figures, the result has the same number of significant figures as the measurement with the lowest number of significant figures

5.02	$\times$	89.665	$\times$	0.10	= 45.0118	= 45
3 sig. figs.		5 sig. figs.		2 sig. figs.		2 sig. figs.

5.892	$\div$	6.10	= 0.96590	= 0.966
4 sig. figs.		3 sig. figs.		3 sig. figs.

Addition and Subtraction with Significant Figures

- When adding or subtracting measurements with significant figures, the result has the same number of decimal places as the measurement with the lowest number of decimal places

$$\begin{array}{r} 2.345 \\ 0.07 \\ +\ 2.9975 \\ \hline 5.4125 \end{array} = 5.41$$

$$\begin{array}{r} 5.9 \\ -\ 2.221 \\ \hline 5.679 \end{array} = 5.7$$

Both Multiplication/Division and Addition/Subtraction with Significant Figures

- When doing different kinds of operations with measurements with significant figures, do whatever is in parentheses first, evaluate the significant figures in the intermediate answer, then do the remaining steps

$$3.489 \quad \times \quad (5.67 \quad - \quad 2.3) \quad =$$

2 dp 1 dp

$$3.489 \quad \times \quad 3.\underline{3}7 \quad = \quad 12$$

4 sf 1 dp & 2 sf 2 sf

Perform the Following Calculations to the Correct Number of Significant Figures

a) $1.10 \times 0.5120 \times 4.0015 \div 3.4555$

b)
$$\begin{array}{r} 0.355 \\ +105.1 \\ -100.5820 \\ \hline \end{array}$$

c) $4.562 \times 3.99870 \div (452.6755 - 452.33)$

d) $(14.84 \times 0.55) - 8.02$

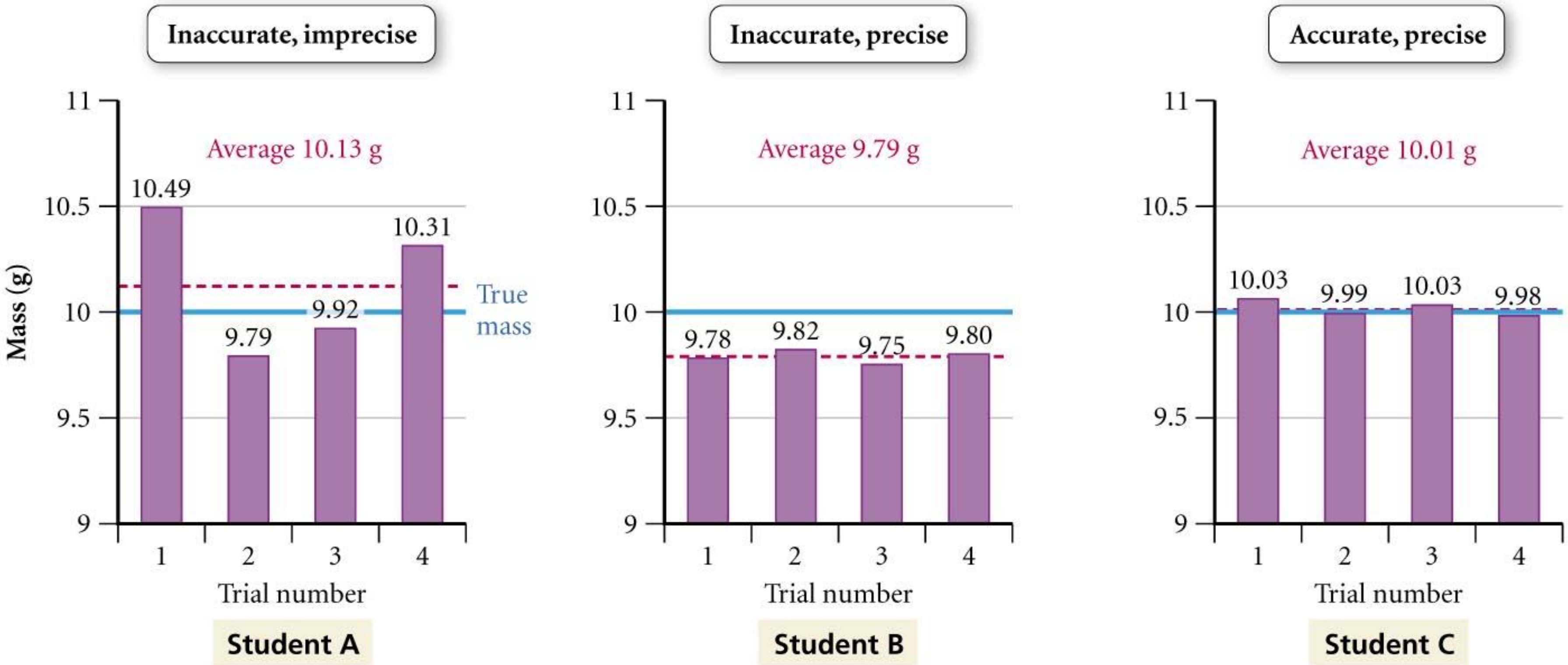
Accuracy vs. Precision

- Uncertainty comes from limitations of the instruments used for comparison, the experimental design, the experimenter, and nature's random behavior

- **Accuracy** is an indication of how close a measurement comes to the **actual** value of the quantity

- **Precision** is an indication of how close repeated measurements are to each other (consistency)
  - how reproducible a measurement is

Accuracy vs. Precision

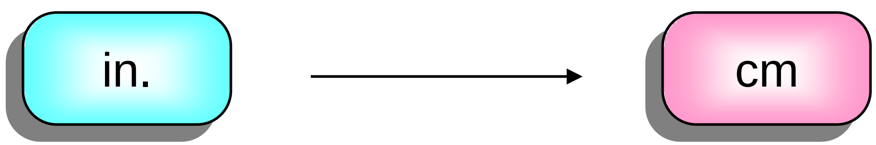


Looking at the graph of the results shows that Student A is neither accurate nor precise, Student B is inaccurate, but is precise, and Student C is both accurate and precise.

Unit Conversion and Conversion Factors

- Convert inches into centimeters

1. Find relationship equivalence: 1 in. = 2.54 cm
2. Write a conceptual plan



3. Change equivalence into conversion factors with starting units on the bottom

$$\frac{2.54\ \text{cm}}{1\ \text{in}}$$

Convert 30.0 mL to quarts (qt)

(1 mL = 0.001 L; 1 L = 1.057 qt)

How many cubic centimeters (cm^3) are there in 2.11 yd^3?

(1 yd = 36 in., 1 in. = 2.54 cm)

Density as a Conversion Factor

- **Can use density as a conversion factor between mass and volume!!**
  - density of H_2O = 1.0 g/mL ∴ 1.0 g H_2O = 1 mL H_2O
  - density of Pb = 11.3 g/cm^3 ∴ 11.3 g Pb = 1 cm^3 Pb

How much does 4.0 cm^3 of lead weigh?

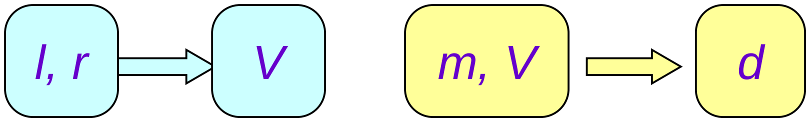
$$4.0\ \cancel{cm^3\ Pb} \times \frac{11.3\ g\ Pb}{1\ \cancel{cm^3\ Pb}} = 4\underline{5}.2\ g\ Pb = 45\ g\ Pb$$

Calculate the Following

- How much does 3.0×10^2 mL of ether weigh (g) ? (*d* = 0.71 g/mL)

- What volume (cm^3) does 100.0 g of marble occupy? (*d* = 4.0 g/cm^3)

Find the density of a metal cylinder with mass 8.3 g, length 1.94 cm, and radius 0.55 cm



$V = \pi r^2 l$

$d = m/V$

What is the mass in kilograms of a cube of lead that measures 0.12 m on each side?
(d_{Pb} = 11.3 g/cm^3)

Homework

Chapter 1 HW

Will be announced