Upon completion of this chapter, you should be able to:

- **Know the Scientific approach to knowledge**

- Define Mater, atom and molecule
  - ✓ • Explain and give examples of the following: element, mixture , mixture separation, physical change, chemical change, physical property, chemical property, extensive property, and intensive property.
  - ✓ • Know and convert between the metric units and the prefixes specified (Giga- through femto-).
  - ✓ • Recognize precision and accuracy.
  - ✓ • Identify the number of significant figures in a given number and the result from different calculations including addition, subtraction, multiplication and division using proper rounding
  - ✓ • Use **dimensional analysis** calculations (with multiple steps) to convert from one set of units to another.
  - ✓ • Use the relationship between mass, volume and density to solve problems

- **Matter** : is any thing that occupies space and has mass.
- **Atom**: Is the smallest constituents of matter.

Atoms and molecules determine how matter behaves.
The properties of matter are determined by the properties of molecules and atoms.

- The state of matter changes from solid to liquid to gas with increasing temperature.

- Matter can also be classified according to its composition: elements, compounds, and mixtures.

The Classification of Matter by Components

Pure: A pure substance is composed of only one type of atom or molecule.

1. An element is a pure substance that cannot be decomposed into simpler substances.

2. A compound is composed of two or more elements in fixed proportions.

Mixture: substance composed of two or more different types of atoms or molecules that can be combined in variable proportions.

A. Homogeneous mixture has the same composition throughout

B. Heterogeneous mixture has different compositions in different regions.

Types of Properties

- Intensive Properties

- Extensive Properties

Physical property: is one that a substance displays without changing its composition

physical change: Changes that alter only state or appearance, but not composition.. The atoms or molecules that compose a substance *do not change* their identity, e.g _____

Chemical property: chemical property is one that a substance displays only by changing its composition via a chemical change

Chemical change: alter the composition of matter, atoms rearrange, transforming the original substances into different substances, e.g _____

In chemical and physical changes, matter often exchanges energy with its surroundings. We will talk about this in **chapter 6**

The Units of Measurement:

- **The two most common unit systems are as follows:**
  - **Metric system**, used in most of the world
  - **English system**, used in the United States
- Scientists use the **International System of Units (SI)**, which is based on the metric system.

The abbreviation *SI* comes from the French, phrase *Système International d' Unités*

TABLE 1.1 SI Base Units

Quantity	Unit	Symbol
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Temperature	Kelvin	K
Amount of substance	Mole	mol
Electric current	Ampere	A
Luminous intensity	Candela	cd

TABLE 1.2 SI Prefix Multipliers

Prefix	Symbol	Multiplier	
exa	E	1,000,000,000,000,000,000	(10^{18})
peta	P	1,000,000,000,000,000	(10^{15})
tera	T	1,000,000,000,000	(10^{12})
giga	G	1,000,000,000	(10^{9})
mega	M	1,000,000	(10^{6})
kilo	k	1000	(10^{3})
deci	d	0.1	(10^{-1})
centi	c	0.01	(10^{-2})
milli	m	0.001	(10^{-3})
micro	μ	0.000001	(10^{-6})
nano	n	0.000000001	(10^{-9})
pico	p	0.000000000001	(10^{-12})
femto	f	0.000000000000001	(10^{-15})
atto	a	0.000000000000000001	(10^{-18})

- Temperature scales and conversions
  - **Celsius to Fahrenheit and vice versa**

°F = 1.8(°C) + 32 $\qquad$ $°C = \frac{(°F - 32)}{1.8}$

2

  - **Kelvin to Celsius and vice versa** **K = °C + 273.15**

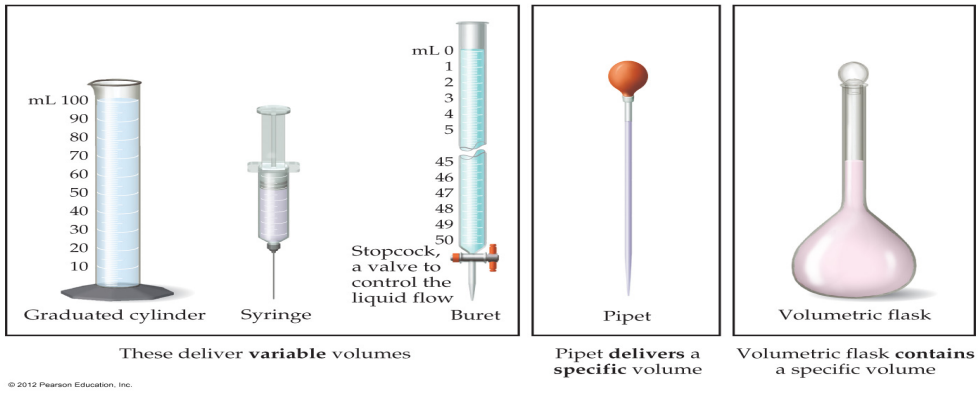
Significant Figures

Types of Observations and Measurements:
Qualitative:
Quantitative:
In the lab, weigh out compounds and use a balance:

5.5 g	
5.53 g	
5.5360g	

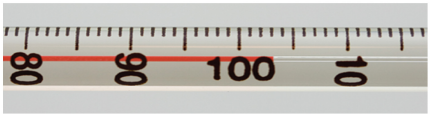
- We're limited by the instrument/technique/conditions we use to make the measurement

Uncertainty in Measurements: Different measuring devices have different uses and different degrees of accuracy and precision **look at the smallest marking**



Analyze the ***markings*** on each instrument, then give the best reading.

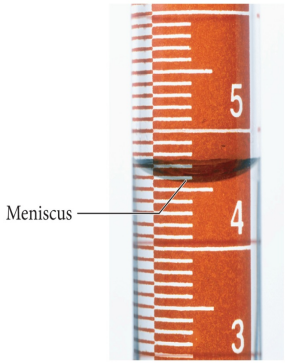
a) Thermometer:



Markings are _____ apart.

Reading is _____

b) Graduated cylinder



Markings are _____ apart.
Reading is _____

Precision and Accuracy:

❖ **Accuracy** refers to how close the measured value is to the actual value.

❖ **Precision** refers to how close a series of measurements are to one another or how reproducible they are.

Rounding Numbers

If the digit you want to drop is less than 5:

Round 680.4 to 3 significant digits

If the digit you want to drop is more than 5:

Round 330.7 to 3 significant digits

Round only the final answer can use **Scientific Notation**

✓ **Rules for Significant Figures:**

1) All nonzero integers are significant.
   8.579
2) All zeros to the left of the first nonzero digit are NOT significant. (These are called placeholders)
   0.0028
3) All zeros between nonzero digits are significant
   0.08006
4) All zeros at the end of a number that has a decimal point are significant
   46.6800
5) Zeros at the end of a whole number **are not significant** 900
6) Exact Numbers: no uncertainty as to its true value. Do not limit the number of Sig. Fig. in calculations

Mathematical Operations with Significant Figures:

Do not just copy all digits from your calculator:
Too many significant figures!

1) **Addition or Subtraction**: The answer should have the least number of decimal places

	Calculator answer	final answer
8.325 m + 4.2 m =	12.525	

2) **Multiplication or Division**: The answer should have the least number of significant figures

	Calculator answer	final answer
3.608 m x 27.0 m x 3.000 m =	292.248	

3) **Mixed Cases**: Remember the order is: **P.E.M.D.A.S**. Parenthesis | Exponents | Multiplication | Division | Addition | Subtraction. Perform the operations inside a parenthesis first.

(45 m – 40.2 m)/2.00 s =

Solving Chemical Problems:

- ✓ **Dimensional Analysis**

Information given × conversion factor(s) = information sought

$$\text{Given unit} \times \frac{\text{desired unit}}{\text{given unit}} = \text{desired unit}$$

A person has a height of 2.0 meters. What is that height in inches? 1 in = 2.54 cm

How many seconds are 2.5 hours?

How many minutes are in 1.4 days

If a ski pole is 3.0 feet in length, how long is the ski pole in mm? 1 ft = 12in, 1 in = 2.54 cm, 1 cm = 10 mm

- ✓ **Density is the ratio of a substance's mass to volume; it has units of mass (g)/volume (ml). $1cm^3 = 1$ ml**

 A piece of copper has a mass of 57.54 g. It is 9.36 cm long, 7.23 cm wide, and 0.95 mm thick. Calculate density (g/cm^3).

 What is the density (g/cm^3) of 48.0 g of a metal if the level of water in a graduated cylinder rises from 25.0 mL to 33.0 mL after the metal is added?

 **If olive oil has a density of 0.92 g/mL, how many liters of olive oil are in 285 g of olive oil?**

 **Convert 175 cm^3 to m^3**

 If your pace on a treadmill is 65 meters per minute, how many minutes will it take for you to walk a distance of 7500 feet?

A group of students collected 125 empty aluminum cans to take to the recycling center. If 21 cans make 1.0 lb aluminum, how many liters of aluminum (D=2.70 g/cm^3) are obtained from the cans?

1) 1.0 L 2) 2.0 L 3) 4.0 L

Quantity	U.S.	Metric (SI)	Metric–U.S.
Length	**1 ft = 12 in.**	**1 km = 1000 m**	**2.54 cm = 1 in. (exact)**
	1 yard = 3 ft	**1 m = 1000 mm**	**1 m = 39.37 in.**
	1 mile = 5280 ft	**1 cm = 10 mm**	**1 km = 0.6214 mi**
Volume	**1 qt = 4 cups**	**1 L = 1000 mL**	**1 L = 1.057 qt**
	1 qt = 2 pints	**1 dL = 100 mL**	
	1 gallon = 4 qts	**1 mL = 1 cm^3**	
Mass	**1 lb = 16 oz**	**1 kg = 1000 g**	**1 kg = 2.205 lb**
		1 g = 1000 mg	**453.6 g = 1 lb**
Time		**1 hr = 60 min**	
		1 min = 60 s	