

# **CHAPTER ONE**

## **PROPERTIES, MEASUREMENT AND UNITS**

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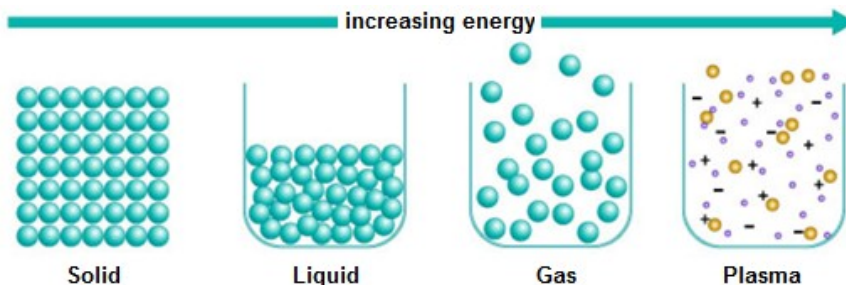
# **CONTENTS:**

- **States of Matter**
- **Physical and Chemical Properties**
- **Physical and Chemical Changes**
- **Extensive and Intensive Properties**
- **Elements, Compound and Mixtures**

# What is **Matter**?

- Anything that has **mass** and **takes up space**

## What are the 4 Physical States of Matter?



- **Solids:**
  - Definite shape and volume
  - Close packing of molecules
  - Strong molecular forces
- **Liquids:**
  - Definite volume but not definite shape (assumes shape of container)
  - Slightly weaker molecular forces than solids (this is what allows liquids to flow)
- **Gas:**
  - No definite shape or

# What are Properties?

- **Characteristics** and **behaviors** we use to describe matter

- There are 2 types of properties:

- **Physical**
- Can be observed or measured **without changing the identity** of the matter
- Properties you notice when using one of your **five senses** or **measurement tools**
  - Feel - mass, volume, texture, malleability
  - Sight - color, luster, mass, volume,

# What are Physical Properties:

# Physical Properties

- **Density**: The amount of matter in a given volume.
- $D = m/v$  (mass/volume)
- Ice cubes float in water because they are less dense than liquid water



# Physical Properties

- **Ductility** :The ability to be pulled into a thin strand.
- Wire, Paper clip, Copper wire.



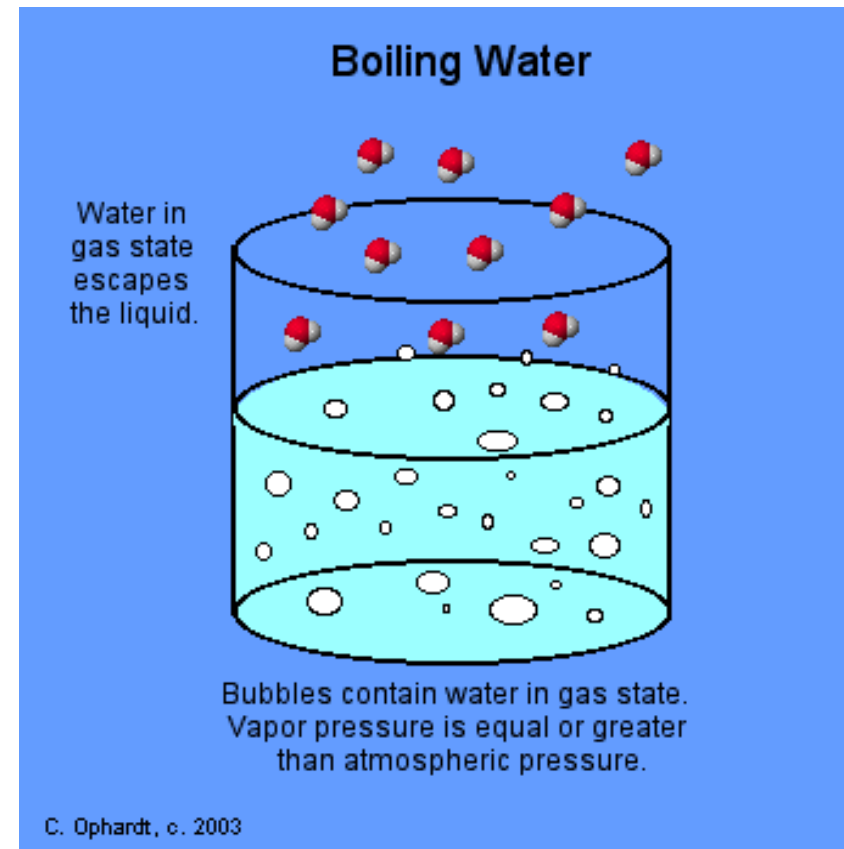
# Physical Properties

- **Malleability**: The ability to be pressed or pounded into a thin sheet
  - Tin foil



# Physical Properties

- **Boiling Point:** The temperature at which a substance changes from a liquid to a gas.
- Water to steam.



# Physical Properties

- **Melting point:** The temperature at which a substance changes from a solid to a liquid
- Ice cube melts to a puddle of water



# Physical Properties

- **Electrical conductivity**: How well a substance allows electricity to flow through it
- Water conducts electricity so never swim during a lightning storm



# Physical Properties

- **Solubility**: The ability to dissolve in another substance.
- Adding sugar to coffee.



# What are Chemical Properties?

- A substance's ability to combine with or **change into a new substance**
- Common chemical properties:
  - Reactivity - how likely a substance is to react with another substance to create something new
    - Reactive to oxygen
    - Reactive to air
    - Reactive to water

If it **CH**anges, it's **CH**emical

- **Flamability** - how likely a substance is to catch fire

# What is a **Chemical Change?**

- Changes to a substance that **results in an entirely new substance forming.**
- Chemical changes are often much more obvious than physical changes.
- Examples:
  - Color change
  - Light, heat or energy released

## Examples of Chemical Changes

**Soured milk** smells bad because bacteria have formed new substances in the milk.



**Effervescent tablets** bubble when the citric acid and baking soda in them react in water.

**The hot gas** formed when hydrogen and oxygen join to make water helps blast the space shuttle into orbit.

**The Statue of Liberty** is made of shiny, orange-brown copper. But the metal's interaction with carbon dioxide and water has formed a new substance, copper carbonate, and made this landmark lady green over time.



# Chemical Changes

**Rusting** - free Iron oxidizes (rusts), forming a new substance (Iron oxide)



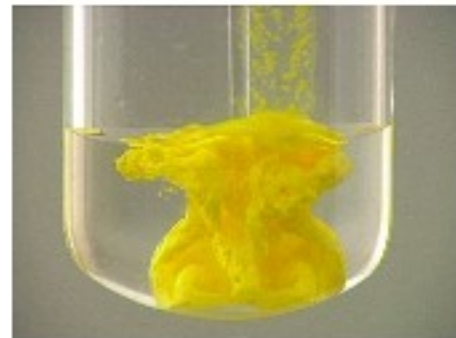
**Fireworks** - light, heat (energy)



**Color change** - light, heat (energy)



**Precipitate** - yellow solid forms when two chemicals are added



# 5 Signs of a Chemical Change

- The only sure way to know there has been a chemical change is the observance of a new substance formed.

## 1. Odor Production

- this is an odor far different from what it should smell like

Ex: Rotting eggs,  
decomposing flesh



## 2. **Change in Temperature**

**a. Exothermic** - When energy is released during the chemical change

- ex: wood burning



**b. Endothermic** - Energy is absorbed causing a decrease in temperature of the reactant material.

- ex: cold pack in first aid kit



### 3. Change in Color:

- Ex: fruit changing color when it ripens, leaves changing color in the Autumn, dying your hair.



### 4. Formation of Bubbles:

- This can indicate the presence of a gas.
- Bubbles produced when boiling water is not a chemical change.



## 5. Formation of a Precipitate:

- When two liquids are combined and a solid is produced



# Generally, Physical & Chemical Properties

Properties can be broken down into two types - physical and chemical properties. What's the difference?

**Physical:** properties of a **pure substance**, we can see without changing it into a new substance. Examples

1. **Physical state:** solid, liquid, gas
2. Color
3. Shape
4. Mass
5. Texture
6. Melting ( $0^{\circ}\text{C}$ ) & boiling point ( $100^{\circ}\text{C}$ )
7. Density
8. Solubility in water - the ability to dissolve in water
9. Odor
10. Luster - shine
11. Malleability - ability to be hammered into thin sheets

**Chemical:** properties of a **pure substance** that describe its ability to combine with or change into a new substance. Examples:

1. Flammability
2. Reactivity to water
3. Reactivity to air
4. Reactivity to oxygen

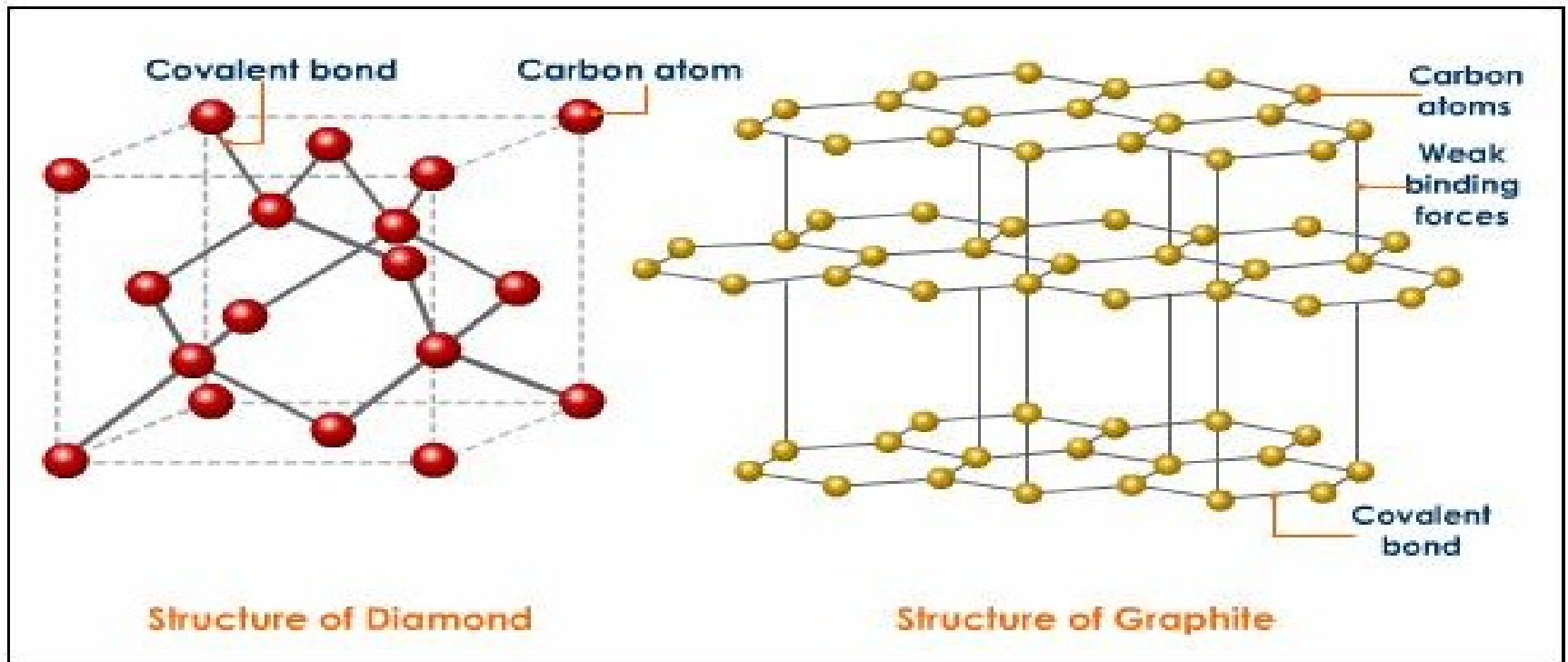
**\*\*\*Notice that Chemical Properties are not as easy to notice as Physical Properties.**

# Intensive and Extensive Properties of Matter

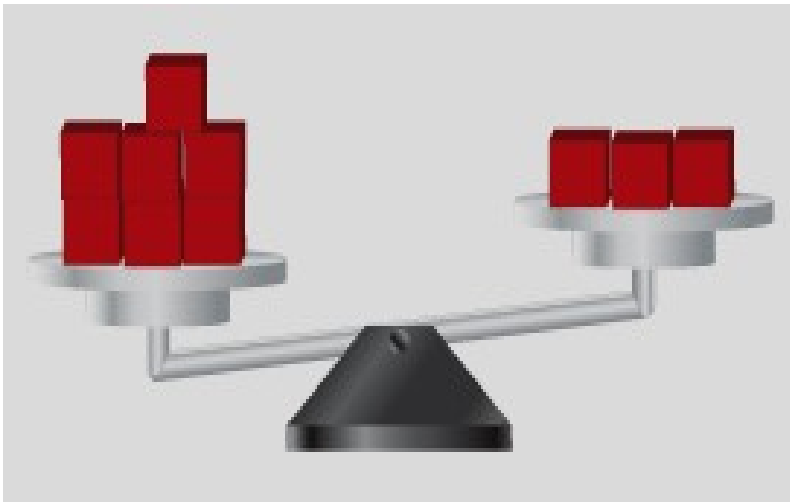
- + **Intensive property-** One that DOES NOT depend on the amount of the substance present.
- + **Extensive property-** One that DOES depend on the amount of the substance present.

■ **Intensive properties** are determined by the chemical composition of the particles and their structure (arrangement).

■ **Intensive ~ Internal**



- **Extensive properties:** Depend only on the number of particles, not on their composition or internal arrangement.
- Extensive  $\sim$  External



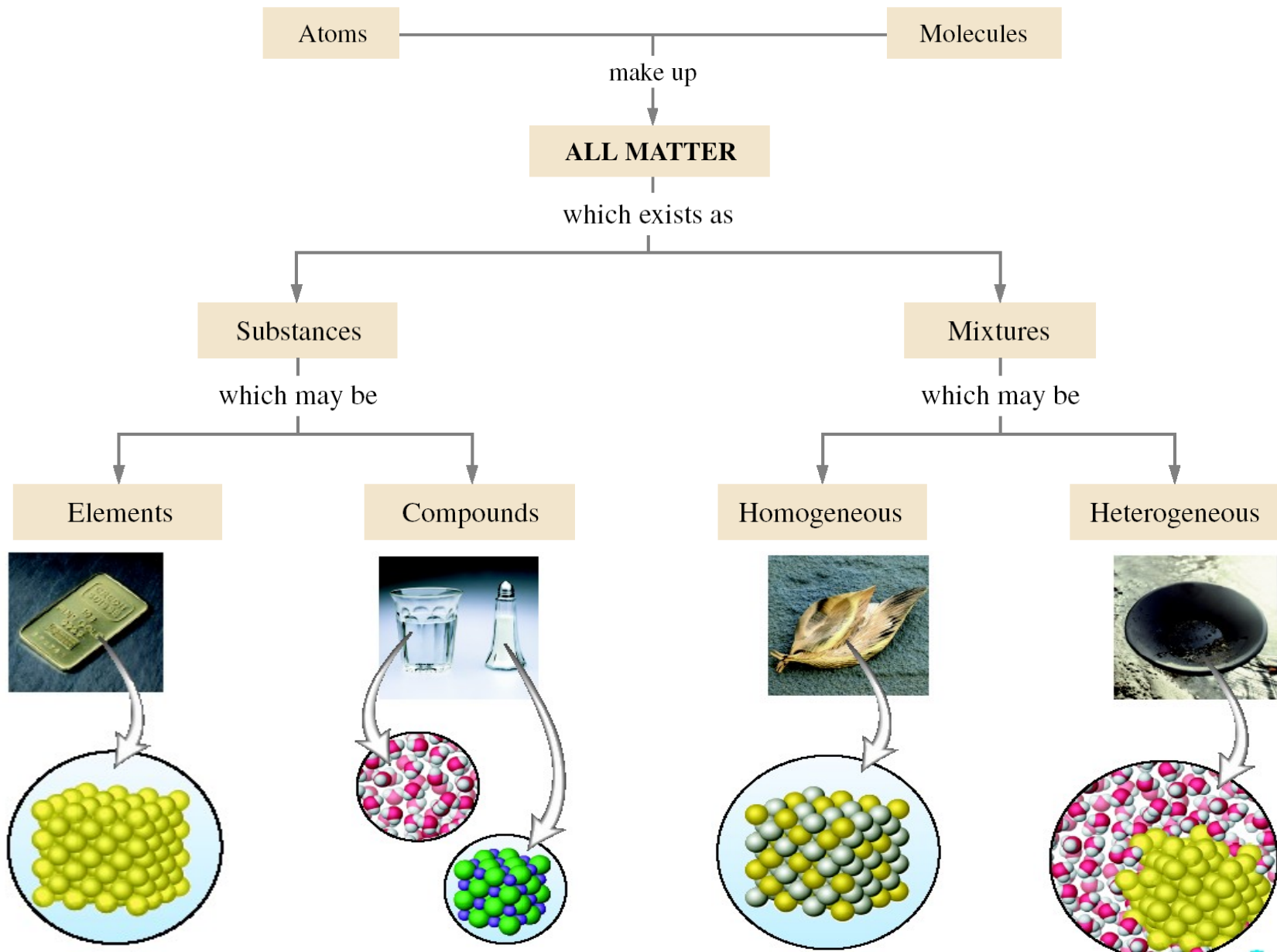
# Classifying Matter:

## Pure Substances and Mixtures

# Classifying Matter by Composition

- Another way to classify matter is to examine its **composition**.
- Composition includes:
  - Types of particles
  - Arrangement of the particles
  - Attractions and attachments between the particles

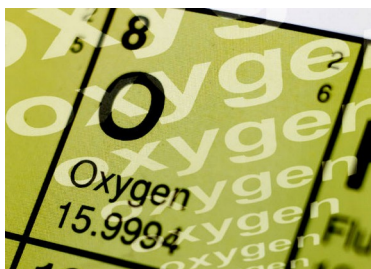
# Classifying Matter



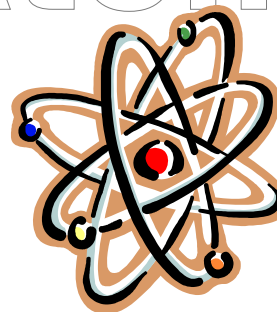
# Pure Substances

- A sample of matter that has definite chemical and physical properties.

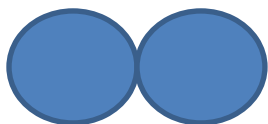
Elements



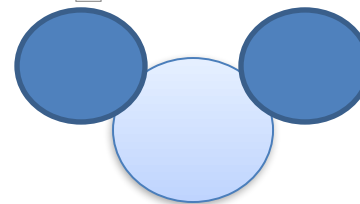
Atoms



Molecules



Compounds



# Elements

- Pure substance that cannot be separated into simpler substance by physical or chemical means.

|                                   |    |    |     |     |     |     |     |     |     |     |     |     |     |    |    |
|-----------------------------------|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|----|
| Periodic Table<br>of the Elements |    |    |     |     |     |     |     |     |     |     |     |     |     |    |    |
| 1                                 | 2  |    |     |     |     |     |     |     |     |     |     |     |     | 3  | 4  |
| 1                                 | H  | 2  | He  |     |     |     |     |     |     |     |     |     |     |    |    |
| 2                                 | 3  | 4  |     |     |     |     |     |     |     |     |     |     |     |    | 10 |
| 2                                 | Li | Be |     |     |     |     |     |     |     |     |     |     |     |    | Ne |
| 3                                 | 11 | 12 |     |     |     |     |     |     |     |     |     |     |     |    | 18 |
| 3                                 | Na | Mg |     |     |     |     |     |     |     |     |     |     |     |    | Ar |
| 4                                 | 19 | 20 | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32 | 36 |
| 4                                 | K  | Ca | Sc  | Ti  | V   | Cr  | Mn  | Fe  | Co  | Ni  | Cu  | Zn  | Ga  | Ge | Kr |
| 5                                 | 37 | 38 | 39  | 40  | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50 | 54 |
| 5                                 | Rb | Sr | Y   | Zr  | Nb  | Mo  | Tc  | Ru  | Rh  | Pd  | Ag  | Cd  | In  | Sn | Xe |
| 6                                 | 55 | 56 | 57  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  | 81  | 82 | 86 |
| 6                                 | Cs | Ba | *La | Hf  | Ta  | W   | Re  | Os  | Ir  | Pt  | Au  | Hg  | Tl  | Pb | Rn |
| 7                                 | 87 | 88 | 89  | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 |    |    |
| 7                                 | Fr | Ra | +Ac | Rf  | Ha  | Sg  | Ns  | Hs  | Mt  | 110 | 111 | 112 | 113 |    |    |

|                     |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
|---------------------|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|
| * Lanthanide Series | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68  | 69  | 70  | 71  |
|                     | Ce | Pr | Nd | Pm | Sm | Eu | Gd | Tb | Dy | Ho | Er  | Tm  | Yb  | Lu  |
| + Actinide Series   | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 |
|                     | Th | Pa | U  | Np | Pu | Am | Cm | Bk | Cf | Es | Fm  | Md  | No  | Lr  |

# Compounds



✚ Pure substance composed of two or more *different elements joined by chemical bonds.*

▶ Made of elements in a specific ratio that is always the same

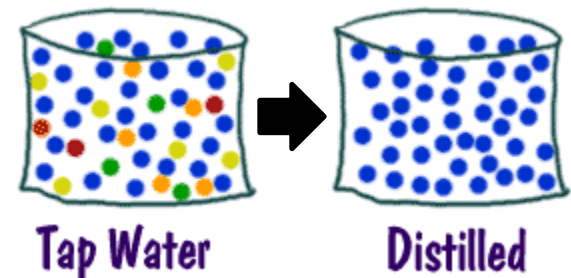
▶ Has a chemical formula

▶ Can only be separated by chemical means, not physically



# Mixtures

- ✗ A combination of two or more pure substances that are not chemically combined.
- ✗ Substances held together by *physical forces*, *not chemical*.
- ✗ No chemical change takes place
- ✗ Each item retains its properties in the mixture
- ✗ They can be separated physically



# MIXTURES

- 🍷 A mixture is something that CAN be broken down into simpler materials using physical methods.
- 🍷 There are 3 possible types of mixtures:
  - ✗ Element + Another Element
  - ✗ Compound + Another Compound
  - ✗ Element + Compound

# Types of Mixtures

👉 There are **THREE** types of mixtures:

a. Solutions

b. Suspensions

c. Colloids

# Tyndall Effect

■ The scattering of light by particles in a mixture.



## a. Solutions

✚ A **solution** is a mixture that appears to be a single substance, but it is actually composed of **2 or more substances** that are distributed evenly amongst each other.

✚ **Examples:** Salt dissolved in water, sugar dissolved in water, apple juice, tea, copper (II) sulfate solution in water, alloys, carbon dioxide is dissolved in water, rubbing alcohol (ethyl alcohol and water), Air (nitrogen and oxygen).

## ✚ SOLUTIONS ARE:

- ◆ **HOMOGENEOUS**
- ◆ **No Tyndall effect**
- ◆ Very small particles
- ◆ Particles don't settle
- ◆ Well-mixed (uniform) – single phase
- ◆ Transparent
- ◆ Cannot be separated by filter
- ◆ Do not separate on standing



## b. Suspensions

A **suspension** is a mixture in which particles of a material are dispersed throughout a liquid or gas, but are **large enough that they settle out**.

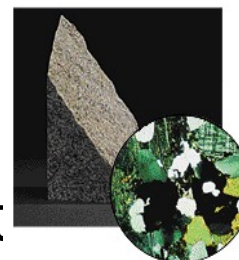
**SUSPENSIONS ARE:**

**✗ HETEROGENEOUS**

**✗ Tyndall effect**

**✗ Large particles**

**✗ Does NOT have uniform properties**



A Granite, a heterogeneous mixture



B Human blood, a heterogeneous mixture

**Examples:** muddy water, Sand water, oil and water, sulfur and iron, granite, blood, fresh-squeezed lemonade...

## c. Colloids

- A **colloid** is a mixture in which the particles are dispersed throughout but are **not** heavy enough to settle out.
- Colloids have properties of both solutions & suspensions.

### ■ COLLOIDS ARE:

- ◆ **HOMOGENEOUS**
- ◆ **Tyndall effect**
- ◆ Medium-sized particles
- ◆ Particles don't settle
- ◆ Non transparent, non uniform, cloudy (milky) **but stable system.**



■ **Examples: milk, clouds, smoke...**

# Methods of Mixture Separation

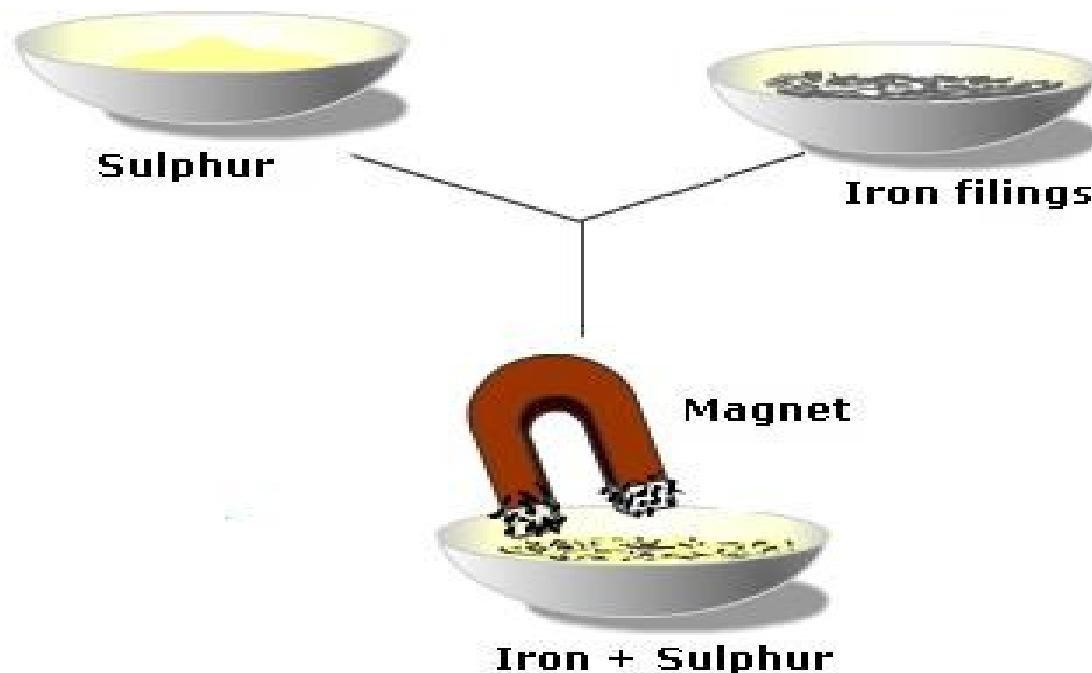
**1.Mechanical Separation:** (often by hand) takes advantage of physical properties such as color and shape.

**Example:** Recycling Plastic, Paper, Metal



**2. Magnetic Separation:** takes advantage of the physical property of **magnetism**.

**Example:** Separating Metals in a Scrap Yard



**3. Filtration:** takes advantage of the physical property of the **state of matter**.

- A screen lets the liquid particles through, but traps the solid particles.
- A **filter** can also be used to **separate solid particles of different sizes**.

**Example:**

Filtering Coffee,  
Spaghetti, a  
window screen,



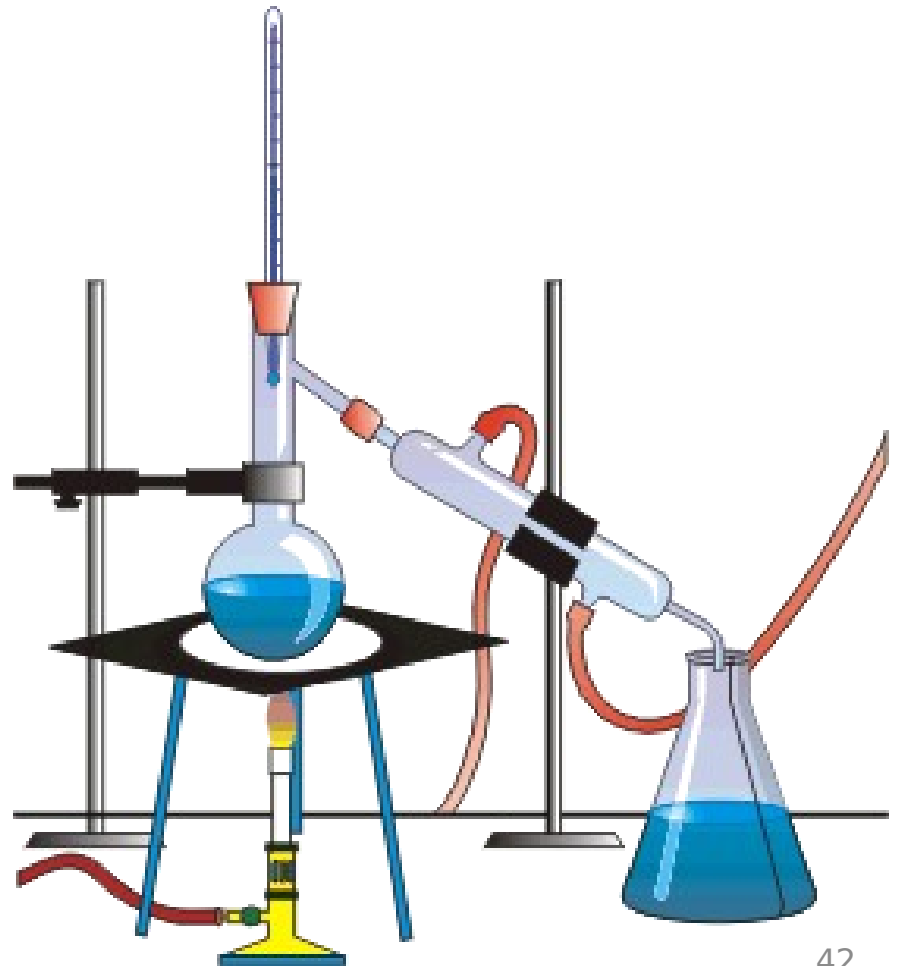
**4. Decanting:** To pour off a liquid, leaving another liquid or solid behind. Takes advantage of **differences in density.**

**Example:** To decant a liquid from a precipitate or water from rice.



**5. Distillation:** The separation of a mixture of liquids based on the physical property of **boiling point**.

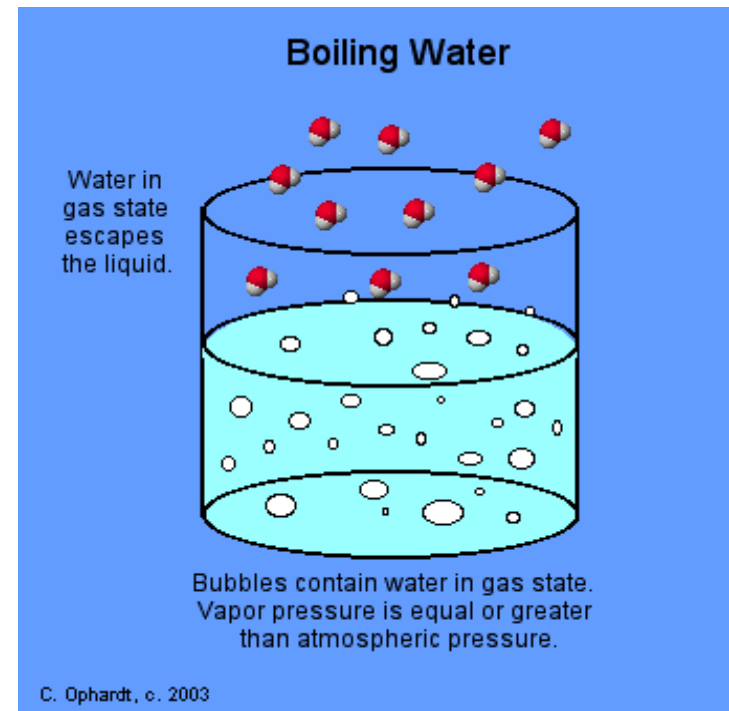
**Example:** the  
distillation of  
alcohol or oil



**6. Evaporation:** Vaporizing a liquid and leaving the dissolved solid(s) behind.

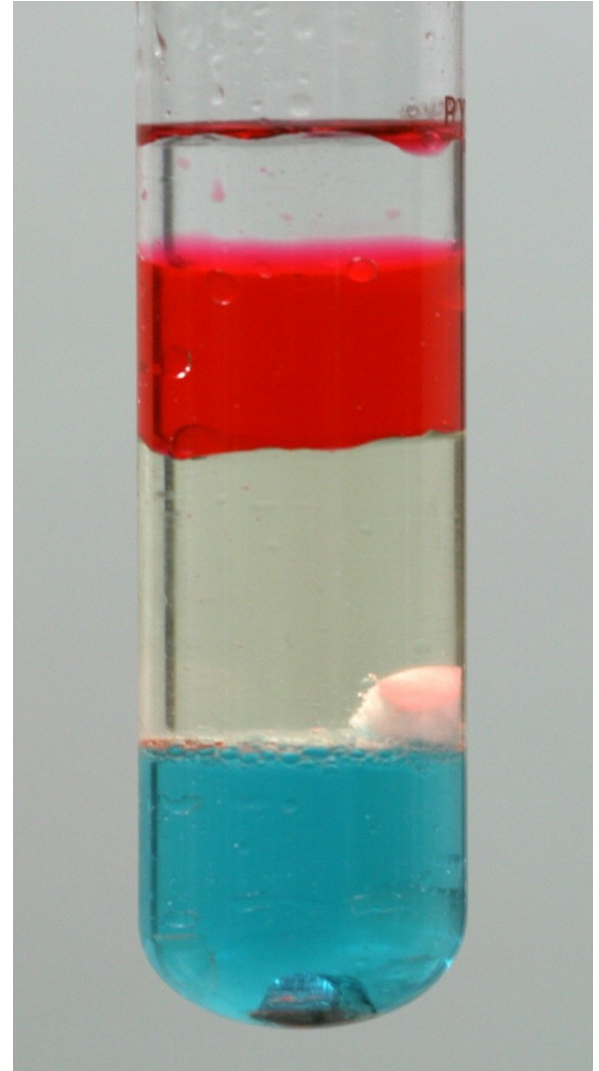
✚ Used to separate salt solutions.

**Example:** Obtaining sea salt from sea water



## 7. Density

**Separation:** More dense components sink to the bottom and less dense components float.



**8. Centrifuge:** Circular motion helps denser components sink to the bottom faster.

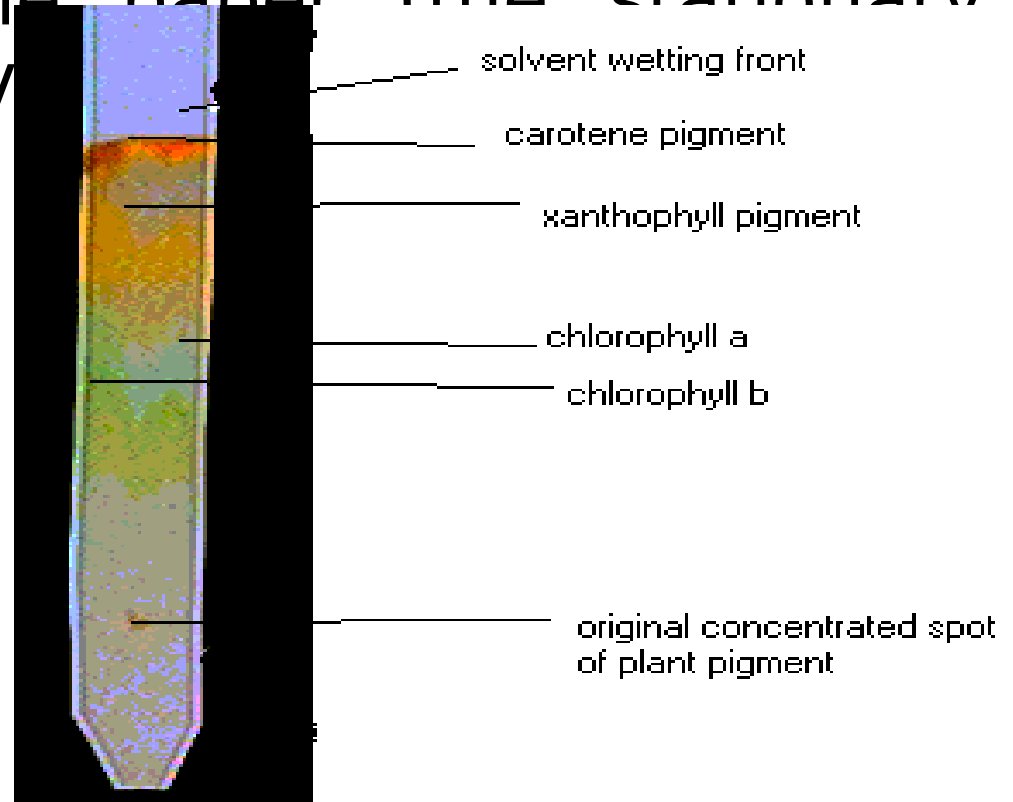
**Examples:** The separation of blood or DNA from blood



**9. Paper chromatography:** Uses the **property of molecular attraction** to separate a mixture.

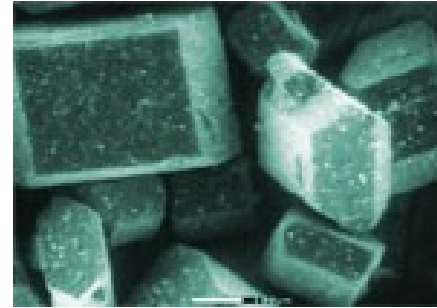
+ Different molecules have different attractions for the paper (the stationary phase) vs. the solvent.

**Example:** the separation of plant pigments and dyes



## 10. Fractional Crystallization:

Dissolved substances crystallize out of a solution once their **solubility limit** is reached as the solution cools.



### Examples:

Growing Rock  
Candy or the  
Crystallization of a  
Magma Chamber



# Mixtures vs. Compounds

|                      | Mixture                                                                        | Compound                                                                         |
|----------------------|--------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| <b>Composition</b>   | Variable composition – you can vary the amount of each substance in a mixture. | Definite composition – you cannot vary the amount of each element in a compound. |
| <b>Joined or not</b> | The different substances are not chemically joined together.                   | The different elements are chemically joined together.                           |
| <b>Properties</b>    | Each substance in the mixture keeps its own properties.                        | The compound has properties different from the elements it contains.             |
| <b>Separation</b>    | Each substance is easily separated from the mixture.                           | It can only be separated into its elements using chemical reactions.             |
| <b>Examples</b>      | Air, sea water, most rocks.                                                    | Water, carbon dioxide, magnesium oxide, sodium chloride.                         |

# Review:

- ◆ An **element** contains just one type of atom.
- ◆ A **compound** contains two or more different atoms joined together.
- ◆ A **mixture** contains two or more different substances that are only physically joined together, not chemically.
- ◆ A mixture can contain both elements and compounds.

# **Measurements and Units**

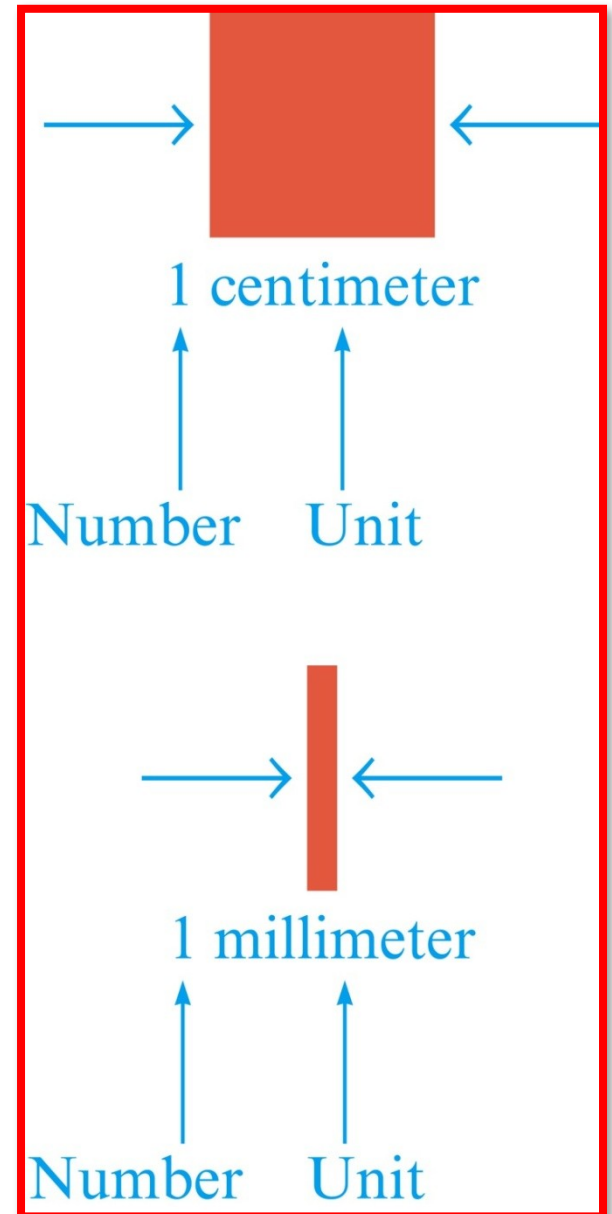
# Scientific Notation and Units

## Objectives

1. To show how very large or very small numbers can be expressed in scientific notation
2. To learn the English, metric, and SI systems of measurement
3. To use the metric system to measure length, volume and mass

# Measurement

- A quantitative observation
- Consists of 2 parts
  - ▶ Number
  - ▶ Unit – tells the scale being used



## A. Scientific Notation

- ✚ Very large or very small numbers can be expressed using scientific notation.
  - ✖ The number is written as a number between 1 and 10 multiplied by 10 raised to a power.
  - ✖ The power of 10 depends on
    - ◆ The number of places the decimal point is moved.
    - ◆ The direction the decimal point is moved.
- ◆ Left ⇒ Positive exponent
- ◆ Right ⇒ Negative exponent

## ■ Representing Large Numbers

$$\begin{aligned} 93,000,000 &= 9.3 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \\ &= 9.3 \times 10^7 \end{aligned}$$

Number between 1 and 10      Appropriate power of 10  
( $10,000,000 = 10^7$ )

## ■ Representing Small Numbers

- To obtain a number between 1 and 10 we must move the decimal point.

$$0.000167$$

1 2 3 4

i.e:  $0.000167 = 1.67 \times 10^{-4}$

## B. Units

- Units provide a scale on which to represent the results of a measurement.

**Table 5.1** Common Fundamental SI Units

| Physical Quality | Name of Unit | Abbreviation |
|------------------|--------------|--------------|
| mass             | kilogram     | kg           |
| length           | meter        | m            |
| time             | second       | s            |
| temperature      | kelvin       | K            |

✚ There are THREE commonly used unit systems.

◆ English

◆ Metric (uses prefixes to change the size of the unit)

◆ SI (uses prefixes to change the size of the

**Table 5.2** Commonly Used Prefixes in the Metric System

| Prefix | Symbol | Meaning     | Power of 10 for Scientific Notation |
|--------|--------|-------------|-------------------------------------|
| 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  | $\mu$  | 0.000001    | $10^{-6}$                           |
| nano   | n      | 0.000000001 | $10^{-9}$                           |

# C. Measurements of Length, Volume and Mass

## Length

- Fundamental unit is meter

- 1 meter = 39.37 inches

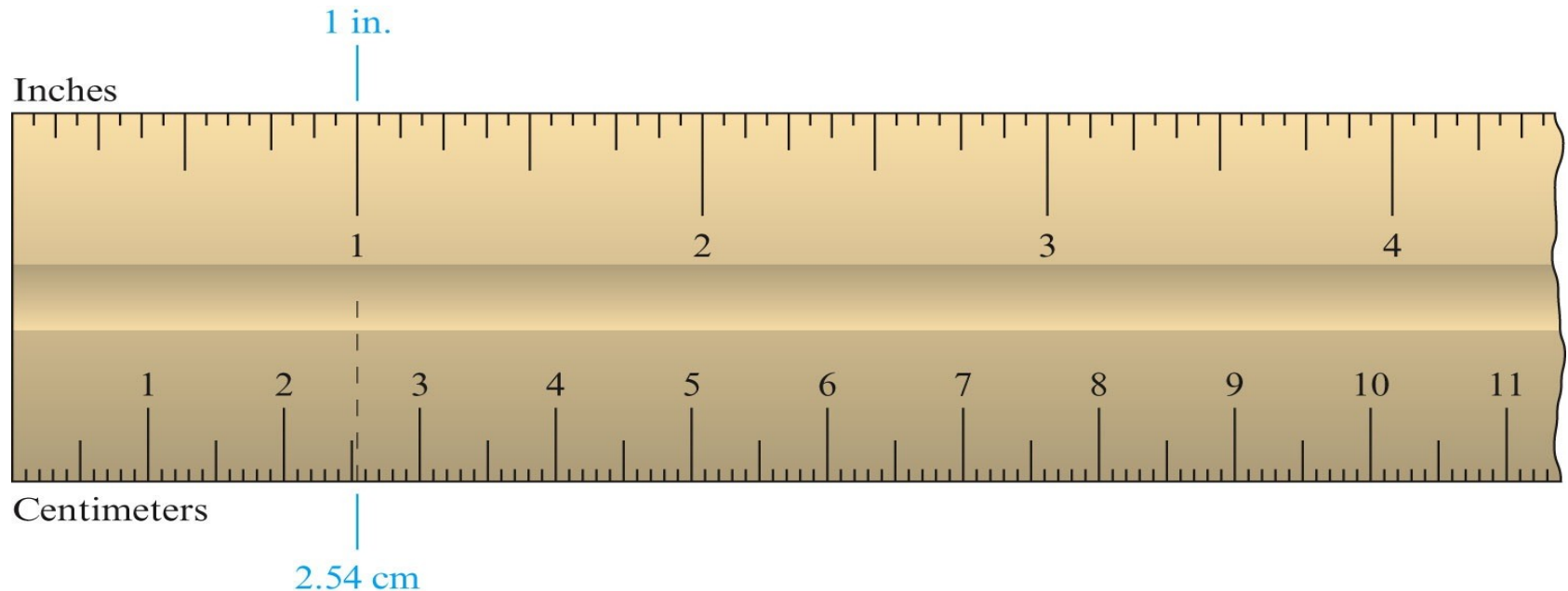


**Table 5.3** Metric System for Measuring Length

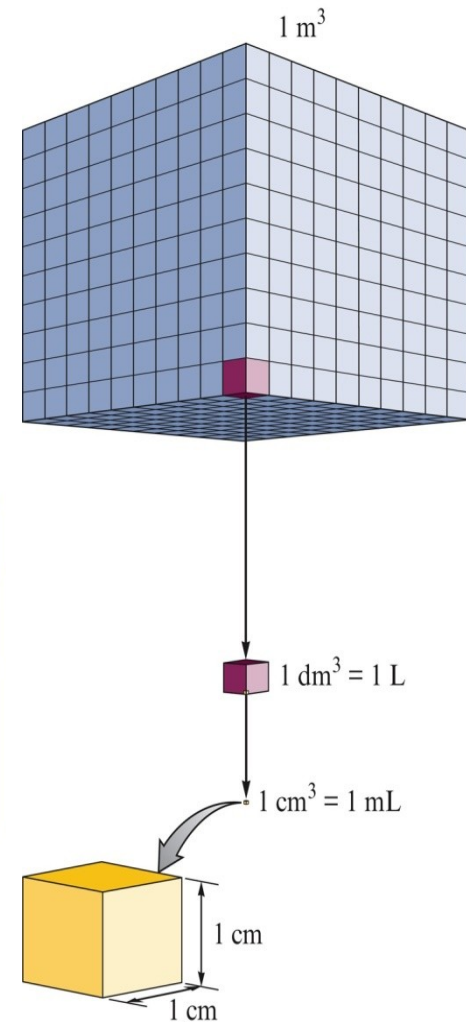
| Unit       | Symbol        | Meter Equivalent             |
|------------|---------------|------------------------------|
| kilometer  | km            | 1000 m or $10^3$ m           |
| meter      | m             | 1 m or 1 m                   |
| decimeter  | dm            | 0.1 m or $10^{-1}$ m         |
| centimeter | cm            | 0.01 m or $10^{-2}$ m        |
| millimeter | mm            | 0.001 m or $10^{-3}$ m       |
| micrometer | $\mu\text{m}$ | 0.000001 m or $10^{-6}$ m    |
| nanometer  | nm            | 0.000000001 m or $10^{-9}$ m |

# Volume

- Amount of 3-D space occupied by a substance
- Fundamental unit is meter<sup>3</sup> (m<sup>3</sup>)

**Table 5.4** Relationship Between the Liter and Milliliter

| Unit       | Symbol | Equivalence                             |
|------------|--------|-----------------------------------------|
| liter      | L      | 1 L = 1000 mL                           |
| milliliter | mL     | $\frac{1}{1000}$ L = $10^{-3}$ L = 1 mL |



## Mass

- Quantity of matter in an object
- Fundamental unit is kilogram

**Table 5.5** Most Commonly Used Metric Units for Mass

| Unit      | Symbol | Gram Equivalent                                      |
|-----------|--------|------------------------------------------------------|
| kilogram  | kg     | $1000 = 10^3 \text{ g} = 1 \text{ kg}$               |
| gram      | g      | 1 g                                                  |
| milligram | mg     | $0.001 \text{ g} = 10^{-3} \text{ g} = 1 \text{ mg}$ |

## C. Measurements of Length, Volume and Mass *commonly used*

**Table 5.6** Examples of Commonly Used Units

|        |                                                                                                        |
|--------|--------------------------------------------------------------------------------------------------------|
| length | A dime is 1 mm thick. A quarter is 2.5 cm in diameter. The average height of an adult man is 1.8 m.    |
| volume | A 12-oz can of soda has a volume of about 360 mL. A half gallon of milk is equal to about 2 L of milk. |
| mass   | A nickel has a mass of about 5 g. A 120-lb woman has a mass of about 55 kg.                            |

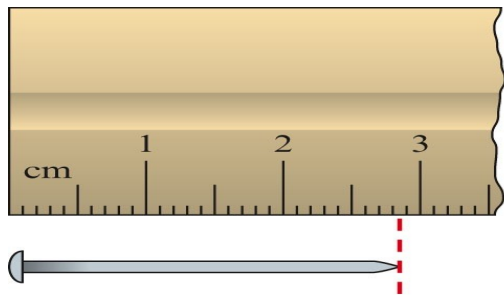
# Uncertainty in Measurement and Significant Figures

## Objectives

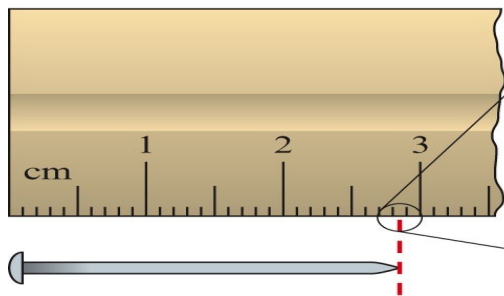
1. To learn how uncertainty in a measurement arises
2. To learn to indicate a measurement's uncertainty by using significant figures
3. To learn to determine the number of significant figures in a calculated result

# A. Uncertainty in Measurement

- A measurement always has some degree of uncertainty.



a



b

 Different people estimate differently.

| Person | Result of Measurement |
|--------|-----------------------|
| 1      | 2.85 cm               |
| 2      | 2.84 cm               |
| 3      | 2.86 cm               |
| 4      | 2.85 cm               |
| 5      | 2.86 cm               |

 Record all **certain** numbers and one **estimated** number.

## B. Significant Figures

- Numbers recorded in a measurement.
- All the certain numbers plus first estimated number.

### Rules for Counting Significant Figures

**1. Nonzero integers** always count as significant figures

**Example**:-1457      4 significant figures

## 2. Zeros

a. Leading zeros – never count

**Example**:- 0.25      2 significant figures

b. Captive zeros – always count

**Example**:- 1.08      3 significant figures

c. Trailing zeros – count only if the number is written with a decimal point

**Example**:- 100      1 significant figure

100.      3 significant figures

120.0      4 significant figures

### 3. **Exact numbers** – unlimited significant figures

- ◆ Not obtained by measurement
- ◆ Determined by counting
  - ◆ **Example**:- 3 apples
- ◆ Determined by definition
  - ◆ **Example**:- 1 in. = 2.54 cm, exactly

## Rules for Rounding Off

1. If the digit to be removed
  - a. is less than 5, the preceding digit stays the same. For example, 1.33 rounds to 1.3.
  - b. is equal to or greater than 5, the preceding digit is increased by 1. For example, 1.36 rounds to 1.4, and 3.15 rounds to 3.2.
2. In a series of calculations, carry the extra digits through to the final result and *then* round off.\* This means that you should carry all of the digits that show on your calculator until you arrive at the final number (the answer) and then round off, using the procedures in rule 1.

# Rules for Multiplication and Division

- The number of significant figures in the result is the same as in the measurement with the **smallest number of significant**

**f**  $4.56 \times 1.4 = 6.384$    $6.4$

Three significant figures      Limiting (two significant figures)      Two significant figures

Round off

$\frac{8.315}{298} = 0.0279027$    $2.79 \times 10^{-2}$

Four significant figures      Limiting (three significant figures)      Result shown on calculator      Three significant figures

Round off

# Rules for Addition and Subtraction

- The number of significant figures in the result is the same as in the measurement with the **smallest** number of decimal places.

$$\begin{array}{r} 12.11 \\ 18.0 \\ 1.013 \\ \hline 31.123 \end{array}$$

Limiting term (has one decimal place)



31.1  
↑  
One decimal place

$$\begin{array}{r} 0.6875 \\ -0.1 \\ \hline 0.5875 \end{array}$$

Limiting term (one decimal place)



0.6

# Problem solving and Unit Conversions

## Objectives

1. To learn how dimensional analysis can be used to solve problems
2. To learn the three temperature scales
3. To learn to convert from one temperature scale to another
4. To practice using problem solving techniques
5. To define density and its units

# A. Tools for Problem Solving

🍷 Be systematic

🍷 Ask yourself these questions

- ✗ Where do we want to go?

- ✗ What do we know?

- ✗ How do we get there?

- ✗ Does it make sense?

# Converting Units of Measurement

- ✚ We can convert from one system of units to another by a method called dimensional analysis using conversion factors.

$$\text{Unit}_1 \times \text{conversion factor} = \text{Unit}_2$$

- ✚ **Conversion factors** are ratios of the two parts of the equivalence statement that relate the two units.

 **Conversion factors** are built from an ***equivalence statement*** which shows the relationship between the units in different systems.

 lb means Pound

**Table 5.7** English-Metric and English-English Equivalents

|        |                                                                                                                                                 |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| Length | $1 \text{ m} = 1.094 \text{ yd}$<br>$2.54 \text{ cm} = 1 \text{ in.}$<br>$1 \text{ mi} = 5280. \text{ ft}$<br>$1 \text{ mi} = 1760. \text{ yd}$ |
| Mass   | $1 \text{ kg} = 2.205 \text{ lb}$<br>$453.6 \text{ g} = 1 \text{ lb}$                                                                           |
| Volume | $1 \text{ L} = 1.06 \text{ qt}$<br>$1 \text{ ft}^3 = 28.32 \text{ L}$                                                                           |

# Converting Units of Measure

$$2.85 \text{ cm} = ? \text{ in.}$$

$$2.85 \text{ cm} \times \text{conversion factor} = ? \text{ in.}$$

Equivalence statement

$$2.54 \text{ cm} = 1 \text{ in.}$$

Possible conversion factors

$$2.85 \text{ cm} \times \frac{1 \text{ in.}}{2.54 \text{ cm}} = \frac{2.85 \text{ in.}}{2.54} = 1.12 \text{ in.}$$

Does this answer make sense?

# **Tools for Converting from One Unit to Another**

Step 1: Find an equivalence statement that relates the two units.

Step 2: Choose the conversion factor by looking at the direction of the required change (cancel the unwanted units).

Step 3: Multiply the original quantity by the conversion factor.

**Example 1:** A golfer putted a golf ball 6.8 ft across a green. How many inches does this represent?

- ◆ To convert from one unit to another, use the equivalence statement that relates the two units.

$$1 \text{ ft} = 12 \text{ in}$$

- ◆ The two conversion factors are:

$$\frac{1 \text{ ft}}{12 \text{ in}} \text{ and } \frac{12 \text{ in}}{1 \text{ ft}}$$

- Derive the appropriate conversion factor by looking at the direction of the required change (to cancel the unwanted units).

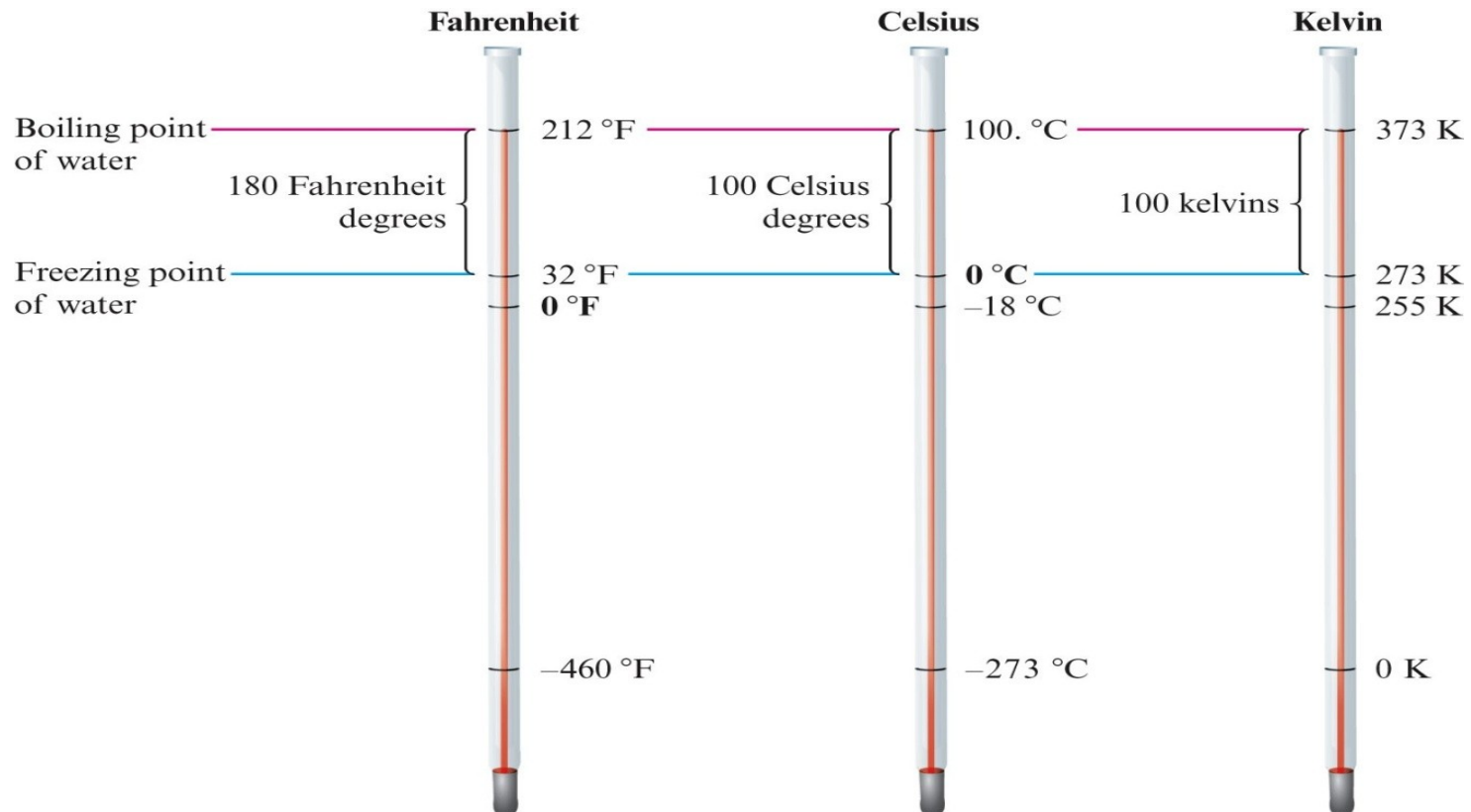
$$6.8 \cancel{\text{ft}} \times \frac{12 \text{ in}}{1 \cancel{\text{ft}}} = \text{----- in}$$

- Multiply the quantity to be converted by the conversion factor to give the quantity with the desired units.

$$6.8 \cancel{\text{ft}} \times \frac{12 \text{ in}}{1 \cancel{\text{ft}}} = 82 \text{ in}$$

## B. Temperature Conversions

- There are three commonly used temperature scales, Fahrenheit, Celsius and Kelvin.



# Converting between the Kelvin and Celsius Scales

 Note that:

- ◆ The temperature unit is the same size.
- ◆ The zero points are different.

 To convert from Celsius to Kelvin, we need to adjust for the difference in zero points.

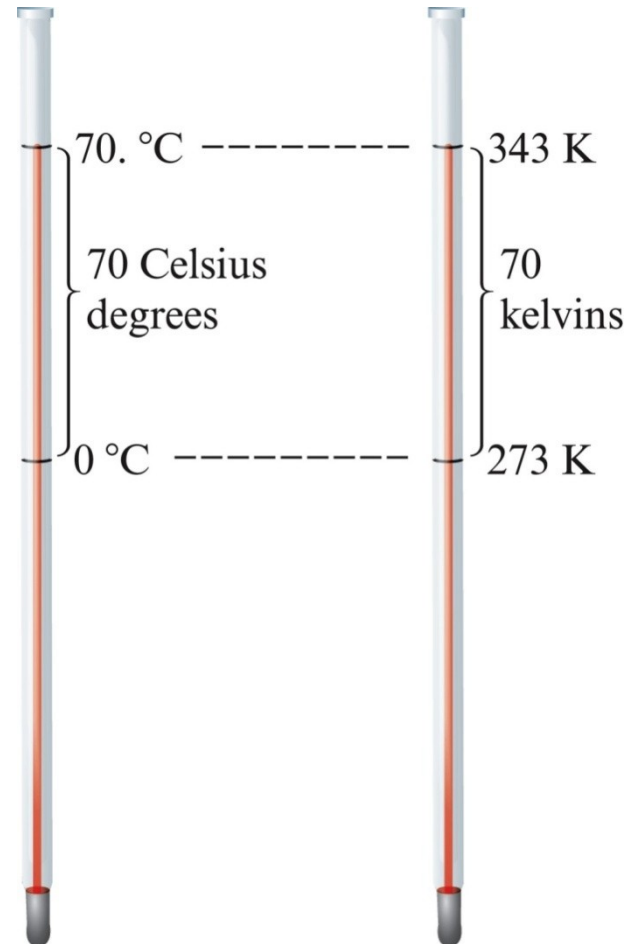
$$T_K = T_{°C} + 273$$

# Converting between the Kelvin and Celsius Scales

$$70.^{\circ}\text{C} = ? \text{ K}$$

$$T_{^{\circ}\text{C}} + 273 = T_{\text{K}}$$

$$70. + 273 = 343 \text{ K}$$



# Converting between the Fahrenheit and Celsius Scales

🌐 Note:

- The different size units
- The zero points are different

🌐 To convert between Fahrenheit and Celsius, we need to make 2 adjustments.

$$\begin{array}{ccc} T_{\circ\text{F}} & = & 1.80(T_{\circ\text{C}}) + 32 \\ \uparrow & & \uparrow \\ \text{Temperature} & & \text{Temperature} \\ \text{in } ^\circ\text{F} & & \text{in } ^\circ\text{C} \end{array}$$

$$T_{\circ\text{F}} = \frac{9^{\circ}\text{F}}{5^{\circ}\text{C}}(T_{\circ\text{C}}) + 32$$



## Exercise

At what temperature does  $^{\circ}\text{C}$   
 $=$   $^{\circ}\text{F}$ ?

## C. Density

- Density is the amount of matter present in a given volume of substance.
- Common units are g/cm<sup>3</sup> or g/mL.

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

**Table 5.8** Densities of Various Common Substances at 20°C

| Substance              | Physical State | Density (g/cm <sup>3</sup> ) | Substance | Physical State | Density (g/cm <sup>3</sup> ) |
|------------------------|----------------|------------------------------|-----------|----------------|------------------------------|
| oxygen                 | gas            | 0.00133*                     | aluminum  | solid          | 2.70                         |
| hydrogen               | gas            | 0.0000084*                   | iron      | solid          | 7.87                         |
| ethanol                | liquid         | 0.78                         | copper    | solid          | 8.96                         |
| benzene                | liquid         | 0.880                        | silver    | solid          | 10.5                         |
| water                  | liquid         | 1.000                        | lead      | solid          | 11.34                        |
| magnesium              | solid          | 1.74                         | mercury   | liquid         | 13.6                         |
| salt (sodium chloride) | solid          | 2.16                         | gold      | solid          | 19.32                        |

\*At 1 atmosphere pressure

**Exercise 1:-** A certain mineral has a mass of 17.8 g and a volume of 2.35 cm<sup>3</sup>. What is the density of this mineral?