INTRODUCTION TO CHEMISTRY

- Chemistry is the science that deals with the ***materials*** of the universe, and the ***changes*** they undergo.

- ***Materials*** of the universe can be of several forms:

  Gas: air, oxygen

  Liquid: water, gasoline, vinegar, orange juice,

  Solid: rocks, charcoal, table salt, sugar, wood, baking soda

- Some examples of **changes**:

  Burning of charcoal

  charcoal + oxygen $\longrightarrow$ carbon dioxide

  Burning of gasoline

  gasoline + oxygen $\longrightarrow$ carbon dioxide+ water vapor

  Fermentation of grape juice

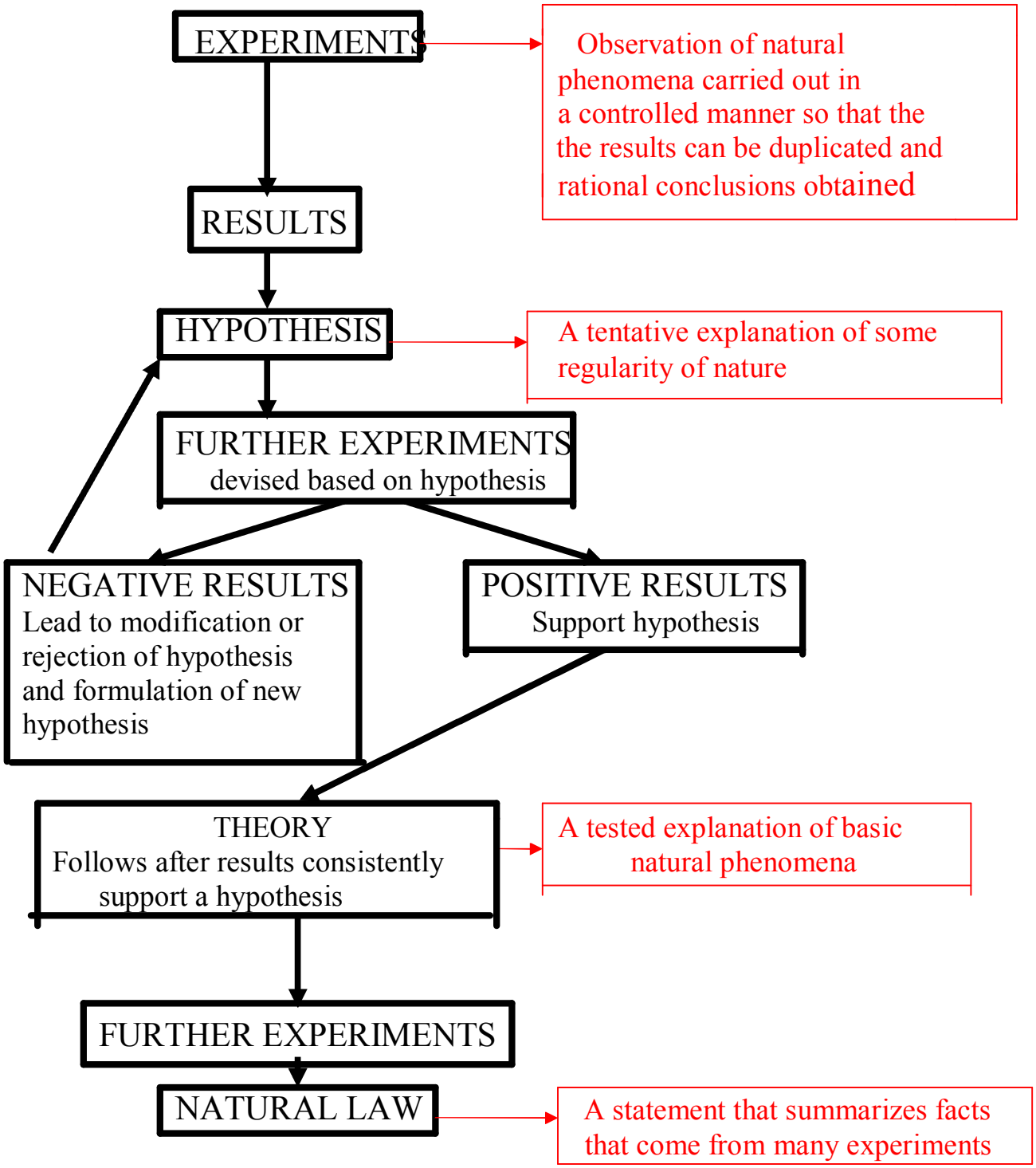
  glucose $\longrightarrow$ ethyl alcohol + carbon dioxide
  (in water) (in water)

  Souring of wine

  ethyl alcohol + oxygen $\longrightarrow$ acetic acid
  (in water) (from air) (in water)

SCIENTIFIC METHOD

- is a general, overall philosophy of approach to the study of nature
- a formal statement of the steps that any of us follow as we **logically** approach a problem



LAW OF CONSERVATION OF MASS

Antoine Lavoisier (1743-1794)
- studied chemical changes
- pioneered the use of balances in chemical research
- weighed the substances before and after a chemical change
- studied the process of burning (combustion)

SHOWED THAT WHEN A MATERIAL BURNS, A COMPONENT OF AIR (HE CALLED IT OXYGEN) COMBINES CHEMICALLY WITH THE MATERIAL.

Examples:

1. Mercury is heated in air to form mercuric oxide

Mercury	+	Oxygen	——>	Mercuric Oxide
200.6 g		?	——>	more or less than 200.6 g ?
200.6 g		?	——>	216.6 g
200.6 g	+	16.0 g	——>	216.6 g

2. When sugar is heated it forms carbon and water vapor. Will the carbon weigh more or less than the sugar?

sugar ——>	carbon	+	water (g)
34.2 g	14.4 g		?
34.2 g	14.4 g		19.8 g

THE TOTAL MASS REMAINS CONSTANT DURING A CHEMICAL CHANGE

MASS vs. WEIGHT

MASS	WEIGHT
• The quantity of matter in an object • Independent of location on earth • Measured in grams (g) or kilograms (kg) • Measured on a balance (massing) • Commonly used in chemical laboratory • Sometimes mistakenly referred to as weight	• The force of gravity exerted on an object • Depends on location on earth (the closer to the center of the earth, the more the object weighs) • Measured in Newtons (N) • Measured with a spring scale (weighing)

PHYSICAL & CHEMICAL PROPERTIES

- The characteristics of a sample are its properties.

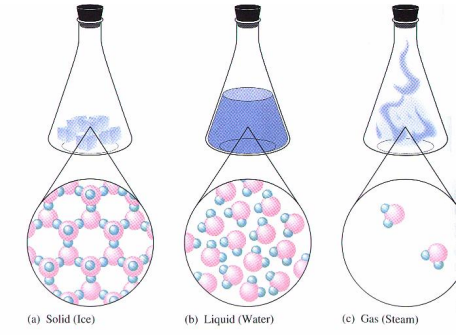
PHYSICAL PROPERTIES	CHEMICAL PROPERTIES
• A property that can be observed without changing the chemical identity of the sample of matter **Examples:** • Physical state (solid, liquid, gas) • Odor • Color • Melting point • Boiling point • Density • Specific heat	• A property that refers to the ability of a substance to form different substances **Examples:** • Charcoal burns in air • Iron rusts • Grape juice ferments • Wine sours • Alcohol is flammable

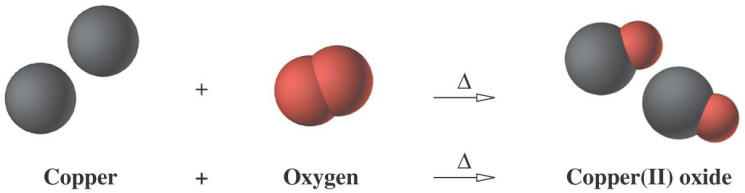
Examples:
Identify each of the following properties as physical or chemical:

1. Oxygen is a gas
2. Helium is unreactive
3. Water has a high specific heat
4. Gasoline is flammable
5. Sodium is soft and shiny

PHYSICAL & CHEMICAL CHANGES

PHYSICAL CHANGES	CHEMICAL CHANGES (REACTIONS)
• A change in the form of matter but not in its chemical identity **Examples:** • Freezing of water • Boiling of water • Melting of ice • Evaporation of alcohol • Sublimation of dry ice	• A change in which one or more kinds of matter are transformed into a new kind of matter or several new ones **Examples:** • Souring of wine • Rusting of iron • Burning of alcohol • Explosion of a firecracker • Electrolysis of water





Physical Changes **Chemical Changes**

Examples:
Identify each of the following changes as physical or chemical:

1. Cooking food
2. Mixing sugar in tea
3. Carving wood
4. Burning gas
5. Food molding

CLASSIFICATION OF MATTER

I. By Physical State
II. By Chemical Constitution

I. CLASSIFICATION OF MATTER BY PHYSICAL STATE

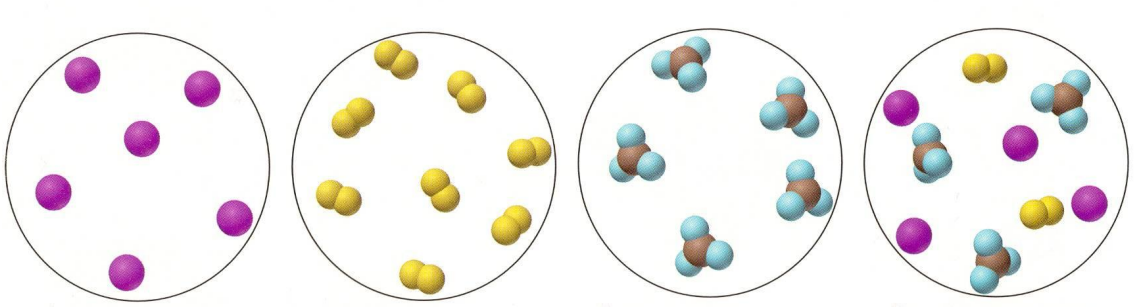
Solids	Liquids	Gases
• Fixed volume • Fixed shape • Maintain their shape • Are rigid • Incompressible	• Fixed volume • No fixed shape • Flow • Are fluid • Incompressible	• No fixed volume • No fixed shape • Flow • Are fluid • Compressible

NOTE:

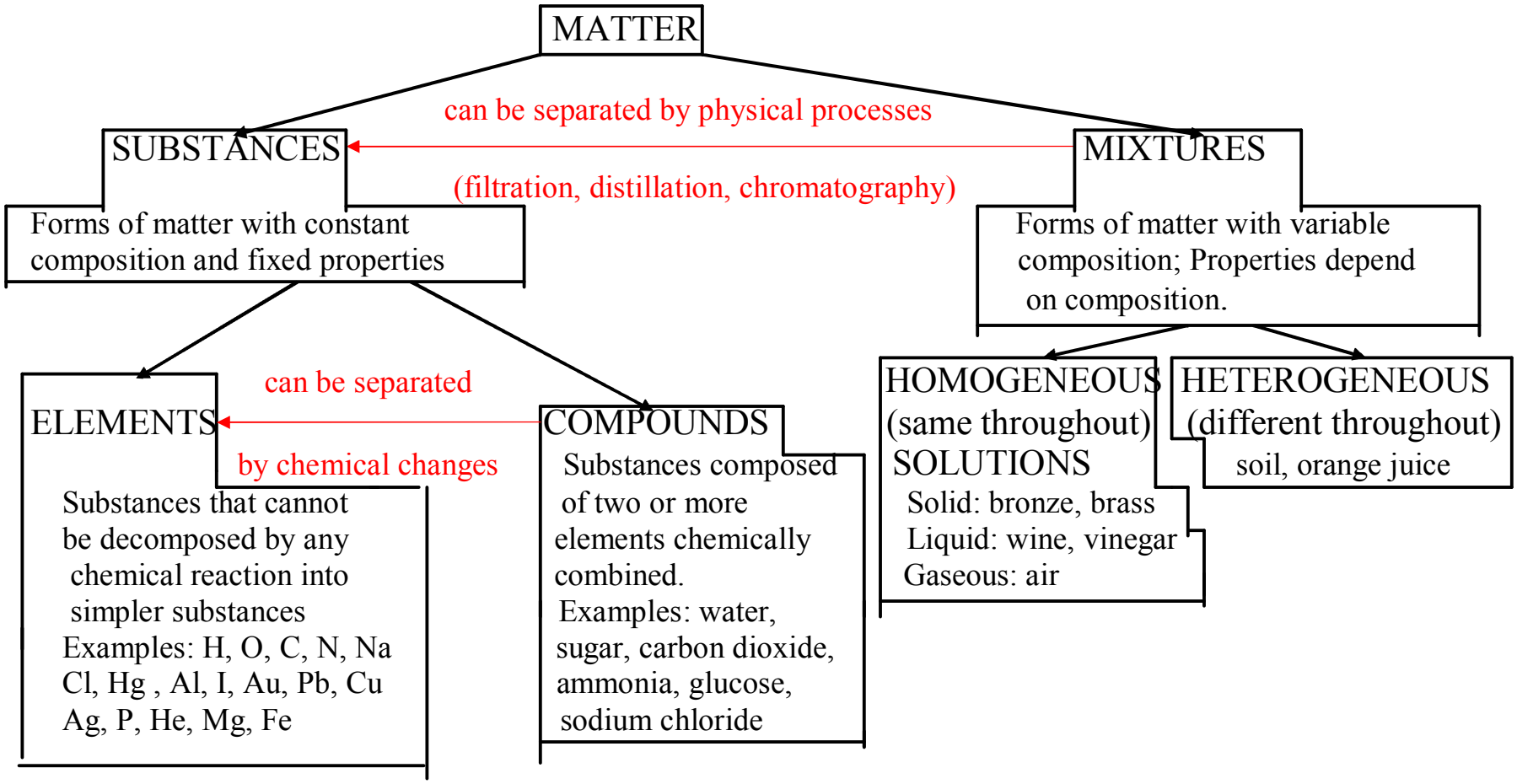
1. The three forms of matter (solid, liquid, gas) are referred to as states of matter
2. This classification is not very meaningful, since the majority of the different forms of matter may exist in all three physical states, depending on conditions.

Example : water can exist as:
1. solid water (ice) at very low temperatures (below 0^0C)
2. liquid water (between 0^0C and 100^0C
3. gaseous water or water **vapor** (above 100^0C)

The term **vapor** is used to refer to the gaseous state of a form of matter that exists as a solid or a liquid at room temperature (25 ^{0}C)



II. CLASSIFICATION OF MATTER BY CHEMICAL CONSTITUTION



MEASUREMENT

- Is the comparison of a physical quantity with a unit of measurement.
  Example: The mass of the same penny is measured by 3 different students on the same balance:
  $m_1 = 3.11$ g $m_2 = 3.12$ g $m_3 = 3.13$ g

The mass of the penny is reported as : **3.12 g**

we are sure of this digit
this digit is accurate (certain)
the **accuracy is ± 0.1 g**

we are not sure of this digit
this digit is uncertain
the **uncertainty is ± 0.01 g**

The mass of the penny should be reported as : (3.12 ± 0.01) g

the uncertainty of the measurement
(normally not shown, but implied)

- The three student obtained measured values which are very close to each other.
- We say that their measurements had good REPRODUCIBILITY or had good PRECISION

PRECISION: – is a determination of the reproducibility of a measurement.
– tells you how closely several measurements agree with one another.
– precision is affected by **random errors**.

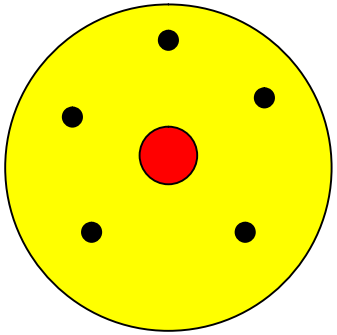
ACCURACY: – closeness of a measurement to a true, accepted value.
– is subject to **systematic errors** (errors which are off in the same direction, either too high or too low)

Are we confident that the correct mass of the penny is 3.12 g ?
Actually the True Value of the penny is: 3.03 g

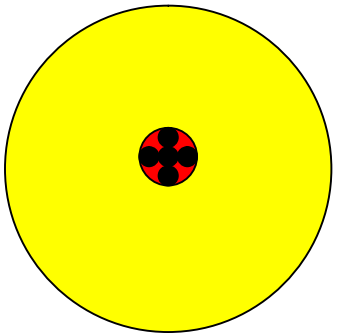
What went wrong?

- The balance may not have been zeroed,
- The pan of the balance may have been dirty?
- This measurement is badly off from the true value Such a measurement is said to have LOW ACCURACY

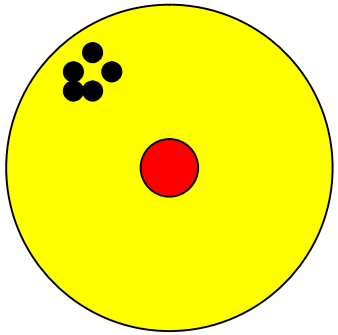
Conclusion:
The measurement of the penny as reported (3.12 g) has: HIGH PRECISION (measured values are close to each other) but LOW ACCURACY (reported value is far off from true value)



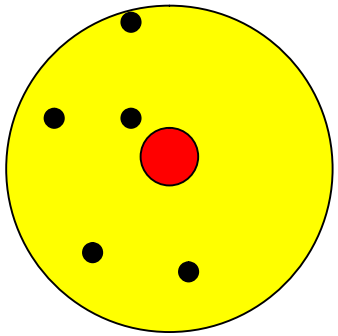
Poor Precision
Good Accuracy



Good Precision
Good Accuracy

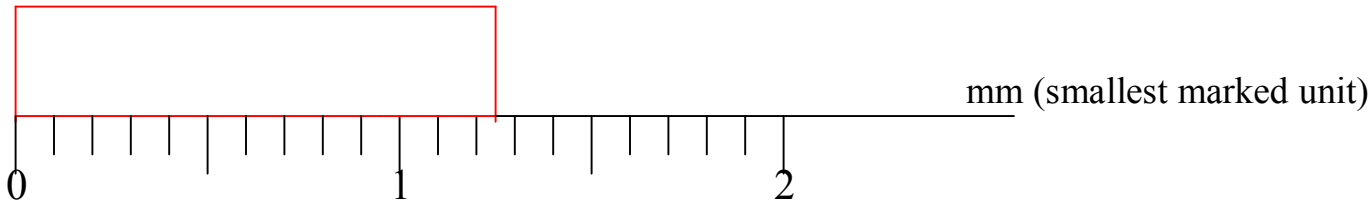


Good Precision
Poor Accuracy



Poor Precision
Poor Accuracy

- Consider that the length of an object is measured with two different rulers:



Several observers report: 1.25 cm
1.24 cm
1.26 cm

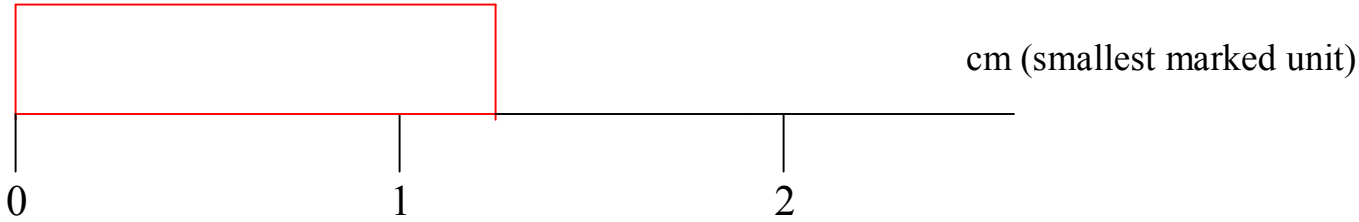
Length should be reported as 1.25 cm (implies ± 0.01 cm)

certain digits

uncertain digit

NOTE:

- The accuracy of the ruler is 0.1 cm (1mm)
- The uncertainty of the ruler is 0.01 cm (0.1 mm)
- One must record the measured value to one more place than the scale is marked



Several observers report: 1.3 cm
1.2 cm
1.4 cm

Length should be reported as 1.3 cm (implies ± 0.1 cm)

certain digit

uncertain digit

- **Precision and accuracy of a measurement are limited by the instrument.**