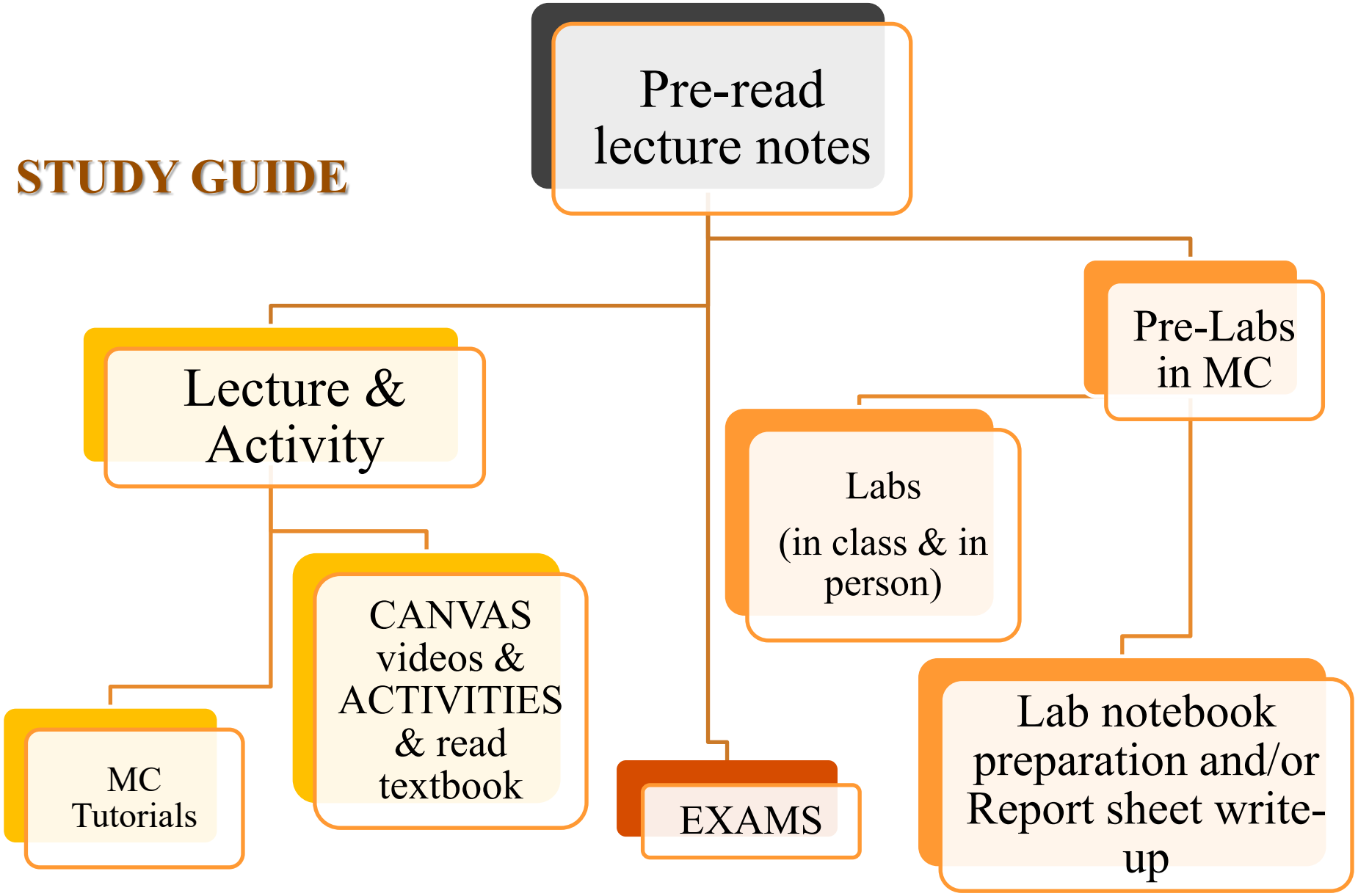
STUDY GUIDE

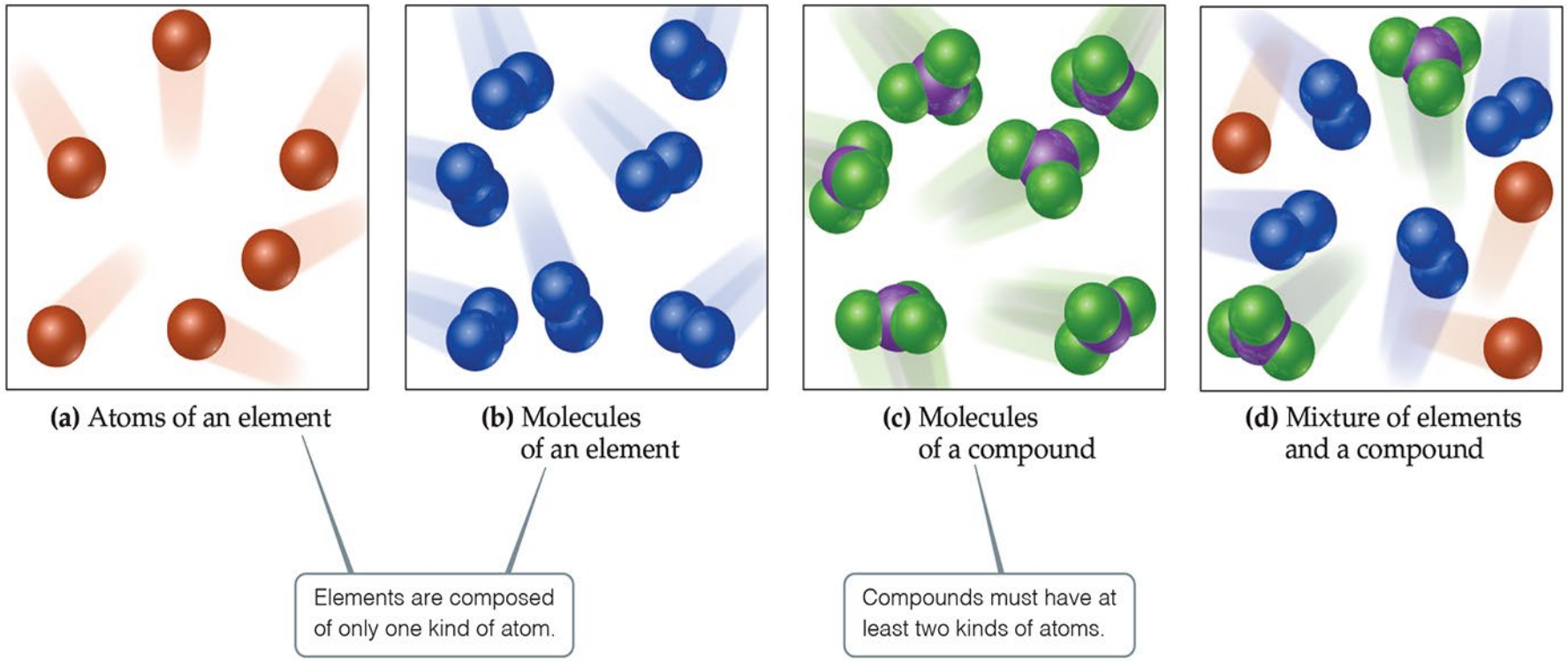

Pre-read lecture notes
Lecture & Activity
MC Tutorials
CANVAS videos & ACTIVITIES & read textbook
Pre-Labs in MC
Labs (in class & in person)
Lab notebook preparation and/or Report sheet write-up
EXAMS

Chapter 1

Matter

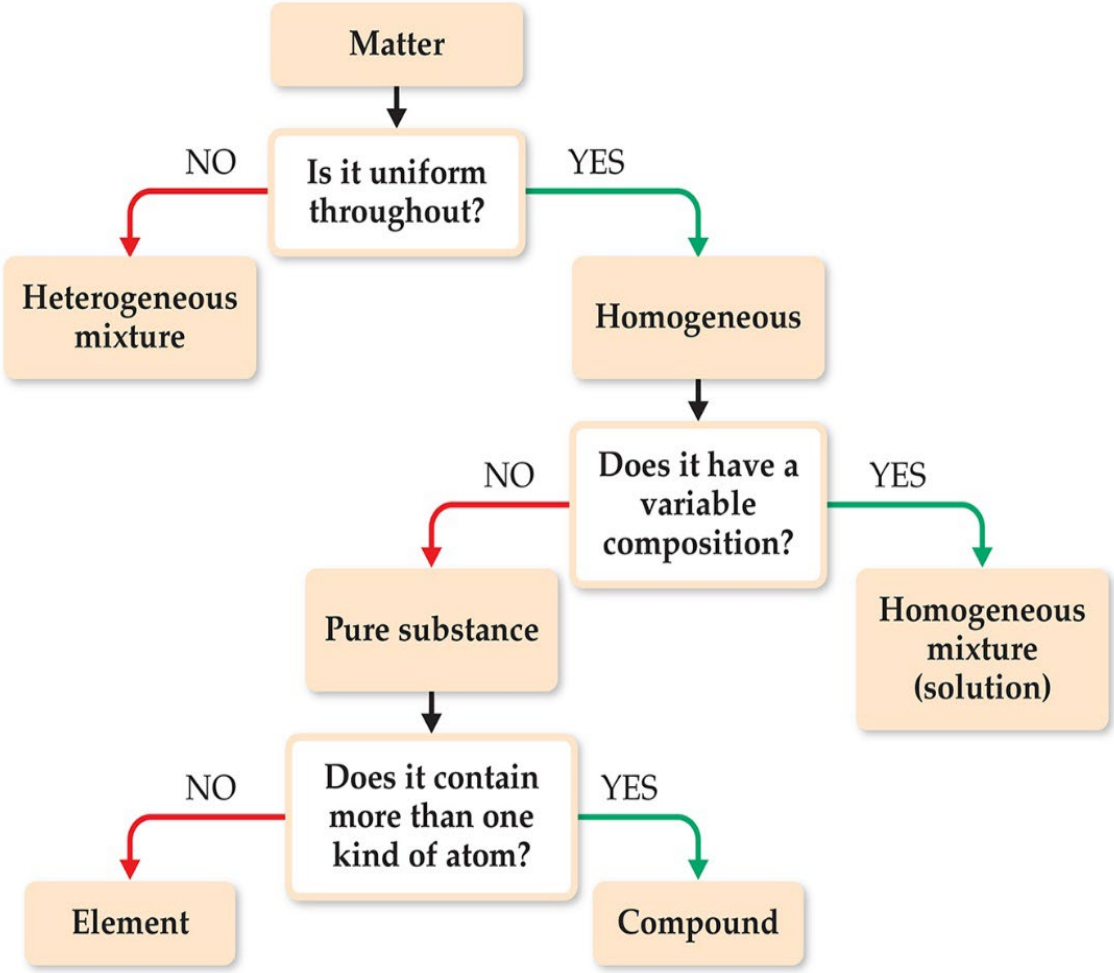
Chemistry is the study of Matter

Matter is anything that has mass and takes up space.



Classification of Matter Based on Composition

- With this scheme, you can determine how to classify any type of matter.
  - Homogeneous mixture
  - Heterogeneous mixture
  - Element
  - Compound



Classification of Matter by Composition

- matter whose composition does not change from one sample to another is called a **pure substance**
  - ✓ made of a single type of atom or molecule
  - ✓ because composition is always the same, all samples have the same characteristics
- matter whose composition may vary from one sample to another is called a **mixture**
  - ✓ two or more types of atoms or molecules combined in variable proportions
  - ✓ because composition varies, samples have the different characteristics

Classification of Matter—Mixtures

- **Mixtures** exhibit the properties of the substances that make them.
- Mixtures can *vary in composition* throughout a sample (**heterogeneous**; atoms or molecules not mixed uniformly) or can have the same composition throughout the sample (**homogeneous**; atoms or molecules mixed uniformly).
- A homogeneous mixture is also called a **solution**.

(a)

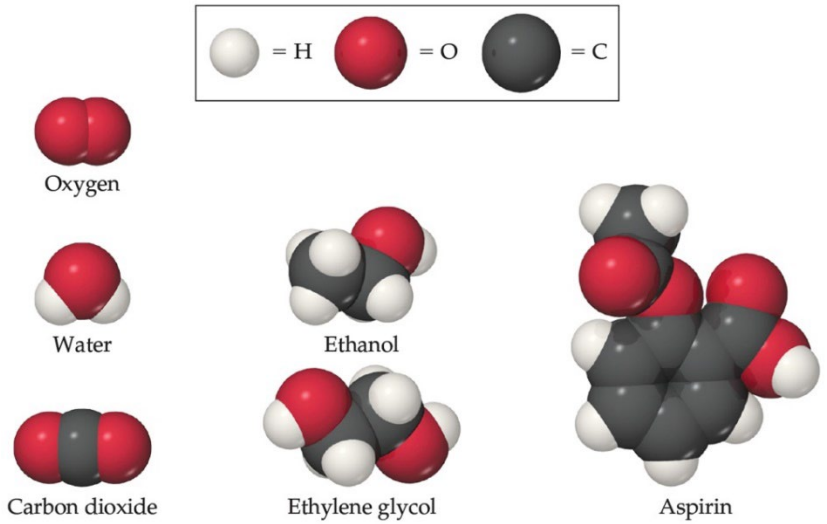
(b)

If you take an aliquot of the solution shown to the left; each aliquot studied would yield the same analysis.

Classification of Matter Based on Composition

A **substance** has distinct properties and a composition that does not vary from sample to sample.

- **Atoms** are the building blocks of matter.
- Each **element** is made of a unique kind of atom, but can be made of more than one atom of that kind.
- A **compound** is made of atoms from two or more different elements.

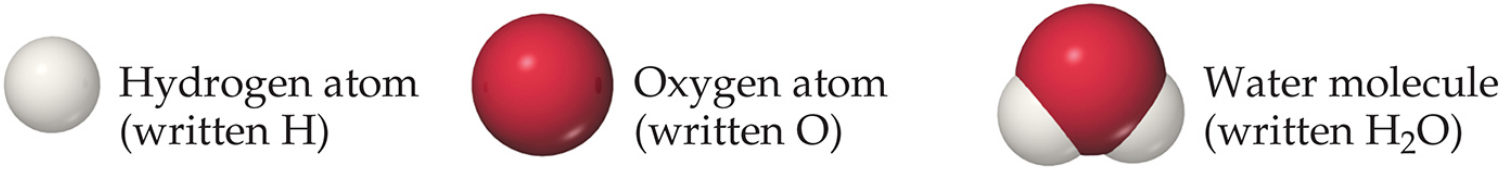


Note: Balls of different colors are used to represent atoms of different elements. Attached balls represent connections between atoms that are seen in nature. These groups of atoms are called **molecules**.

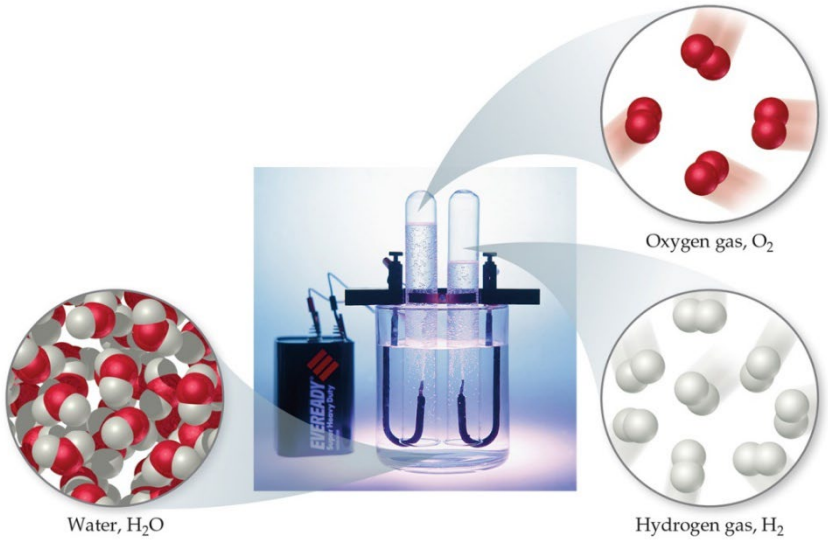
ELEMENTS to MEMORIZE

Aluminum	**Al**	**Manganese**	**Mn**
Antimony	**Sb**	**Mercury**	**Hg**
Argon	**Ar**	**Neon**	**Ne**
Arsenic	**As**	**Nickel**	**Ni**
Barium	**Ba**	**Nitrogen**	**N**
Beryllium	**Be**	**Oxygen**	**O**
Boron	**B**		
Bromine	**Br**	**Phosphorus**	**P**
Calcium	**Ca**	**Platinum**	**Pt**
Carbon	**C**	**Plutonium**	**Pu**
Cesium	**Cs**	**Potassium**	**K**
Chlorine	**Cl**	**Radium**	**Ra**
Chromium	**Cr**	**Radon**	**Rn**
Cobalt	**Co**		
Copper	**Cu**	**Selenium**	**Se**
Fluorine	**F**	**Silicon**	**Si**
Gallium	**Ga**	**Silver**	**Ag**
Germanium	**Ge**	**Sodium**	**Na**
Gold	**Au**	**Strontium**	**Sr**
Helium	**He**	**Sulfur**	**S**
Hydrogen	**H**	**Tin**	**Sn**
Iodine	**I**	**Titanium**	**Ti**
Iron	**Fe**	**Tungsten**	**W**
Krypton	**Kr**	**Uranium**	**U**
Lead	**Pb**	**Xenon**	**Xe**
Lithium	**Li**	**Zinc**	**Zn**
Magnesium	**Mg**		

Compounds and Composition



- Compounds have a definite composition. That means that the relative number of atoms of each element in the compound is the same in any sample.
- This is **The Law of Constant Composition** (or **The Law of Definite Proportions**).

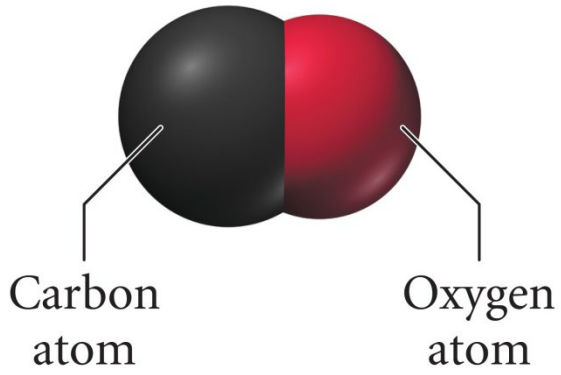


Structure Determines Properties

- the properties of matter are determined by the atoms and molecules that compose it

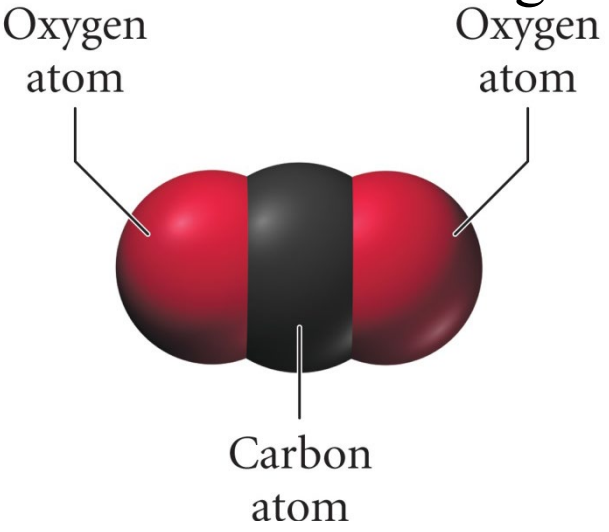
carbon monoxide

1. composed of one carbon atom and one oxygen atom
2. colorless, odorless gas
3. burns with a blue flame
4. binds to hemoglobin



carbon dioxide

1. composed of one carbon atom and two oxygen atoms
2. colorless, odorless gas
3. incombustible
4. does not bind to hemoglobin



Types of Properties

- **Intensive properties** are independent of the amount of the substance that is present.
  - Examples include density, boiling point, or color.
  - These are important for **identifying** a substance.
  - Electrochemistry
- **Extensive properties** depend upon the amount of the substance present.
  - Examples include mass, volume, or energy.
  - Thermodynamics

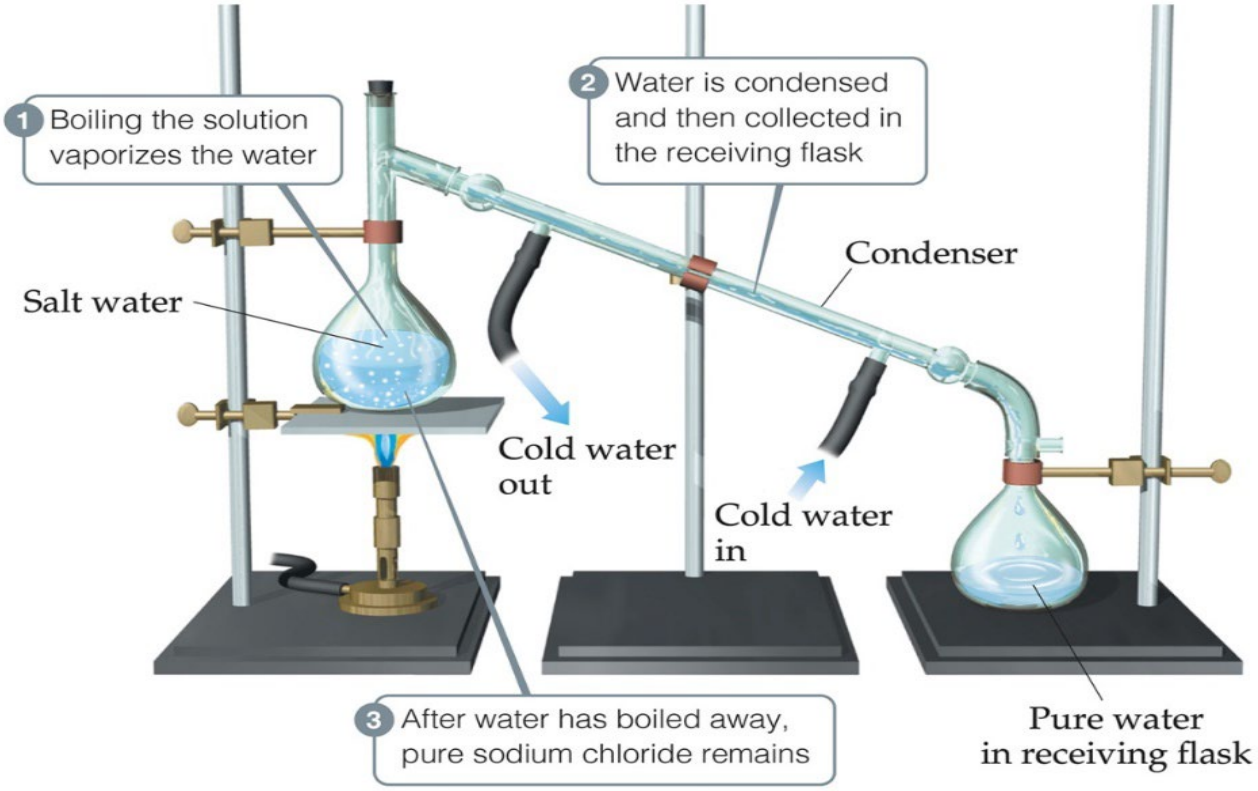
Properties of Matter

- **physical properties** are the characteristics of matter that can be changed without changing its composition
  - ✓characteristics that are directly observable

- **chemical properties** are the characteristics that determine how the composition of matter changes as a result of contact with other matter or the influence of energy
  - ✓characteristics that describe the behavior of matter

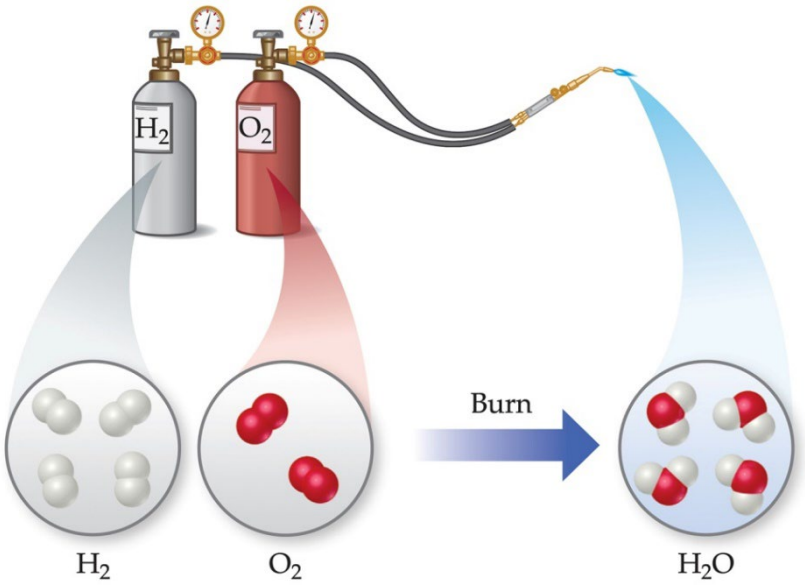
Physical Properties

- **Physical properties** can be observed without changing a substance into another substance.
  - Some examples include color, odor, density, melting point, boiling point, and hardness.



Chemical Properties

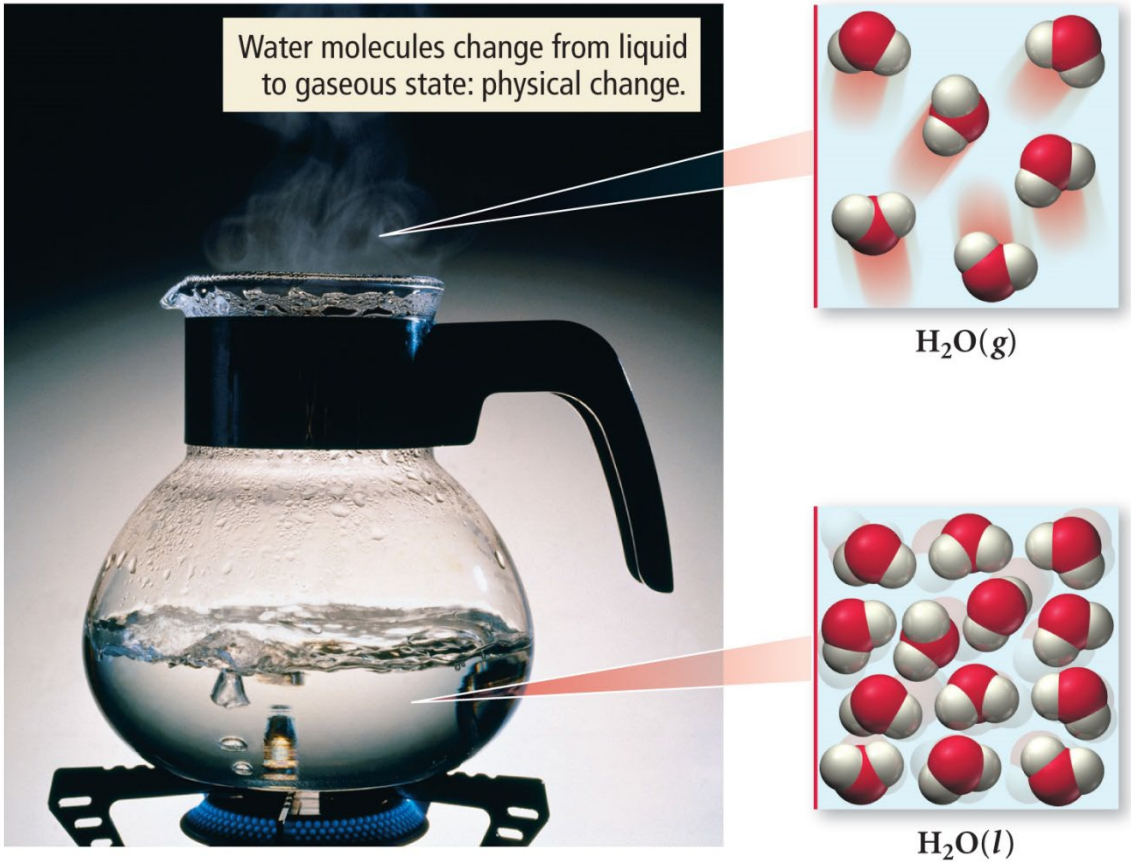
- **Chemical properties** can **only** be observed when a substance is changed into another substance.
  - One common chemical property is flammability, or the ability to burn in oxygen.



Changes in Matter

- changes that alter the state or appearance of the matter without altering the composition are called **physical changes**
- changes that alter the composition of the matter are called **chemical changes**
  - ✓during the chemical change, the atoms that are present rearrange into new molecules, but all of the original atoms are still present

Physical Changes in Matter

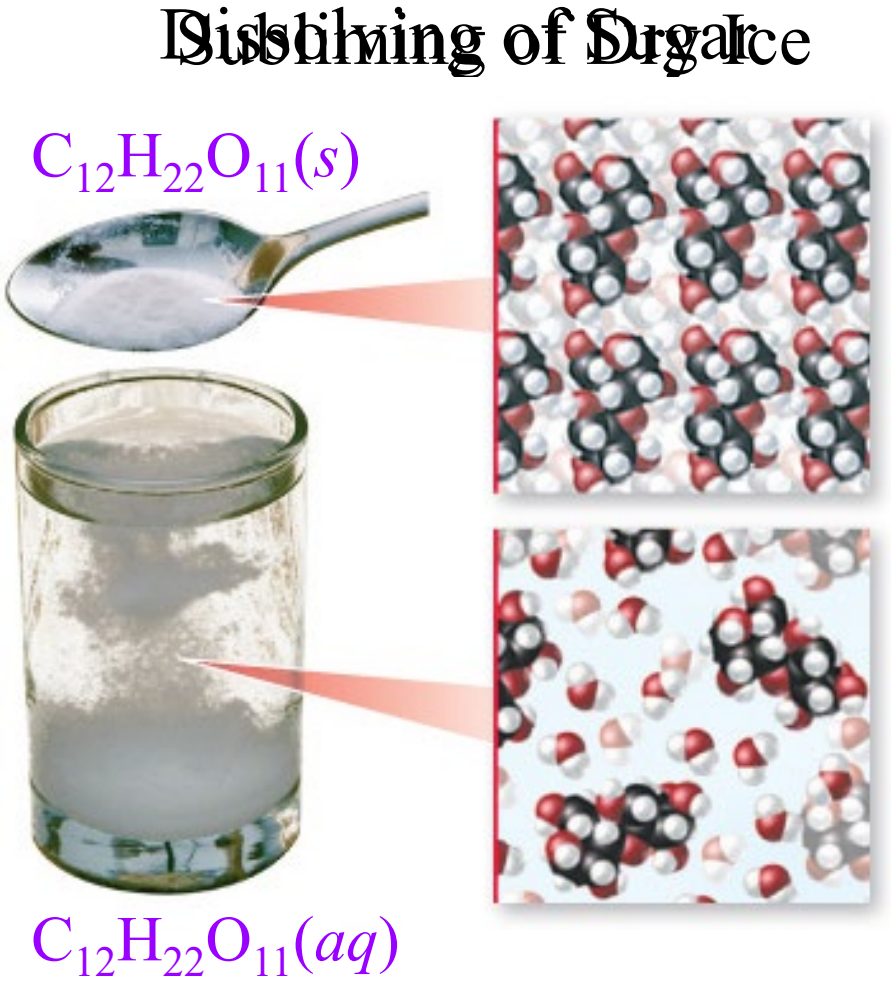


The boiling of water is a physical change. The water molecules are separated from each other, but their structure and composition do not change.

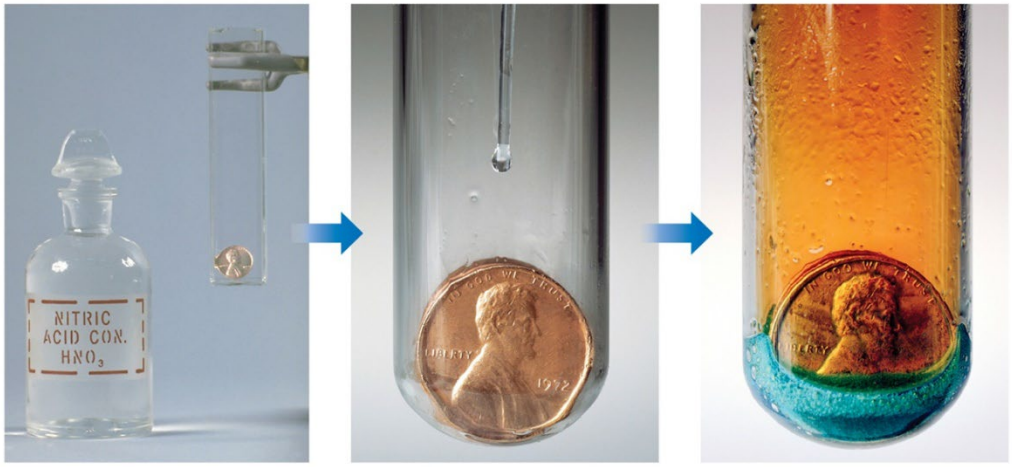
H_2O (l) → H_2O (g)

Common Physical Changes

- processes that cause changes in the matter that do not change its composition
- state changes
  - ✓boiling / condensing
  - ✓melting / freezing
  - ✓subliming
- dissolving



Chemical Reactions (Chemical Change)



In the course of a chemical reaction, the reacting substances are converted to new substances. Here, the copper penny reacts with nitric acid; it gives a blue solution of copper(II) nitrate and a brown gas called nitrogen dioxide (unbalanced equation below).

$$Cu(s) + HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + NO_2(g) + H_2O(l)$$

Note: Physical properties, like color, often helps us "**See**" that chemical change has occurred.

Common Chemical Changes

- processes that cause changes in the matter that change its composition
- rusting
- processes that release lots of energy
- burning

$$C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(l)$$

In Class "YOU TRY IT" PROBLEMS

1. From the thermal decomposition of a pure solid, we obtained a solid and a gas, each of which is a pure substance. From this information, we can conclude with certainty that

   a. the original solid is not an element
   b. both products are elements
   c. at least one of the products is an element
   d. the solid is a compound and the gas is an element

2. A solution can be distinguished from a compound by its

   a) liquid state
   b) heterogeneous nature
   c) lack of color
   d) variable composition
   e) all of the above

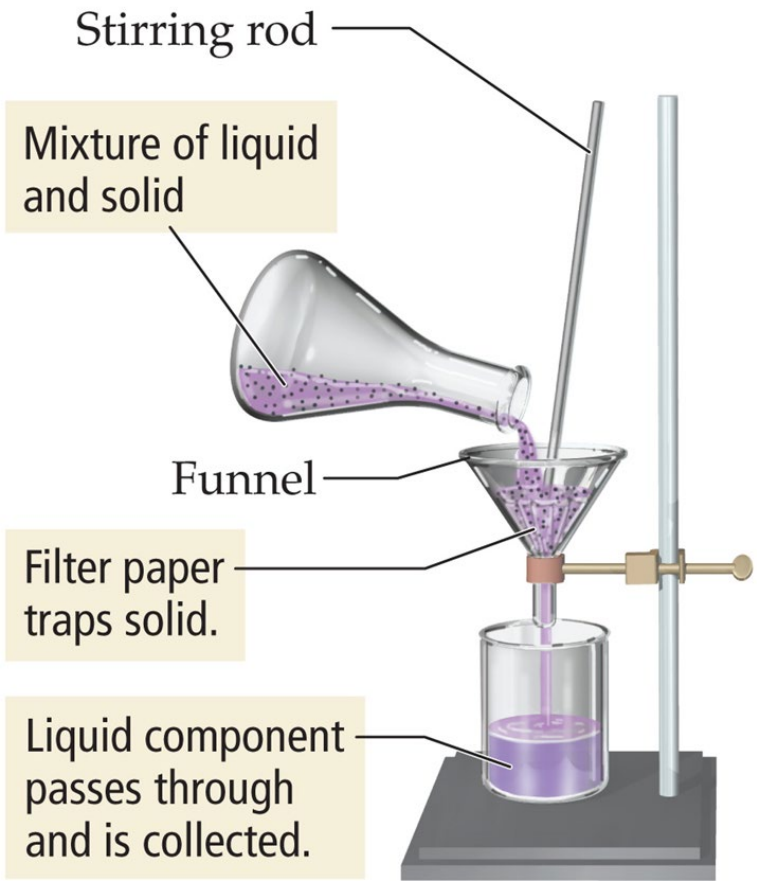
3. A clear blue liquid in an open beaker was left in the hood. After 1 week, the beaker contained only blue crystals. The original liquid can be classified as a(n) ?

Separating Mixtures

- Mixtures can be separated based on physical properties of the components of the mixture. Some methods used are
  - Filtration - Evaporation
  - Distillation - Centrifugation
  - Chromatography - Decanting

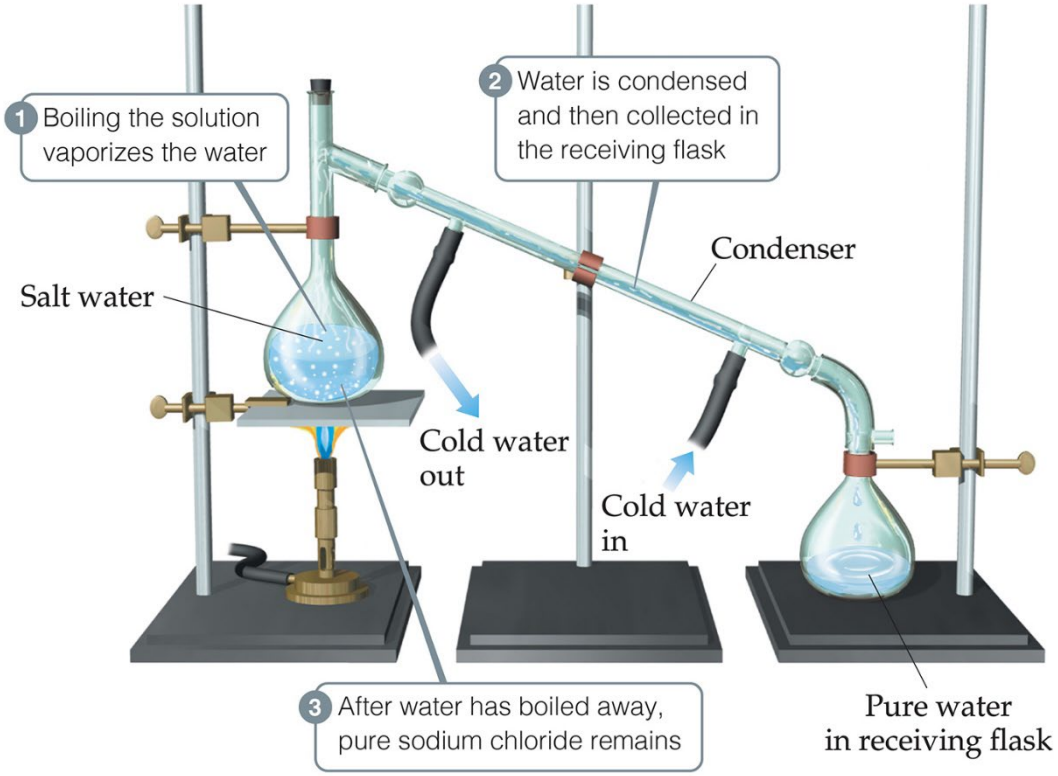
Filtration

- In filtration, solid substances are separated from liquids and solutions.



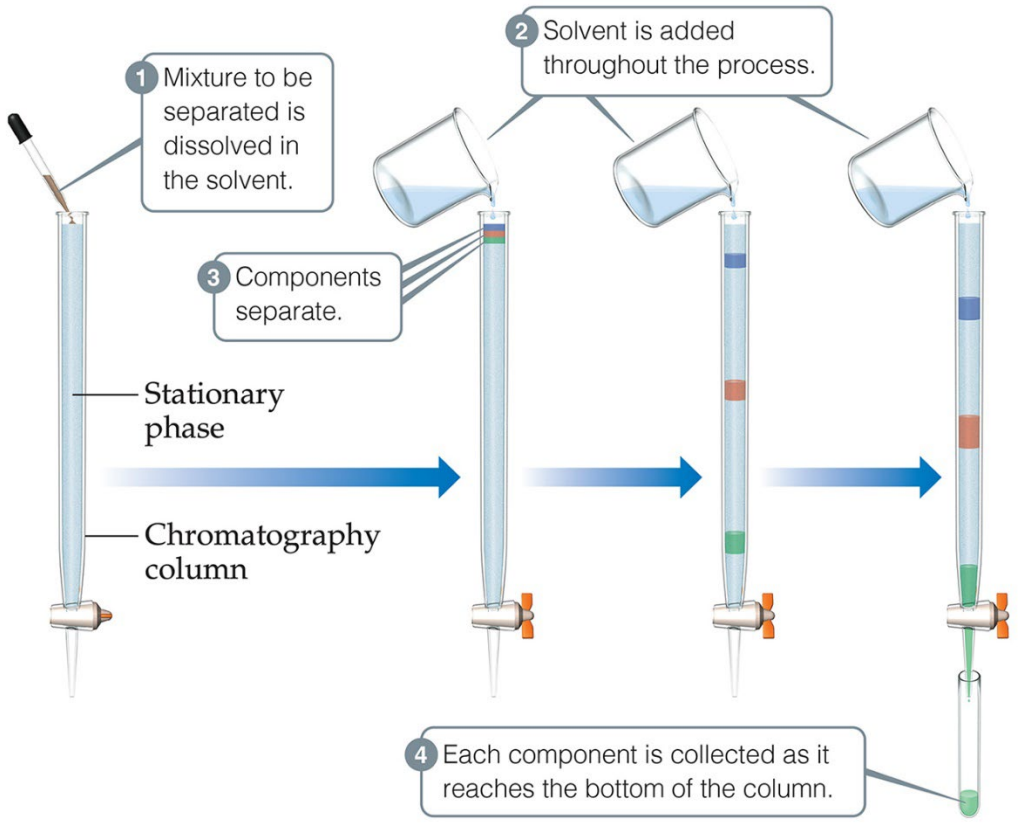
Distillation

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



Chromatography

- This technique separates substances on the basis of differences in the ability of substances to adhere to the solid surface, in this case, dyes to paper.



In Class “YOU TRY IT” PROBLEMS

1) Describe the best technique for separating a solid from its liquid.

2) What techniques would you use to separate with liquids?

Classifying Matter by Physical State

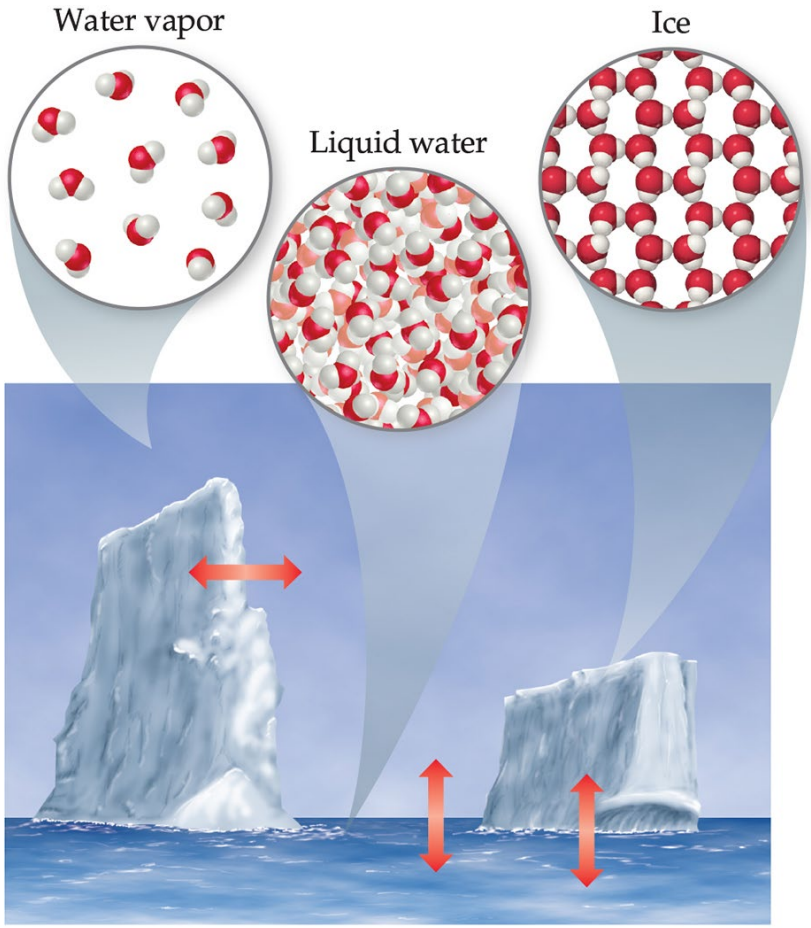
- matter can be classified as solid, liquid, or gas based on the characteristics it exhibits

State	***Shape***	***Volume***	***Compress***	***Flow***
Solid	Fixed	Fixed	No	No
Liquid	Indef.	Fixed	No	Yes
Gas	Indef.	Indef.	Yes	Yes

  - Fixed = keeps shape when placed in a container
  - Indefinite = takes the shape of the container

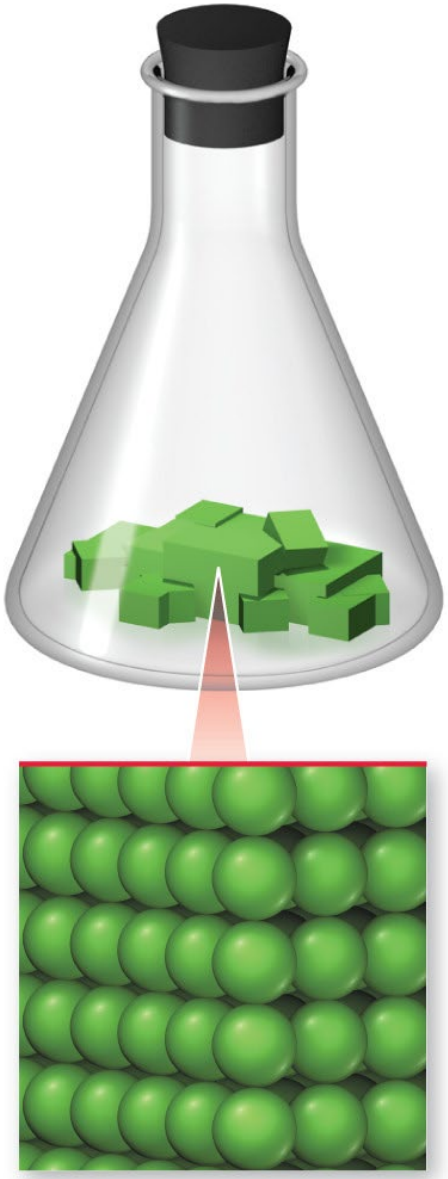
States of Matter

- The three states of matter are
  1) **solid.**
  2) **liquid.**
  3) **gas.**
- In this figure, those states are **ice**, **liquid water**, and **water vapor**.



Solids

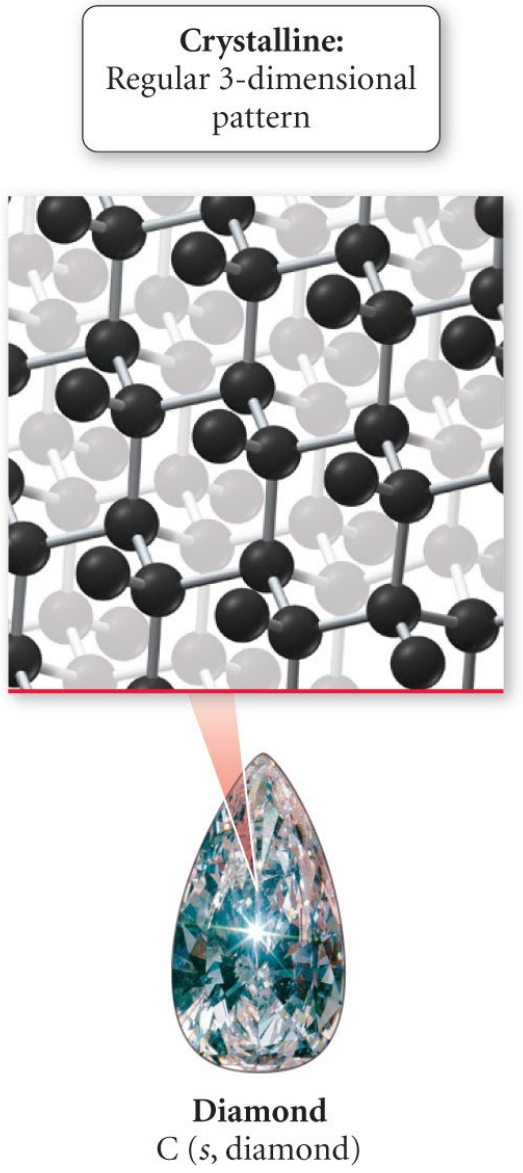
- the particles in a solid are packed close together and are fixed in position
  - ✓ though they may vibrate
- the close packing of the particles results in solids being incompressible
- the inability of the particles to move around results in solids retaining their shape and volume when placed in a new container, and prevents the particles from flowing



Solid matter

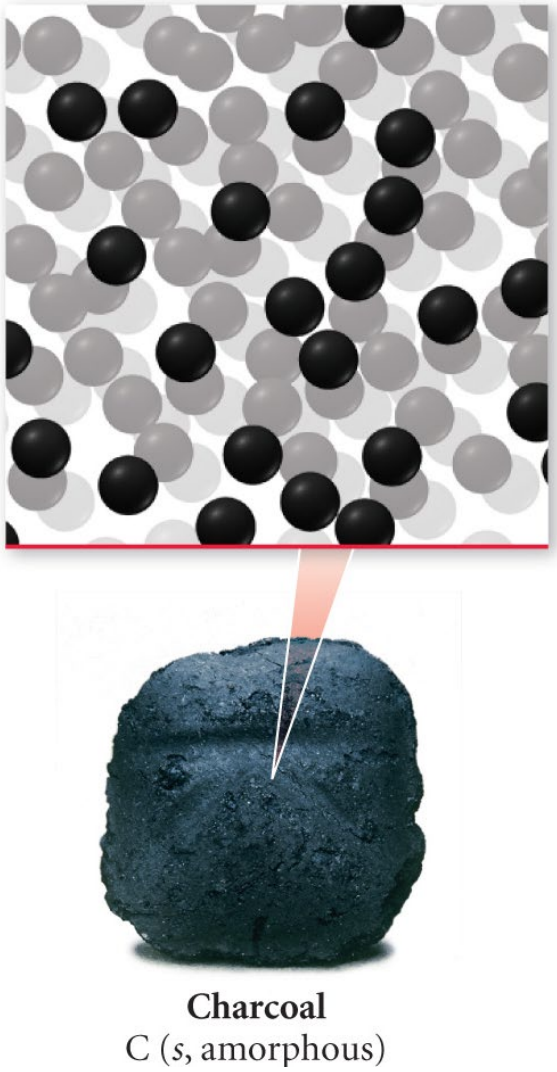
Crystalline Solids

- some solids have their particles arranged in an orderly geometric pattern – we call these **crystalline solids**
  - ✓salt and diamonds



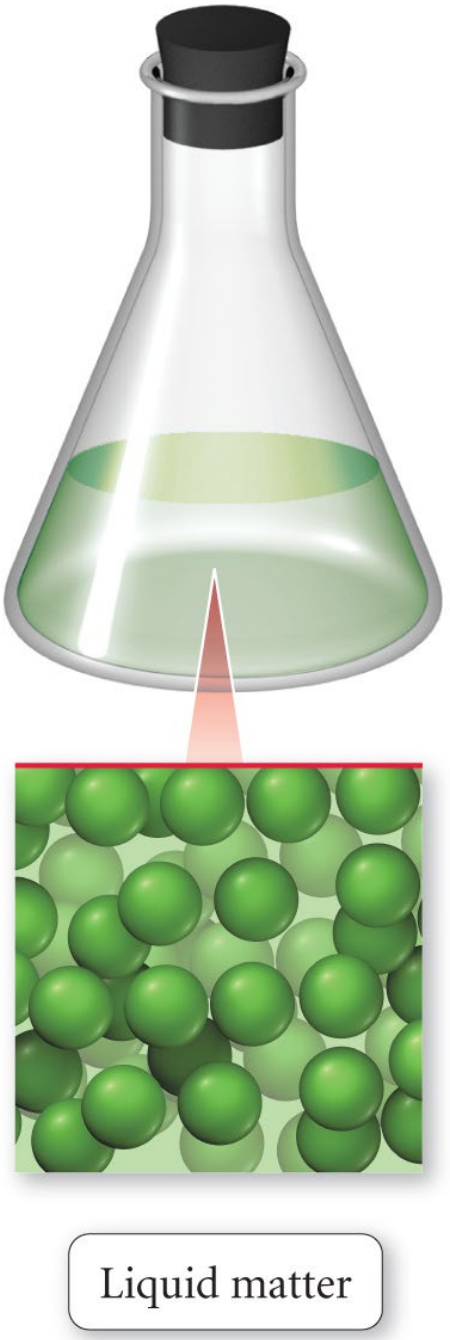
Amorphous Solids

- some solids have their particles randomly distributed without any long-range pattern – we call these **amorphous solids**
  - ✓plastic
  - ✓glass
  - ✓charcoal



Liquids

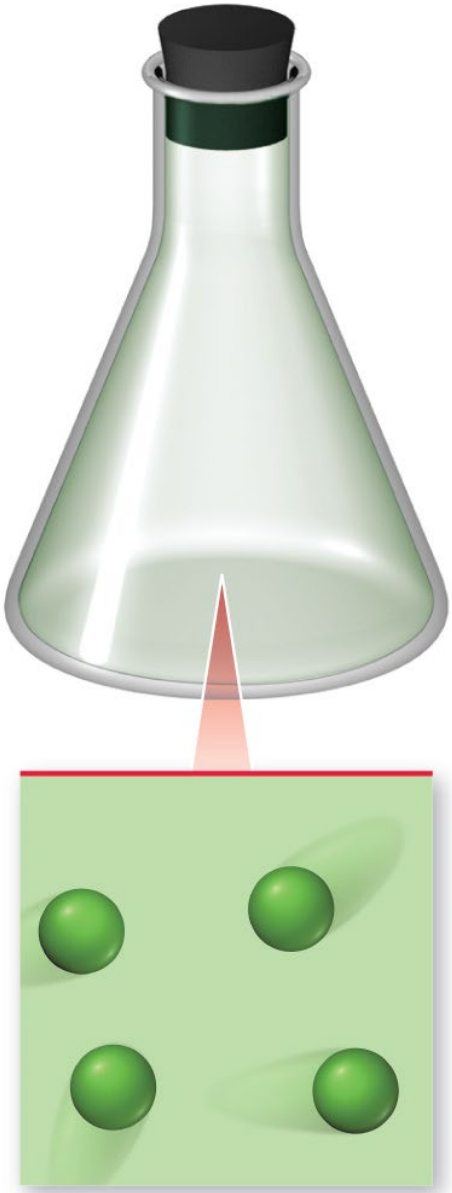
- the particles in a liquid are closely packed, but they have some ability to move around
- the close packing results in liquids being incompressible
- but the ability of the particles to move allows liquids to take the shape of their container and to flow – however, they don't have enough freedom to escape and expand to fill the container



Liquid matter

Gases

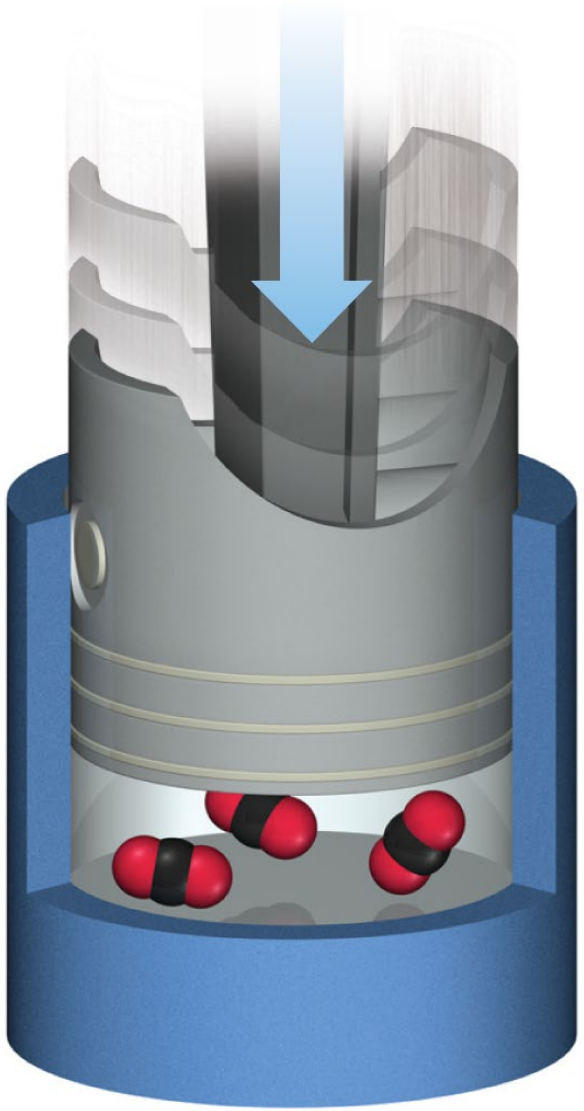
- in the gas state, the particles have complete freedom from each other
- the particles are constantly flying around, bumping into each other and the container
- in the gas state, there is a lot of empty space between the particles
  - ✓ on average



Gaseous matter

Gases

- because there is a lot of empty space, the particles can be squeezed closer together – therefore gases are compressible
- because the particles are not held in close contact and are moving freely, gases expand to fill and take the shape of their container, and will flow



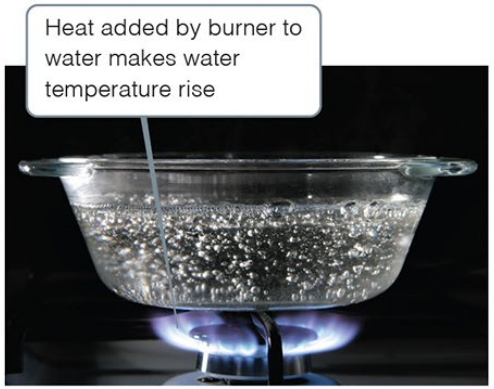
Gas–compressible

Energy

changes in matter, both physical and chemical, result in the matter either gaining or releasing energy

- **Energy** is the capacity to do work or transfer heat.
- **Work** is the energy transferred when a force exerted on an object causes a displacement of that object.
- **Heat** is the energy used to cause the temperature of an object to increase.
- **Force** is any push or pull on an object.

(a)



(b)

Energy of Matter

- all matter possesses energy
- energy is classified as either kinetic or potential
- energy can be converted from one form to another
- when matter undergoes a chemical or physical change, the amount of energy in the matter changes as well
- whatever process you do that converts energy from one type or form to another, the total amount of energy remains the same

✓**Law of Conservation of Energy & Matter**

Spontaneous Processes

- materials that possess high potential energy are less stable
- processes in nature tend to occur on their own when the result is material(s) with lower total potential energy
  - ✓ processes that result in materials with higher total potential energy can occur, but generally will not happen without input of energy from an outside source
- when a process results in materials with less potential energy at the end than there was at the beginning, the difference in energy is released into the environment