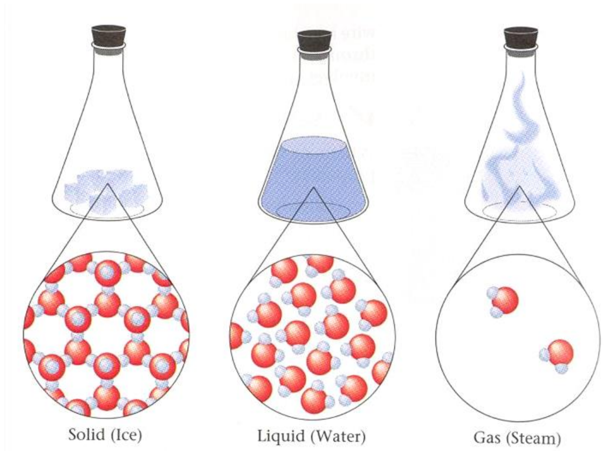
MATTER & ITS FORMS

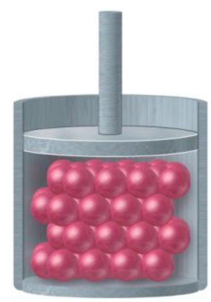
- ***Matter*** is defined as anything that has ***mass*** and ***occupies space***.
- ***Matter*** can be classified by its states: ***solid, liquid, and gas***.

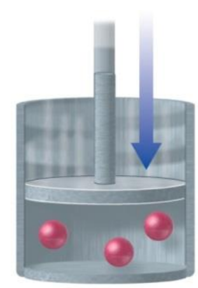


Solid:
- ***Densely*** packed matter with ***definite shape*** and ***volume***.
- Particles have ***strong forces*** of attraction towards each other.

Liquid:
- ***Loosely*** packed matter with ***definite volume*** but ***indefinite shape***.
- Particles have ***moderate forces*** of attraction towards each other.

Gas:
- ***Very loosely*** packed matter with ***no definite shape*** or ***volume***.
- Particles have ***little or no forces of attraction*** towards each other.

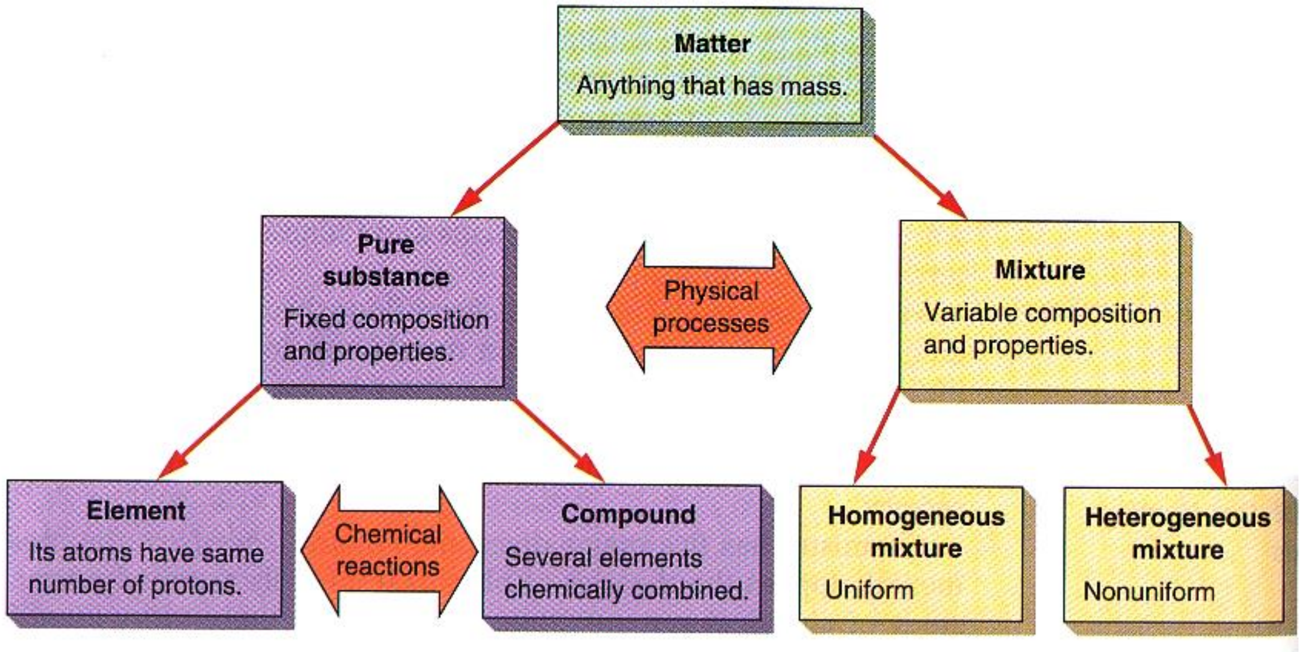




SUMMARY OF PROPERTIES OF MATTER

State	Shape	Volume	Particles	Compressibility
Solid	Definite	Definite	Densely packed	Very slight
Liquid	Indefinite	Definite	Mobile	Slight
Gas	Indefinite	Indefinite	Far apart	High

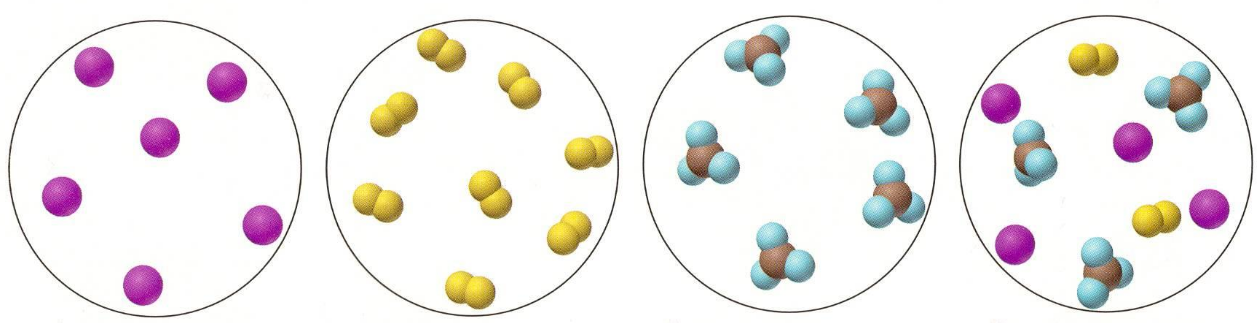
CLASSIFICATION OF MATTER



Element:
- ***Pure substance*** that is made up of only ***one type of atom***.
- Examples include: gold, copper, hydrogen.

Compound:
- ***Pure substance*** that is made up of ***two or more elements chemically*** combined together.
- ***Properties are unique*** compared to its components.
- Smallest particle is a ***molecule***.
- Examples include: water, salt, aspirin.

Classify each of the following substances as element, compound or mixture.

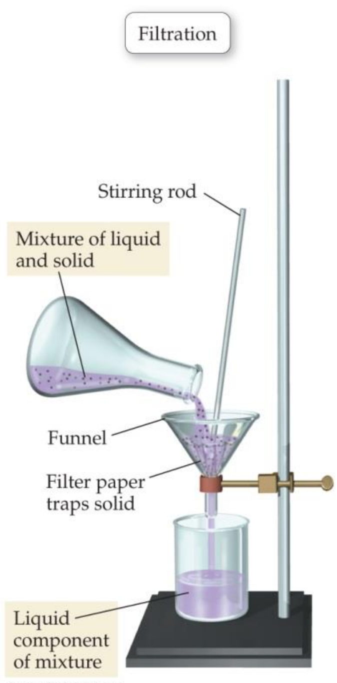


MIXTURES

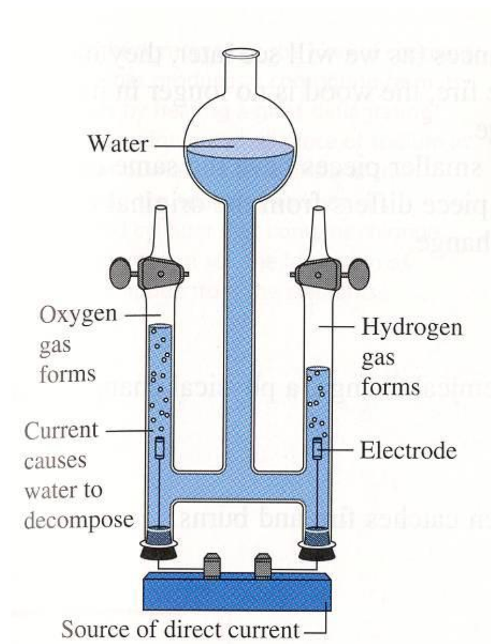
Mixture:
- ***Two or more substances physically*** combined together.
- ***Properties are similar*** to those of its components.
- Can be ***separated easily*** by a ***physical process.***
- Two types***: heterogeneous and homogeneous.***

Heterogeneous:
- Mixture that is ***non-uniform*** in composition.
- Examples include: vegetable soup, cement, salad dressing.

Homogeneous:
- Mixture that is ***uniform*** in composition**.**
- Commonly referred to as ***solution***.
- Examples include: gasoline, soda pop, salt solution.



Separation of a mixture through physical methods



Separation of a compound through chemical methods

PROPERTIES OF MATTER

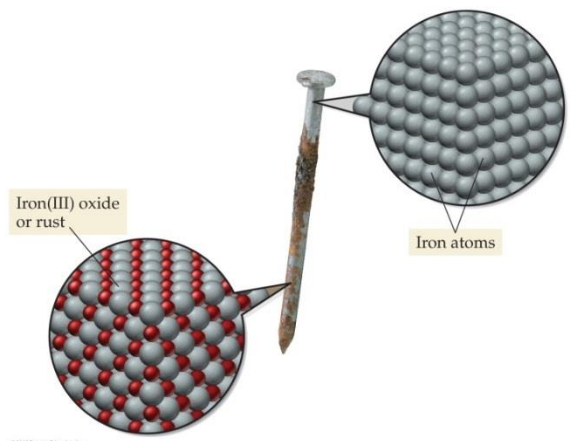
Properties are characteristics that give substances their ***unique*** identity, and can be used to ***distinguish*** one sample from another.

- A ***physical property*** is one, which a substance displays ***without changing*** its ***composition***. Examples: color, melting point, density, electrical conductivity
- A ***chemical property*** is one, which a substance displays as it ***interacts*** with, or ***transforms*** into other substances (***changes its composition***). Examples: flammability, corrosiveness, reactivity with acids.
- A ***physical change*** is change in ***physical properties*** of matter ***without change in composition***. Physical changes are ***reversible***. Examples: melting of ice, formation of dew.
- A ***chemical change*** (or chemical reaction) is a change that ***creates new matter***. Chemical changes are ***not easily reversible***. Examples: burning of paper, cooking of food, corrosion of metals.

<u>Examples:</u>

1. Identify each of the following properties as physical or chemical:

   a) Oxygen is a gas
   b) Helium is un-reactive
   c) Water has high specific heat
   d) Gasoline is flammable
   e) Sodium is soft & shiny



2. Identify each of the following changes as physical or chemical:

   a) Cooking food
   b) Mixing sugar in tea
   c) Carving wood
   d) Burning gas
   e) Food molding

CONSERVATION OF MASS

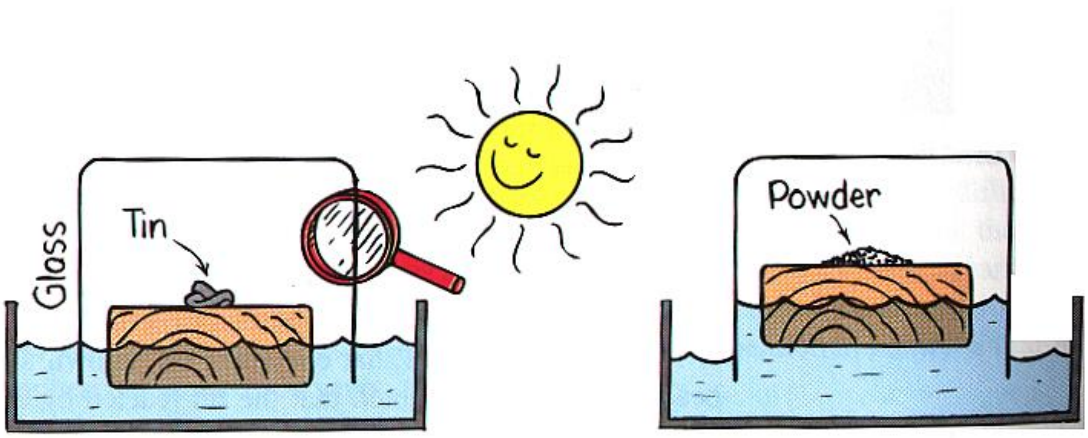
- The most fundamental chemical observation of the 18th century was the ***law of conservation of mass***:

Matter is neither created nor destroyed in a chemical reaction.

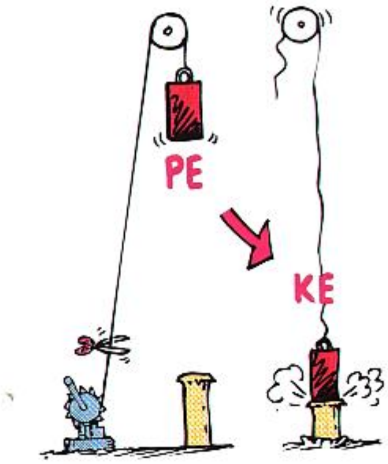
$$\underbrace{\underset{58\text{ g}\ +\ 208\text{ g}}{\text{Butane + Oxygen}}}_{266\text{ g}} \longrightarrow \underbrace{\underset{176\text{ g}\ +\ 90\text{ g}}{\text{Carbon dioxide + Water}}}_{266\text{ g}}$$

- The ***number*** of substances and their ***properties*** may ***change***, but the ***total amount of matter*** remains ***constant***.

- Antoine ***Lavoisier*** first proposed the ***law of conservation of mass*** after performing careful experiments with ***closed*** systems such as that shown below.



ENERGY & HEAT



- ***Energy*** is defined as the capacity of matter to do ***work***.
- There are two types of energy:

  Potential (stored) and ***Kinetic*** (moving)

- Energy possesses many ***forms*** (chemical, electrical, thermal, etc.), and can be ***converted*** from one form into another.
- In chemistry, ***energy*** is commonly expressed as ***heat***.
- ***Heat*** is measured in SI units of ***joule*** or the common unit of ***calorie***. (1 cal=4.184 J)
- A related energy unit is the ***nutritional Calorie*** which is equivalent to 1000 calories (or 1 kcal).
- Residential energy use is measured units of **kilowatt-hour (kWh).**

TABLE 3.2 Energy Conversion Factors

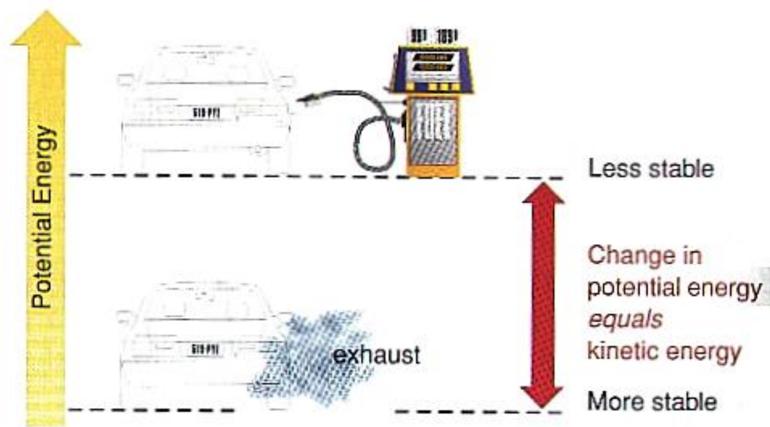
1 calorie (cal)	=	4.184 joules (J)
1 Calorie (Cal)	=	1000 calories (cal)
1 kilowatt-hour (kWh)	=	3.60×10^6 joules (J)

<u>Examples:</u>

1. A candy bar contains 225 Cal of nutritional energy. How many joules does it contain?

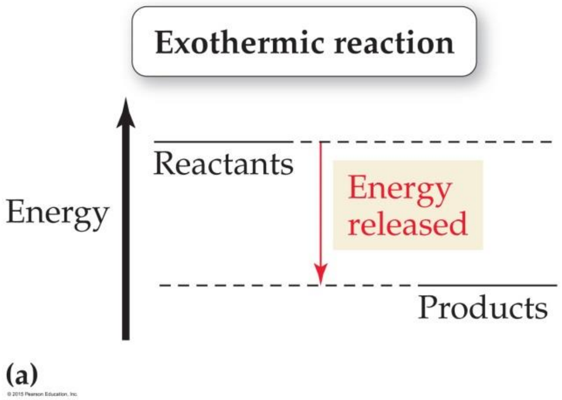
ENERGY IN PHYSICAL & CHEMICAL CHANGES

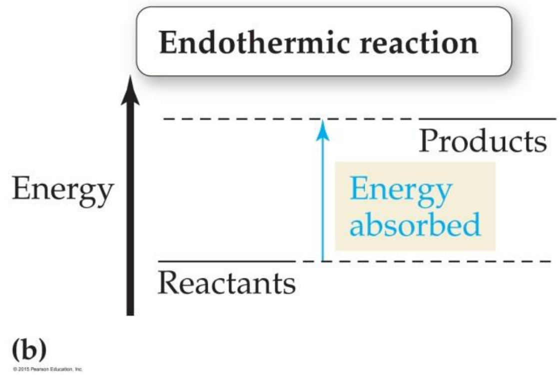
- In all ***physical & chemical changes***, matter either ***absorbs or releases energy***.
- ***Higher energy*** systems are ***less stable*** than lower energy systems.



- When ***energy is released*** during a change, it is said to be ***exothermic***.

- When ***energy is gained*** during a change, it is said to be ***endothermic***.





TEMPERATURE & HEAT

- ***Temperature*** of a substance is the measure of its ***thermal energy.***

- The hotter an object, the greater the random motion of its particles, and the higher its temperature.

- Heat is ***the transfer or exchange*** of ***thermal energy*** caused by a temperature difference.

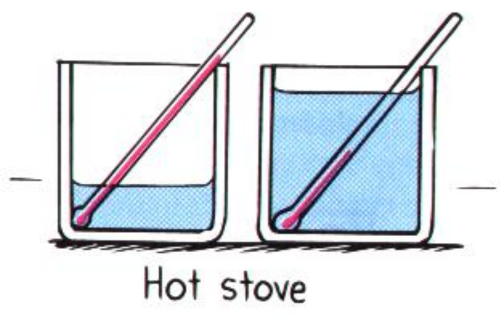
<u>Heat vs. Temperature:</u>

- ***Heat*** and ***temperature*** are not the same thing. ***Heat*** energy is ***the total kinetic energy*** of the particles of a substance, while ***temperature*** is the ***average kinetic energy*** of the particles of a substance.

- As an analogy, consider the test scores in a class, with points being analogous to heat. In this analogy, heat is like the total number of points, while temperature is the average score.

Test	***Score***
Test 1	100
Test 2	50
Test 3	100
Test 4	50
Total pts.	300
Avg. pts.	75

- Although the ***same*** amount of ***heat*** is added to both containers, the ***temperature increases*** more in the container with the ***smaller amount*** of water.

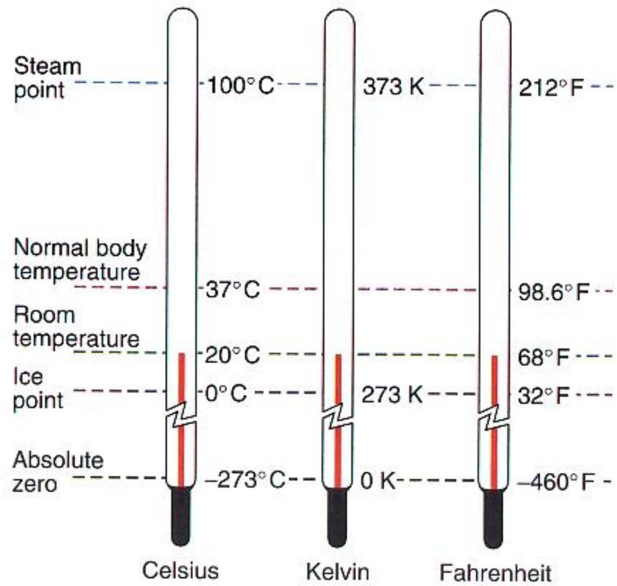


TEMPERATURE SCALES

- ***Thermometer*** is an instrument that measures temperature and is based on ***thermometric properties*** (i.e. expansion of solids or liquids, color change, etc.) of matter.

- Three ***scales*** are used for measuring temperature:

  1. ***Fahrenheit*** (32 - 212)
  2. ***Celsius*** (0 - 100)
  3. ***Kelvin (absolute)*** (273 -373)



- To convert from one scale to another, the following relationships can be used:

$$K = °C + 273$$
$$°F = (1.8 \times °C) + 32$$
$$°C = (°F – 32) \div 1.8$$

or alternately,

$$°F = [(°C+40) \times 1.8] – 40$$
$$°C = [°F+40) \div 1.8] – 40$$

Examples:

1. The melting point of silver is 960.8°C. Convert to Kelvin.

   K = °C + 273 K =

2. Pure iron melts at about 1800 K. What is this temperature in °C?

   °C = K – 273 C =

3. On a winter day the temperature is 5°F outside. What is this temperature on the Celsius scale?

   °C = [°F+40) ÷ 1.8]–40 =

4. To make ice cream, rock salt is added to crushed ice to reach a temperature of –11°C. What is this temperature in Fahrenheit?

QUANTITY OF HEAT

- Different materials have different ***capacities*** for storing heat.
- The ***specific heat*** of a substance is the ***amount of heat*** required to change the temperature of ***1 g*** of that substance by ***1 °C***.
- The amount of heat lost or gained by a system is determined by the following equation:

$$\textbf{Heat} = \begin{pmatrix}\textbf{mass of}\\ \textbf{substance}\end{pmatrix} \begin{pmatrix}\textbf{specific heat}\\ \textbf{of substance}\end{pmatrix} \begin{pmatrix}\textbf{change in}\\ \textbf{temperature}\end{pmatrix}$$

$$\mathbf{q = (m) \times (C) \times (\Delta T)}$$

The filling of hot apple pie may be too hot to eat, whereas the crust is not.

- Shown below are the specific heat of some common substances:

Substance	**(cal/g°C)**	**(J/g°C)**
Aluminum	0.214	0.897
Copper	0.0920	0.385
Iron	0.0308	0.129
Ammonia	0.488	2.04
Ethanol	0.588	2.46
Water	1.00	4.184

- When heated, substances with ***low specific heat*** get hot ***faster*** while substances with ***high specific*** heat get hot at a ***slower*** rate.
- When cooled, substances with ***low specific heat*** get cool ***faster*** while substances with ***high specific*** heat cool at a ***slower*** rate.

Examples:

1. Determine the amount of heat needed to raise the temperature of 200. g of water by 10.0 °C. (Specific heat of water is 4.184 J/g°C)

   m =

   C =

   ΔT =

   q =

2. Calculate the specific heat of a solid if 1638 J of heat raises the temperature of 125 g of the solid from 25.0 to 52.6 °C.

   m =

   C =

   ΔT =

   q =

3. Ethanol has a specific heat of 2.46 J/g°C. When 655 J are added to a sample of ethanol, its temperature rises from 18.2°C to 32.8°C. What is the mass in grams of the ethanol sample?

   m =

   C =

   ΔT =

   q =