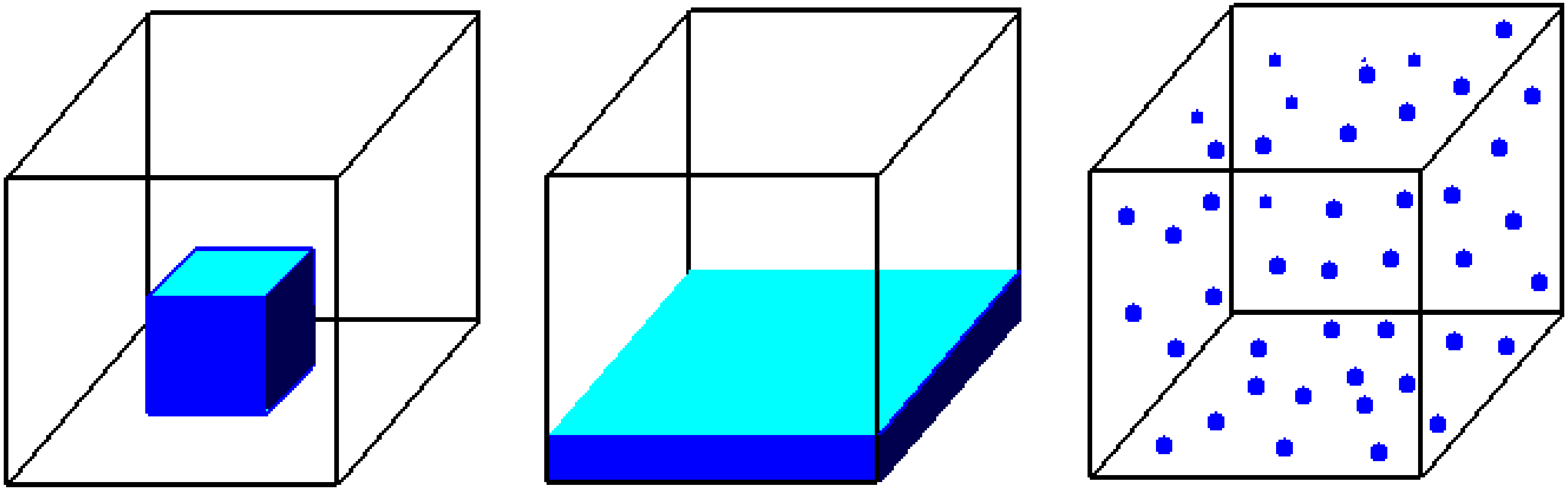
Matter & Energy

Matter

Matter: has mass and takes space.

States of Matter



Solid	Liquid	Gas
Holds Shape	Shape of Container	Shape of Container
	Free Surface	
Fixed Volume	Fixed Volume	Volume of Container

Changes

Chemical change (chemical reaction):

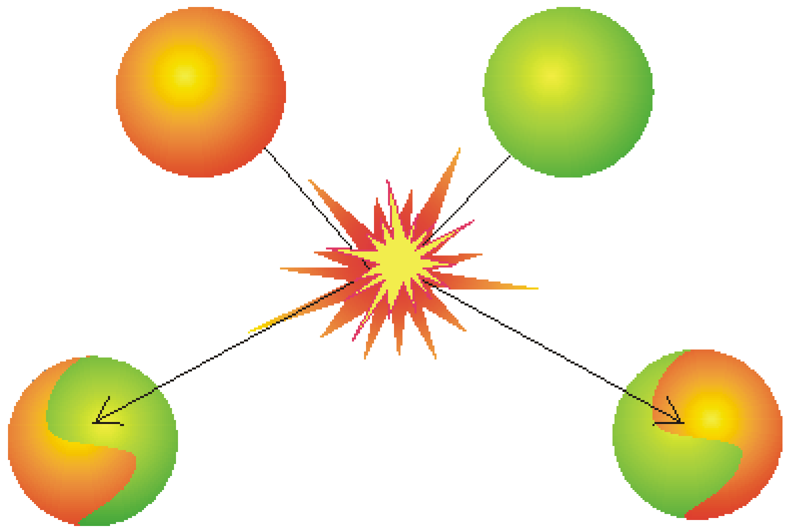
substance(s) are used up (disappear) → others form

burning or cooking the egg

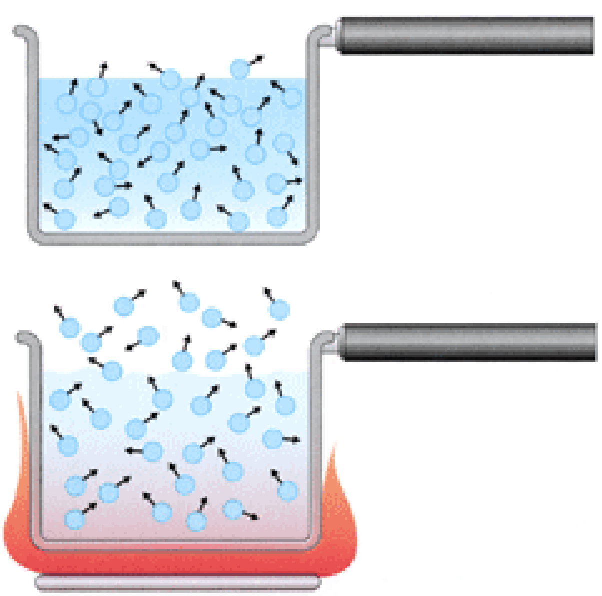
Physical change: identities of the substances do not change.
(change of state)

evaporation of water or melting

Physical Changes

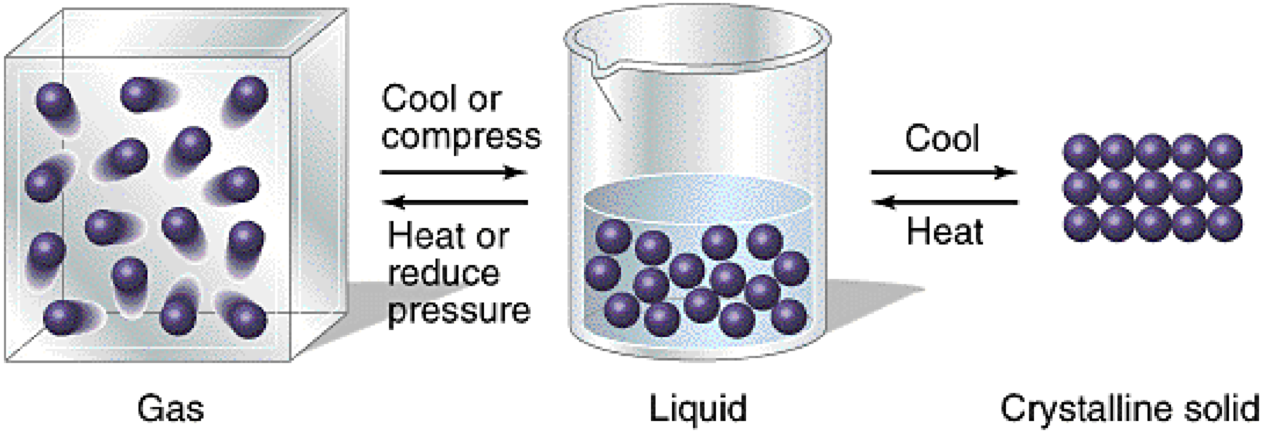


T ↑ ⇒ move faster
Kinetic energy ↑



Boiling is a physical change.

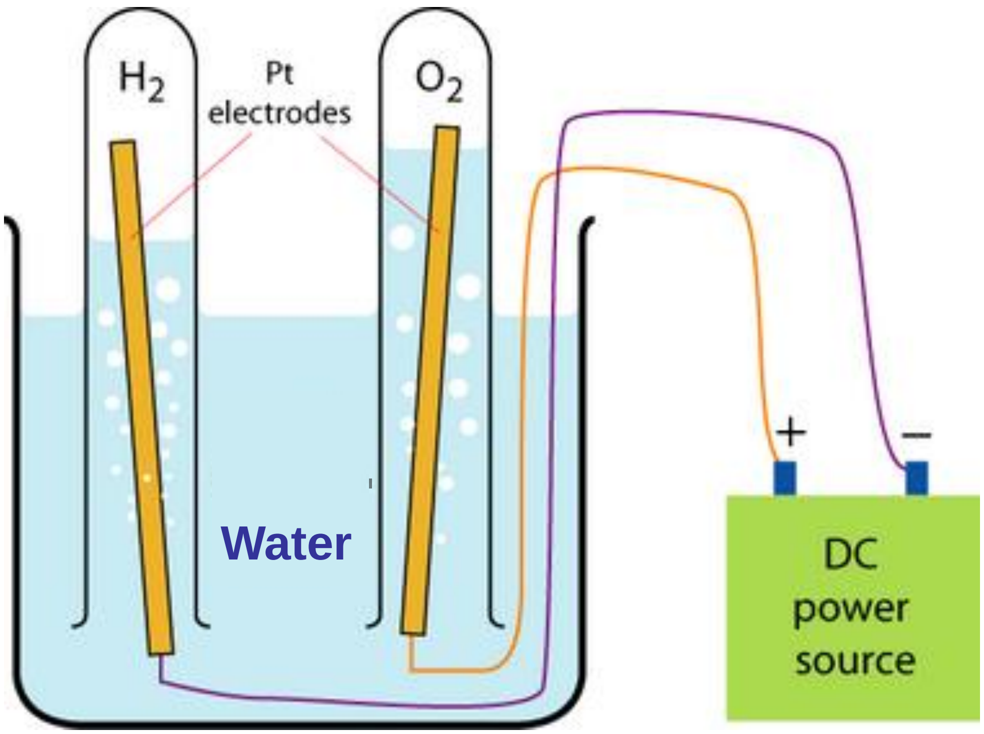
Physical Changes



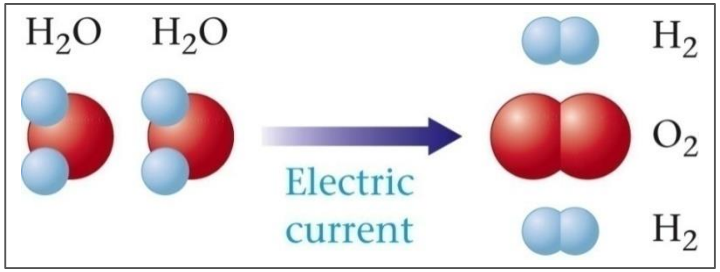
Composition of the substance is not affected.

Change of states

Chemical Changes (reactions)



Electrolysis



Decomposition

Chemical and physical Changes

Think about it: Classify each of the following as a **physical** or **chemical** change.

- Bleaching clothes
- Burning of wood
- Dissolving of sugar in water
- Melting a popsicle on a warm summer day
- Baking soda (sodium carbonate) forming $CO_2(g)$
- Iron metal melting

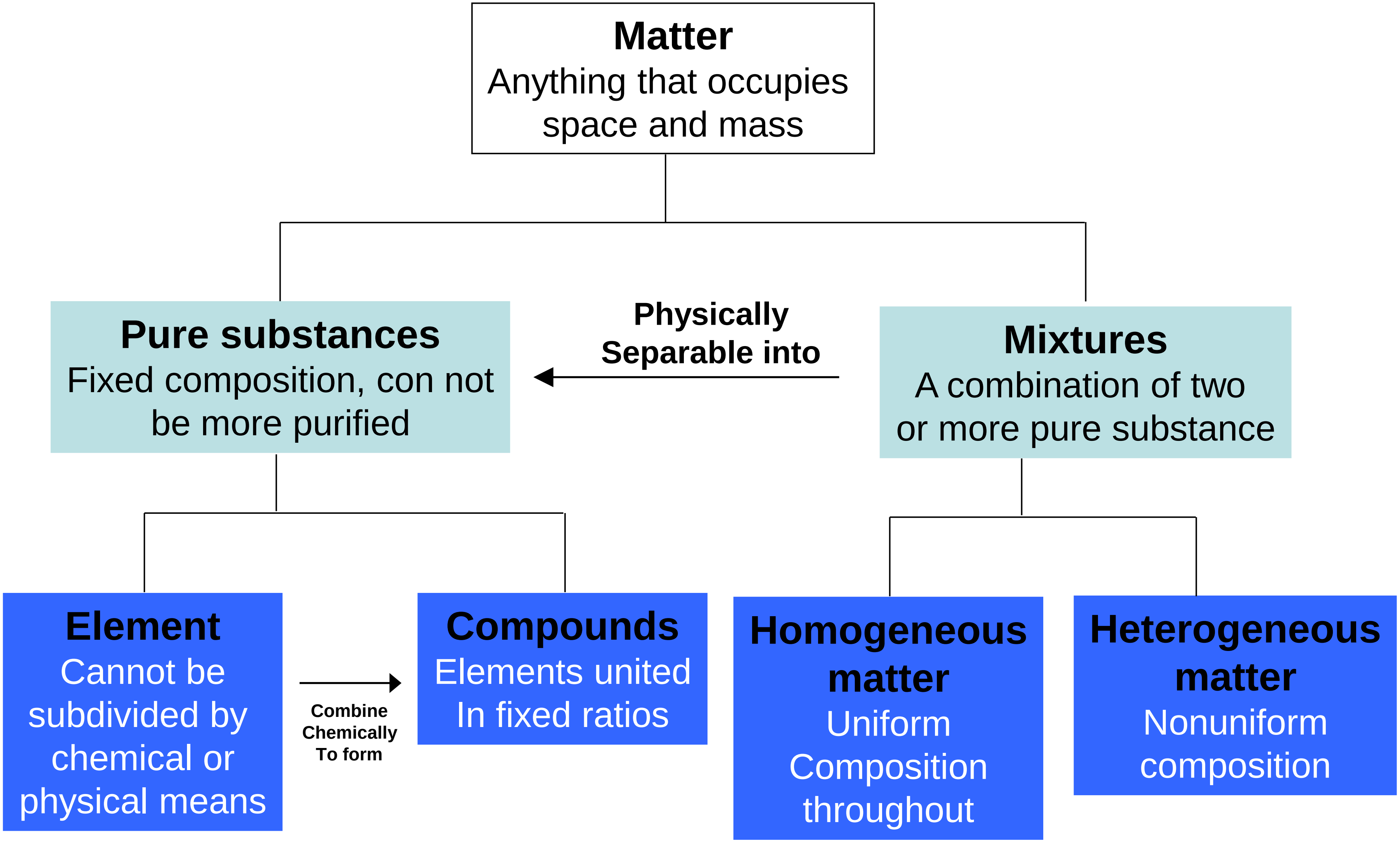
Physical and Chemical Properties

Physical Properties: a directly observable characteristic of a substance exhibited as long as no chemical change occurs.

Color, Odor, Volume, State, Density, Melting and boiling point.

Chemical Properties: Ability to chemical changes.
(forming a new substance(s))

Burning wood – rusting of the steel


Matter
Anything that occupies space and mass
Pure substances
Fixed composition, con not be more purified
Physically Separable into
Mixtures
A combination of two or more pure substance
Element
Cannot be subdivided by chemical or physical means
Combine Chemically To form
Compounds
Elements united In fixed ratios
Homogeneous matter
Uniform Composition throughout
Heterogeneous matter
Nonuniform composition

Elements

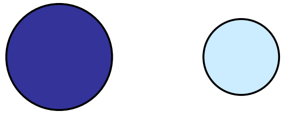
Element: is a substance consists of identical atoms.

Cannot be divided by chemical & physical methods.

Carbon, Hydrogen, Oxygen

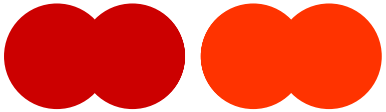
116 elements – 88 in nature

Monatomic



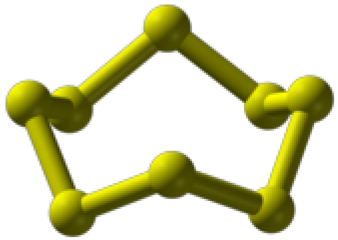
Ar He

Diatomic



N_2 O_2

Polyatomic



S_8

Element Symbols

The first letter or two first letters of element name:

Oxygen	O	Silicon	Si
Carbon	C	Argon	Ar

Sometimes, two letters are not the first letters:

Chlorine	Cl	Zinc	Zn

Sometimes, old names are used (Latin or Greek):

Iron (Ferrum)	Fe	Lead (Plumbum)	Pb

Compounds

Compound: is a pure substance made up of two or more elements in a fixed ratio by mass.

H_2O (Water): 2 Hydrogen & 1 Oxygen

CO_2: 1 Carbon & 2 Oxygen

20 million compounds

Compounds $\xrightarrow{\text{By Chemical Methods}}$ Elements

Compounds $\Rightarrow$ Formula

Identifies each element

Ratios

H_2O

Subscript (number of each atom)

Subscript 1 is not written.

Elements & Compounds

The character of each element is lost when forming a compound.

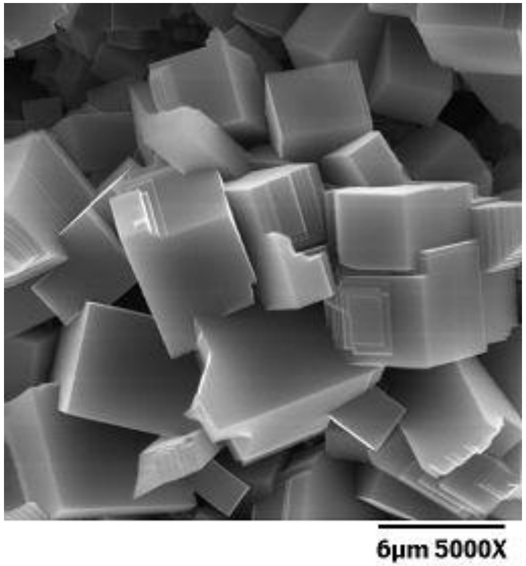
H_2O (liquid)

Oxygen (gas)

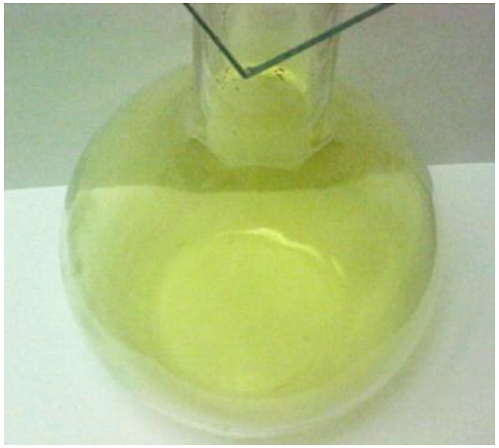
Hydrogen (gas)

Elements & Compounds

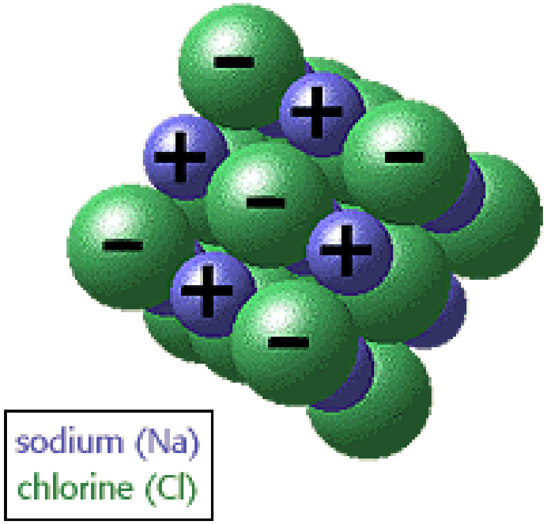
Sodium (Na)



NaCl



Chlorine (Cl)

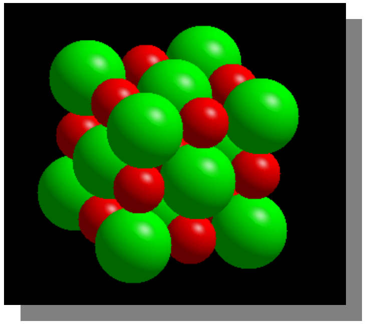


Compound & molecule

Molecule:

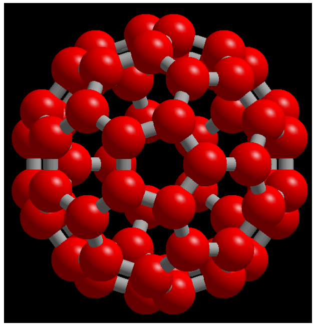
1. the smallest unit of a compound that retains the characteristics of that compound. H_2O, CO_2

2. atoms of one element bonded into a unit.
   Buckyballs, C_{60} oxygen, O_2 ozone, O_3



NaCl, salt

compound



Buckyball, C_{60}

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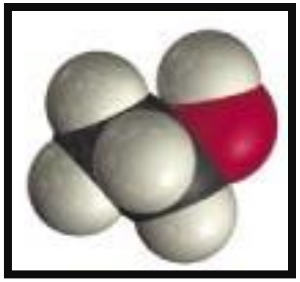
molecule



Ethanol, C_2H_6O

compound

molecule

Pure substance & Mixture

Pure substance: same composition

Elements - Compounds

Water

Mixture: different composition

Different water samples (impurities).

salad dressing

Coffee

Mixtures

Mixture: is a combination of two or more pure substances.

Homogeneous (solutions): uniform and throughout

Air, Salt in water

Heterogeneous: nonuniform

Soup, Milk, Blood, sand in water

Separation of Mixtures

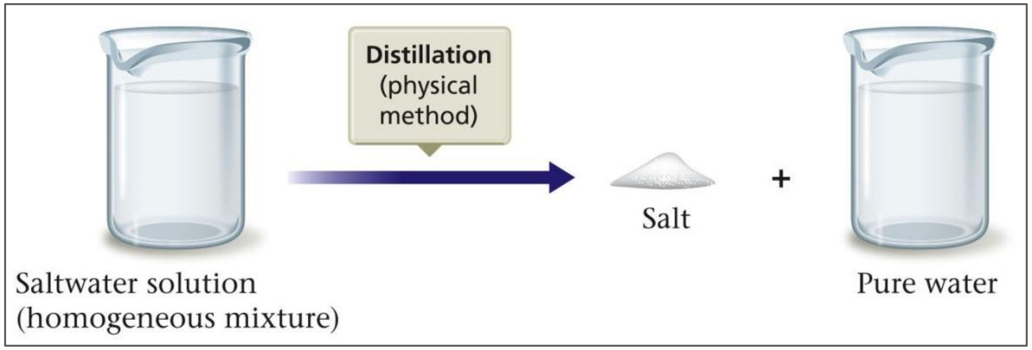
Physical Methods

Mixture $\Longrightarrow$ Two or more pure substances

Different Physical Property	**Technique**
Boiling point	Distillation
State of matter (solid/liquid/gas)	Filtration
Adherence to a surface	Chromatography
Volatility	Evaporation

Separation of Mixtures

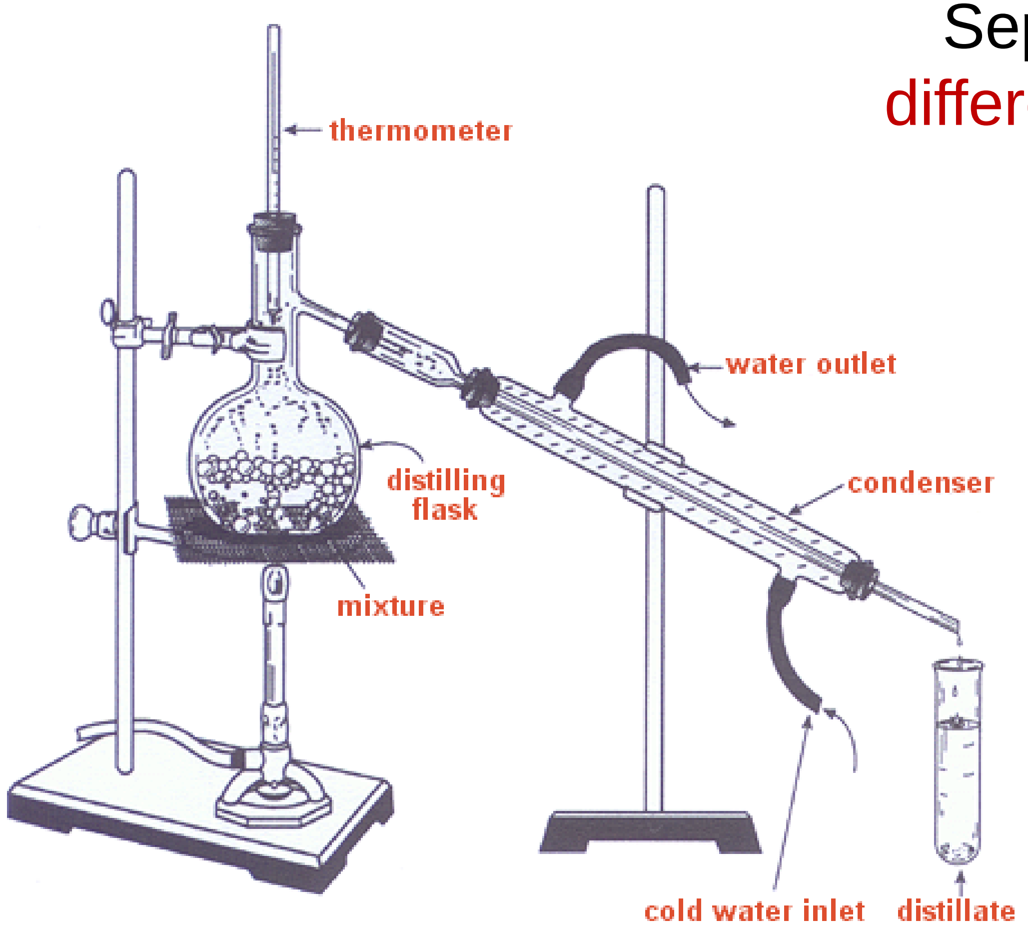
Distillation



Filtration

Decantation

Distillation

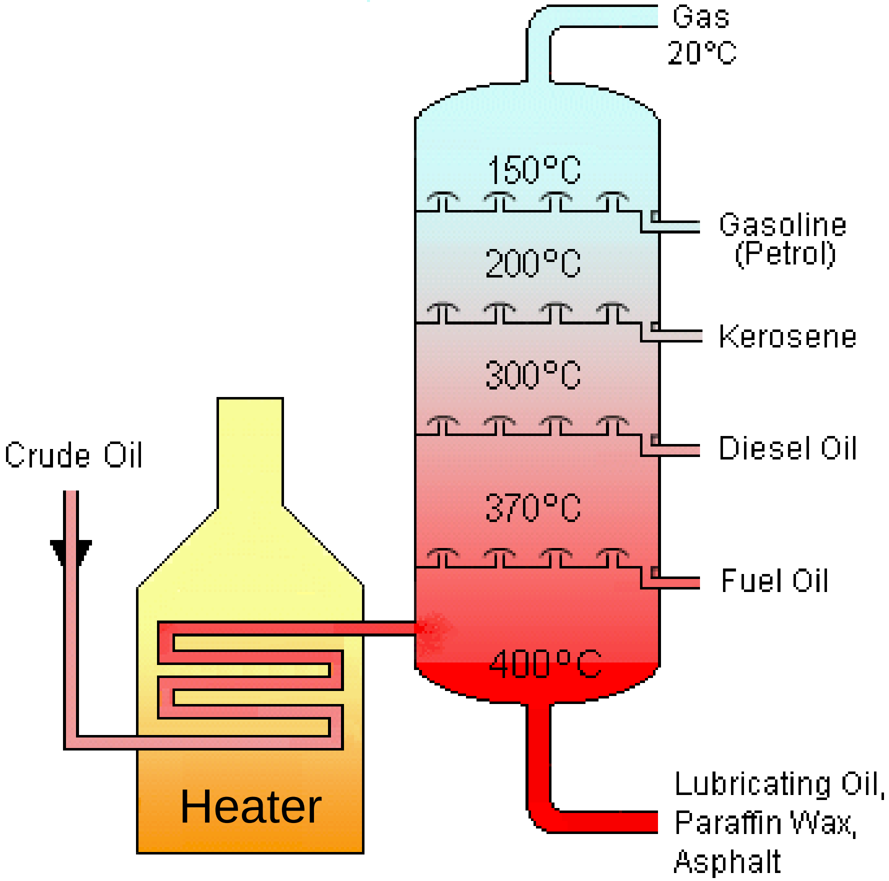


Separation by using the differences in boiling points.

(Physical change)

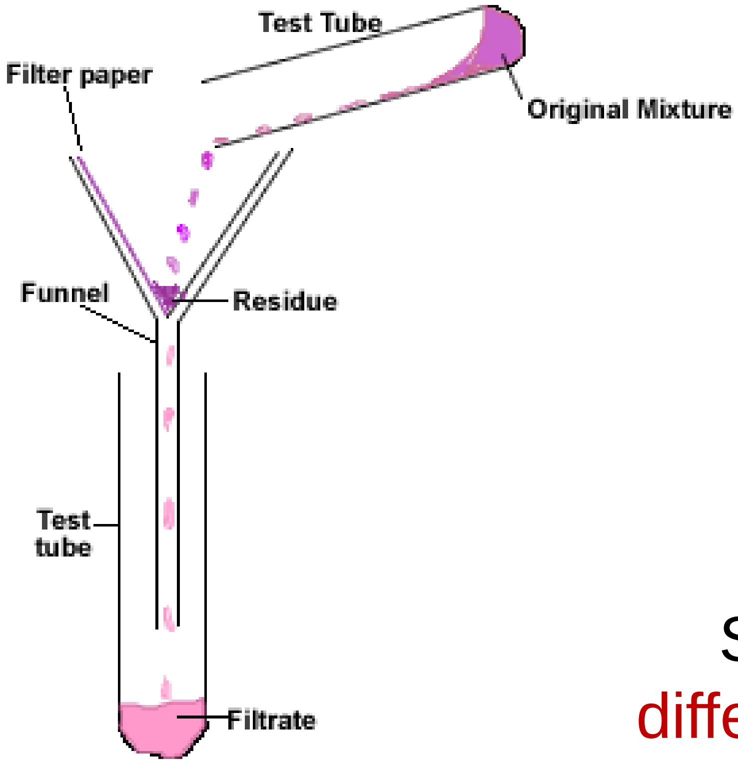
Salt & Water

Distillation



Distillation Tower

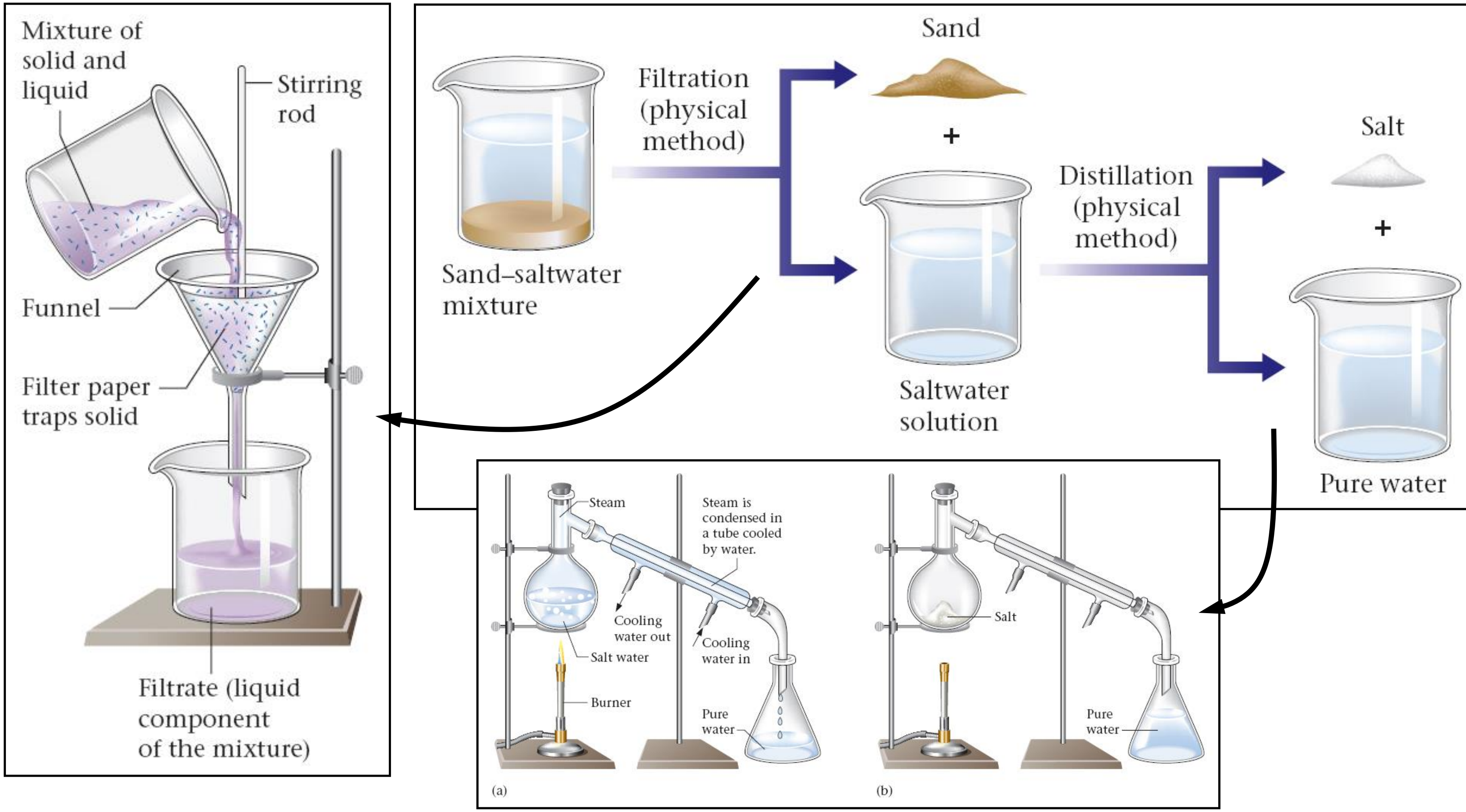
Filtration



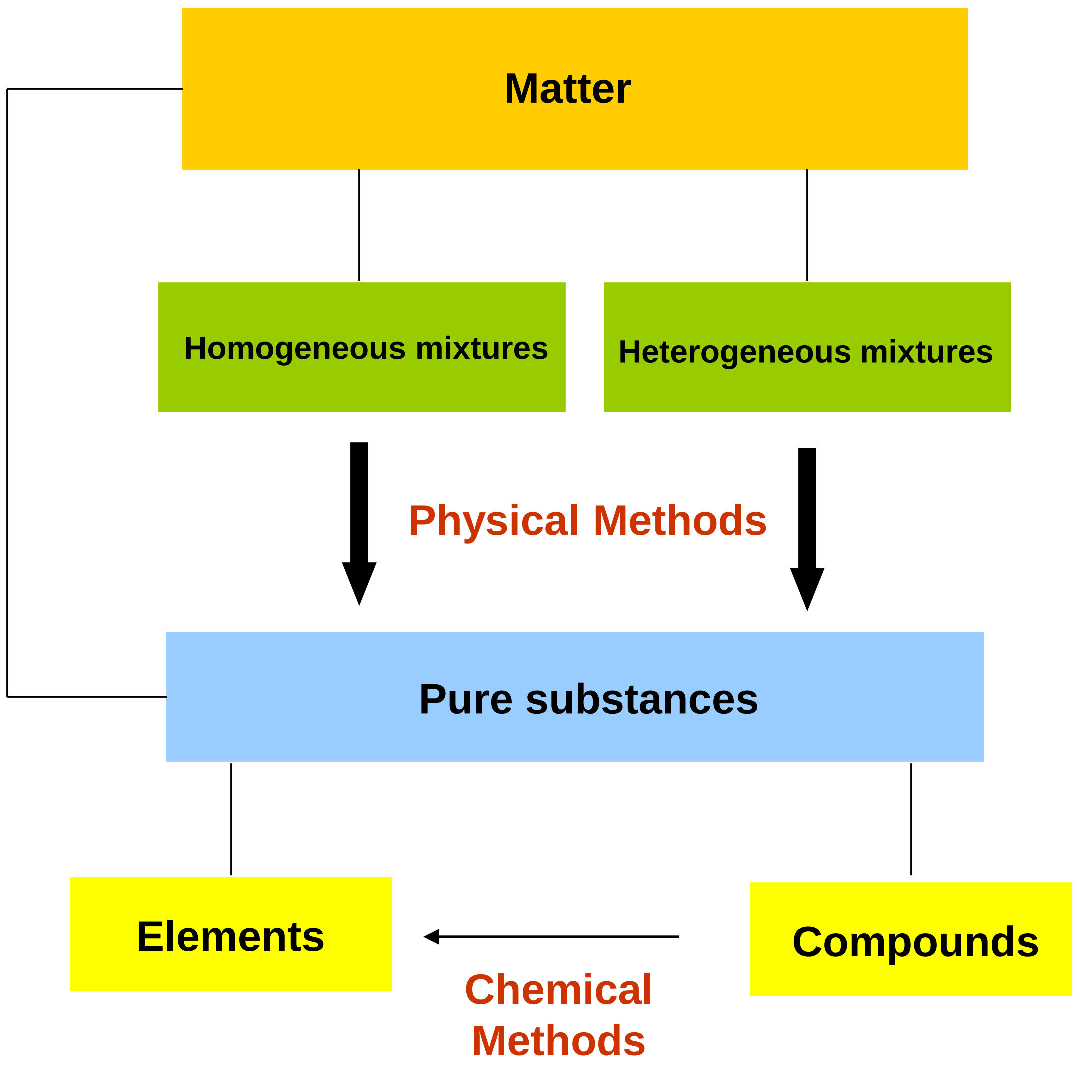
For Heterogeneous mixtures.

Separation by using the differences in size of particles.

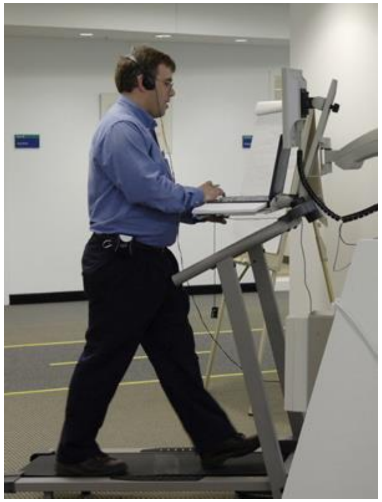
Salt, Sand and Water



Separation


Matter
Homogeneous mixtures
Heterogeneous mixtures
Physical Methods
Pure substances
Elements
Compounds
Chemical Methods

Energy



Kinetic energy (KE): energy of motion

Potential energy: stored energy

Law of conservation of energy

Heat

units of heat: calorie (cal) or joule (J)

1 cal = 4.184 J

Amount of heat = specific heat capacity× mass × change in temperature

Amount of heat = $C \times m \times (T_f - T_i)$

C = Specific heat capacity (cal/g °C)

T_f = final temperature

T_i = initial temperature

Heat

- **Specific heat capacity** is the energy required to change the temperature of a mass of one gram of a substance by one Celsius degree.

Table 10.1 The Specific Heat Capacities of Some Common Substances

Substance	Specific Heat Capacity (J/g °C)
water (*l*)* (liquid)	4.184
water (*s*) (ice)	2.03
water (*g*) (steam)	2.0
aluminum (*s*)	0.89
iron (*s*)	0.45
mercury (*l*)	0.14
carbon (*s*)	0.71
silver (*s*)	0.24
gold (*s*)	0.13

Heat

Practice 1:

- Calculate the amount of heat energy (in joules) needed to raise the temperature of 6.25 g of water from 21.0°C to 39.0°C.

- We are told the mass of water and the temperature increase. We look up the specific heat capacity of water, 4.184 J/g°C.

$$Q = C \times m \times \Delta T$$

$$Q = (4.184\ \text{J/g°C}) \times (6.25\ \text{g}) \times (39.0\text{°C} - 21.0\text{°C})$$

$$\boxed{\mathbf{Q = 471\ J}}$$

Heat

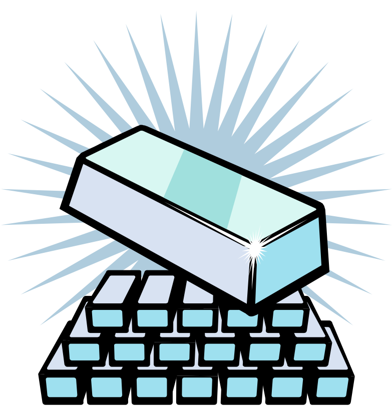
Practice 2:

- A silver-gray metal weighing 15.0 g requires 133.5 J to raise the temperature by 10.°C. Find the heat capacity.

$$Q = C \text{ x } m \text{ x } \Delta T$$

$$(133.5 \text{ J}) = \mathbf{C} \text{ x } (15.0 \text{ g}) \text{ x } (10.°\text{C})$$

$$\boxed{\mathbf{C = 0.89\ J/g°C}}$$



Al

Can you determine the identity of the metal using Table 10.1?