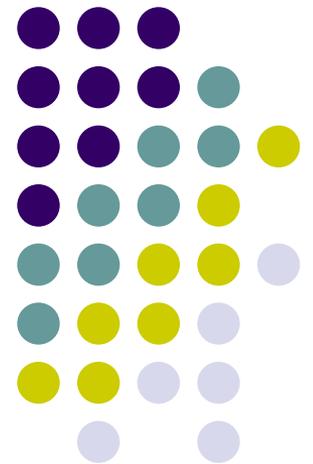
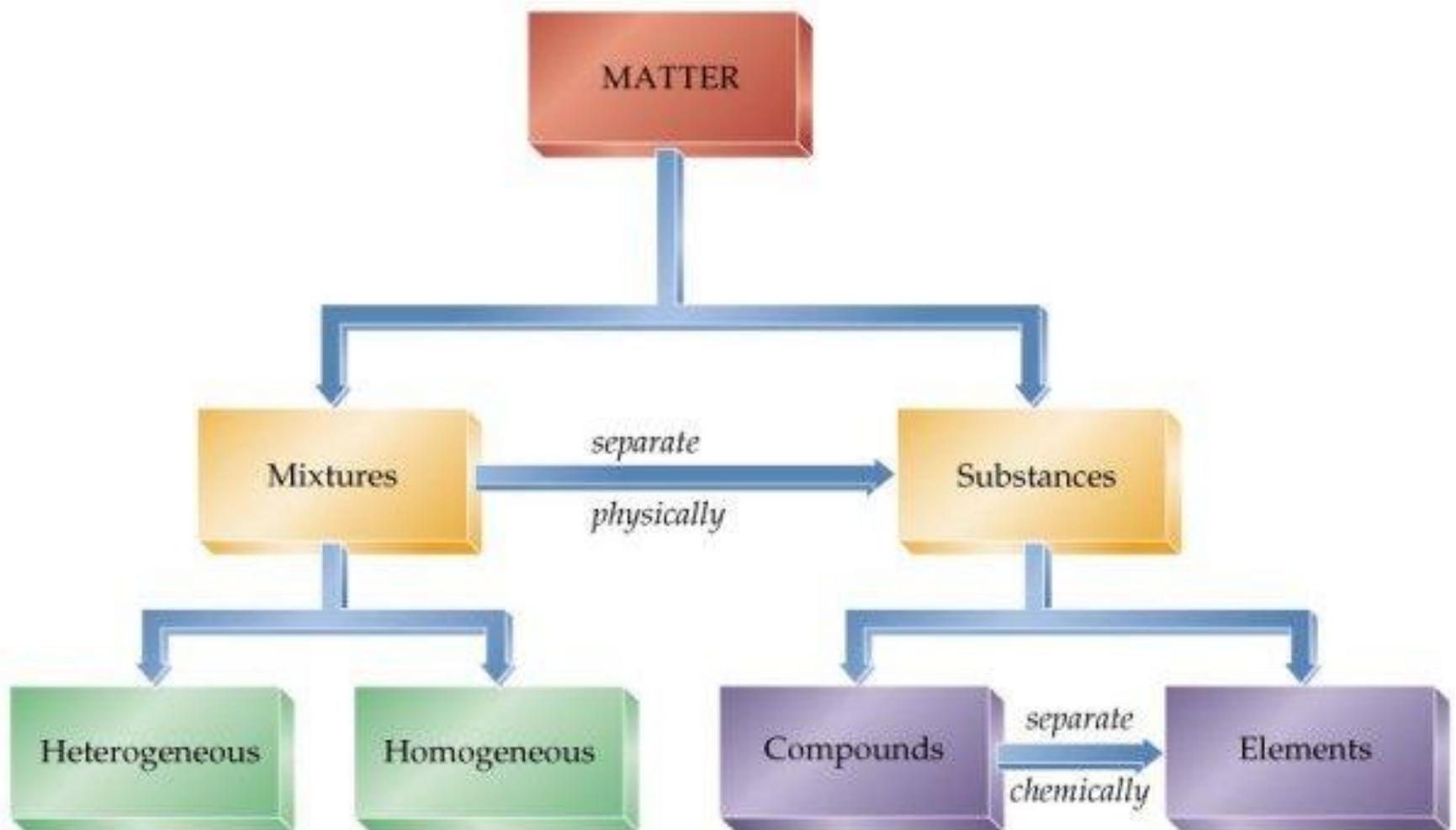


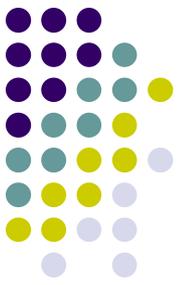
# Matter and Change



# A) Classification of Matter



# Some Criteria for the Classification of Matter



- Properties
- State (solid, liquid, gas)
- Composition



# Properties

## Intensive

-Do not depend on amount of matter.

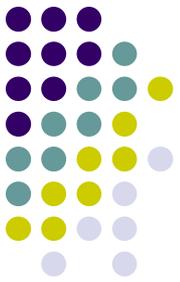
## Extensive

-Depend on amount of matter.

# Intensive and Extensive Properties



Sulfur Photo from MII, courtesy of the Smithsonian Institution



# Properties

- **Physical:** observed without changing the composition of the substance.
- **Chemical:** the ability of a substance to undergo a specific chemical change

# Examples of Physical Properties



- Color, odor, hardness, density, melting point, boiling point, state, solubility.



## Example: Physical Properties

Substance		State	Color	Melting Point (C°)	Boiling Point (C°)	Density (g/cm <sup>3</sup> )
Oxygen	O <sub>2</sub>	Gas	Colorless	-218	-183	0.0014
Mercury	Hg	Liquid	Silvery-white	-39	357	13.5
Bromine	Br <sub>2</sub>	Liquid	Red-brown	-7	59	3.12
Water	H <sub>2</sub> O	Liquid	Colorless	0	100	1.00
Sodium Chloride	NaCl	Solid	White	801	1413	2.17

# States of Matter

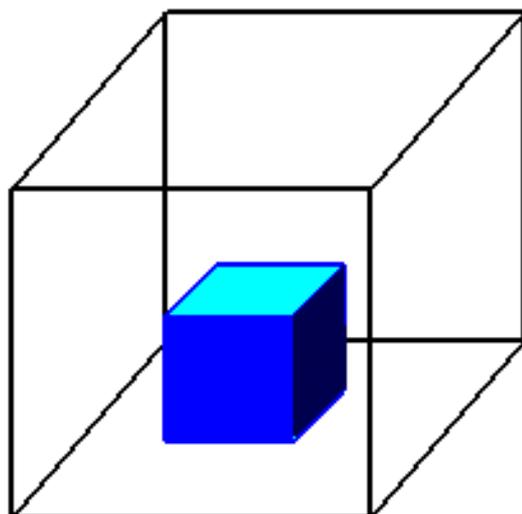


- Solid
  - fixed shape and volume, incompressible
- Liquid
  - fixed volume, takes the shape of its container
- Gas
  - takes the volume and shape of its container



# States of Matter

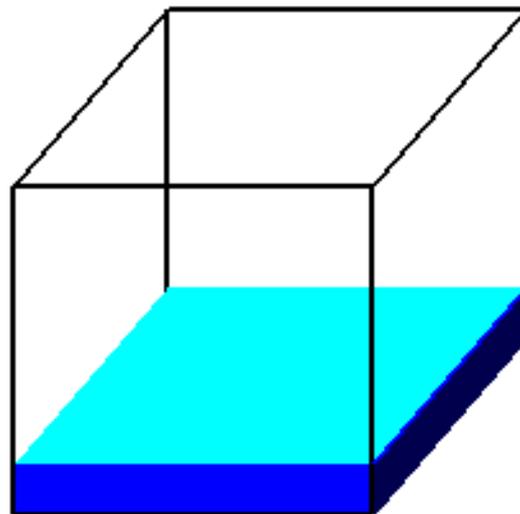
Glenn  
Research  
Center



**Solid**

**Holds Shape**

**Fixed Volume**

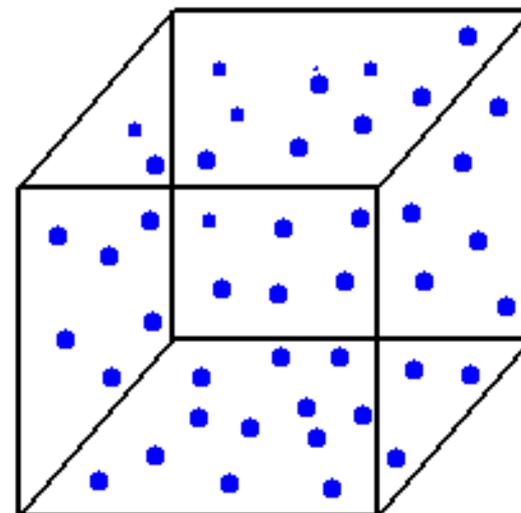


**Liquid**

**Shape of Container**

**Free Surface**

**Fixed Volume**



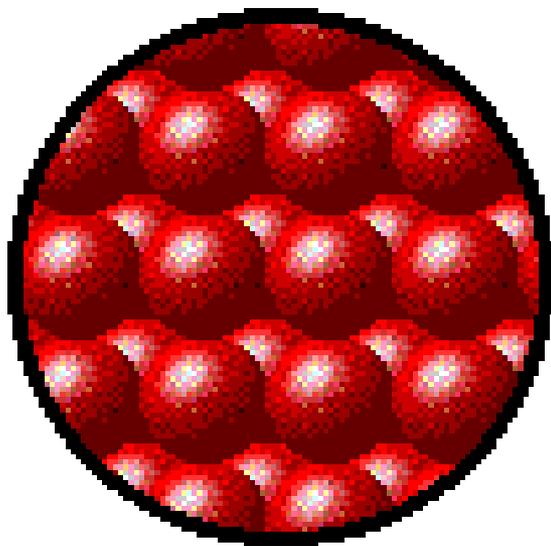
**Gas**

**Shape of Container**

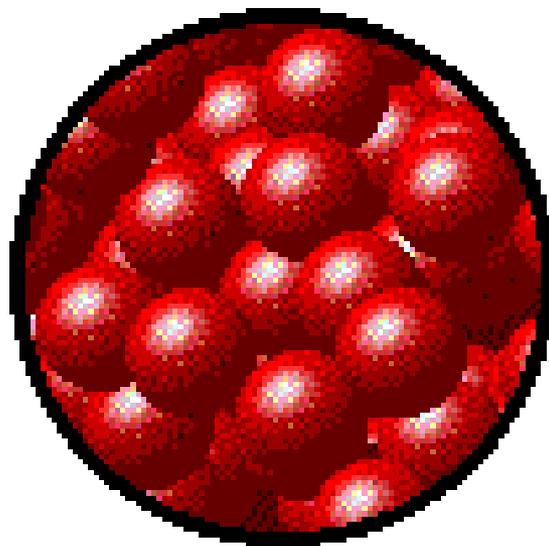
**Volume of Container**



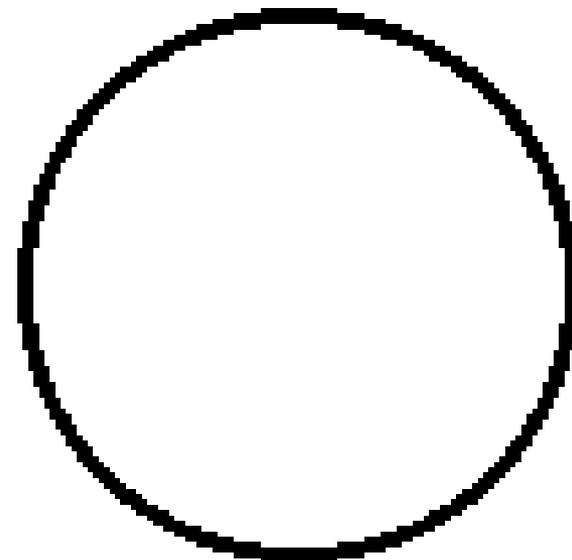
**Solid**



**Liquid**

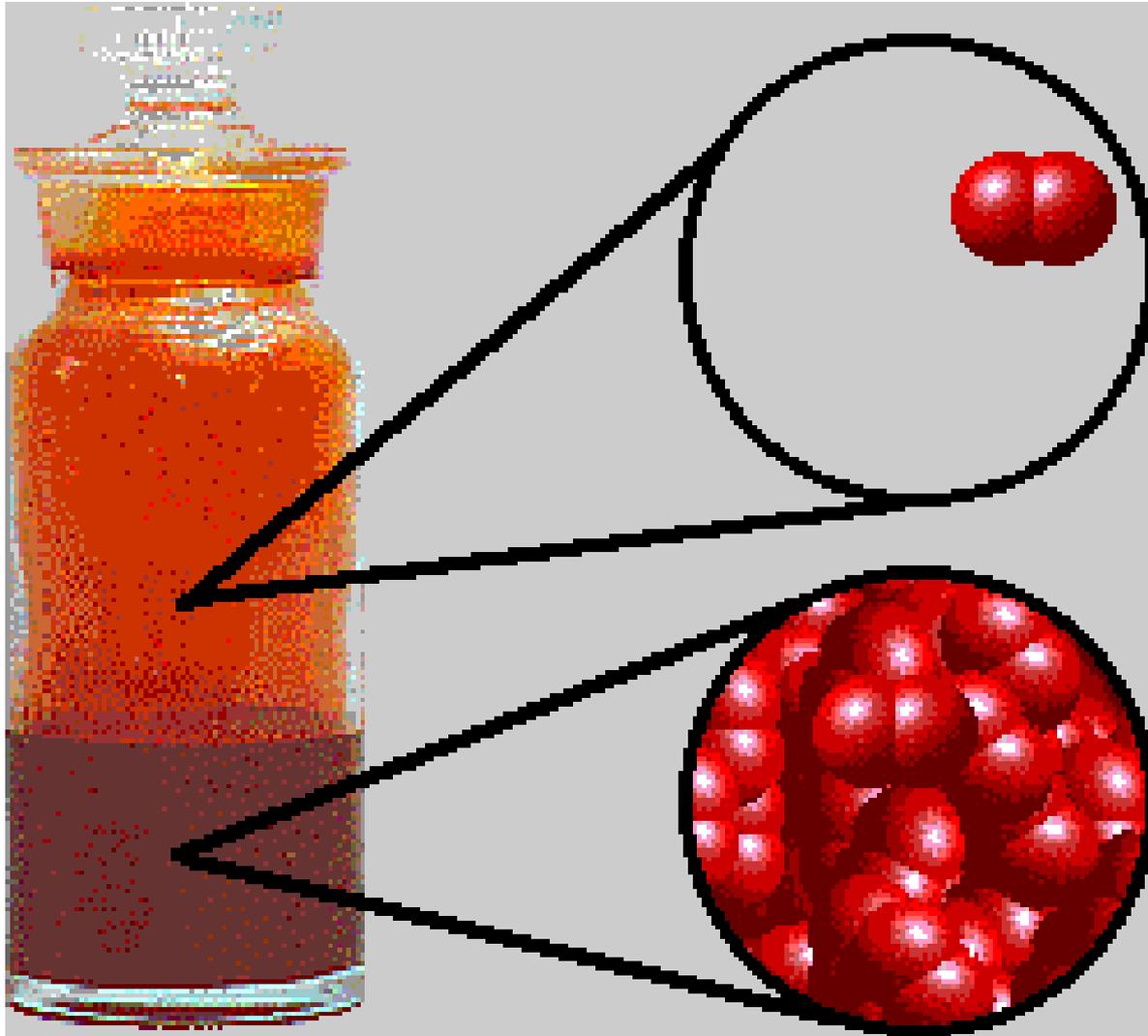
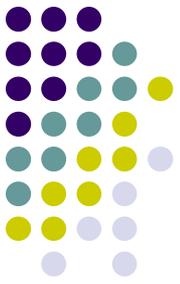


**Gas**



<http://www.chem.purdue.edu/gchelp/atoms/states.html>

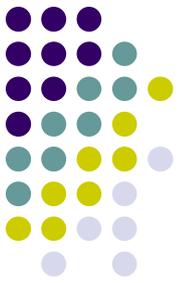
# Bromine



Gas  
(Vapor)

Liquid

# Change of Phase



**Melting**                      solid                      →                      liquid

**Condensation**                      gas                      →                      liquid

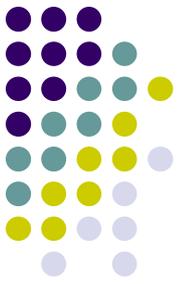
**Freezing**                      liquid                      →                      solid

**Evaporation**                      liquid                      →                      gas

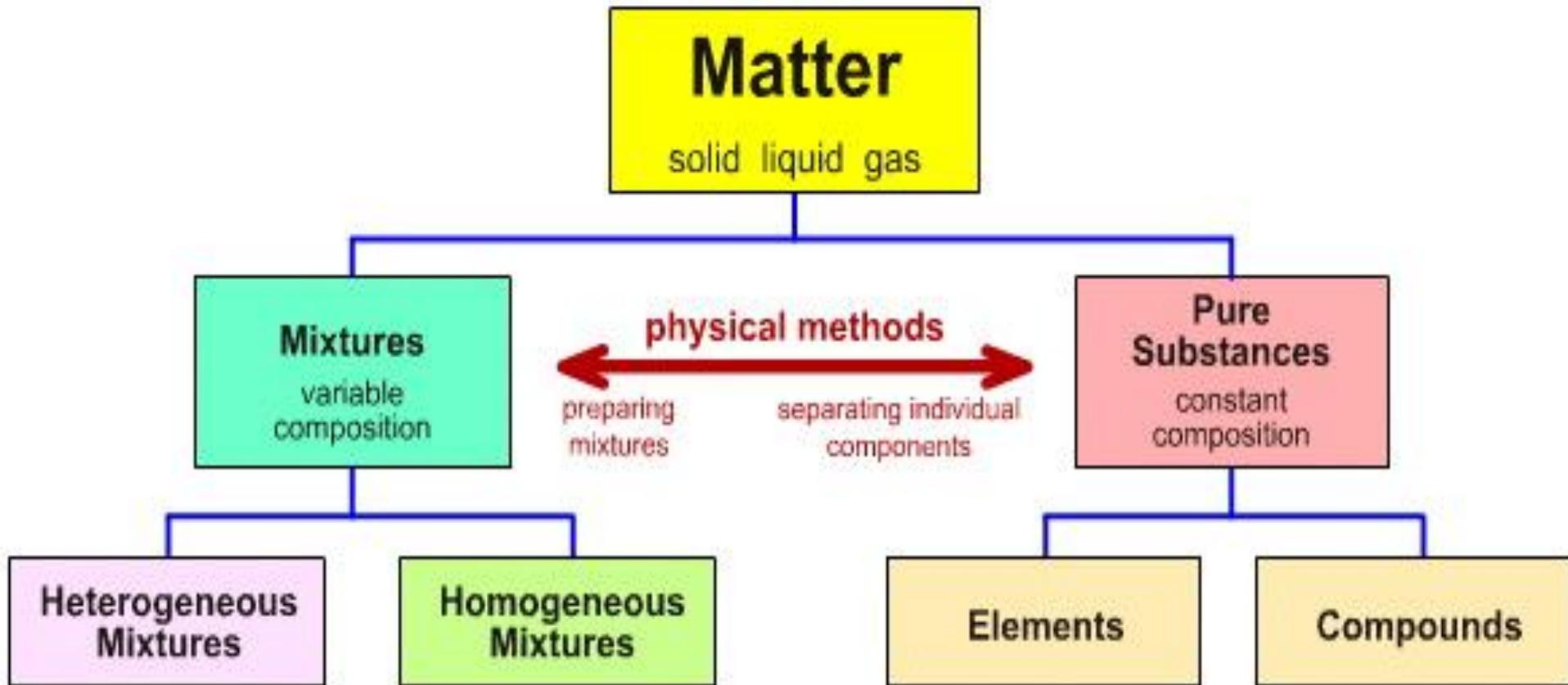
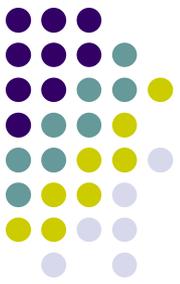
**Sublimation**                      solid                      →                      gas

**Boiling:** Evaporation occurring beneath the liquid's surface.

**Is changing phase a physical  
or chemical change?**



# Classification of Matter (by composition)



# (Pure) Substance



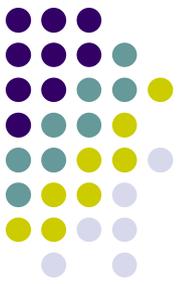
- Matter that has a uniform and definite composition.
  - Elements
  - Compounds



**Mixture:** a physical blend of two or more substances that are not chemically combined.

- Homogeneous
- Heterogeneous

# B) Mixtures



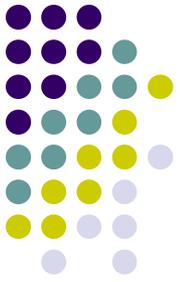


# Mixture

- A physical blend of two or more substances.

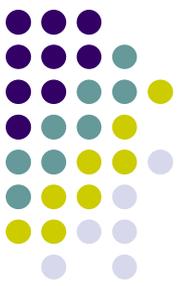


# Mixtures



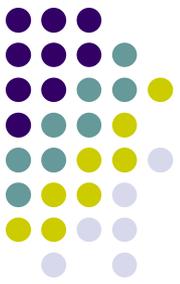
- Homogeneous
- Heterogeneous

# Homogeneous mixture (solution)



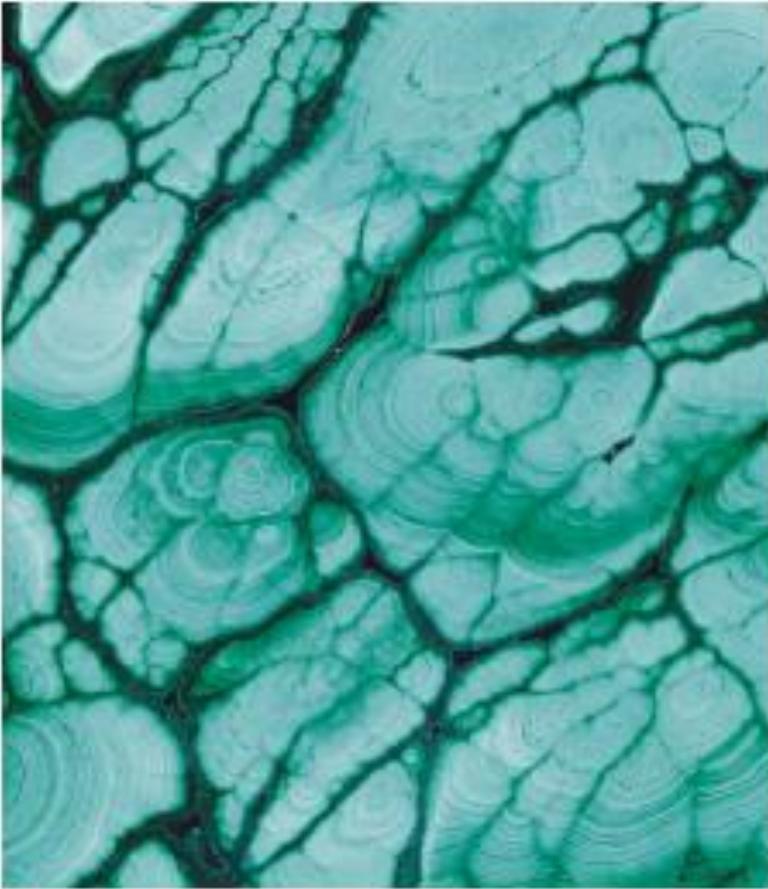
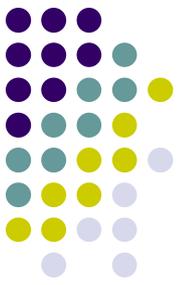
- Uniform composition throughout.
- One phase.

# Phase of a Mixture



- A part of a mixture with uniform properties and composition.

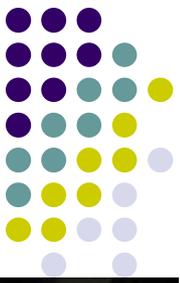
# Copper II Sulfate and its solution in water.



(a)



(b)



# Example: Stainless Steel

A homogeneous mixture of:

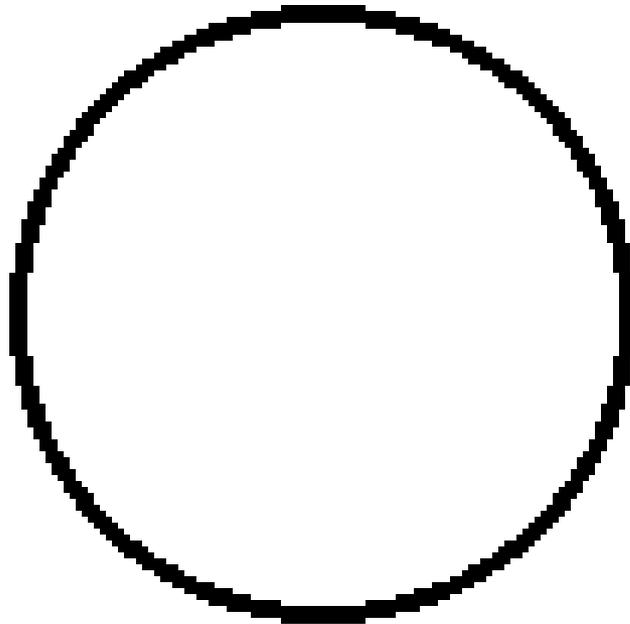
- Iron (Fe)
- Chromium (Cr)
- Nickel (Ni)





# Example: Gaseous Mixture

- Elements argon and nitrogen and a compound (water vapor).



# Heterogeneous Mixtures



Example:

Oil and vinegar



- Non-uniform composition throughout the mixture
- Two or more phases.



## Note:

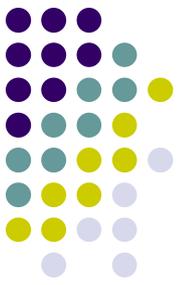
- Mixtures can be physically separated.
- Mixtures exhibit physical properties similar to the components of the mixture.

# Separation Methods

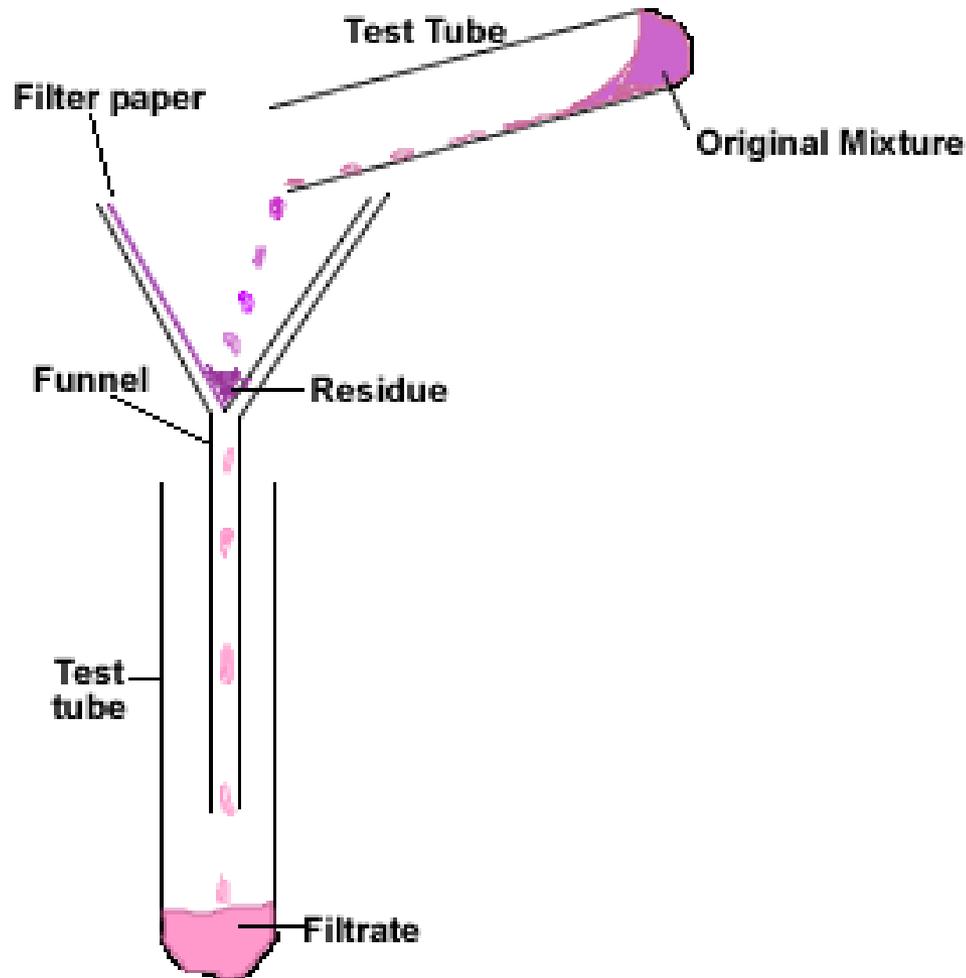


- Use differences in the physical properties of the components of the mixture.

# Example: Separate iron filings from sulfur using a magnet.

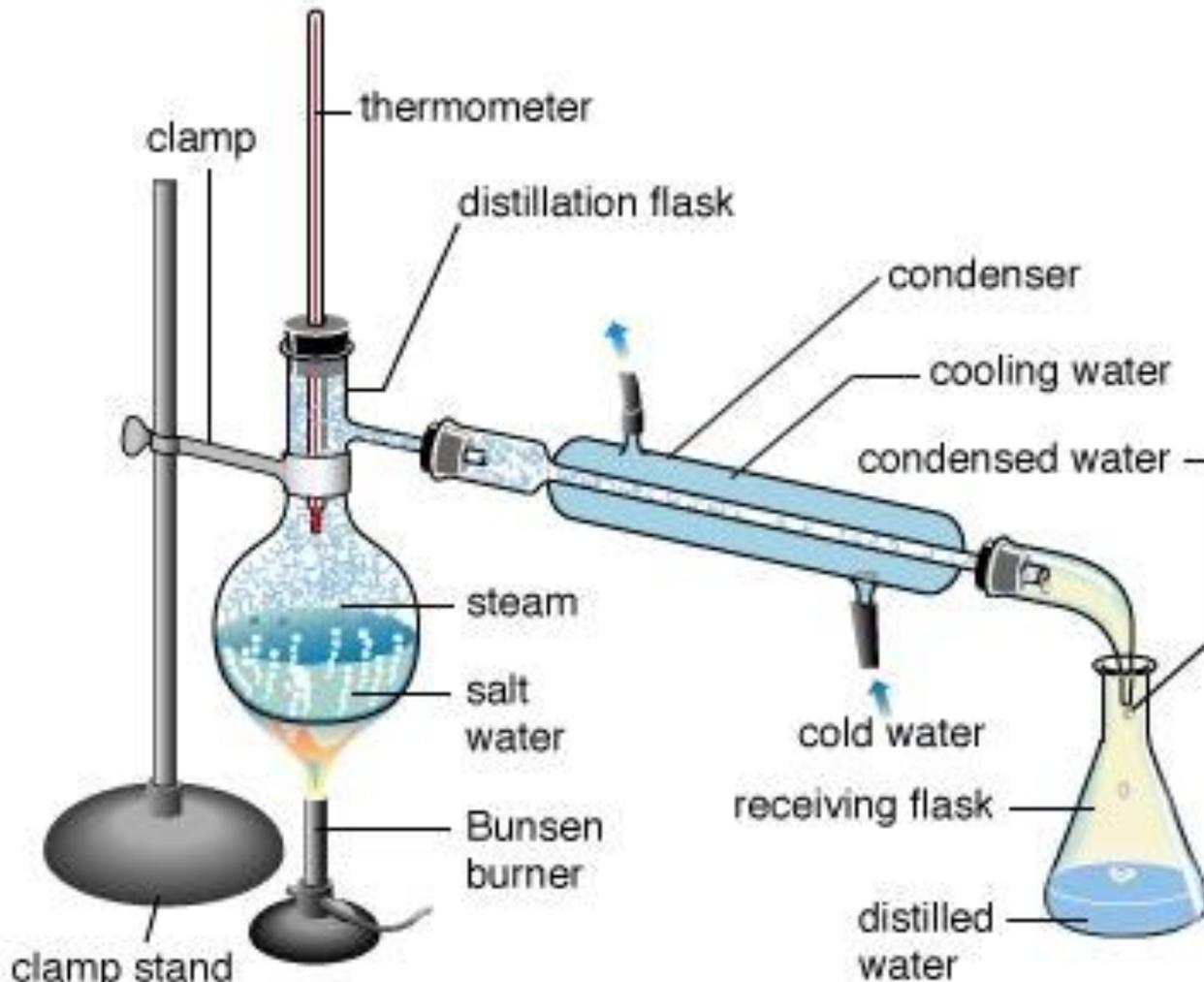


# Filtration: separates a solid from a liquid in a heterogeneous mixture



# Distillation:

- separate dissolved solids from a liquid
- uses boiling and condensation.

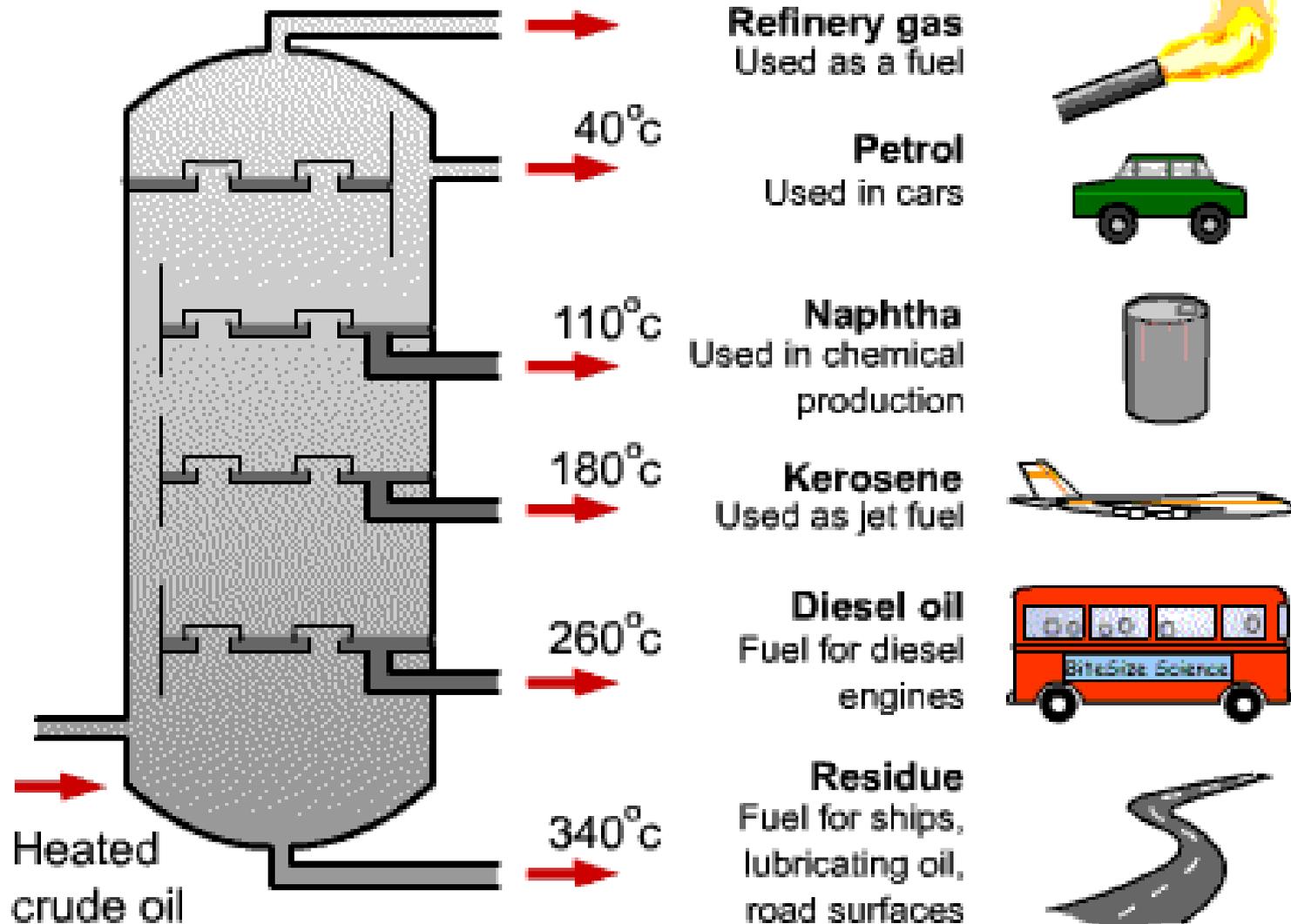
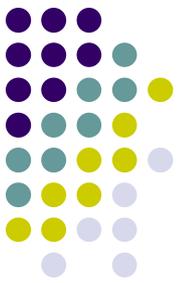


# Distillation of Crude Oil (Refining)

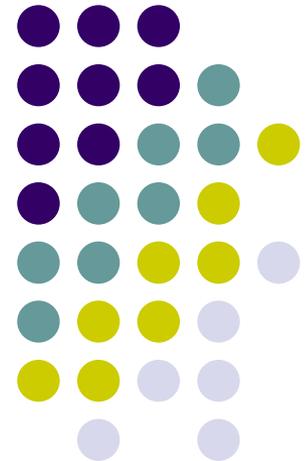


- Crude Oil is a mixture of Hydrocarbons

# Distillation of Crude Oil



# c) Elements and Compounds



# Elements



- The simplest substances.
- Can not be separated into simpler substances.
- Building blocks of all matter.
- More than 100 known elements.
- Represented by chemical symbols.

# Chemical Symbols of Elements



- System started by Jons Berzelius (Sweden, 1779-1848)
- One or two first letters of name of the element.
- Many elements names have roots from: Latin, Greek, mythology, geography, names of scientists.



# Examples:

- Americium, Am
- Einsteinium, Es
- Bromine, Br
- Helium, He
- Lead(Plumbum), Pb
- Niobium, Nb
- Iron (Ferrum), Fe
- Mendeleevium, Md

# Compound



- A substance that contains two or more elements chemically combined.
- Compounds have different properties from the individual substances.

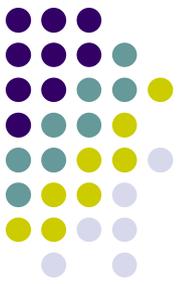
(Ex:  $\text{H}_2\text{O}$ )

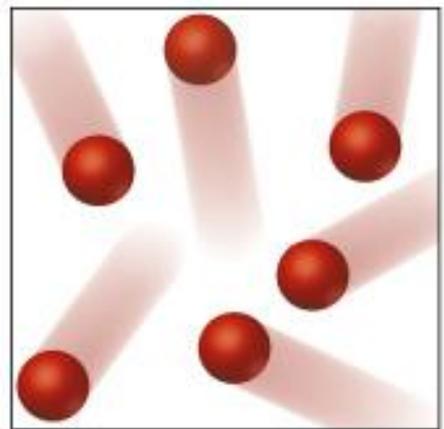
# Example: H<sub>2</sub>O



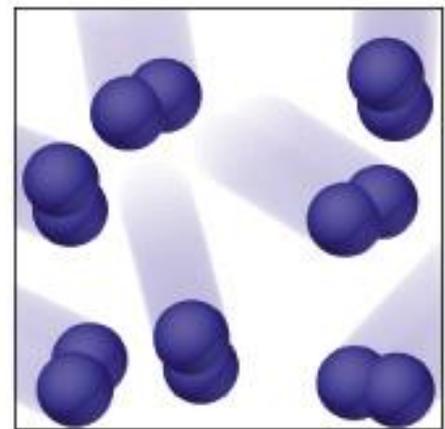
# Substance or mixture?

- If composition is fixed and may not change → substance

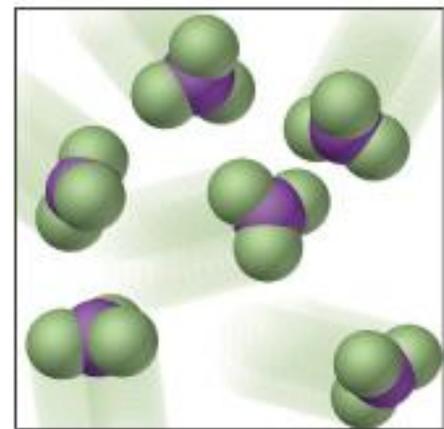




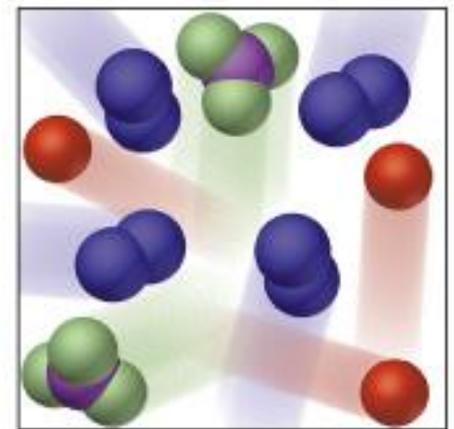
(a) Atoms of an element



(b) Molecules of an element

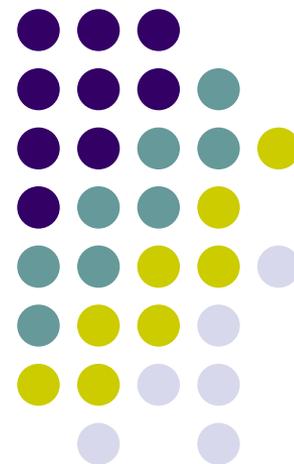


(c) Molecules of a compound



(d) Mixture of elements and a compound

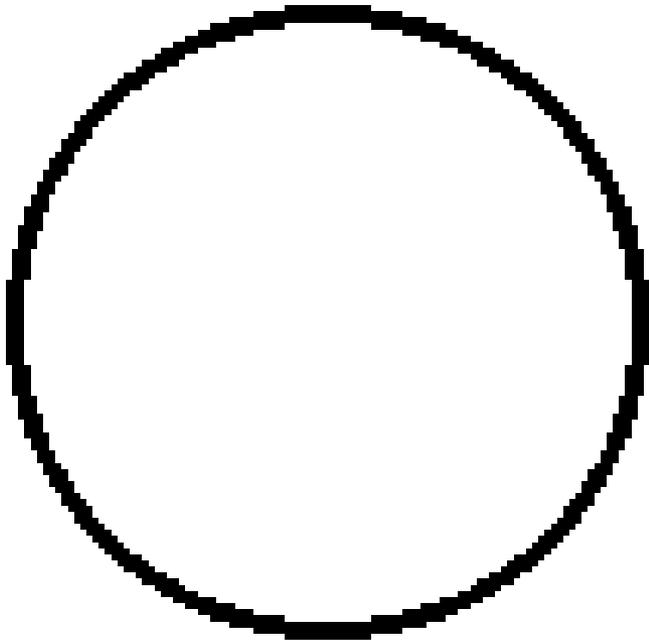
# d) Chemical Properties and Chemical Changes



# H<sub>2</sub>O composition is fixed- compound



Gaseous Phase



Liquid Phase

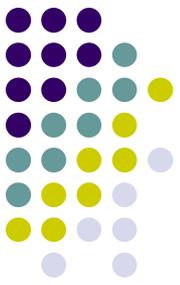




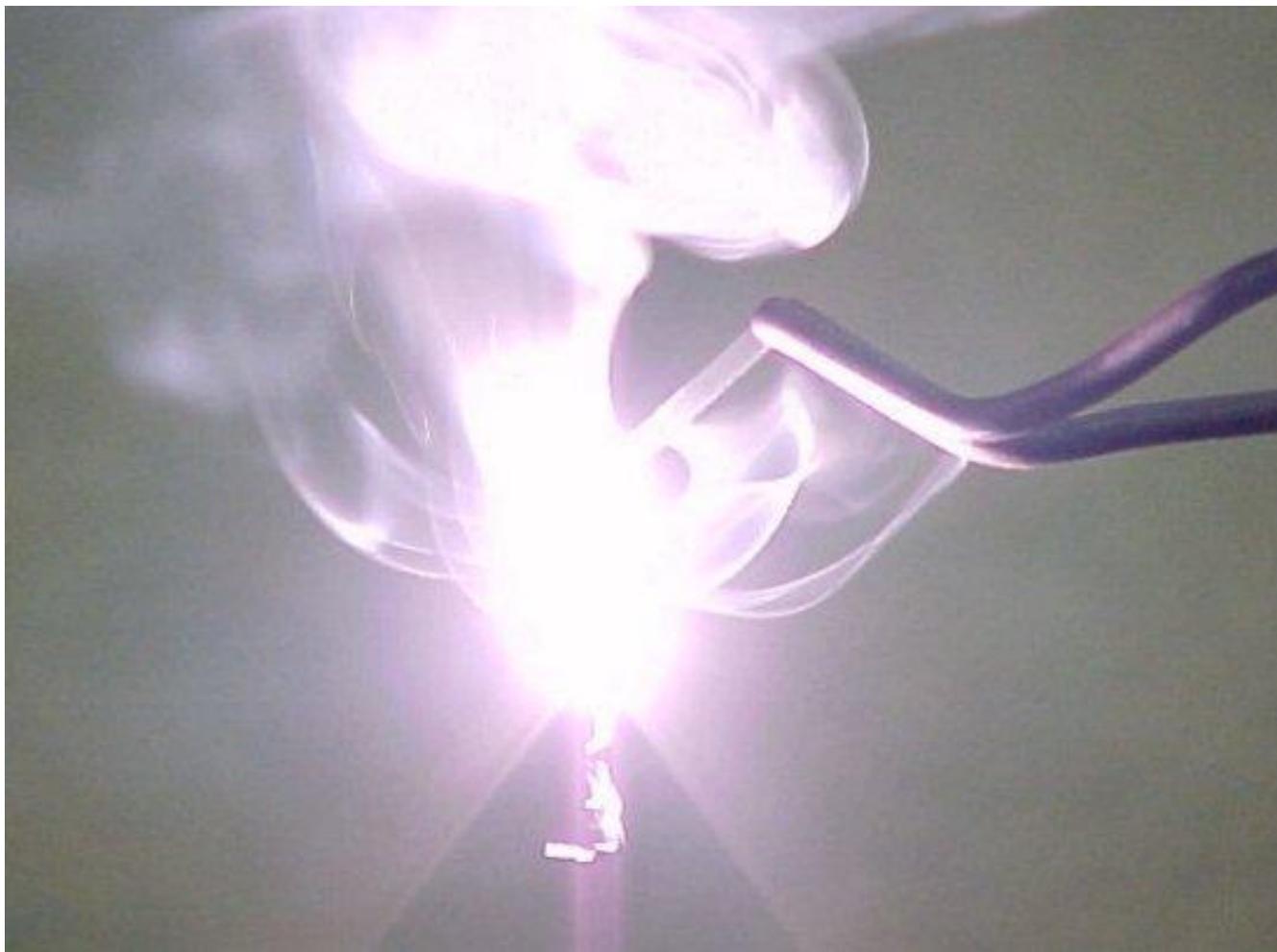
# Chemical Properties

- The ability of a substance to transform into a new substance (to undergo a chemical change).
- Example: Magnesium reacts with oxygen to form magnesium oxide.

# Magnesium Mg

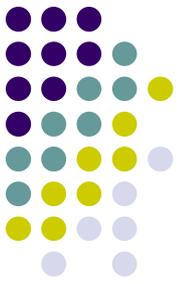


# Burning of Magnesium

$$2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$$


# Physical Changes

- **Physical change**: a change in the physical properties of a substance.
- Composition does not change.

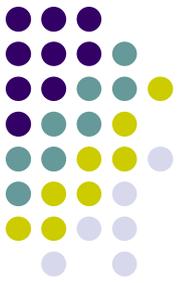




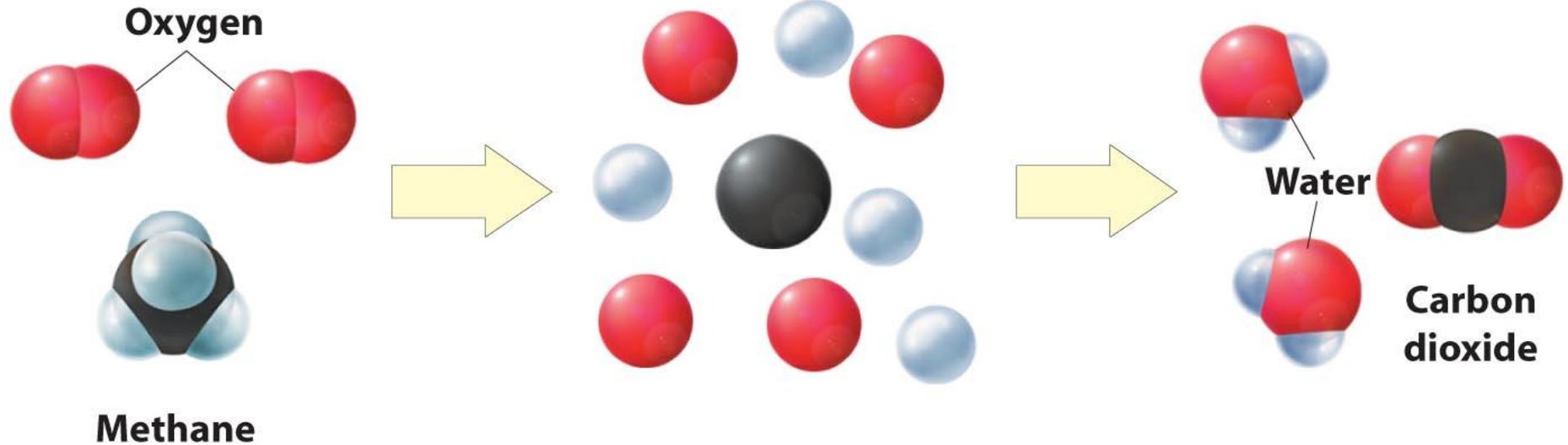
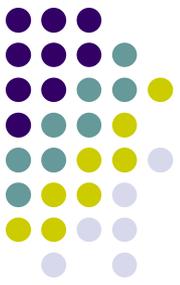
# Chemical Change

- A change that produces matter with a different composition than the original matter.
- Atoms rearrange themselves into new combinations.

# Burning of Methane



# Burning of Methane



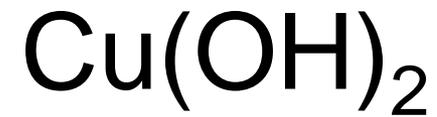
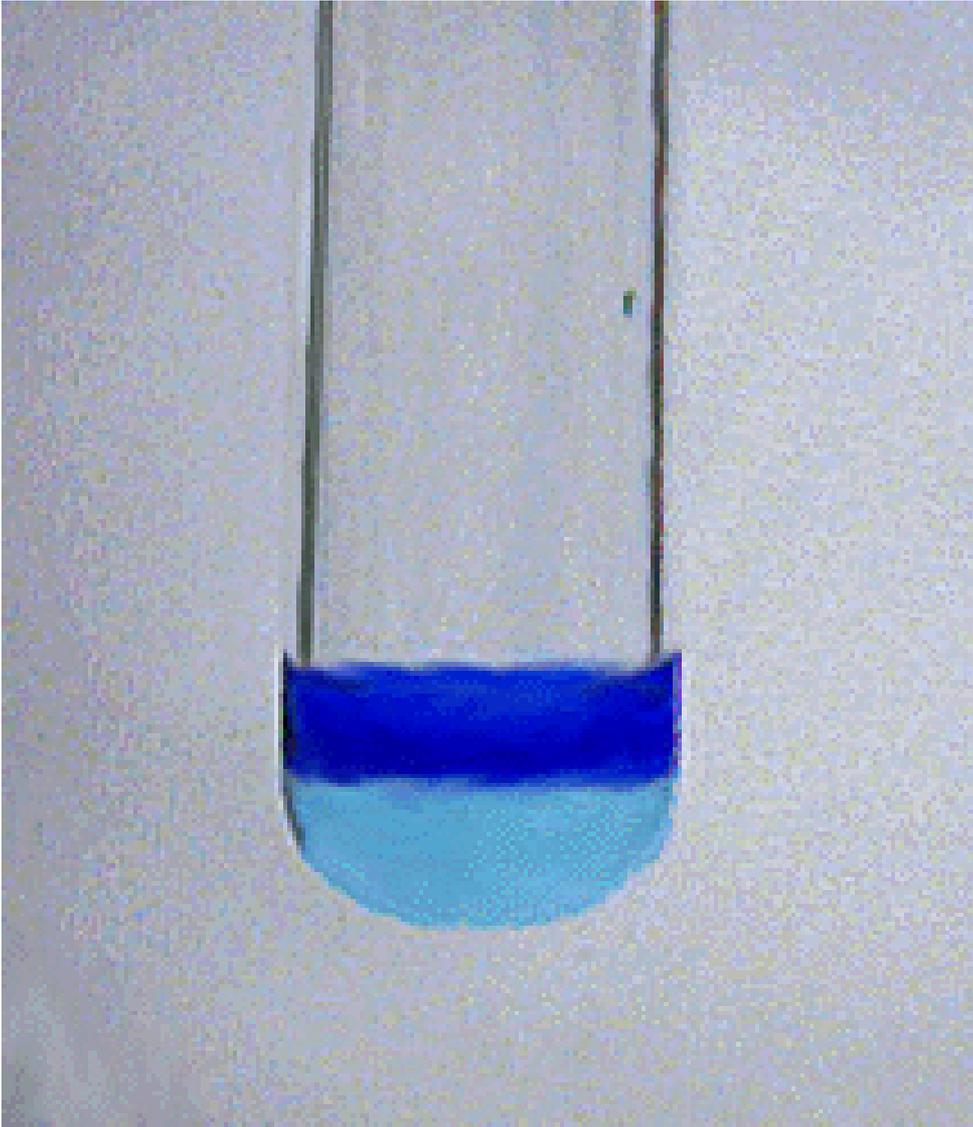
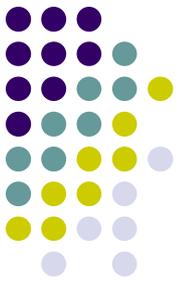
# Recognizing a Chemical Change



- energy exchange
- production of a gas
- color change
- formation of a precipitate



# Formation of a Precipitate



Precipitate