1º ESO

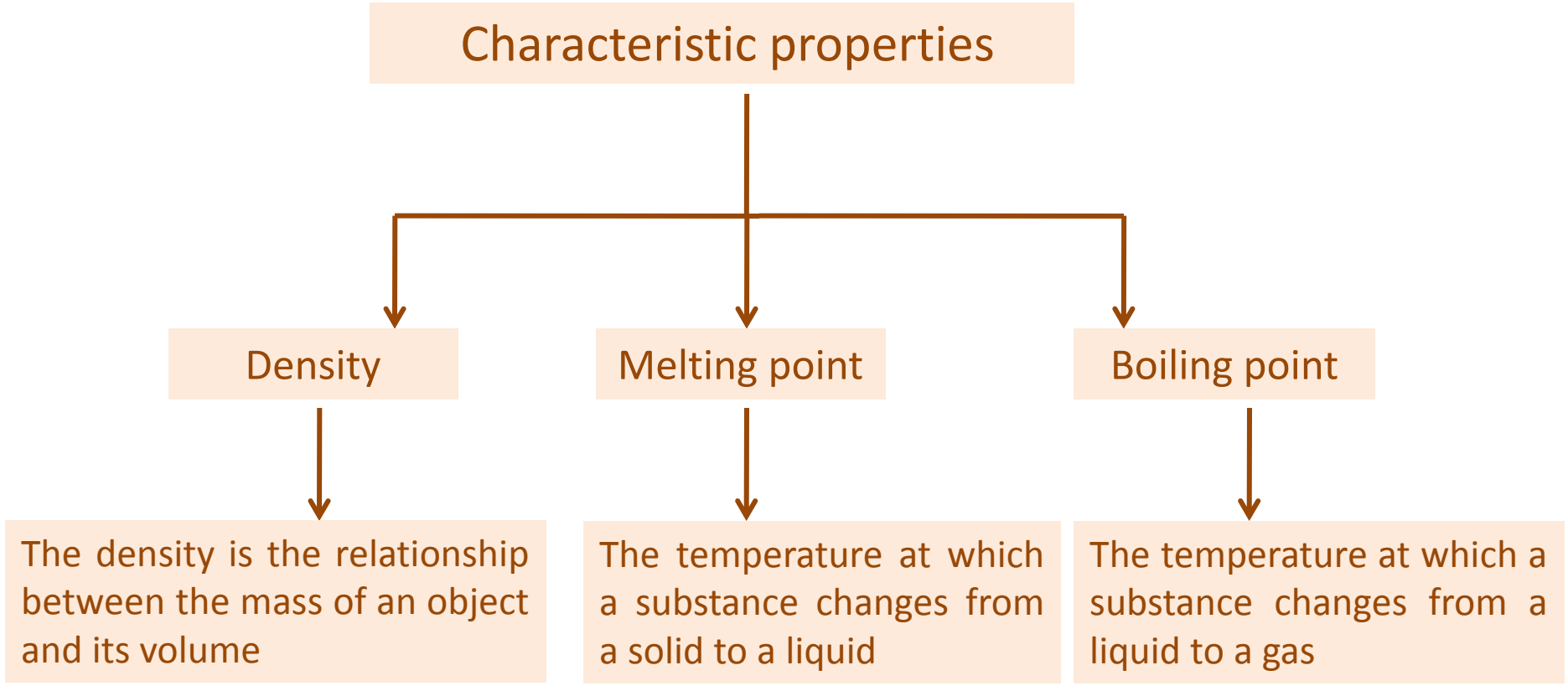
UNIT 3: Pure substances and mixtures

Objectives

1. To know that a substance is identified according to its characteristic properties like: density and melting or boiling points.
2. To know the concepts of pure substance, heterogenous mixtures and dissolutions at experimental and theoretical level.
3. To know that in the dissolution, the dissolved substances are disintegrated at molecular level.
4. To know the differences between dissolution, dissolvent and solute.
5. To differentiate between simple substance and compound.
6. To know how to differentiate between dissolutions and heterogenous mixtures observing its properties.
7. To know that the properties of the substances at macrocospic level cannot be applied to their molecules.
8. To know how to draw molecular diagrams that they represent mixtures and pure substances.
9. To distinguish between the most suitable methods to separate components of homogenous mixtures and those of heterogenous mixtures.
10. To know how to use techniques of separation like the decantation, the filtration, the distillation, the crystallization or the heating to dryness to separate substances of a mixture.
11. To know the parts of a distillation, crystallisation and heating equipment.
12. To know the parts of a decantation and filtration equipment.
13. To know the composition alloys of common use.
14. To know the main substances that compose the air, as well as the proportion of nitrogen and oxygen.
15. To know the physical properties most important of water.
16. To know the approximated composition of sea water.

Characteristic properties

A characteristic property is a physical or chemical property that we can use to identify a substance.



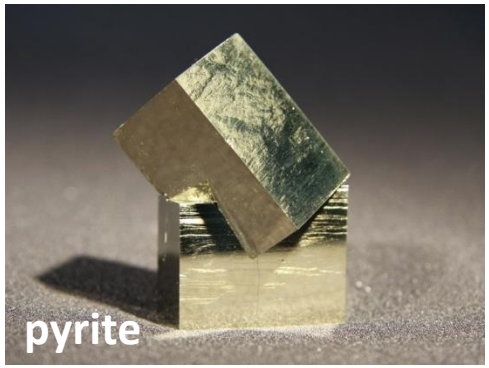
Mass and volume are not characteristic properties. A small piece of gold has less mass and less volume than a large piece of gold. They depend on the amount of substance.

Classification of matter

We can classify matter, in two categories: ***pure substances and mixtures***

Pure substance: only one substance, its characteristic properties do not change, in the same conditions of temperature and pressure

The following systems are pure substances



Types of pure substances

There are two types of pure substances: ***simple substances and compounds***

We can differentiate them, watching their behavior when exposed to heat or electricity.

Simple substances are those which do not decompose into simpler pure substances by means of heating or electrolysis.

Thus oxygen is a simple substance because it does not decompose by means of heating or electrolysis. Gold, mercury and sulphur are simple substances too.

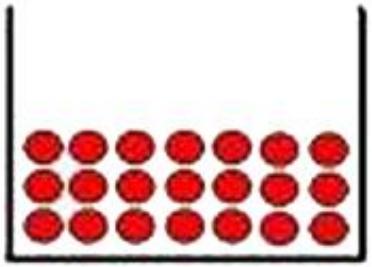
Compounds are those substances that decompose into simpler pure substances by means of heating or electrolysis.

Thus water is a compound because it is decomposed by electricity into two elements, hydrogen and oxygen. Rock salt, pyrite, sugar and copper sulphate are compounds too.

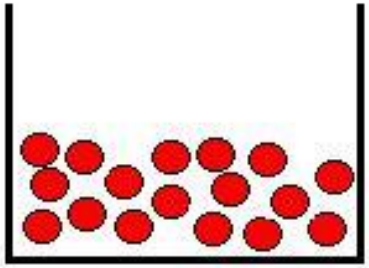
Structure of pure substances

From the point of view of their structure, the pure substances have only one type of molecules.

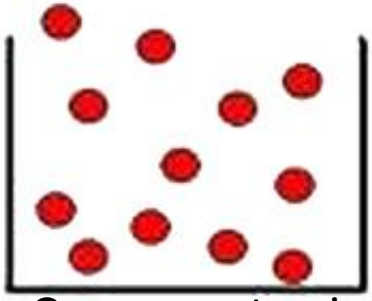
Simple substances have equal molecules with only one type of atoms



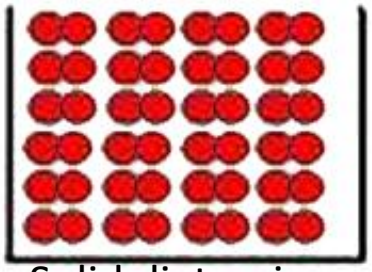
Solid monoatomic



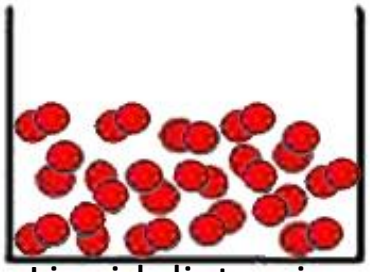
Liquid monoatomic



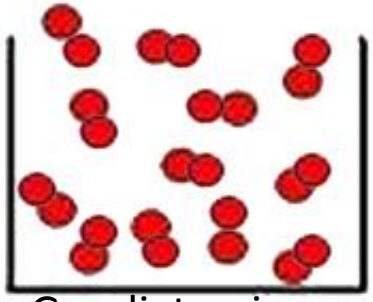
Gas monoatomic



Solid diatomic

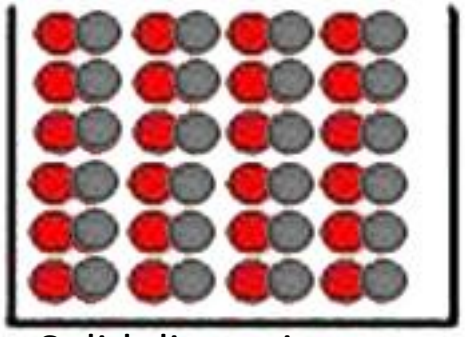


Liquid diatomic



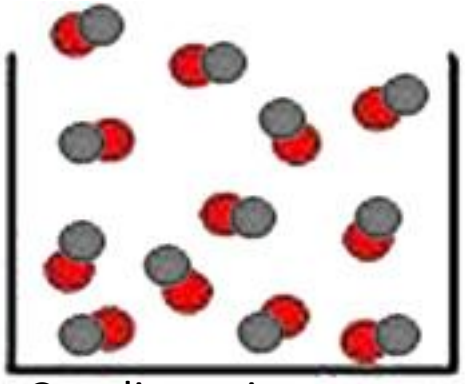
Gas diatomic

Compounds have equal molecules with two or more types of atoms



Solid diatomic

Liquid diatomic

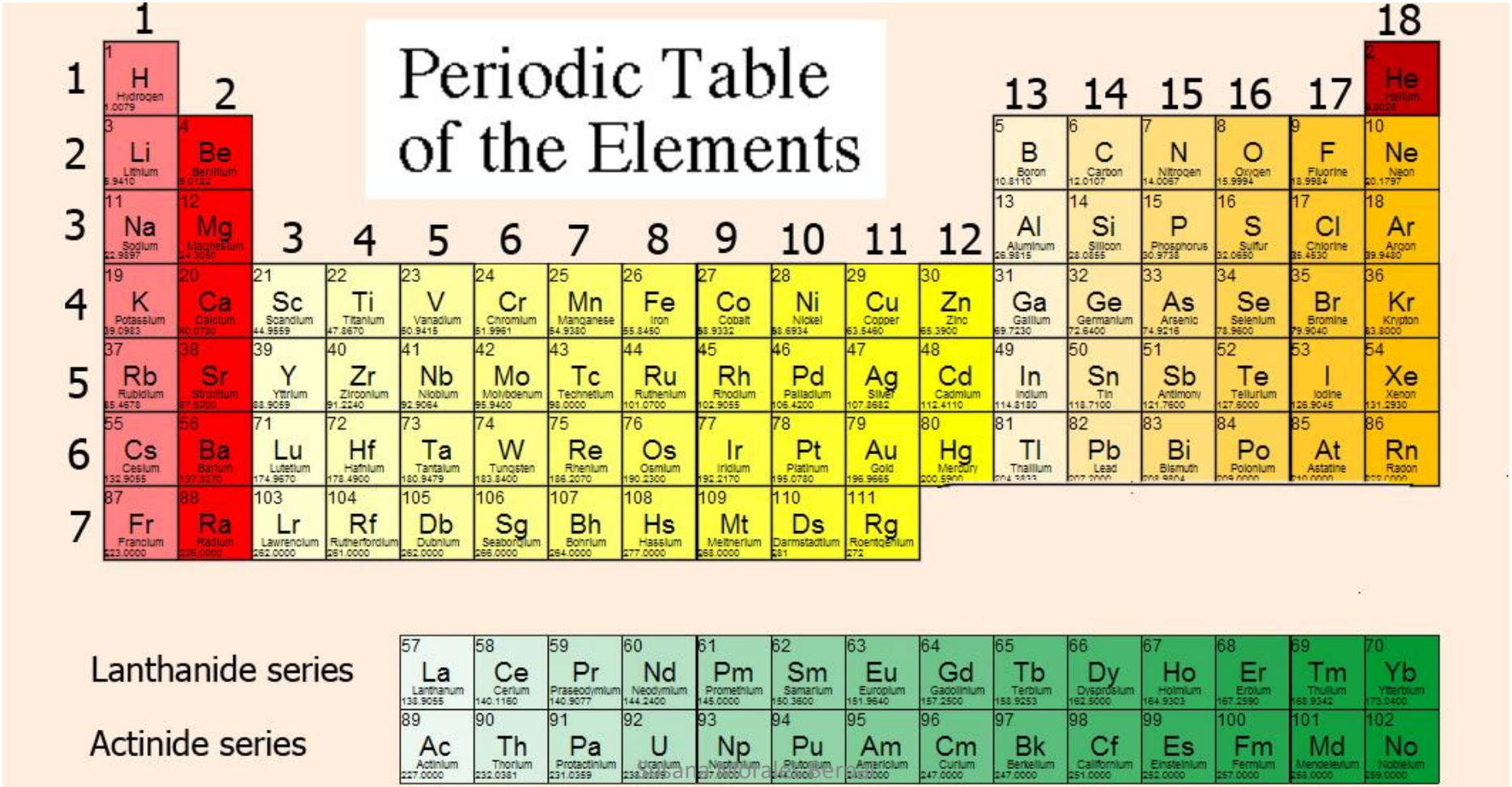


Gas diatomic

ELEMENTS

Element is the representation of each type of atom, it is not the same as simple substance. An element has not properties, a simple substance has them.

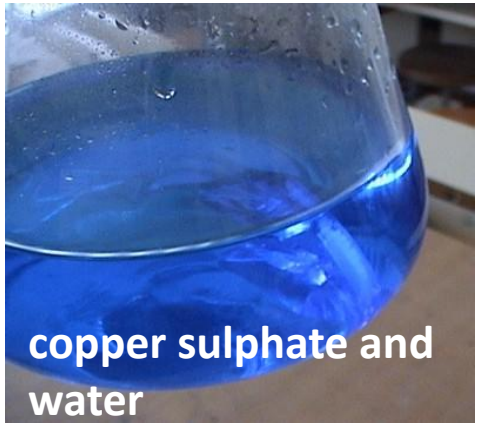
Although only 92 elements occur naturally on earth, they can combine to produce an unlimited number of compounds.

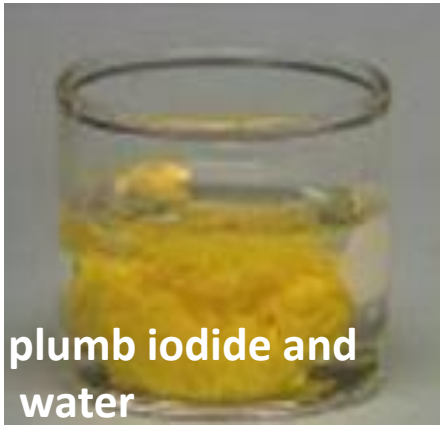


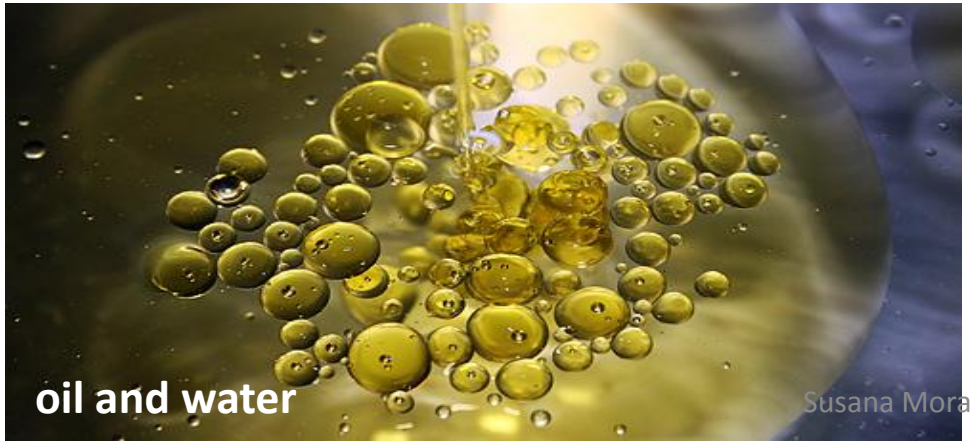
Mixture: two or more substances, its characteristic properties change, depending on the type of substances is formed by and on the amount of each substance

The following systems are mixtures


granite


copper sulphate and water


plumb iodide and water


oil and water

Types of mixtures

There are two types of mixtures: ***homogeneous and heterogeneous.***

Homogeneous: mixtures which have the same properties throughout the mixture. We can call this type of mixture, dissolution.
For example:

- Sugar dissolved in water
- Salt dissolved in water
- Copper sulphate dissolved in water
- Some type of metal alloy like the cromium-molybdenum used in many bike frames

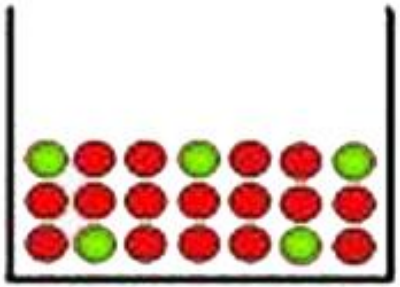
Heterogeneous: mixtures which have different properties throughout the mixture.
For example:

- Sand mixed with water
- Oil mixed with water
- Granite
- Plumb iodide and water

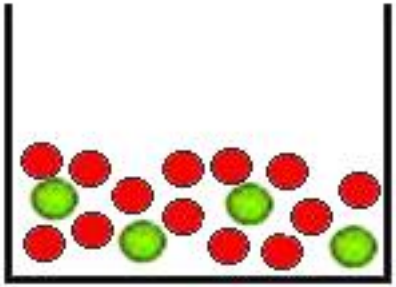
Structure of mixtures

From the point of view of their structure, the mixtures have two or more types of molecules.

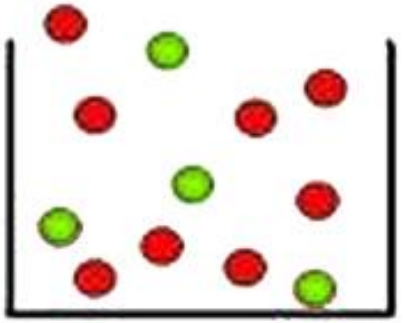
Homogeneous mixture: it has different molecules distributed uniformly



Solid dissolution

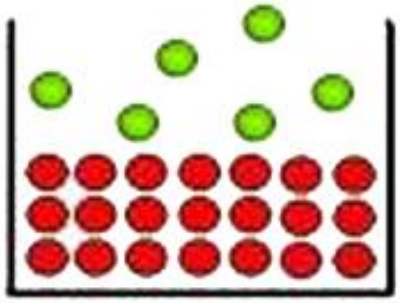


Liquid dissolution

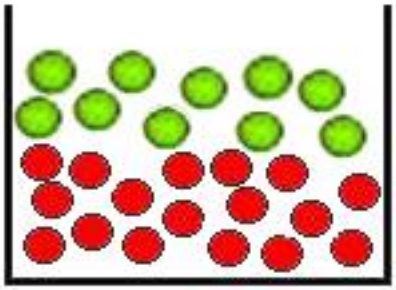


Gaseous dissolution

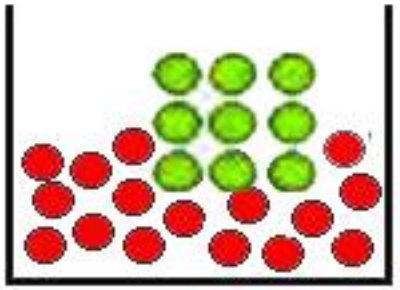
Heterogeneous mixture: it has different molecules that are not distributed uniformly



Heterogeneous mixture of one solid and one gas



Heterogeneous mixture of two liquids



Heterogeneous mixture of one solid and one liquid

Homogeneous mixtures

***Homogeneous mixture*:** is that has the same properties at all its points

A dissolution (solution) is a homogeneous mixture composed of two or more substances.

When we mix two substances and we obtain a solution, we say that these substances are soluble. A solute is dissolved in another substance, known as a solvent.

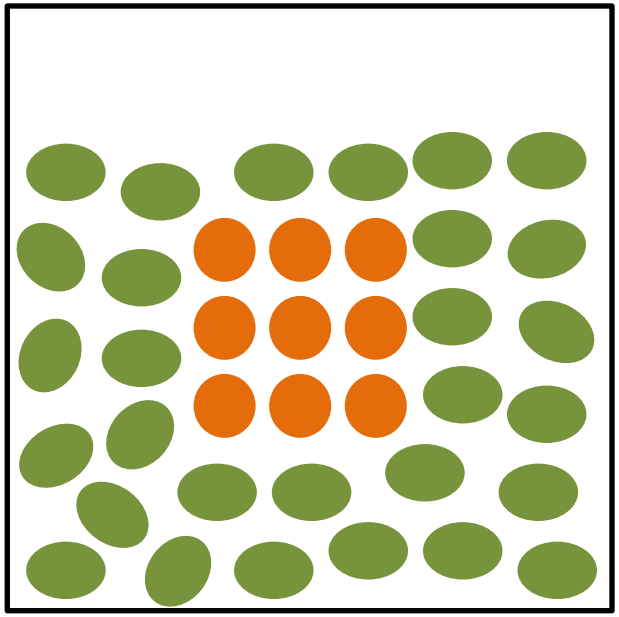
Solute is the substance that is in smaller proportion, unless it is water in which case we consider it the dissolvent.

When we mix two substances and we do not obtain a solution, we say that these substances are insoluble.

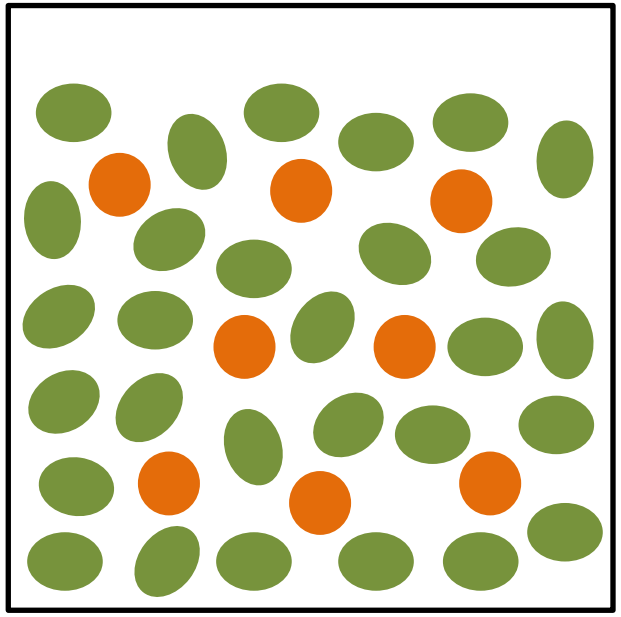
EXAMPLES OF SOLUTIONS		SOLUTE		
		GAS	LIQUID	SOLID
SOLVENT	GAS	Air (oxygen and other gases)	Water in air	Naphthalene in air (it sublimes)
	LIQUID	Carbon dioxide in water	Ethanol in water	Sodium chloride in water, sucrose in water, gold in mercury
	SOLID	Hydrogen dissolved in metals	Mercury in gold	Steel (metal alloys)

Process of solution

When a dissolution of a solid in a liquid takes place, the molecules of the liquid bang to the solid, pulling molecules away and separating them. Finally, the molecules of the solid remain surrounded by molecules of the liquid and distributed uniformly.



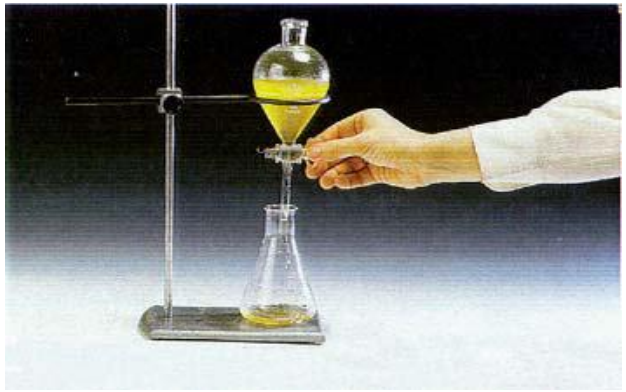
Before dissolving



After dissolving

Methods of separation of substances in mixtures

The main techniques of separation of the substances that integrate the heterogeneous mixtures are: **decantation, filtration and magnetic separation**

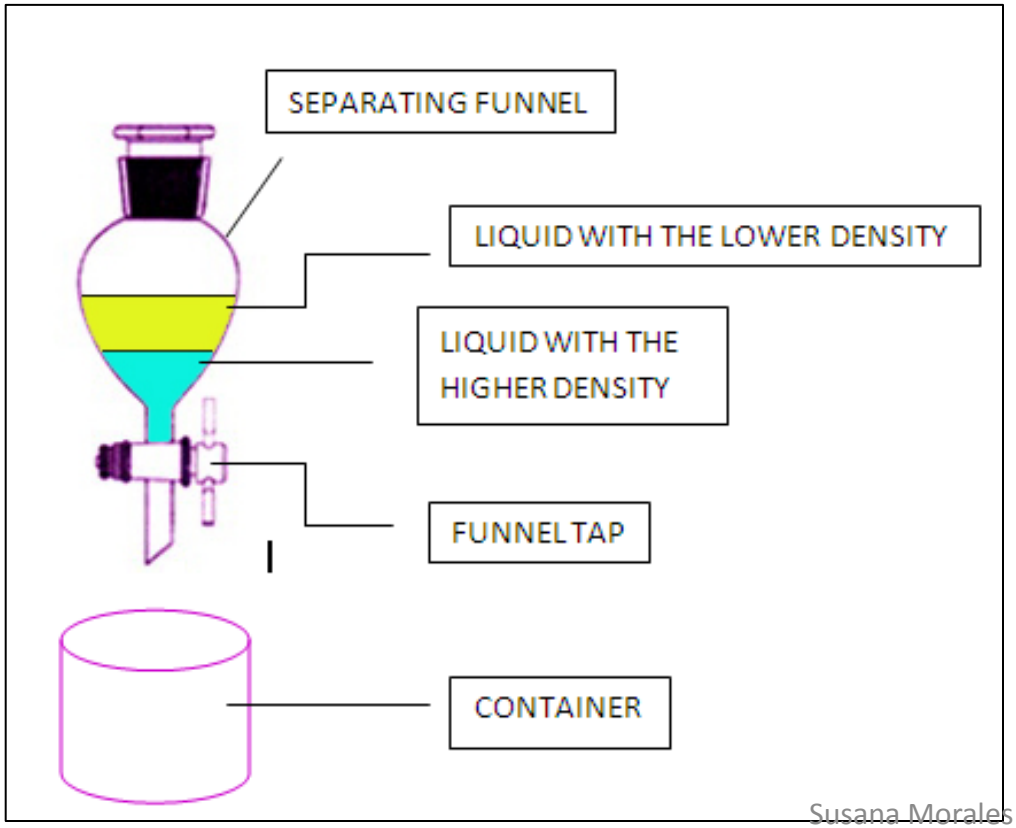


The main techniques of separation of the substances that integrate the homogeneous mixtures are: **heating to dryness, crystallisation and distillation**

DECANTATION

We use this methode to separate two or more inmiscible liquids with different densities.

We put the mixture into a separating funnel and we allow it to stand for some time. This separates the liquids into layers. The liquid with the lowest density floats on the top and the one with higher density lies below it.

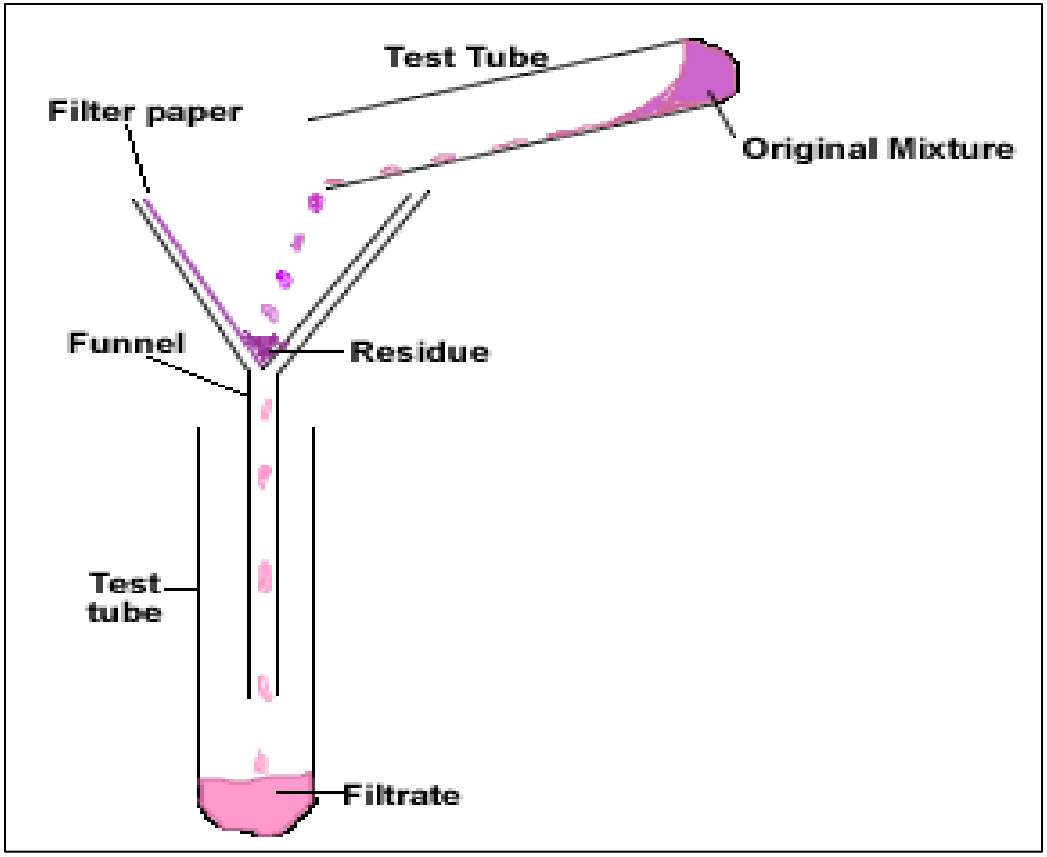


After this, we open the funnel tap and the liquid at the bottom of the funnel is transferred into a container. We do not collect the part of liquid that can contain a small part of the other liquid. After this, we collect the next layer in another container, obtaining two separate liquids.

FILTRATION

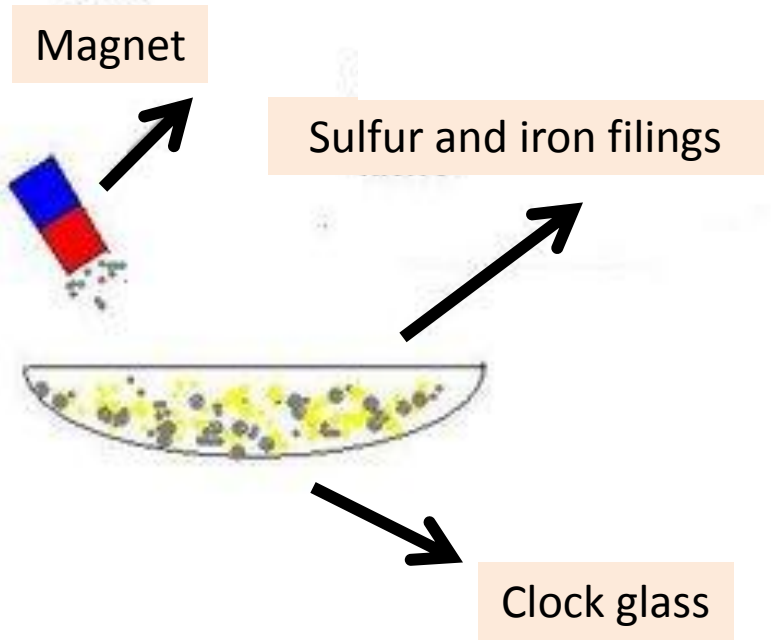
We use this method to separate an insoluble solid from a liquid. We take a filter paper and fix it to a funnel.

Then, we pour the mixture slowly into a container; through the funnel. We can see the particles of solid on the filter paper. We call residue to the solid particles and we call filtrate to the clear liquid obtained.



MAGNETIC SEPARATION

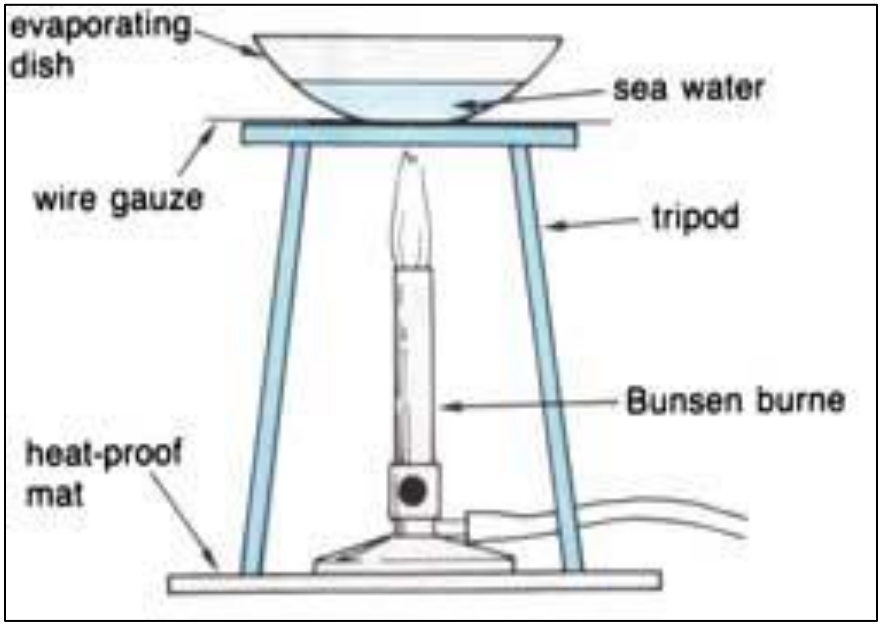
We use this methode to separate magnetic solids from non magnetic solids.



Iron filings are very small pieces of iron that look like a light powder.

HEATING TO DRYNESS

We use this method to separate soluble solids from solutions. We heat the solution in an evaporating dish until the solvent vaporizes.



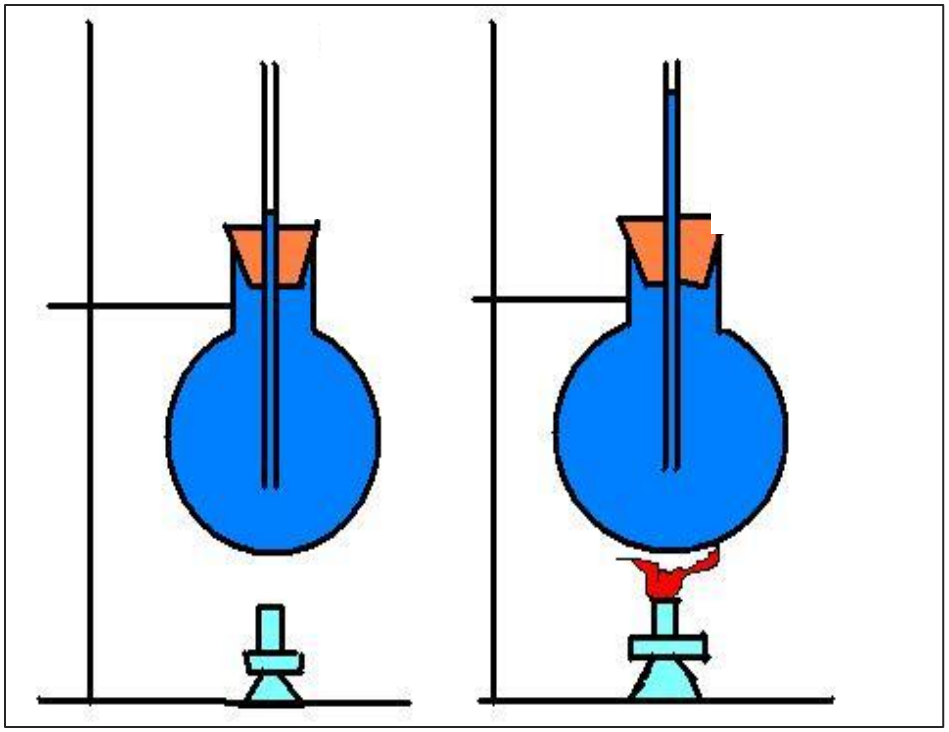
When we heat:

- We waste energy
- Crystals are smaller
- The process is faster

In this process we only obtain the solute, not the solvent.

CRYSTALLISATION

We use this method to separate soluble solids from solutions. In this process we must wait for the liquid to evaporate at room temperature without heating it and the solid crystallizes.



In the crystallisation:

- We do not waste energy
- Crystals are greater
- The process is slower

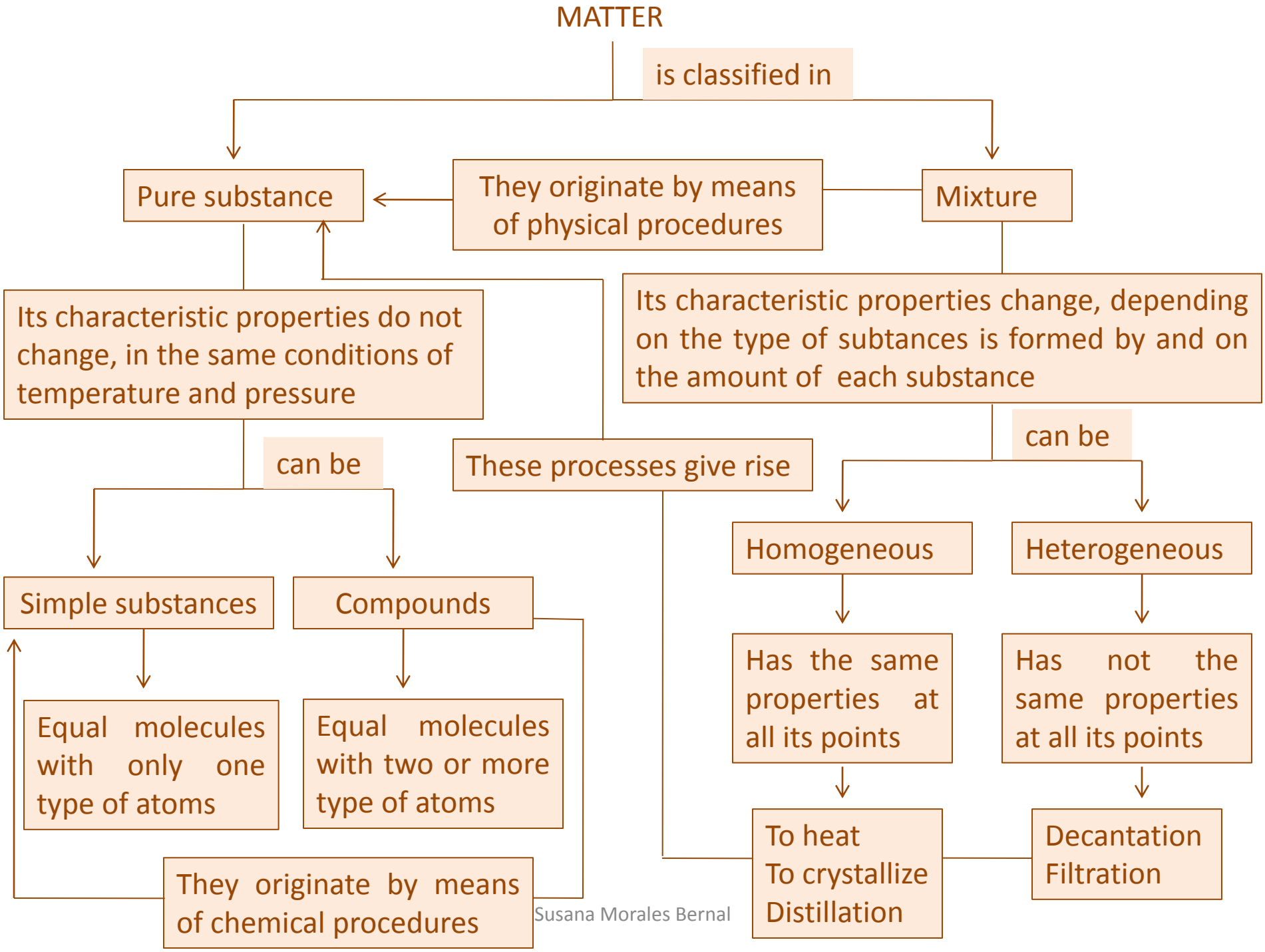
In this process we only obtain the solute, not the solvent.

DISTILLATION

We use this method to obtain both the solute and the solvent from a solution. The solute can be a soluble solid or a liquid. We take the solution in a distillation flask and we heat it so that the solvent slowly starts to vaporize. We connect the distillation flask to a condenser tube which has a lower tube for the inlet of cool water and an upper tube for the outlet of water. The circulation of cold water in the condenser helps to cool the gases from the solution and they form the distillate.

We collect the distillate (the solvent) in a separate container. The remaining residue, in the distillation flask, is the solute.

In this process we obtain the solute and the solvent.


MATTER
is classified in
Pure substance
They originate by means of physical procedures
Mixture
Its characteristic properties do not change, in the same conditions of temperature and pressure
Its characteristic properties change, depending on the type of subtances is formed by and on the amount of each substance
can be
These processes give rise
can be
Simple substances
Compounds
Homogeneous
Heterogeneous
Equal molecules with only one type of atoms
Equal molecules with two or more type of atoms
Has the same properties at all its points
Has not the same properties at all its points
To heat
To crystallize
Distillation
Decantation
Filtration
They originate by means of chemical procedures
Susana Morales Bernal

EXERCISE 1

Indicate which of the following properties are characteristic and which are extensive or intensive.

PROPERTIES	CHARACTERISTIC	INTENSIVE OR EXTENSIVE
MASS		
VOLUME		
DENSITY		
COLOUR		
BOILING POINT		
LENGTH		
HARDNESS		
MELTING POINT		
SMELL		
TEMPERATURE		
DUCTILITY		
BRIGHTNESS		

EXERCISE 2

Connect the terms of the two columns

A. Granite	1. Pure substance
B. Water	2. Heterogeneous rock
C. Gold	3. Solution
D. Salt with water	4. Liquid metal to room temperature
E. Mercury	5. Solid metal to room temperature

EXERCISE 3

Is the water that we drink an absolutely pure substance?

A. No, because it is a heterogenous substance
B. It is not pure, it has mineral salts dissolved
C. Otherwise, we cannot drink it
D. Of course, it is distilled water

EXERCISE 4

What do you remember? Separating components of a homogeneous mixtures.

Join with arrows.

A. By distillation	1. Salt and sea water in the salt mines
B. By crystallisation	2. Alcohol and water
C. By heating	3. Copper sulphate and water

EXERCISE 5

What do you remember? Separating components of a heterogeneous mixtures.

Join with arrows.

A. By magnetism	1. Sand and water
B. By filtration	2. Oil and water
C. By decanting	3. Sand and iron particles

EXERCISE 6

Can we decompose a pure substance in others by means of physical procedures?

A. No, we cannot
B. Yes, filtering it
C. Yes, by means of distillation
D. Clear that yes

EXERCISE 7

Separating mixtures

Complete the sentences. Use the words in the box.

FILTRATION , HEATING, DECANTATION, DISTILLATION

A. ..... is good for separating a liquid from a solution.

B. ..... is good for separating a soluble solid from a liquid.

C. ..... is good for separating an insoluble solid from a liquid.

D. ..... is good for separating two inmiscible liquids.

EXERCISE 8

Each verb in the table represents a separation process.

Write down the corresponding noun.

VERB	Evaporate	Distil	Filter	Crystallise
NOUN				

EXERCISE 9

What is the rock called “granite”?

1. A pure substance and heterogeneous
2. A homogeneous rock
3. A pure substance
4. A heterogeneous solid mixture

EXERCISE 10

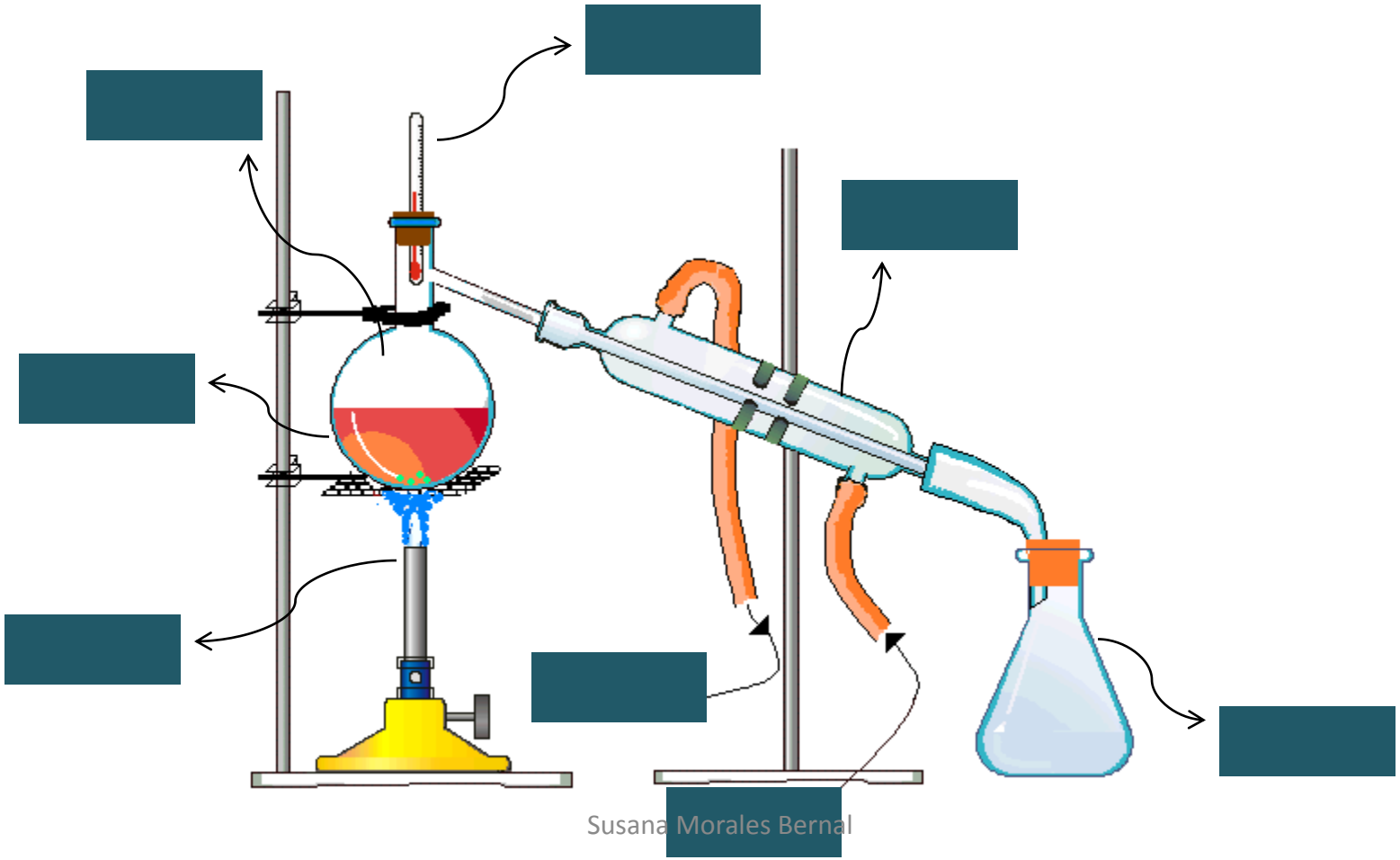
Classify the following products as: simple substance, compound, dissolution or mix heterogeneous

PRODUCTS	SIMPLE SUBSTANCE, COMPOUND, DISSOLUTION OR MIX HETEROGENEOUS
Wine	
Vinegar	
Soft drink	
Gasoline	
Alcohol 96 %	
Marmalade	
Milk	
Bleach	
Bread	
Blood	
Oil	
Iron	
Drinkable water	
Granite	

EXERCISE 11

Distillation is the separation of a liquid from a solution by boiling and condensing. Use words from the box to label the diagram:

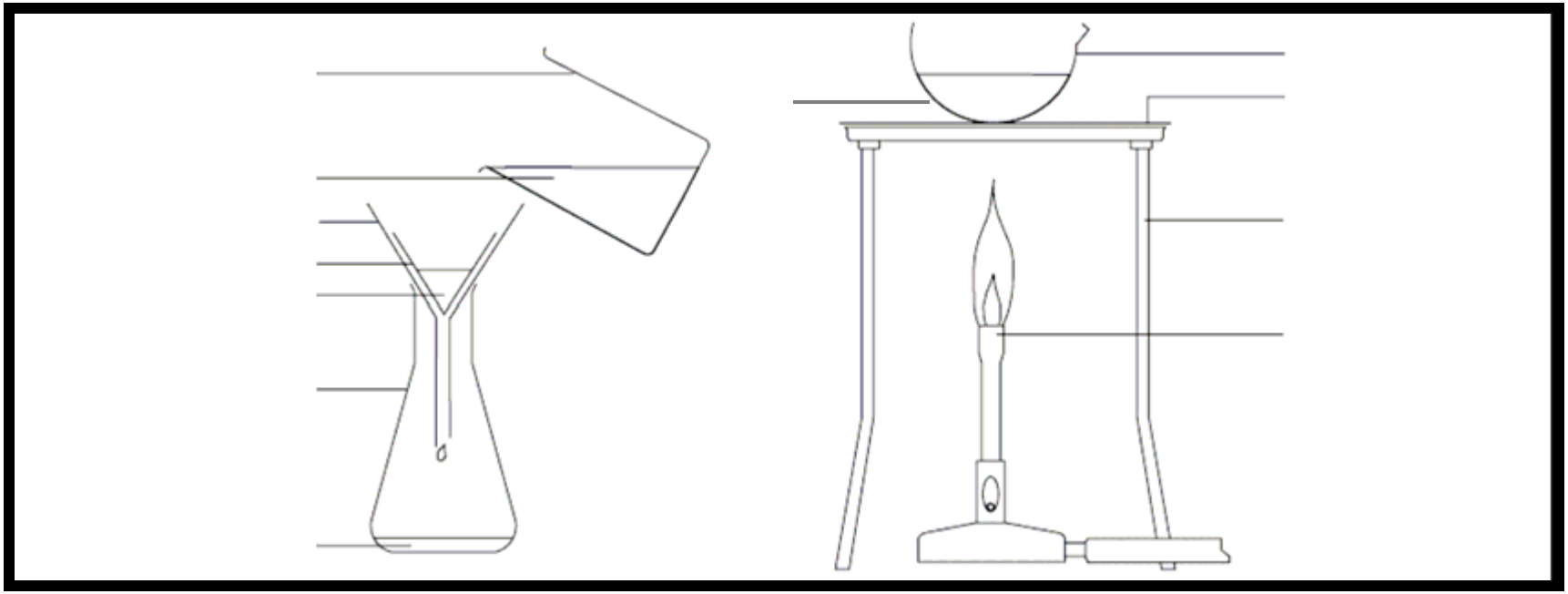
Thermometer, Cold water out, Vapour, Distillate, Solution, Heat, Cold water in, Condenser



EXERCISE 12

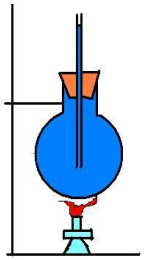
We can heat to separate soluble solids from solutions and we filter to separate insoluble solids from liquids. Use words from the box to label the diagram:

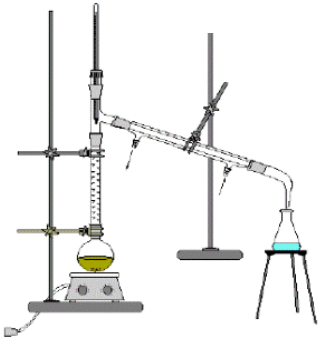
Salt solution, Filter funnel, Filter paper, Sand, Conical flask, Mixture of sand and water, Beaker, Evaporating dish, Gauze, Tripod, Bunsen burner, Water

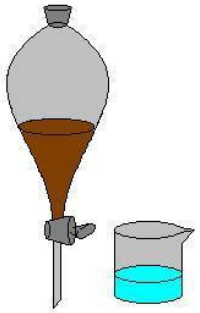


EXERCISE 13

Connect the terms of the two columns





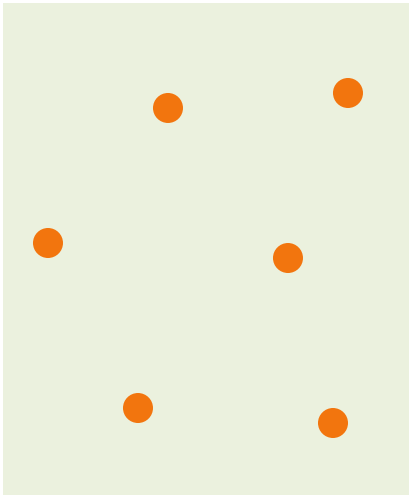


A. How can you separate oil from water?
B. How can you separate a mixture of alcohol and water?
C. How can you obtain salt from sea water?
D. How can you separate a mixture of sand and stones?
E. How can you separate a mixture of sulfur and iron filings?

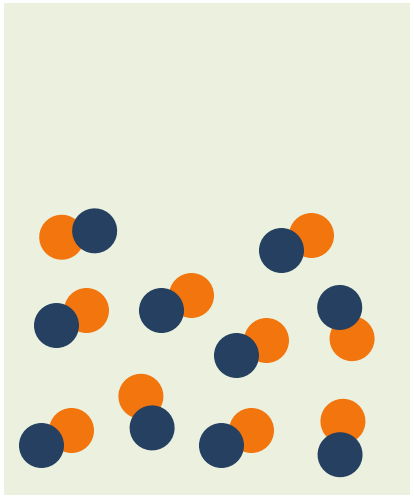
1. With a magnet
2. With a separating funnel
3. With a sieve
4. Heating until water vaporizes
5. Distilling

EXERCISE 14

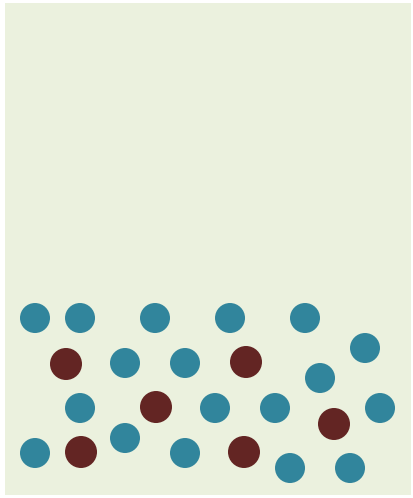
Classify the following systems as: simple substance, compound substance, homogeneous mixtures or heterogeneous mixtures



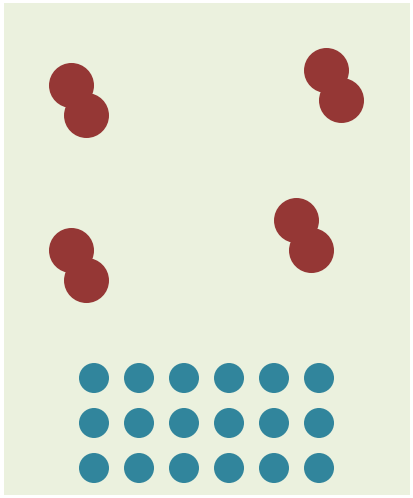
SYSTEM A



SYSTEM B



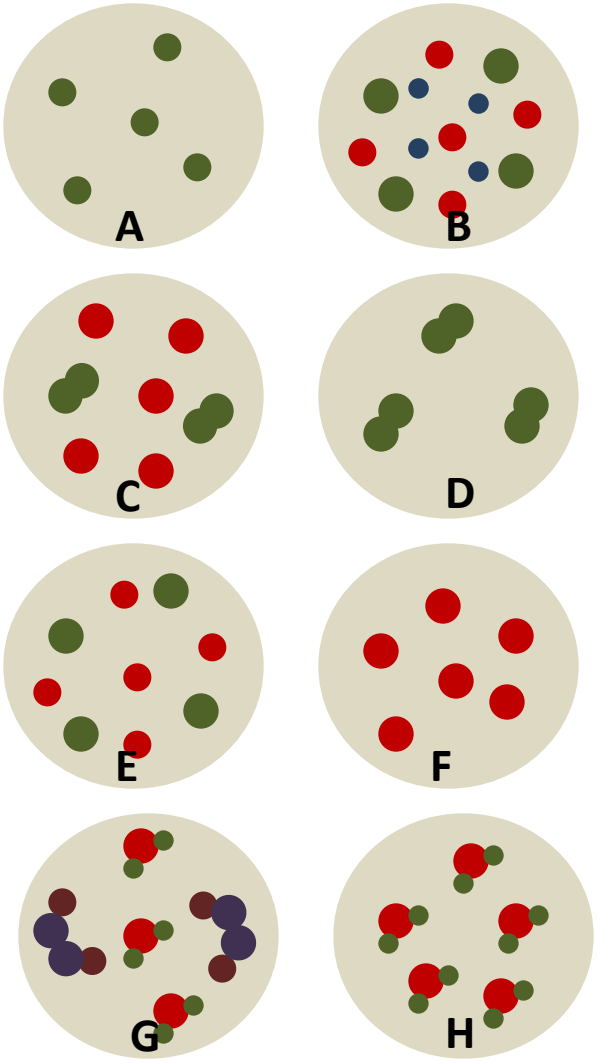
SYSTEM C



SYSTEM D

EXERCISE 15

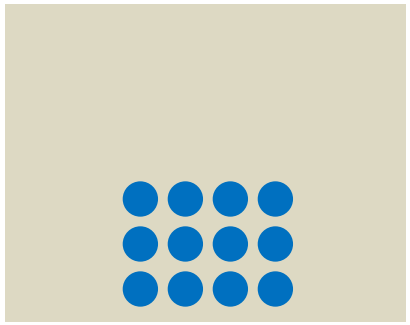
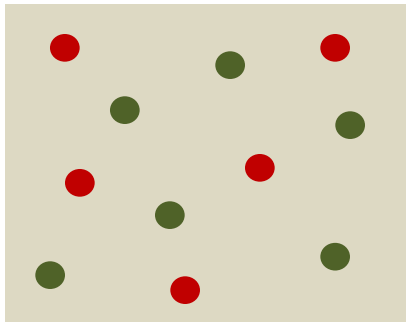
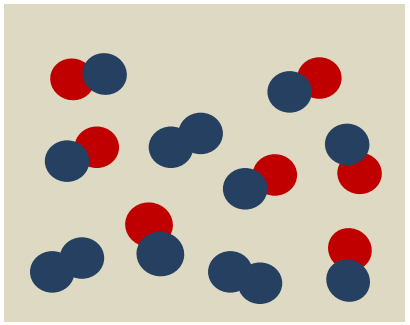
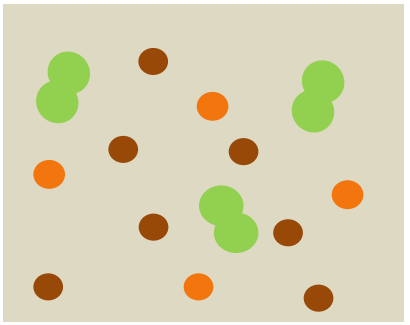
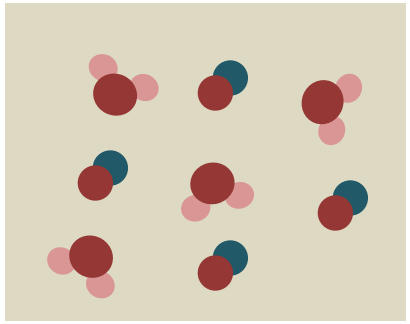
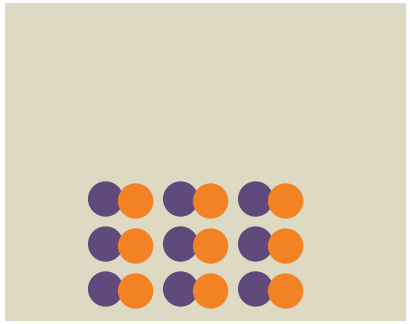
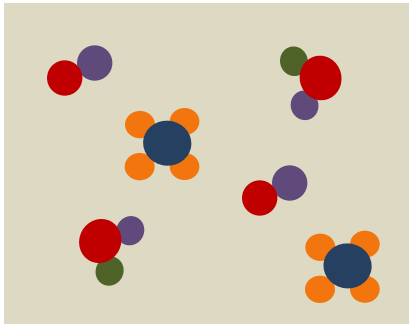
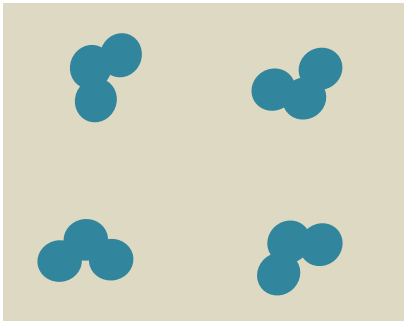
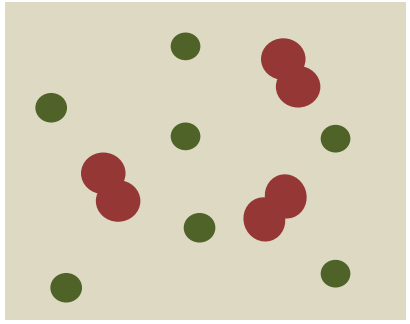
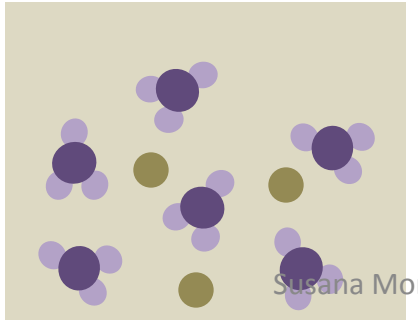
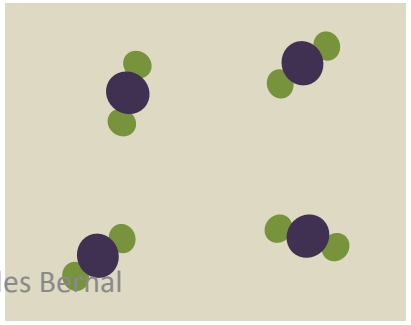
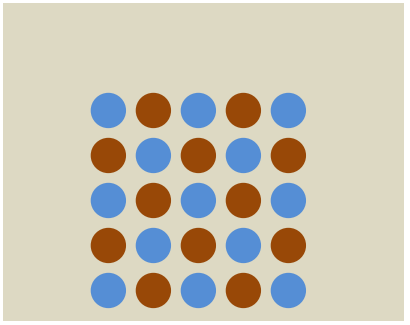
Choose the correct letters in the boxes on the right.



Mixture of two simple substances	
A simple substance with diatomic molecules	
Mixture of three simple substances	
One compound substance	
One simple substance	
Mixture of two compounds	
A simple substance with monoatomic molecules	

EXERCISE 16

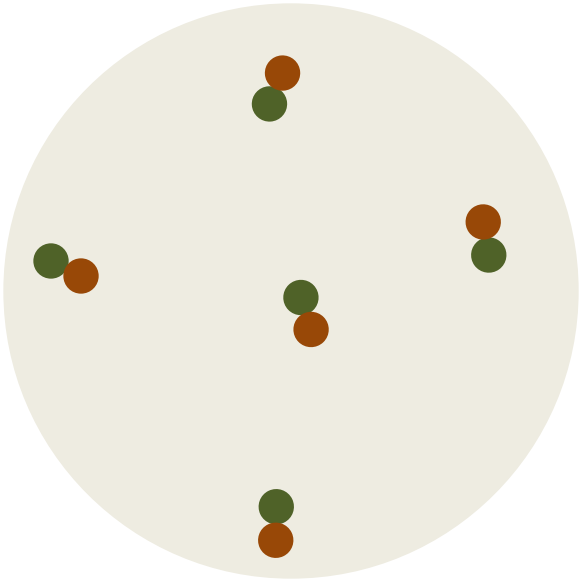
Classify the following diagrams as: simple substance, compound, mixture of simple substances, mixture of compounds, mixture of simple substances and compounds.

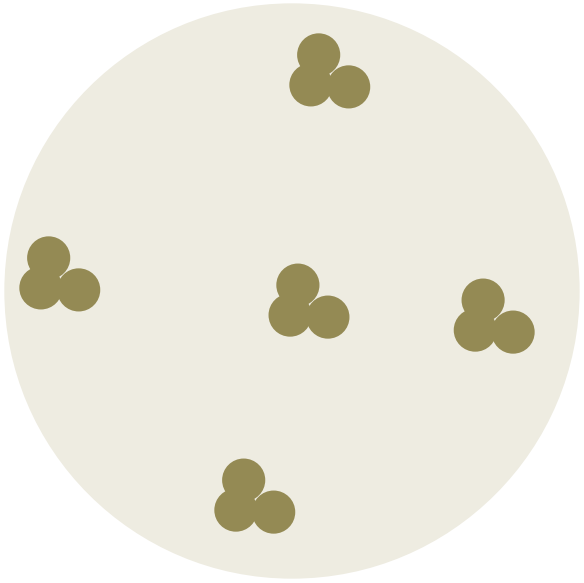













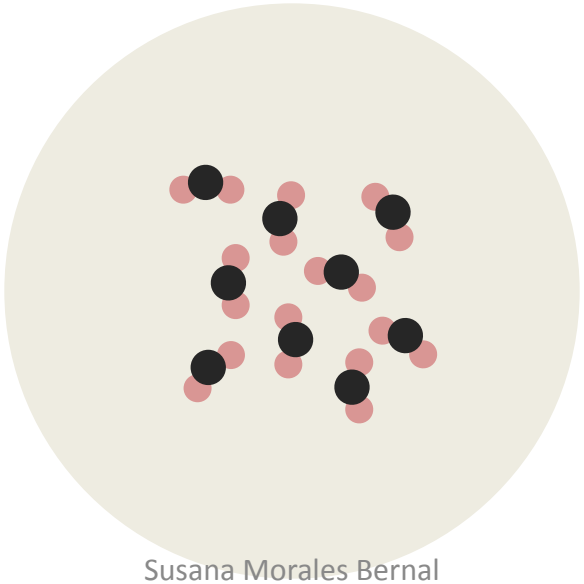
EXERCISE 17

Which of the following diagrams represent:

1. **The compound CO (gas)**
2. **The simple substance O_3 (gas)**
3. **The compound H_2O (liquid)**
4. **The compound NaCl (solid)**







EXERCISE 18

Is the air a pure substance?

A. No, the air is a gas mixture.
B. Yes, because it is a gas.
C. No, because a simple gas form it.
D. Yes, for that reason we can breathe it.

EXERCISE 19

We add a small amount of a solid substance to a glass with water. After a while, the solid substance disappears and the water is of pink colour.

A. What is this process called? What tests can you do to verify it?
B. Indicate which is the solute and which is the solvent.
C. Make a drawing of how you imagine the molecules of the solid substance and water are, before and later.
D. What changes occur in the molecules of the solid substance when it disappears in the water?
E. Why does all the water change colour, although you do not shake with a teaspoon, and not only the part nearest where you put the solid?
F. A classmate says that the water colours because the molecules of the solid are of pink colour and they mix with those of water that do not have colour. Do you agree? Justify your answer.
G. A classmate says that if you want to return the water to its original transparent state, you can filter the mixture. Do you agree? Explain your answer.
H. A classmate says that the pink solid is not the one that you think but another that has the same colour. How can you prove it?

EXERCISE 20

Revise your vocabulary. Choose a word and fill the blanks below

compounds, simple, heterogeneous, atoms, pure substances , decantation, homogeneous, identify, mixtures, distillation, mixtures, physical, pure, crystallisation, change, depending, types, decompose, heating, electrolysis, filtration, dryness, substances, atoms, molecules, compounds, molecules

A. A characteristic property is a …….. or chemical property that we can use to …….. a substance.
B. We can classify matter, in two categories: …….. and ……..
C. …….. substances are those which characteristic properties do not ……., in the same conditions of temperature and pressure.
D. In the ……., the characteristic properties change, …….. on the type of subtances form it and on the amount of each substance.
E. There are two …….. of pure substances: simple substances and ……..
F. …….. substances are those which do not …….. into simpler pure substances by means of …….. or …….. .
G. Simple …….. have equal …….. with only one type of …….. .
H. …….. have equal …….. with two or more types of …….. .
I. There are two types of mixtures: …….. and …….. .
J. The main techniques of separation of heterogeneous mixtures are: the ……., the …….. and the magnetic separation.
K. The main techniques of separation of homogeneous mixtures are: the heating until ……., the …….. and the ……..

GLOSSARY

- Alloy
- Atom
- Bunsen burner
- Clock glass
- Condenser
- Container
- Compound
- Crystallisation
- Decantation
- Dissolution
- Distillation
- Distillation flask
- Electrolysis
- Element
- Evaporating dish
- Filtration
- Frame
- Funnel
- Filter paper
- Heterogeneous mixture
- Homogeneous mixture
- Insoluble
- Layer
- Magnet
- Magnetic separation
- Mixture
- Pressure
- Pure substance
- Residue
- Separating funnel
- Simple substance
- Soluble
- Solute
- Solution
- Solvent
- Structure
- Test tube
- To bang
- To collect
- To decompose
- To dissolve
- To distribute
- To filter
- To float
- To give rise to
- To heat
- To identify
- To pull away
- To remain
- To shake
- To surround
- To transfer
- Tripod
- Wire gauze

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